Bureau of Mines
Special Publication

LIST OF BUREAU OF MINES PUBLICATIONS AND ARTICLES

January 1 to December 31, 1982

With Subject and Author Index

Compiled by Staff, Branch of Editorial Services

UNITED STATES DEPARTMENT OF THE INTERIOR

1983

Bureau of Mines
Special Publication

LIST OF BUREAU OF MINES PUBLICATIONS AND ARTICLES

January 1 to December 31, 1982

With Subject and Author Index

Compiled by Staff, Branch of Editorial Services

UNITED STATES DEPARTMENT OF THE INTERIOR

James G. Watt, Secretary

BUREAU OF MINES

Robert C. Horton, Director

As the Nation's principal conservation agency, the Department of the Interior has responsibility for most of our nationally owned public lands and natural resources. This includes fostering the wisest use of our land and water resources, protecting our fish and wildlife, preserving the environmental and cultural values of our national parks and historical places, and providing for the enjoyment of life through outdoor recreation. The Department assesses our energy and mineral resources and works to assure that their development is in the best interests of all our people. The Department also has a major responsibility for American Indian reservation communities and for people who live in island territories under U.S. administration.

The Library of Congress cataloged the first issue of this work as follows:

Z6736
.U759

U.S. **Bureau of Mines**
List of Bureau of Mines publications and articles, with subject and author index. 1960-
Washington, U.S. Govt. Print. Off.

v. 28 cm. (*Its* Special publication)

Supersedes the Bureau's List of publications, Bureau of Mines and List of journal articles by Bureau of Mines authors.

1. Mineral industries—Bibl. 2. U.S. Bureau of Mines—Bibl. (Series)

Z6736.U759 61–64978

For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D C 20402

CONTENTS

LIST OF BUREAU OF MINES PUBLICATIONS AND ARTICLES

January 1 to December 31, 1982

With Subject and Author Index

Compiled by Staff, Branch of Editorial Services

INTRODUCTION

The Bureau of Mines was established in the public interest to conduct inquiries and scientific and technologic investigations concerning mining and the preparation, treatment, and utilization of mining substances; to promote health and safety in the mineral industries; to conserve material resources and prevent their waste; to further economic development; to increase efficiency in the mining, metallurgical, quarrying, and other mineral industries; and to inquire into the economic conditions affecting those industries. The organic act of the Bureau, as amended by Congress and approved February 25, 1913, made it the province and duty of the Bureau to "disseminate information concerning these subjects in such manner as will best carry out the purposes of this Act."

In accordance with this directive, the Bureau reports the findings of its research and investigations in its own series of publications and also in articles that appear in scientific, technical, and trade journals; in proceedings of conventions and seminars; in reference books; and in other non-Bureau publications. The number of these reports, the wide range of subjects they cover, and the variety of mediums in which they appear make the kind of list and index presented in this special publication both necessary and valuable.

This issue of the Bureau of Mines List of Publications and Articles describes reports and articles published during the period January 1 to December 31, 1982. This publication supplements the 50-year list of Bureau publications issued from July 1, 1910, to January 1, 1960;[1] the 50-year list of articles by Bureau authors published outside the Bureau from July 1, 1910, to January 1, 1960;[2] the 5-year lists of publications and articles, from January 1, 1960, to December 31, 1964,[3] from January 1, 1965, to December 31, 1969,[4] from January 1, 1970, to December 31, 1974,[5] and from January 1, 1975, to December 31, 1979;[6] and the annual lists of publications and articles from January 1 to December 31, 1980,[7] and from January 1 to December 31, 1981.[8]

[1] Available from National Technical Information Service (NTIS), 5285 Port Royal Rd., Springfield, VA 22161, PB 295 062/AS.
[2] Available from NTIS, PB 295 432/AS.
[3] Available from NTIS, PB 295 481/AS.
[4] Available from NTIS, PB 198 112/AS.
[5] Available from NTIS, PB 252 843/AS.
[6] Available from the Superintendent of Documents, U.S. Government Printing Office (GPO), Washington, DC 20402. GPO Stock No. 024–004–02079–2. $12.
[7] Available from GPO. GPO Stock No. 024–004–02096–2. $6.
[8] Available from GPO. GPO Stock No. 024–004–02104–7. $6.50.

BUREAU PUBLICATIONS

Some Bureau of Mines publications, including most Bulletins and the Minerals Yearbook, are sales publications; other series contain both free and sales publications. Because the price of sales publications varies, the price is indicated in the individual listing of any publication for which a charge is made.

Sales publications of the Bureau of Mines must be obtained from the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402, to whom orders should be sent directly. Sales publication purchases may be made by check or money order payable to the Superintendent of Documents, charged to a deposit account at the U.S. Government Printing Office, or charged to a valid VISA or MasterCard account. Payment for orders going to foreign countries should be made by International Postal Money Order, by draft on a U.S. or Canadian bank (in U.S. dollars), or by UNESCO Coupons. Orders received with postage stamps, International Response Coupons, or foreign money are not acceptable and will be returned unprocessed. No charge is made for postage on publications mailed to points within the United States or its possessions. There is a special handling charge on all orders mailed to other countries; the charge is one-fourth of the current selling price of the publication(s) ordered. There is a minimum charge of $1 for each mail order.

Free publications of the Bureau of Mines may be obtained from the Section of Publications, Bureau of Mines, U.S. Department of the Interior, 4800 Forbes Avenue, Pittsburgh, PA 15213. Because of the limited editions, only 1 copy of any publication can be sent to the person applying and a maximum of 10 titles to any 1 applicant.

The following types or series of publications are issued by the Bureau of Mines.

Bulletins report the results of broad and significant projects or programs of scientific, historical, or economic research, or other investigations, including comprehensive and important mineral resource studies and compilations. Bulletins are usually prepared after all laboratory and field work has been completed, but they sometimes report a major phase of a larger or continuing investigation or research study. They rarely represent the first public report on the subject. As a rule, Bulletins encompass published work together with essential unpublished data and details.

Minerals Yearbook—annual statistical publication of the Bureau—summarizes the significant economic and technologic developments in the mineral industries. Three separate volumes are issued each year—Volume I, Metals and Minerals; Volume II, Area Reports: Domestic; and Volume III, Area Reports: International. Volume I presents, by mineral commodity, the salient statistics on production, trade, consumption, and other pertinent data. Volume II reviews the U.S. mineral industry by State and island possessions. Volume III presents the latest available mineral statistics for more than 150 countries and areas together with a review of the role of minerals in the economies of these nations. Chapters in these volumes are issued separately as preprints before the bound volumes are available.

Reports of Investigations present the results of research and investigations conducted by the Bureau at its research centers or laboratories, or in mines, quarries, smelters, refineries, oilfields, plants, and other non-Bureau properties. Reports of Investigations differ from Bulletins in that they describe the principal features and results of individual experiments (single or multiple), minor research projects, or a significant coordinated phase of a major project or program. Reports of Investigations may include a summary of several projects or activities in a given subject area that are not necessarily related directly to each other, new technical or economic theory, mineral resource studies that emphasize original evaluation of deposits, results of laboratory analyses of an unusual nature, and comparative and nonroutine testing of cores, explosives, and other commodities.

Information Circulars differ from Reports of Investigations in that they are not concerned primarily with original Bureau research or investigative work. Information Circulars cover surveys of mineral resources and related mining and operating activities, guides to marketing of mineral commodities, compilations of historical or statistical and economic data on minerals, summaries of scientific and technical meetings and symposia, bibliographies, descriptions of new instrumentation and techniques, and descriptions of new industrial mining methods and metallurgical processes (as distinguished from those developed by the Bureau).

Technical Progress Reports present highly significant and newsworthy developments in Bureau of Mines programs and are intended for use in conveying information that, to be of maximum value, must be published in a matter of days. Technical Progress Reports are expanded fact sheets giving the technical background and details necessary to supplement a press release that reports important progress in an area of Bureau activity meriting widespread public interest. A more comprehensive treatment of the subject may be published later as a Report of Investigations.

Mineral Commodity Profiles are designed to supplement the Minerals Yearbook and Mineral Facts and Problems. Comprehensive data will be presented for each commodity, including background information on industry structure, technology, resources and reserves, timely economic and production data, and forecasts of future supply-demand relationships and uses. Data in the Mineral Commodity Profiles will be the latest available at the time of issue.

Mineral Issues series comprises reports that identify and evaluate mineral policy issues to assist Government and private sector analysts and decisionmakers. Mineral Issues present mineral information in an analytically convenient form for the support of policy formulation and analysis; assess options to achieve mineral-related policy goals and provide an assessment of their economic, social, and environmental effects; examine specific issues of mineral economics using an accepted economics or operations research methodology; and/or assess the impact of Federal and State mineral-related policies.

Mineral Perspectives present the latest available data on commodities that are of critical importance in a particular foreign country or region of the world.

Handbooks are instruction or information manuals designed to improve efficiency in the mineral industries or to promote the wise use of mineral resources. Based on research and the practical experience of Bureau personnel, Handbooks cover a wide range of subjects.

Mineral Industry Surveys contain timely statistical and economic data on minerals. The surveys are designed to keep Government agencies and the public, particularly the

mineral industry and business community, regularly informed of trends in the production, distribution, inventories, and consumption of minerals. Frequency of issue depends on the need for current data. Most of the reports are issued monthly, quarterly, or annually. Preliminary annual data on commodities are published as soon as possible after the close of each calendar year and comprise statistics that are later printed in permanent form in the Minerals Yearbook. Preliminary annual area reports also contain data on mineral production by State, and final figures are published in Volume II of the Yearbook.

Special Mineral Commodity Publications are issued to help domestic producers and consumers of mineral commodities, policymakers, mineral industry experts, and the general public keep abreast of developments in the mineral industries and markets, both domestic and foreign, and provide a brief summary of significant information from U.S. Foreign Service offices and other sources, which may otherwise not be made avilable to the general public.

Special Publications include the annual list of Bureau of Mines Publications and Articles and popular-type pamphlets prepared for the general public and distributed in response to requests for information on specific subjects. Special publications also include certain long and detailed publications that do not belong in any of the other series.

Computer tapes and printouts are occasionally available containing mineral data.

ASSOCIATED DOCUMENTS

Although the material in the categories that follow is not published by the Bureau of Mines, it is listed and indexed in this publication as a service to those who may be interested.

Cooperative Publications result from investigations conducted cooperatively by the Bureau of Mines and another Government or outside organization. Although usually written either wholly or in part by Bureau personnel, they are published by the other organization. Cooperative publications incude monographs and joint reports.

Open File Reports are unpublished Bureau of Mines manuscripts, reports prepared for the Bureau under contracts, or material not in manuscript form, which the Bureau makes available for consultation in a library or Bureau facility. See the list of open file reports for information as to where they are available for examination. Some open file reports can be purchased from the National Technical Information Service of the U.S. Department of Commerce in paper copy or microfiche.

Mineral Land Assessments, a special open file report series, present results of mineral investigations of areas studied by the Bureau of Mines. The results of these mineral investigations are to be incorporated in joint reports with the U.S. Geological Survey to provide information essential for determining the suitability of land for inclusion in the National Wilderness Preservation System.

Outside Publications (OP's) are journal articles, papers in proceedings and transactions of symposia and society meetings, and other non-Bureau publications published by technical and trade journals, scientific organizations, and publishing houses.

Patents issued to the Bureau during the calendar year are listed, with instructions on how to apply for permission to use such patents.

Reprints of Bureau of Mines publications that have been made available for purchase from the National Technical Information Service, U.S. Department of Commerce, are listed in the section "Reports Available From the National Technical Information Service."

BULLETINS

Sales publication purchases may be made by check or money order payable to the Superintendent, charged to a deposit account at GPO, or charged on a VISA or MasterCard credit card. Address requests to—

Superintendent of Documents
U.S. Government Printing Office
Washington, DC 20402

or call 202-783-3238.

B 672. Thermodynamic Properties of Elements and Oxides, by L. B. Pankratz. With a section on Process Applications, by R. V. Mrazek. 1982. 509 pp. Thermodynamic data on the elements and oxides were reviewed, evaluated, and compiled at the Bureau of Mines Albany Research Center. Values for $C_p°$, $S°$, $H° - H°_{298}$, $-(G° - H°_{298} / T$. $\Delta Hf°$, $\Delta Gf°$, and log K are given in tabular form. $C_p°$, $H° - H°_{298}$, $\Delta Hf°$, and $\Delta Gf°$ are also expressed algebraically. Examples of calculations using these data are given. A short statement of some fundamental ideas of thermodynamics and several examples of their use are included. The examples illustrate several alternate methods of calculation using both the tabulated values and the equations. Comparisons are also made on the bases of ease of calculation and accuracy of results. GPO Stock No. 024-004-02101-2. $17.

Application for free publications should be made to—

Section of Publications
Bureau of Mines
U.S. Department of the Interior
4800 Forbes Avenue
Pittsburgh, PA 15213

or call 412-621-4500, extension 342.

B 673. The Inductoslag Melting Process, by P. G. Clites. 1982. 32 pp. 35 figs. This bulletin summarizes the results of Bureau of Mines research on the development of the inductoslag melting process. Inductoslag melting is an induction melting technique using a segmented, water-cooled, copper crucible. The process was developed as part of the Bureau's work on effective utilization of reactive metal scrap, and the process has been applied to melting Ti, Zr, Cr, Co, Fe, Ni, and V. Construction details are given for the segmented crucibles and for both an ingot furnace and a casting furnace. The melting process is described, and results of tests conducted with a variety of reactive metals are given.

PATENTS

The following patents were granted to the Bureau of Mines during calendar year 1982. These processes, which may be used by any U.S. citizen or organization without royalty payment upon authorization by the U.S. Department of the Interior, were developed by Bureau scientists or under contracts with the Bureau. Application for the use of any of the patents should be made to the Branch of Procurement and Patents, Division of General Law, Office of the Solicitor, U.S. Department of the Interior, Washington, DC 20240.

P 1–82. Amine Flotation of Chromite From Acidic Pulps. Gregory E. Smith, Jerry L. Huiatt, and Monte B. Shirts. U.S. Pat. 4,311,584, Jan. 19, 1982.

P 2–82.* Modified Sulfur Cement. William C. McBee and Thomas A. Sullivan. U.S. Pat. 4,311,826, Jan. 19, 1982.

P 3–82. Electrochemical Apparatus for Simultaneously Monitoring Two Gases. Stanley Bruckenstein and John A. Kosek. U.S. Pat. 4,315,753, Feb. 16, 1982.

P 4–82. Multilayer Pressure Vent for Explosion Proof Enclosures. Robert J. Gunderman and Michael W. Riley. U.S. Pat. 4,328,901, May 11, 1982.

P 5–82. Method for Wrought and Cast Aluminum Separation. Dominic Montagna and Harry V. Makar. U.S. Pat. 4,330.090, May 18, 1982.

* This patent, although developed by Bureau of Mines personnel, is being licensed by the U.S. Department of Commerce. For details, contact National Technical Information Service, Office of Government Inventions and Patents, U.S. Department of Commerce, P.O. Box 1423, Springfield, VA 22151.

P 6–82. Separation of Zirconium and Uranium. Helen G. Henry. U.S. Pat. 4,330,509, May 18, 1982.

P 7–82. Instrumentation for Surveying Underground Cavities. Walter G. Krawza and George A. Savanick. U.S. Pat. 4,331,975, May 25, 1982.

P 8–82. Regeneration of Waste Metallurgical Process Liquor. David M. Soboroff, Jerry D. Troyer, and Andrew A. Cochran. U.S. Pat. 4,337,129, June 29, 1982.

P 9–82. Recovery of Platinum-Group Metals From Ores. Edward R. Peasley and John M. Gomes. U.S. Pat. 4,337,226, June 29, 1982.

P 10–82. Recovery of Chromium From Waste Solutions. Hector O. McDonald and Lawrence C. George. U.S. Pat. 4,337,227, June 29, 1982.

P 11–82. Preflush-Lixiviant Process for Solution Mining of Uranium Ore Beds. William M. Breland, Terry R. Guilinger, and Robert S. Schechter. U.S. Pat. 4,340,253, July 20, 1982.

P 12–82. Air Diversion and Dust Control System for Longwall Shearers. Fred N. Kissell, Terry L. Muldoon, William E. Schroeder, Jr., and Carl R. Peterson. U.S. Pat. 4,358,160, Nov. 9, 1982.

P 13–82. Purifying Titanium-Bearing Slag by Promoted Sulfation. Gerald W. Elger and Ruth A. Holmes. U.S. Pat. 4,362,557, Dec. 7, 1982.

P 14–82. Froth Flotation of Rutile. Thomas O. Llewellyn and Gerald V. Sullivan. U.S. Pat. 4,362,615, Dec. 7, 1982.

SPECIAL PUBLICATIONS

Application for free publications should be made to—

Section of Publications
Bureau of Mines
U.S. Department of the Interior
4800 Forbes Avenue
Pittsburgh, PA 15213

or call 412-621-4500, extension 342.

SP 1–82. Mineral Commodity Summaries 1982, by Staff, Bureau of Mines. 1982. 183 pp. This report is the earliest Government publication to furnish estimates covering 1981 nonfuel mineral industry data. Most of the estimates are based on 9 months data. These data sheets contain information on the domestic industry structure, Government programs, tariffs, and 5-year salient statistics for 86 individual minerals and metals. World resource data appearing in the statements have been provided by the Geological Survey.

Sales publication purchases may be made by check or money order payable to the Superintendent, charged to a deposit account at GPO, or charged on a VISA or MasterCard credit card. Address requests to—

Superintendent of Documents
U.S. Government Printing Office
Washington, DC 20402

or call 202-783-3238.

SP 2–82. List of Bureau of Mines Publications and Articles, January 1 to December 31, 1980. With Subject and Author Index, compiled by Staff, Branch of Editorial Services. 1982. 131 pp. This compilation supplements the 5-year list of Bureau publications issued from January 1, 1975, to December 31, 1979. The list summarizes publications by Bureau authors published in the regular Bureau of Mines series; in scientific, technical, or trade journals; or in other media. Those available from the Bureau of Mines are indicated. Patents issued to Bureau personnel are also listed, and instructions are given on how to apply for permission to use them. An outstanding feature of this Special Publication is an exhaustive subject and author index. GPO Stock No. 024–004–02096–2. $6.

SP 3–82. Bureau of Mines Research 82. A Summary of Significant Results in Mineral Technology and Economics, compiled and edited by Jerald R. Pederson. 1982. 140 pp. 87 figs. Minerals, and the adequacy of America's mineral supply, are subjects of growing national concern in the 1980's. They have been subjects of concern to the Bureau of Mines for most of this century. The Bureau's mission is to help assure an adequate and dependable flow of minerals at reasonable costs. That mission is pursued through the acquisition and analysis of minerals data on a worldwide basis, and through research to make mining and mineral processing safer, more productive, and more compatible with the effective use of all the Nation's resources. Research 82 is the 12th annual summary of significant developments in Bureau programs. It reflects both the scope of the Bureau's mission, and the success with which that mission is being pursued. GPO Stock No. 024–004–02106–3. $6.50.

SP 4–82. Improving Dust Control Technology for U.S. Mines. The Bureau of Mines Respirable Dust Research Program, 1969–82, by John A. Breslin and George E. Niewiadomski. 1982. 40 pp. 43 figs. This report summarizes the principal activities and significant results of the Bureau of Mines respirable dust research program since passage of the Federal Coal Mine Health and Safety Act of 1969 and the Federal Mine Safety and Health Amendments Act of 1977. This program has investigated new and improved techniques and equipment to reduce or prevent the formation of dust during the cutting cycle; to dilute, suppress, or collect airborne dust generated during mining, handling, and processing; and to improve the measurement of dust levels for evaluation of engineering controls and for enforcement of Federal dust standards. The report is intended for mining industry dust control specialists and other interested parties. It includes a brief summary of the program to date, a section on future research plans and goals, and a list of publications resulting from the Bureau's respirable dust program. GPO Stock No. 024–004–02103–9. $4.75.

SP 5–82. List of Bureau of Mines Publications and Articles, January 1 to December 31, 1981. With Subject and Author Index, compiled by Staff, Branch of Editorial Services. 1982. 152 pp. The list summarizes publications by Bureau of Mines authors published in the regular Bureau series; in scientific, technical, or trade journals; or in other media. Those available from the Bureau of Mines are indicated. The list includes abstracts of open file reports—reports prepared for the Bureau under contracts, or material not in manuscript form—and gives information on their availability. Patents issued to the Bureau of Mines for work done by Bureau personnel or under contracts with the Bureau are listed, and instructions are given on how to apply for permission to use them. An additional feature of this Special Publication is an extensive subject and author index. GPO Stock No. 024–004–02104–7. $6.50.

MINERAL INDUSTRY SURVEYS

Mineral Industry Surveys are processed reports that contain statistical and economic data on various mineral commodities. These reports are issued at regular intervals so that information on mineral commodities may be made available quickly and in a convenient form. Most of the data contained in these reports appear in permanent form in the Bureau of Mines Minerals Yearbook. Single copies of these reports may be obtained from the Section of Publications, Bureau of Mines, U.S. Department of the Interior, 4800 Forbes Ave., Pittsburgh, PA 15213. Mineral Industry Surveys dealing with various mineral commodities will be forwarded regularly if application stating in detail the need for certain reports is made to the Branch of Editorial Services, Bureau of Mines, U.S. Department of the Interior, 4900 La Salle Rd., Avondale, MD 20782. The following Mineral Industry Surveys were being published in 1982 by the Bureau of Mines.

MONTHLY

Aluminum Industry.
Cement.
Chromium.
Cobalt.
Copper Industry.
Copper Production.
Gold and Silver.
Gypsum.
Iron and Steel Scrap.
Iron Ore.
Lead Industry.
Lead Primary Production.
Lime.
Manganese.
Molybdenum.
Nickel.
Phosphate Rock.
Silicon.
Sodium Compounds.
Sulfur.
Tin Industry.
Tungsten.
Vanadium.
Zinc Industry.
Zinc Production.

QUARTERLY

Antimony.
Bauxite.
Bismuth.
Cadmium.
Copper Sulfate.
Fluorspar.
Magnesium.
Mercury.
Platinum-Group Metals.
Selenium.
Titanium.

ANNUALLY

Abrasive Materials.
Aluminum and Bauxite.
Antimony.
Arsenic.
Asbestos.
Barite.
Beryllium.
Bismuth.
Boron.
Bromine.
Cadmium.
Cement.
Cesium and Rubidium.
Chromium.
Clays.
Cobalt.
Columbium and Tantalum.
Copper.
Corundum.
Diamond, Industrial.
Diatomite.
Feldspar.
Ferroalloys.
Fluorspar.
Gallium.
Garnet.
Gem Stones.
Gold and Silver.
Graphite, Natural.
Gypsum.
Iodine.
Iron and Steel.
Iron and Steel Scrap.
Iron Ore.
Iron Oxide Pigments.
Kyanite and Related Materials.
Lead.
Lime.
Lithium.
Magnesium and Magnesium Compounds.
Manganese.
Mercury.
Mica.
Molybdenum.
Nickel.
Nitrogen, Fixed.
Peat.
Perlite.
Phosphate Rock.
Phosphate Rock (Crop Year).

Platinum-Group Metals.
Potash.
Potash (Crop Year).
Pumice and Pumicite.
Quartz Crystal.
Rare-Earth Elements, Yttrium, and Thorium.
Rhenium.
Salt.
Sand and Gravel.
Selenium and Tellurium.
Silicon.
Slag, Iron and Steel.
Sodium Carbonate.
Sodium Sulfate.
Stone.
Strontium.
Sulfur.
Talc and Pyrophyllite.
Tin.
Titanium.
Tungsten.
Vanadium.
Vermiculite.
Zinc.
Zirconium and Hafnium.

SPECIAL MINERAL COMMODITY PUBLICATIONS

The following publications are issued to assist producers and consumers of mineral commodities, policymakers, mineral industry experts, and the general public to keep abreast of developments in the mineral industries. The publications provide brief summaries or tabulations of significant information from various sources. These publications may be obtained from the Section of Publications, Bureau of Mines, 4800 Forbes Ave., Pittsburgh, PA 15213.

Minerals & Materials—A Bimonthly Survey. Minerals & Materials presents a bimonthly analysis of key issues affecting the U.S. and world mineral industry; including the performance of the U.S. and world economy; international events; Federal, State, and local actions; and U.S. mineral industry highlights.

Mineral Commodity Summaries. Issued annually, this publication gives preliminary data, in summary form, for most metals and nonfuel minerals.

1981 MINERALS YEARBOOK

The 1981 Minerals Yearbook, published in three volumes, provides a record of performance of the Nation's mineral industries during the year and a review of world mineral production, consumption, and trade on a country-by-country basis. This edition of the Minerals Yearbook marks the centennial of the first annual publication of comprehensive mineral statistics by the Federal Government. The complete volumes are available for the prices indicated from—

Superintendent of Documents
Government Printing Office
Washington, DC 20402

Volume I. Metals and Minerals. Centennial Edition 1981, prepared by the staff of the Bureau of Mines. 1982. 73 ch. 968 pp. This volume of the Minerals Yearbook, covering metals and minerals, contains 71 commodity or commodity group chapters with data on approximately 90 minerals that were obtained as a result of the mineral information gathering activities of the Bureau of Mines. In addition, the volume contains a chapter on mining and quarrying trends and a statistical summary. GPO Stock No. 024–004–02107–1. $17.

Volume II. Area Reports: Domestic. Centennial Edition, 1981, prepared by the staff of the Bureau of Mines. 1983. 53 ch. 561 pp. This volume of the Minerals Yearbook contains chapters on the mineral industry of each of the 50 States, the U.S. island possessions in the Pacific Ocean and the Caribbean Sea, and the Commonwealth of Puerto Rico. This volume also has a statistical summary. GPO Stock No. 024–004–02114–4. $17.

Volume III. Area Reports: International. Centennial Edition, 1981, prepared by the staff of the Bureau of Mines. 1983. 90 ch. 1413 pp. This volume of the Minerals Yearbook contains the latest available mineral data on more than 130 foreign countries and discusses the importance of minerals in the economies of these nations. A separate chapter reviews the international minerals industry in general and its relationship to the world economy. GPO Stock No. 024–004–021110–0. $22.

TECHNICAL PROGRESS REPORTS

Application for free publications should be made to—

Section of Publications
Bureau of Mines
U.S. Department of the Interior
4800 Forbes Avenue
Pittsburgh, PA 15213
or call 412-621-4500, extension 342.

Technical Progress Reports make known new or improved systems and techniques in mining and metallurgy developed by the Bureau of Mines.

TPR 115. Electric Arcing at High Voltage During Methane-Air Explosions Inside Explosion-Proof Enclosures, by Lawrence W. Scott and Joseph G. Dolgos. 1982. 9 pp. 7 figs. The problem of electric arcing at high voltage during methane-air explosions in explosion-proof enclosures was investigated by the Bureau of Mines, with the following conclusions: (1) the mixture at which arcing is most likely to occur is approximately 9.8 pct methane-air at any given voltage and conductor spacing; (2) arcing will occur before there is any appreciable pressure build-up; and (3) conductor spacings presently required in normal atmosphere are not sufficient when there is the possibility of a methane-air explosion. This report presents information on the clearances between energized conductors, which, in a series of experiments, did prevent arc discharges from occurring as methane-air explosions took place in an explosion-proof enclosure.

TPR 116. Dust Deposition in Coal Mine Airways, by Welby G. Courtney, John Kost, and Jay Colinet. 1982. 15 pp. 6 figs. The Bureau of Mines conducted an exploratory field survey to determine the amount of airborne coal dust, the size distribution of the dust, and the rate of dust deposition in coal mine airways. The survey was taken at eight underground locations in operating coal mines. The rate of dust deposition in the airways depended upon the concentration of airborne dust and decreased exponentially with distance from the dust source. The rate was seemingly independent of the size of the airborne dust particles. The rate of deposition, along a return, for the coal dust from a face being mined with a continuous mining machine closely matched the rate for the rock dust from a trickle duster. A sample rock-dusting schedule for that return is presented; that is, the trickle duster should be operated for 3½ hours after every five shifts to protect the average deposit of new float coal dust in the return, but operation after every three shifts is preferred, to protect an occasional heavier deposit.

TPR 117. A New Sonic Velocity-Logging Technique and Results in Near-Surface Sediments of Northeastern New Mexico, by James J. Snodgrass. 1982. 24 pp. 16 figs. A new technique was used to obtain detailed sonic logging data in drill holes above the water table at a coal mine site in northeastern New Mexico. The equipment was developed under contract to the Bureau of Mines and the U.S. Department of Energy to indirectly evaluate the in situ structural properties of coal and overburden. The system comprises a hydraulically operated, wall-clamping downhole probe compatible with standard four-conductor logging cable, and a surface control module. Resolution of layering is 0.6 meter (2.0 ft), and a redundancy of data from separate receivers provides accurate timing measurements. Preliminary results in the settled overburden of an excavated longwall panel indicated a low average velocity zone, extending approximately 18 meters (60 ft) into the immediate roof of the coal seam. Subsequent measurements improved the field and recording procedures to produce high-quality waveforms from which both P and S arrivals may be visually interpreted. Over a representative section of interbedded sandstone, siltstone, shale, and coal, V_P and V_S varied considerably even within lithologic units. Compressional wave velocity in the coal seam, V_P = 1,740 m/sec (5,700 ft/sec), was in the range of variability of published data.

TPR 118. Evaluation of a Sheathed Permissible Explosive Charge for Open Shooting in Flammable Atmospheres, by Richard J. Mainiero and J. Edmund Hay. 1982. 9 pp. 6 figs. The Bureau of Mines has developed a prototype nonincendive explosive rock-breaker charge that can be fired unconfined in underground bituminous coal mines without the danger of igniting a flammable atmosphere that might be present. At present, unconfined shooting in underground coal mines is prohibited, but there are situations where the use of such shots would yield an overall improvement in safety. The charge consists of 1-1/2 lb of permissible water gel explosive in the form of a short cylinder 7 inches in diameter and 7/8 inches high, surrounded by a 1/2-inch-thick layer of damp salt, and encased in latex rubber reinforced with cheese cloth. The latex rubber housing provides a charge package that is strong enough to resist rough handling yet is pliable enough to conform to an irregular stone surface. A charge of this shape was found to be more effective at breaking rock than charges with lined or unlined cavities. Incendivity tests in a gallery have shown that the prototype charge will not ignite a flammable methane-air atmosphere when fired. Rockbreaking tests made with limestone boulders indicate that the charge will satisfactorily break stone slabs weighing 1 to 2 tons, and that two or more charges might be effective for slabs weighing up to 10 tons. In cooperation with the Mine Safety and Health Administration (MSHA), a test protocol for the certification of these charges as "permissible" for use in flammable atmospheres is being developed.

TPR 119. Field Test of an Automated Temporary Roof Support (ATRS) on a Low-Coal, Single Fixed-Head Roof-Bolting Machine (Squirmer), by Charles T. Chislaghi and Thomas E. Marshall. 1982. 11 pp. 10 figs. An economical, remotely operated (automated), temporary roof support (ATRS) has been developed by the Bureau of Mines for use on a single, fixed-head roof-bolting machine (squirmer) that operates in low coal seams (less than 42 inches thick). The ATRS eliminates the need for squirmer operators and helpers to go under unsupported roof to set or remove temporary support prior to or during the roof-bolting cycle—a task that annually accounts for approximately 20 pct of all roof fall fatalities. The ATRS can be adapted to any squirmer used in the U.S. low coal fields. A prototype ATRS was field tested at Imperial Colliery Co.'s Mine No. 20 in Eskdale, W. Va. The Mine No. 20 amended roof-control plan, which requires the use of the Bureau's ATRS as temporary support during face bolting, has been approved by the Mine Safety and Health Administration (MSHA), U.S. Department of Labor.

REPORTS OF INVESTIGATIONS

The following publications can be obtained from—

Section of Publications
Bureau of Mines
U.S. Department of the Interior
4800 Forbes Avenue
Pittsburgh, PA 15213

RI 8590. Aluminum Chloride Hexahydrate Crystallization by HCl Gas Sparging, by J. H. Maysilles, D. E. Traut, and D. L. Sawyer, Jr. 1982. 38 pp. 13 figs. The Bureau of Mines is conducting research on various technologies to recover alumina from domestic resources for feedstock to existing aluminum smelting capacity as a means to reduce dependence on imported bauxite, which represents 93 pct of U.S. aluminum requirements. One of the more promising technologies being investigated is the hydrochloric acid leaching of kaolinitic clay. In the hydrochloric acid leaching technology, alumina is recovered from iron-free aluminum chloride leach liquor and separated from impurity elements by sparging the liquor with HCl gas to crystallize aluminum chloride hexahydrate (ACH). A large-scale crystallizer with a 336-gallon usable volume was constructed and operated to obtain engineering and design data for potential scale up and to demonstrate the ability of the technology to produce specification grade alumina. Test campaigns involving about 1,400 hours of operation were completed. ACH meeting all chemical purity requirements could not be produced by a single crystallization, but was produced by recrystallizing the product from the calcined kaolin clay leach liquor. Product crystals with a size distribution of more than 80 pct plus 100 mesh and 65 pct plus 65 mesh were made at a rate of 10 pounds of ACH/(hr)(ft^3). The zirconium tube heat exchanger used to maintain constant process temperature operated with an overall heat transfer coefficient of 420 to 500 BTU/(hr)(ft^2)(°F).

RI 8592. Beneficiation of Low-Grade California Chromite Ores, by H. B. Salisbury, M. L. Wouden, and M. B. Shirts. 1982. 15 pp. 6 figs. The Bureau of Mines conducted research to determine if low-grade California chromite ores could be beneficiated to produce products suitable for commercial use. This research is part of a Bureau goal to provide technology capable of using low-grade domestic ores to meet emergency demands of the Nation for metals and minerals and in particular those minerals, such as chromite, which are considered critical. Two ores from California were ground and treated using gravity concentration and magnetic separation techniques. An ore from Auburn in central California, assaying 2.5 pct Cr_2O_3, was treated by tabling and magnetic separation to yield a nonmagnetic product containing 44.7 pct Cr_2O_3 at a recovery of 36.4 pct. Core drilling samples from the Seiad Creek area of northern California, assaying about 6 pct Cr_2O_3, were upgraded by tabling to yield a concentrate containing nearly 50 pct Cr_2O_3 with a recovery of 50 pct. Both products are suitable for metallurgical and/or chemical use.

RI 8594. Electromagnetic Radiation From Rock Failure, by David R. Hanson and Glen A. Rowell. 1982. 21 pp. 30 figs. Experimental work performed by the Bureau of Mines in a laboratory environment has shown that the formation of failure zones within certain rock types is accompanied by the emission of significant amounts of radiofrequency (RF) electromagnetic (EM) energy. This radiation was detected using nonresonant, "electrically short," broadband antennas. Rock types for which emission was observed include granite, quartzite, and taconite; sandstone and marble did not emit measurable radiation. Amplitude spectra of the radiation showed the energy to be concentrated between 10 and 40 kilohertz. These data indicate that emission is directional, but this has not yet been proven. In addition, amplitude of RF emission increases with increasing crack size. Since emission was observed only for brittle quartz-bearing rocks, it appears the formation of piezoelectric fields is a necessary condition for RF radiation. Plausible mechanisms for emission include rapid decay of piezoelectric fields accompanying the sudden stress release at failure and/or the acceleration of an "exoelectron plasma" through the intense local piezoelectric fields. Since emission appears to increase with the scale of failure, and since antennas do not need to be coupled directly to rock surfaces as with conventional geophones, the possibility of developing a portable system to monitor seismically active areas exists.

RI 8595. Evaluation of the Use of Foam for Dust Control on Face Drills and Crushers, by Steven J. Page. 1982. 13 pp. 6 figs. The increasing concern for dust control in metal and nonmetal mining prompted the Bureau of Mines to investigate the dust suppression technique of applying foam to face drilling and crushing operations in a gypsum mine. Previous attempts to achieve effective dust control on face drills using other techniques, such as dry collection and boom-mounted external water sprays, have not been successful. The largest problem encountered when using these techniques has been the lack of sustained effective dust capture at the face. Results for two faces studied show that injection of the foam through the drill steel provided an average dust reduction of 95 pct. However, the use of foam on the crusher provided no dust reduction at the operator's position (because of good local ventilation) and a 27-pct average dust reduction for two feeders at a location midway between the operator's position and the crusher. The conclusions obtained from this study are that (1) foam can be an extremely effective dust control technique when used on localized dust sources such as dust generated within a blasthole during drilling, and (2) foam is only marginally effective as a dust control technique when used on nonlocalized dust sources such as dust generated during the feeder-and-crusher operation.

RI 8596. An Evaluation of Three Wet Dust Control Techniques for Face Drills, by Steven J. Page. 1982. 13 pp. 7 figs. The increasing concern for dust control in metal and nonmetal mining prompted the Bureau of Mines to investigate the comparative effectiveness of three wet dust control techniques for face drilling. Previous attempts to achieve effective dust control on face drills with dry collectors have not met with success, the largest problem being sustained effective dust capture at the face. Results show that (1) foam-through-the-drill can provide 95-pct average total dust reduction in gypsum; (2) water mist-through-the-drill can provide approximately 91-pct average total dust reduction and 93-pct average respirable dust reduction in salt; (3) external boom-mounted water sprays can provide approximately 50-pct average dust reduction for both total and respirable dust in salt. The investigation showed that (1) foam and water in small quantities are very effective dust control techniques for face drills when applied through the drill steel at the point of dust generation, and (2) boom-mounted water sprays are only minimally effective for dust control on face drills.

RI 8597. Stress Distribution and Pillar Design in Oil Shale Retorts, by Syd S. Peng and Richard E. Thill. 1982. 33 pp. 21 figs. The design of retort interchamber pillars is important in determining surface stability over in situ retort mines and to the health and safety of miners, particularly with respect to possible escape of heat and toxic gases from retort chambers. Stress distribution in retort interchamber pillars, roof, and floor was examined with the aid of linear, finite-element analysis using data from experimentally determined mechanical properties. Properties determined included elastic moduli, strength, and creep constants in laboratory tests on core covering a 100-foot depth interval in the oil shale from the Piceance Basin in Colorado. The most critical stress concentration was found in the rib side of the interchamber pillar at a height above the floor line of 1.25 times the width. Guidelines for pillar design that consider pillar strength, creep, and retorting temperature effects are proposed.

RI 8598. Rock Mechanics Investigation of Two-Bed Trona Mining, Green River, Wyo., by R. O. Kneisley. 1982. 22 pp. 14 figs. Rock mechanics measurements indicate that the present two-bed mine design used at the Big Island trona mine, Green River, Wyo., results in stable workings. Vertical pressure changes in the lower panel pillars and horizontal pressure changes in the lower bed roof and floor indicated negligible upper bed mining influence. Pillar stresses stabilized soon after upper bed mining was completed. Strata movements in the pillar ribs, roof, and floor were also negligible and stabilized soon after completion of upper bed mining. Using tributary area theory, the confined core approach, and studies of model trona pillars it is shown that increased extraction ratio is possible. A program of gradually increased extraction ratio accompanied by simple measurements should result in a mine design that includes both higher recovery and long-term stability.

RI 8601. Crushing Techniques for Pneumatic Concentration of Mica, by C. W. Smith, C. E. Jordan, and G. V. Sullivan. 1982. 16 pp. 7 figs. Research was conducted by the Bureau of Mines to determine the effectiveness of various types of crushers for use with the Bureau-developed pneumatic concentration technique for mica. Three types of crushers were investigated in this study, a roll crusher, a jaw crusher, and a hammer mill. All the mica concentrates produced contained over 82 percent mica, but recoveries varied considerably. The roll crusher gave the lowest recovery of 46 percent of the mica followed by the jaw crusher with a recovery of 50 percent of the mica. The hammer mill proved the most effective, producing four concentrates with recoveries of at least 70 percent.

RI 8603. Canopy-Air Curtain Dust Reductions on a Gathering-Arm Loader, by Jon C. Volkwein, Steven J. Page, and Edward D. Thimons. 1982. 9 pp. 6 figs. The canopy-air curtain was originally developed by the Bureau of Mines to surround the operator of a continuous mining machine with a zone of clean air. This report describes the application and testing of a canopy-air curtain on a gathering-arm loader, as well as some of the problems associated with providing a zone of clean air to a standing, semimobile operator. The area of air-curtain coverage and effects of air velocity are discussed. In its present form, the canopy-air curtain provides a 50-percent reduction in respirable dust to the operator.

RI 8604. Electrowinning Nickel and Cobalt From Domestic Laterite Processing. Preliminary Laboratory-Scale Results, by R. E. Mussler and R. E. Siemens. 1982. 20 pp. 9 figs. As part of an overall goal to develop technology that can maintain an adequate supply of minerals to meet national economic and strategic needs, the Bureau of Mines is evaluating a method for selectively extracting nickel and cobalt from low-grade domestic laterites. The method involves electrowinning to recover the metals in pure form; therefore, preliminary laboratory-scale electrowinning tests were conducted in both a nondiaphragm and a diaphragm cell to determine the effect of variables on energy efficiency under controlled conditions. Electrolytes were generally reagent-grade sulfate solutions that were prepared to stimulate electrolyte that could be obtained by stripping nickel- and cobalt-rich solvent extraction reagents. Limited tests were conducted with electrolyte generated from laterite leach solutions. Electrical energy consumption in a nondiaphragm cell was 2.06 kwhr/lb Ni with the cell operated at 50° C, a cell feed of 90 g/l Ni, a pH of 3.5, an extraction of 3.2 g/l, and a cathode current density of 20 amp/ft^2. The energy requirement decreased with increasing concentration and temperature, and increased with increasing extraction and current density. At 50° C, energy consumption in the nondiaphragm cell was 21 pct greater than in the diaphragm cell, but it was only 5 pct greater at 65° C. For this reason and because of overall cost considerations, operation at 65° C with the nondiaphragm cell was preferred. Smooth sheets of cobalt were obtained by electrowinning in a nondiaphragm cell at selected temperatures from 50° to 85° C and with cobalt concentrations from 55 to 87 g/l. The energy consumption (1.48 kwhr/lb) was 22 pct lower with a cobalt concentration of 75 g/l and a cell temperature of 65° C than with a cobalt concentration of 55 g/l and a cell temperature of 50° C.

RI 8605. Solvent Extraction of Nickel and Copper From Laterite-Ammoniacal Leach Liquors, by D. N. Nilsen, R. E. Siemens, and S. C. Rhoads. 1982. 29 pp. 15 figs. The Bureau of Mines is investigating a method to recover Ni, Cu, and Co from low-grade domestic laterites through reduction roasting,

leaching, solvent extraction, and electrowinning unit operations. The objective of this research is to develop processing technology that can convert low-grade domestic deposits containing critical metals into national reserves. As a part of this research, a solvent extraction system was investigated for the extraction of nickel and copper, followed by the separation and production of suitable electrolytes. Nickel and copper were coextracted from ammoniacal ammonium sulfate leach liquors (pH~9.5) with LIX 64N extractant in a laboratory-size mixer-settler continuous circuit. Three extraction stages resulted in >99-pct extraction of nickel, substantial copper extraction, and essentially no cobalt extraction from leach liquors. A crowd stage reduced the ammonia loading on the solvent by maximizing nickel loading. Residual ammonia was removed from the loaded solvent with a pH-controlled scrub. Nickel and copper loaded on the solvent were separated by selective stripping. Typical nickel strip circuit operation using electrolyte containing 90 grams per liter (g/l) Ni and 11.9 g/l H_2SO_4 yielded >99.9 pct Ni stripped from the solvent in five stages. The copper loading on the recycled solvent was controlled in a copper strip stage using electrolyte containing 25 g/l Cu and 160 g/l H_2SO_4.

RI 8606. Evaluation of REO Model BT 300 C-D Blasting Machine Tester, by John H. Scott, Karl R. Becker, and J. Edmund Hay. 1982. 15 pp. 2 figs. At the request of the Mine Safety and Health Administration, U.S. Department of Labor, the Bureau of Mines evaluated the model BT 300 C-D blasting machine tester, manufactured and distributed by Research Energy of Ohio, Inc. (REO), to determine whether the tester performed as stated by the manufacturer and responded satisfactorily to electrical faults introduced into the blasting machine circuit. Tester readings were recorded for 13 blasting machines and for 12 circuits constructed to simulate the electrical parameters of actual machines. The tester readings were acceptable for all of the blasting machines, although the switch position assigned to one machine produced an off-scale reading. The tester responded satisfactorily to the simulated circuits and detected serious voltage or capacitance faults when they were introduced. However, it did not respond accurately to certain resistance faults. Temperature tests were also made, and the tester performed equally well at temperatures of 20°, 42°, and 81° F. This tester was judged a useful accessory for field checking blasting machines for defective batteries and capacitors, despite its limitations. It is recommended that the tester manufacturer specify the lowest acceptable reading at which a blasting machine may be used and below which the blasting machine should be returned to the laboratory or manufacturer for maintenance.

RI 8607. The Theory of Flammability Limits. Radiative Losses and Selective Diffusional Demixing, by Martin Hertzberg. 1982. 38 pp. 7 figs. The concept of limit burning velocities is being used to formulate a quantitative theory of flammability limits. Competing and complicating processes dissipate power from a combustion wave and quench propagation at some characteristically low limit velocity. Two earlier reports dealt with process (a), natural convection (RI 8127); and with process (b) conductive-convective wall losses (RI 8469). This report considers process (c), radiative losses, and process (d), selective diffusional demixing.

RI 8608. Mechanical Properties of Oil Shale and Overlying Strata, Naval Oil Shale Reserve, Anvil Points, Colo., by Dennis R. Dolinar, Frank G. Horino, and Verne E. Hooker. 1982. 43 pp. 24 figs. Physical property tests were conducted on drill core from three exploratory holes on the Naval Oil Shale Reserve near Anvil Points, Colo. Data and regression analysis curves are presented. Data obtained above the Mahogany zone were used to estimate the potential zone of surface effects from underground mining. Single specimen testing was primarily used to obtain Mohr's envelope and subsequent rock properties. The technique is shown to provide satisfactory results for this rock type with a significant reduction of core preparation and testing time.

RI 8609. Beneficiation of High-Magnesium Phosphate From Southern Florida, by T. O. Llewellyn, B. E. Davis, G. V. Sullivan, and J. P. Hansen. 1982. 16 pp. 4 figs. The Bureau of Mines, as part of its goal to develop technology that can conserve domestic mineral resources investigated beneficiation methods for recovering phosphate minerals from two Southern Florida deposits with high magnesium content. Chemical analyses of sized fractions indicated that no coarse pebble concentrate could be produced from either deposit. Conventional fatty acid-fuel oil batch flotation tests on two phosphate samples, analyzing 6.8 and 8.5 pct P_2O_5, yielded concentrates containing 28.97 to 29.80 pct P_2O_5 at recoveries ranging from 72.4 to 76.9 pct of the flotation feed. The MgO content ranged from 1.20 to 1.36 pct. Bubbling SO_2 gas through an aqueous concentrate slurry, further reduced the MgO content of these phosphate concentrates to 0.5 and 0.8 pct, but with a concomitant loss in the phosphate recovery. Settling characteristics of slimes from both phosphate samples showed a slow settling rate, which is a typical characteristic of other slimes in the region. Research at the Tuscaloosa Research Center is carried out under a memorandum of agreement between the Bureau of Mines, U.S. Department of the Interior, and the University of Alabama.

RI 8610. Effect of Ferric Ion on Corrosion Resistance of Zirconium in HCl-$AlCl_3$ Environment, by William D. Riley and Bernard S. Covino, Jr. 1982. 15 pp. 10 figs. In order to evaluate the corrosion resistance of zirconium in mineral extraction processes, such as clay-hydrochloric acid leaching process for extracting alumina, the Bureau of Mines conducted corrosion studies in HCl-$AlCl_3$-$FeCl_3$ environments. A series of weight loss and electrochemical tests were conducted at 25° and 65° C in aluminum chloride ($AlCl_3$) plus hydrochloric acid (HCl) solutions containing 0 to 1,000 ppm ferric ion. It was determined that zirconium, which normally exists in a passive state in chloride-containing solutions, undergoes pitting attack in solutions containing more than 100 ppm of ferric ion. It is also shown that an oxide film prepared in air at high temperature offers protection in acid solutions containing levels of ferric ion from 300 to 1,000 ppm.

RI 8611. Large-Scale Dewatering of Phosphatic Clay Waste From Central Florida, by B. J. Scheiner, Annie G. Smelley, and D. R. Brooks. 1982. 11 pp. 6 figs. As part of its mission to reduce pollution associated with mineral production, the Bureau of Mines is developing a dewatering technique for phosphatic clay waste that uses a flocculant, polyethylene oxide (PEO). This flocculant forms strong, stable flocs, which can be partially dewatered on a static screen and dewatered further on a rotary screen. Using this technique, a field test unit (FTU) was operated at a nominal 100 gal/min. Consolidated phos-

phatic clay material containing 20 percent solids was produced when feed slurries of 3 percent solids were treated with 0.69 pound of PEO per ton of feed solids. Pit and column tests indicated that the PEO-treated material continued to dewater; compacted products containing 40 percent solids were obtained after 45 days.

RI 8612. Improvements in Heap Leaching To Recover Silver and Gold From Low-Grade Resources, by G. E. McClelland and J. A. Eisele. 1982. 26 pp. 15 figs. As part of its mission to assure an adequate domestic supply of metals, essential to the Nation's welfare, the U.S. Department of the Interior, Bureau of Mines, investigated a particle agglomeration technique as a means for improving the flow of leaching solution through heaps of clayey or finely crushed, low-grade, gold-silver ores. Bench- and pilot-scale experiments showed that the percolation rate of cyanide leaching solution was markedly enhanced by mixing the ore with a portland cement binder, moistening the mixture, and mechanically agglomerating and aging the feed prior to heap building and leaching. The rate of gold and silver recovery markedly increased because of the increased, uniform percolation of leaching solution through the agglomerated feed. The use of concentrated cyanide solution instead of water during the agglomeration procedure decreased the leaching time required to obtain maximum recovery. Results of bench- and pilot-scale experiments are discussed.

RI 8613. Effect of Direct-Current Firing Levels on Detonator Delay Times, by Karl R. Becker and J. Edmund Hay. 1982. 13 pp. Detonators representing a sampling of various domestic commercial delay detonators were fired at various direct-current (dc) firing levels. Results of firings using well-below-recommended firing levels showed marked increases in delay times above the nominal values. There was also a marked increase in variation, to the extent that out-of-sequence firings would be essentially assured in any typical blasting round at these low firing levels. Within the range of recommended levels the effects of current increases were not considered to be of great importance relative to other overriding effects, such as the significant difference noted in average values of detonators from different lots having the same nominal delay. This effect, when combined with the normal variation noted among members from the same lot, would cause out-of-sequence firings with detonators from a neighboring delay period. Where comparisons with results from another study were possible, it was found that both studies observed quite similar variations in delay times about the average values, and a lower probability of out-of-sequence firings for the shorter delay period groups. The criterion of the previous study for assessing the likelihood of observing out-of-sequence firings, when applied to the Bureau of Mines data, properly identified two neighboring delay period groups where out-of-sequence firings would occur.

RI 8614. Effectiveness of Three Water Spray Methods Used To Control Dust During Bagging, by Jon C. Volkwein, Robert P. Vinson, and Edward D. Thimons. 1982. 9 pp. 3 figs. The industrial sand industry has been exploring new techniques to reduce dust. One company was experimenting with adding water during bagging operations to the surface of the bag, and into the product as it flowed into the bag. The Bureau of Mines, using instantaneous dust sampling instruments, measured the effectiveness of three methods of adding water. Results indicated that various types of water sprays applied in carefully controlled amounts could reduce dust up to 50% at worker locations at the bagging machine and inside a railroad boxcar. This report also discusses constraints such as product handling, customer acceptance, cold weather problems, dust collector performance, and other areas.

RI 8615. Recovery of Metal Values From Lead Smelter Matte by Chlorine-Oxygen Leaching, by D. L. Pool, B. J. Scheiner, and S. D. Hill. 1982. 19 pp. 6 figs. To increase metal recoveries and to minimize pollution by improved extraction technology, the Bureau of Mines investigated a hydrometallurgical technique to recover copper, lead, nickel, and cobalt from lead smelter mattes. The metals were converted from insoluble sulfides to soluble chlorides using a HCl-Cl_2-O_2 leaching system. Parameters studied in a 50-gallon, glass-lined reactor were the ratio of hydrochloric acid to chlorine, chlorine consumption per pound of matte, oxygen reaction pressure, and temperature. The matte material used contained, in percent, 19.7 Cu, 52 Pb, 2.9 Ni, 1.5 Fe, 0.38 Co, 0.19 As, 0.41 Zn, and 0.12 Cd. Extraction of Cu, Pb, Ni, Co, and Cd ranged from 92 to 98 pct, with concomitant extractions of Fe and As of $<$0.1 pct. The Cu and Pb were recovered as electrowon metals, while the Ni, Co, and Cd were recovered as mixed hydroxides.

RI 8616. Orifice Plate Design Studies for a Multiple-Compartment, Ion-Exchange Column, by G. R. Palmer, I. L. Nichols, R. G. Smith, and D. C. Seidel. 1982. 17 pp. 7 figs. Preliminary studies by the Bureau of Mines were conducted to determine the feasibility of a multiple-compartment, ion-exchange (MCIX) column simulator for examining the effect of multiple-orifice plates in the column. A rectangular, five-orifice, three-compartment, MCIX simulator with a cross-sectional plate area of 0.66 ft^2 was used for the investigation. Orifices with open areas of 1, 3, and 5 percent were used with various operating conditions. The study was separated into three separate sections: (1) solution flow effect, (2) fluidization effect, and (3) resin transfer effect. The solution flow and fluidization studies showed that for solution flow rates of about 3 gpm/ft^2, a 1-percent open area plate functioned best, while at solution flow rates of 9 and 15 gpm/ft^2, the best open areas were 3 and 5 percent, respectively.

RI 8617. Determination of Ferric Ion Diffusion and Activity Coefficients From Chronopotentiometric Data, by B. W. Madsen. 1982. 23 pp. 9 figs. As part of a program to maintain an adequate supply of minerals and metals to meet national economic and strategic needs, the Bureau of Mines conducted research to determine the diffusion coefficients for ferric ions in synthetic copper leach solutions. Determination of ferric ion diffusion coefficients in typical dump leach solutions is necessary for predicting leaching rates of copper from large-scale leaching operations and for optimizing concentrations of ferric iron in solutions to maximize leaching efficiency. Derivative chronopotentiometry, an electroanalytical technique, was used to determine ferric ion diffusion coefficients. The diffusion coefficient decreased dramatically with increasing concentration of iron in solution. An empirical model was used to relate the ferric ion diffusion coefficient to the total amount of sulfate in solution. Measuring the diffusion coefficient dependence on temperature

yielded an activation energy of 5.5 kcal/mole of ferric ion. Activity coefficients of ferric ions as a function of concentration were calculated from diffusion coefficient data.

RI 8618. Effects of Feed Preparation on HCl Leaching of Calcined Kaolinitic Clay To Recover Alumina, by R. S. Olsen, W. G. Gruzensky, S. J. Bullard, and J. L. Henry. 1982. 24 pp. 7 figs. The Bureau of Mines is engaged in a continuing research effort toward the recovery of alumina from kaolinitic clay and other nonbauxitic domestic minerals. Hydrochloric acid extraction of calcined clay is among the acid processes under consideration. Although aluminum is easily leached from calcined clay, the presence of fines and slimes in the leached residue has hindered the application of this and other acid leaching processes. A clay feed preparation method was therefore developed that eliminated the slimy nature and the separation problems normally associated with leached clay residues. The preparation process consists of crushing the raw clay to minus 20 mesh, dampening the crushed clay with a fine water mist while tumbling on a rotating disk, and calcining the misted clay at 750° C. The misting process increases residue settling rates threefold to 9 cm/min (18 ft/hr) and filtration rates by two orders of magnitude. Leaching kinetics were determined for misted clay feeds in a batch, stirred-tank reactor. Rapid leaching occurred during the first 85 to 90 pct of the extraction. The linear relationship of extraction to time during this initial phase corresponded to a zero order reaction with a rate constant of around 10 pct/min.

RI 8619. Removal of Organic Contaminants From Aluminum Chloride Solutions, by Jack C. White, Jack L. Henry, and Charles J. Krogh. 1982. 17 pp. 9 figs. The Bureau of Mines, in its efforts to insure the continued viability of the domestic minerals economy, has been engaged for several years in research on the extraction of alumina from domestic, nonbauxitic resources. Hydrochloric acid leaching of kaolin is one of the more promising technologies being studied for recovering alumina for feedstock to existing aluminum smelting capacity; 93 pct of this feedstock is currently imported either as bauxite or alumina. Organics contamination of pregnant leach liquor, originating during solvent extraction for removal of iron from aluminum chloride solution formed during hydrochloric acid leaching, causes rapid deterioration of the semihard rubber lining of process equipment. These organics were removed by a skimming tank-coalescer-activated carbon adsorption system. Organic levels of less than 10 ppm from the coalescer and less than 0.5 ppm from carbon adsorption were achieved. Analytical methods employing CCl_4 extraction and infrared spectrophotometry were developed to determine the organic content of both the liquor and the carbon. Mass transfer zones delineated in the carbon columns provide adsorption data for the design of larger systems.

RI 8620. Geologic Structures in Coal Mine Roof, by Noel N. Moebs and John L. Ellenberger. 1982. 16 pp. 11 figs. Studies by the Bureau of Mines have identified geologic structures in mine roof rock that contribute to many roof falls in Appalachian coal mines. These structures, including paleochannels, scours, pinchouts, slickensides, clay veins, crevasse splays, and joints, can often be identified during, and sometimes before, mine development. Mine projections can be revised to reduce the adverse effects of discontinuities in roof structure; large roof areas of laminated sandstone or incompetent strata generally can be delineated or inferred from exploratory drill hole data, and the need for supplementary support can be anticipated. Accurate descriptions of roof geology also provide some indication of optimum length and type of roof bolts that should be installed.

RI 8621. Thermodynamic Properties of Synthetic Acmite ($NaFe^{3+}Si_2O_6$), by K. O. Bennington and R. R. Brown. 1982. 12 pp. The thermodynamic properties of synthetic acmite, $NaFe^{3+}Si_2O_6$, were determined by the Bureau of Mines. The enthalpy of formation was determined by hydrofluoric acid solution calorimetry. The values of the standard enthalpy of formation at 298.15 K, $\Delta Hf°_{298.15}$, from the elements and from the oxides, $\Delta H°_{298.15}$, are

$$\Delta Hf°_{298.15} = -615.87 \pm 0.71 \text{ kcal/mole},$$

$\Delta H°_{298.15}$ (from oxides) $= -32.08 \pm 0.53$ kcal/mole. Various experimental data were combined with other data from the literature to calculate all the related thermodynamic properties in the range of 298 to 1,263 K. The standard Gibbs energy of formation is $\Delta Gf°_{298.15} = -575.8$ kcal/mole.

RI 8622. Steels From a Variety of Ferrous Scrap Including Materials of Low Quality, by V. R. Spironello, I. D. Shah, and R. H. Nafziger. 1982. 15 pp. 9 figs. One of the primary objectives of the Bureau of Mines solid waste utilization program is the recycling of the magnetic fraction of municipal solid waste called raw refuse scrap. In this investigation, several types of scrap of differing quality, including refuse and turnings, were melted in a 1-ton electric arc furnace in various combinations to produce steel in noncritical (construction) grades. Information on furnace operation and on the behavior of tramp and alloying elements was obtained. The research showed that it is possible to produce acceptable steel from a variety of steel scrap. Although some scrap is routinely used in steelmaking, it was found that up to 50 to 55 pct of the scrap charge can be refuse, provided it is combined with higher quality scrap. The chemistry of the steels was generally acceptable, and all of them were rolled without difficulty. The specification (ASTM 615) for the steels produced was grade 40 or grade 60, containing 0.30 or 0.40 pct C, with minimum yield strengths of 40,000 or 60,000 psi, respectively. Most of the steels met the specification requirements. Information on typical microstructures of some of the steels is included. The composition of some furnace dusts showed high levels of Sn, Pb, and Zn.

RI 8623. Engineering Properties of Combined Coarse and Fine Coal Wastes, by Bill M. Stewart and L. A. Atkins. 1982. 18 pp. 9 figs. The Bureau of Mines conducted laboratory tests to determine the effects on the physical properties of coarse coal waste of adding large amounts of fine coal waste. Maximum laboratory dry density, optimum moisture content, shear strength, and permeability tests were conducted on samples that contained 18 to 60 pct minus No. 4 (U.S. Standard sieve size) coal waste. For the nonslaky materials, maximum laboratory densities were highest and permeabilities lowest when the samples contained between 30 and 40 pct minus No. 4. Shear strength increased rapidly when the proportion of minus No. 4 was increased from 20 to 40 pct, but then increased only slightly or leveled off when the minus No. 4 was increased to 60 pct. Optimum moisture content and permeability were the physical properties most affected by the addition of fines. Optimum moisture content in-

creased as much as 3 pct, and permeabilities decreased up to three orders of magnitude. Slaky coal waste material had physical property reactions to the addition of fines substantially different from those of nonslaky material.

RI 8624. Zirconium Oxide Molds for Small Molybdenum Investment Castings, by E. D. Calvert and H. W. Leavenworth, Jr. 1982. 26 pp. 18 figs. As part of its goal to minimize the requirements for critical and strategic minerals, the Bureau of Mines is conducting research to foster the use of domestically abundant materials such as molybdenum. This report describes the development of an investment shell molding technique that can be used to make castings of molybdenum and its alloys. The mold material is cubic ZrO_2 with a monoclinic ZrO_2 binder. The shell, formed by standard investment molding techniques described in the text, is prepared for molybdenum casting by firing for 6 hours at 1,550° C (2,822° F) or for 4 hours at 1,650° C (3,002° F). The resulting castings have predictable and reproducible dimensions with good detail. As-cast strength is poorer than the strength of wrought materials below 1,600° F. At and above this temperature, tensile strengths of cast and wrought materials are nearly equal. Aqueous corrosion of the castings in most media is insignificant.

RI 8625. Diagnostics of Sealed Coal Mine Fires, by J. M. Kuchta, A. L. Furno, L. E. Dalverny, M. J. Sapko, and C. D. Litton. 1982. 25 pp. 22 figs. The Bureau of Mines investigated four simulated coal gob fires to obtain a more reliable data base for defining the state of a sealed mine fire and to evaluate the performance of various fire detectors. The fires were conducted in a multiple-entry section of the Bruceton Experimental Mine by heating 4,000 to 21,000 pounds of rubblized bituminous coal to ignition and monitoring the temperature, gas emissions, and smoke under ventilated and sealed combustion conditions. Product gas concentrations depended upon the coal bed size, coal temperature, heating rate, and oxygen concentration or ventilating condition but varied little after the fires were sealed. Expressions are given that define the temporal variations of CO and O_2 after sealing when the coal temperature decreased rapidly. The CO/CO_2 ratio is a more sensitive fire indicator than the $CO/\Delta O_2$ ratio, although the latter is universally used for detecting the incipient state of a coal fire. In comparison, the Jones-Trickett ratio

$$\frac{CO_2 + \frac{3}{4}\ CO - \frac{1}{4}\ H_2}{\Delta O_2}$$

is less reliable for this purpose. The best detector for determining the state of a mine fire after it has been sealed was a prototype submicrometer smoke particulate sensor. Limitations of the various detector systems are also discussed.

RI 8626. Effects of Sodium Chloride Leach Solution Additive on Simulated In Situ Leaching of a Chalcopyrite Ore, by T. G. Carnahan and R. E. Lindstrom. 1982. 16 pp. 6 figs. The Bureau of Mines conducted research to simulate in situ leaching of a porphyry copper sulfide ore. The purpose was to determine the effects on copper leaching of additions of NaCl to a conventional sulfate leach system and to analyze the oxidant requirements and the oxidation products that resulted from leaching of the sulfide minerals in the ore. Baseline sulfate and sulfate plus 2-pct-NaCl-leach-solution experiments employing 167-kg (367-lb) and 152-kg (333-lb) charges, respectively, were conducted. The minus 25.4-cm (10-inch) ore was leached at 90° C under flooded conditions with 2.8 MPa (400 psig) of oxygen bubbling through the system. Sixty-seven pct of the copper was extracted in 1,236 days of leaching in the NaCl experiment, whereas 47 pct of the copper was extracted in 913 days of leaching in the baseline experiment. Diffusion into and out of the ore fragments controlled the rate of leaching, which precluded enhancement of the leach rate by the chloride ions. The calculated oxygen consumption was 3.17 kg/kg of copper extracted in the baseline experiment and 3.46 kg/kg of copper extracted in the experiment to determine the effect of chloride ions.

RI 8627. Amphiboles in Soapstone Ridge, Ga., by Rolland L. Blake. 1982. 17 pp. 17 figs. Petrographic methods of examination were used by the Bureau of Mines on a suite of samples of ultramafic rock from Soapstone Ridge, Ga., located about 8 miles south-southeast of Atlanta. The samples were analyzed to determine (1) their potential for releasing regulatory particles upon crushing and grinding and (2) their concentration of fibrous particles that approach the dimensions of amphibole and serpentine asbestos minerals. Such particles might be generated during grading and excavation for housing and industrial development and could become a health concern. Light optical microscopy, scanning electron microscopy, and X-ray diffraction were the techniques used to examine the samples. Six of the twelve samples contained amphibole as a major mineral; in five, it was a moderate to minor mineral. One sample contained no amphiboles, and serpentine was not observed or identified by X-ray diffraction in any of the samples. In nine of the samples, the amphiboles exhibited a habit that was either prismatic or acicular, but not asbestiform. Two of the samples did contain asbestos, occurring as small veins or fracture fillings, which represented only a minor percentage of the total sample. Similar petrographic screening is recommended for examining any rock deposit or mine location to delineate hazardous and nonhazardous mineral areas.

RI 8628. Investigation of Longwall Gateroad Roof Support Characteristics at Powhatan No. 4 Mine. Instrumentation Plan, by G. J. Chekan and D. R. Babich. 1982. 9 pp. 8 figs. This Bureau of Mines publication describes the plan used to instrument two longwall gateroads at the Powhatan No. 4 Mine of the Quarto Mining Co. Vibrating wire stressmeters, flatjack U-cells, multipoint extensometer stations, and convergence stations were installed in or on the coal pillars, roof bolts, and roof strata of the gateroad entries. The instruments measure pillar stresses, bolt loadings, and strata movements as the gateroad entries are developed and the longwall panel(s) is mined. The report details only the instrumentation plan of the longwall gateroads and not the evaluation of any subsequent data. This is because a complete analysis of the data cannot be made until extraction of the longwall panel(s) is complete.

RI 8629. Analysis of Vapor-Aluminum-Diffused Stainless Steels, by L. L. Oden, M. P. Krug, and R. A. McCune. 1982. 12 pp. 7 figs. The Bureau of Mines analyzed vapor-aluminum-diffused stainless steels prior to conducting corrosion measurements in severely sulfidizing environments. These studies were conducted in response to the national need to better control the environmental and economic costs of corrosion. Specimens of a ferritic alloy and austenitic alloys types 316 and 310 were treated by a

proprietary vapor-aluminum diffusion process and a dual vapor-aluminum diffusion process. Weights and dimensions were recorded before and after treatment, and comprehensive metallographic, X-ray, and electron microprobe analyses were conducted for both single- and dual-vapor-aluminum-diffused specimens. Surface aluminum concentrations ranged from 26 to 34 wt-pct for all alloys. Dual treatment increased the quantity of aluminum per unit area by a factor of 2 and increased the depth of penetration by a factor of 3. The aluminum-diffused region of the ferritic alloy was single-phase, αFe solid solution that was ordered on the surface, whereas two distinct diffusion layers were observed on the austenitic alloys. The outer layer comprised αFe solid solution that was ordered on the surface, and the inner layer was a two-phase mixture of αFe solid solution and the intermetallic compound AlNi.

RI 8630. Assessment of Subsidence Data From the Northern Appalachian Basin for Subsidence Prediction, by Sathit Tandanand and Larry R. Powell. 1982. 14 pp. 7 figs. Geological differences among various coalfields restrain the applicability of subsidence prediction using empirical approaches previously developed. The Bureau of Mines assessed data collected from 16 longwall panels in the Northern Appalachian basin. Attention was focused on the effects of rock lithology, excavation width, and panel depth on the subsidence factor. The results show that the subsidence factor can be expressed in terms of the width-to-depth ratio by a simple exponential equation, which has a coefficient tentatively considered as the subsidence index. This index varies with the lithology of a particular site, and can be expressed in terms of percent distribution of weak and strong rocks in the overburden.

RI 8631. Hydrogenation Catalysts From Intermetallic Compounds, by G. B. Atkinson, L. J. Nicks, E. G. Baglin, and D. J. Bauer. 1982. 8 pp. 5 figs. Properties of catalysts prepared from intermetallic compound precursors were investigated by the Bureau of Mines as part of its mission to decrease U.S. dependence on foreign sources for scarce catalytic materials, such as nickel, cobalt, and chromium. Methods were developed whereby catalysts with surface areas of 30 to 40 m^2/g were prepared from intermetallic compounds. Activity of these catalysts for the methanation reaction and methanol synthesis was determined using a fixed-bed, single-pass, flow-through reactor. Catalysts prepared from rare-earth-nickel intermetallics had specific activity for methanation that was five times greater than that of commercial catalysts and were equal to or better than commercial catalysts with regard to sulfur tolerance. Under identical reaction conditions, catalysts prepared from thorium-copper intermetallics produced more than 10 times as much methanol as a commercial low-pressure catalyst and exhibited a high degree of catalytic stability.

RI 8632. Fire Detection Systems in Conveyor Belt Haulageways, by C. D. Litton, M. Hertzberg, and A. L. Furno. 1982. 26 pp. 9 figs. The results of full-scale fire tests are used to determine optimum distributions of fire sensors for the protection of conveyor belt haulageways in underground coal mines. Empirical relationships are derived that relate the spacing of fire sensors to the rate of development of the fire hazard. For this application, a critical fire size is defined as that size of fire for which belt ignition and subsequent flame spread down the belt is assured. Detection and alarm, regardless of sensor type or sensing methodology, must be achieved at some point in time before the critical fire size is reached. Based upon this approach, it is found that the horizontal spacing for products-of-combustion sensors is in the range of 300 to 600 meters, while the required thermal sensor spacing is found to be ~4 meters or less. Additional design criteria are discussed for product-of-combustion fire sensing systems.

RI 8633. High-Temperature Corrosion Resistance of Basic Refractories to Coal and Lignite Ash Slags, by J. E. Pahlman, C. F. Anderson, and S. E. Khalafalla. 1982. 11 pp. 2 figs. The Bureau of Mines conducted research to determine the resistance of basic refractories to corrosion by ash slags that would result from the burning of coal and lignite in metallurgical operations. Basic refractories are of economic interest because they are from one-third to one-half as expensive as 90- to 99-pct-alumina refractories. Static tests were performed at 1,300° C and dynamic tests at 1,400° to 1,650° C to investigate the stability of refractory specimens in a slag environment. In alkali-containing lignite ash slags, in order of decreasing resistance, magnesite, magnesite-chrome, and chrome-magnesite refractories all had corrosion resistances equal to or better than 90- to 99-pct-alumina refractories. These basic refractories formed slag penetration layers in dynamic tests, which helped protect them from further attack. Chemically bonded basic refractories in general did not have as good a resistance to slag attack as did burned refractories of the same composition. In very acidic coal ash slag, a chrome-magnesite refractory containing 30 pct MgO plus a slag inhibitor and direct-bonded magnesite-chrome refractories with 60 pct MgO had good resistance to attack. Chrome-magnesite refractories (30 to 40 pct MgO) were moderately to severely attacked, and refractories with greater than 70 pct MgO were severely attacked by this same slag.

RI 8634. Iron Extraction From Simulated Aluminum Nitrate Leach Liquor, by J. A. Eisele, F. R. Smith, and D. J. Bauer. 1982. 9 pp. 5 figs. As part of its goal of maintaining an adequate supply of minerals to meet national economic and strategic needs, the Bureau of Mines has studied the removal of iron from simulated aluminum nitrate leach liquors by solvent extraction. Iron must be removed from aluminum nitrate liquor produced by leaching calcined kaolinitic clay with HNO_3 to reduce the iron level in alumina to less than 0.02 wt-pct Fe_2O_3 for use in reduction cells. The parameters reported are for (1) extracting iron from a feed containing 1.5 g/l Fe with di(2-ethylhexyl) phosphoric acid (EHPA), (2) stripping loaded organic phase with 20-pct HCl, and (3) water washing of loaded and stripped organic phase. Recommended operating conditions are two extraction stages using 15 vol-pct EHPA in kerosene and three stripping stages using 20-pct HCl. Results are also given for tests using other extractants and stripping agents.

RI 8635. The Determination of the Points of Zero Charge of Fine Mineral Particles by a Titration Technique, by D. A. Stanley, P. M. Brown, and B. J. Scheiner. 1982. 7 pp. 4 figs. The Bureau of Mines has developed a simple titration technique for determining the points of zero charge (PZC) on minerals. The technique consists of titrating a mineral slurry with the potassium salt of polyvinyl sulfuric acid (PVSK) in the presence of an indicatory dye and a positively charged polymer. Values obtained by

this simple method are in good agreement with values found in the literature.

RI 8636. Preliminary Studies on the Dewatering of Coal-Clay Waste Slurries Using a Flocculant, by Jalna R. Zatko, B. J. Scheiner, and Annie G. Smelley. 1982. 15 pp. 7 figs. Coal-clay waste slurries were dewatered in laboratory- and small-scale continuous tests by the Bureau of Mines using polyethylene oxide (PEO) as a flocculant. Dewatering from a nominal 7-wt-pct solids to over 50-wt-pct solids was accomplished using 0.5 lb of PEO per ton of feed in small-scale continuous tests. Parameters such as pH, initial solids content, and PEO concentrations were investigated. Water recovered from dewatering was reused as dilutant for PEO solutions.

RI 8637. Laboratory Evaluation of the Du Pont P-2500 Automatic Flow-Controlled Personal Dust Sampling Pump, by Robert J. Timko, Kenneth L. Williams, and George H. Schnakenberg, Jr. 1982. 18 pp. 13 figs. The objective of this Bureau of Mines research work was (1) to determine how well the E. I. du Pont de Nemours & Co. P-2500 personal dust sampling pump controls the flow rate at 2 L/min and (2) to compare respirable dust measurements made using the P-2500 with those made using a nonpulsating sampling flow system, both using the Dorr-Oliver 10-mm nylon cyclone dust size classifier. The calibrator and the operation manual for the P-2500, supplied by the manufacturer, were also evaluated. Flow tests consisted of long-term (6- to 8-hour) flow stability tests at various backpressures, a low-flow indicator examination, flow controller response time tests, and pulsation tests. Dust tests were performed using coal, silica, and Arizona road dust. No tests were performed to examine effects of temperature, barometric pressure, vibration, or mechanical shock. These pumps peformed well within manufacturer specifications in all tests.

RI 8638. Description and Economic Evaluation of Flue Gas Desulfurization by the Modified Citrate Process, by R. H. Lien, D. A. Martin, and W. I. Nissen. 1982. 26 pp. 8 figs. The Bureau of Mines developed a flue gas desulfurization process as part of its goal of minimizing the undesirable environmental impacts associated with energy and mineral-processing plants. The modified citrate process involves absorption of sulfur dioxide (SO_2) in a buffered citric acid solution. The SO_2-loaded solution is regenerated by countercurrent contact with steam in a packed tower. The wet SO_2 product is then dried and can be liquefied or further processed to make sulfuric acid. Test data from process investigation unit studies are presented. Material balances, flowsheets, and cost estimates are given for recovering SO_2 from copper smelter reverberatory gas, led smelter sintering machine tail gas, and powerplant stack gas. Operating cost estimates show the process will add $0.04 per pound of copper, $0.01 per pound of lead, and $0.015 per kwhr to the cost of the respective operations. These costs could be substantially reduced if a source of waste heat was available to provide the process steam requirements.

RI 8639. Assessment of Environmental Impacts Associated With Phosphogypsum in Florida, by Alexander May and John W. Sweeney. 1982. 19 pp. 3 figs. In its role to provide technology to prevent or limit adverse environmental impacts associated with mining or minerals processing, the Bureau of Mines has conducted research at its Tuscaloosa Research Center to assess the environmental impacts of phosphogypsum produced by the Florida phosphate industry. Over the years, stockpiles containing 335 million tons of phosphogypsum have accumulated and the industry continues to generate an additional 33 million tons a year. Samples from approximately 1,000 feet of drill core, obtained from nine stockpiles, were characterized using chemical, X-ray diffraction, emission spectrographic, radiological, and physical means. The data developed indicated that phosphogypsum is not a corrosive or toxic hazardous waste as defined by Environmental Protection Agency criteria. Radium concentrations averaged 21 picocuries per gram and its content was inversely related to particle sizes. Thirty-nine elements were detected in phosphogypsum; concentrations of these elements did not vary with depth within the stockpiles. Research at the Tuscaloosa Research Center is carried out under a memorandum of agreement between the Bureau of Mines, U.S. Department of the Interior, and the University of Alabama.

RI 8640. Drilling a Horizontal Coalbed Methane Drainage System From a Directional Surface Borehole, by David C. Oyler and William P. Diamond. 1982. 50 pp. 25 figs. Three long horizontal holes were drilled from a directionally drilled surface hole at the Emerald Mine near Waynesburg, Pa. The purpose was to adapt the technique of directional drilling for use in draining methane from coalbeds. A 504-m (1,652-ft) long, 76-mm (3-in) diameter, circular arc pilot hole was drilled, using a downhole mud motor, to enter the Pittsburgh coalbed at a vertical depth of 350 m (1,000 ft). The hole was reamed to 222 mm (8-3/4 in) and was cased to a measured depth of 486 m (1,595 ft). Three 76-mm (3-in) diameter horizontal drainage holes were then drilled, totaling 2,909 m (9,544 ft) of horizontal hole. Improvements in drilling methods increased the average drilling rate from 20.4 m (67 ft) to 64.9 m (213 ft) per day. The cost of drilling the directional and horizontal holes (using a Government-owned drill rig) was $1,169,530, a figure inflated by inexperience and by delays caused by lost-circulation problems and fishing operations. An estimated total drilling cost of $960,000 (including rental of a drill rig) for an improved system, was determined by a detailed cost analysis. Initial gas and water production from November 1979 through May 1980 was low because of caving of the horizontal holes drilled in shale near the bottom of the casing.

RI 8641. A Microseismic System for Monitoring Slope Stability, by C. Melvin Lepper, Allan P. Poland, and C. Thomas Mullis. 1982. 64 pp. 51 figs. Microseismic energy is generated when stresses accumulated in rock formations are released in the form of fracturing. The acoustic emissions resulting from these rock fractures and movements are detectable as velocity signals in the earth near the energy source. A Bureau of Mines microseismic system that is capable of detecting the acoustic emissions from pit slope movements is described. The digital circuitry incorporated in the system allows a microprocessor program to immediately calculate and present the location coordinates for the seismic energy source in the mine pit wall. This monitoring system is compact, portable, reliable, and relatively inexpensive and rapidly provides accurate information to the mine operators about the stability of a pit slope.

RI 8642. Effects of Temperature on Simulated In Situ Leaching of a Chalcopyrite Ore, by Thomas G. Carnahan. 1982. 16 pp. 6 figs. The Bureau of

Mines conducted research to simulate in situ leaching of a chalcopyrite ore. The purpose was to obtain a direct comparison between moderate-temperature and elevated-temperature in situ leaching of copper from minus 10-inch ore and to analyze the sulfuric acid and oxygen requirements of the leaching system. Experiments employing oxygen were conducted at 35° and 90° C on 362- and 367-lb ore charges, respectively, under flooded conditions and at 400 psig. At 90° C, 47 pct of the copper was extracted in 913 days of leaching; at 35° C, 27 pct of the copper was extracted in 915 days. Diffusion into and out of the ore fragments controlled the rate of leaching. Oxygen consumption was 1.46 lb/lb of copper extracted at 35° C and 3.15 lb/lb of copper extracted at 90° C. Sulfuric acid requirements of the ore were 5.49 and 7.48 lb/lb of copper extracted at 35° and 90° C, respectively.

RI 8643. Gravimetric Preparation of Primary Standard Gas Mixtures in the Parts Per Trillion Range, by Ernest W. Loya, Charles A. Seitz, and David E. Emerson. 1982. 4 pp. A method for preparing gravimetric primary standards of helium in the parts per trillion range has been developed by the Bureau of Mines. The standards are used to calibrate a specially modified mass spectrometer used in determining the abundance of helium-3 and helium-4 in geochemical samples and of helium-3 in isotopically purified helium-4. The desired gas standards are prepared in 5-kg metal cylinders filled to 1,800 psia. Relative errors of less than 1 pct have been attained in the parts per trillion range using a successive dilution technique.

RI 8644. Underground Gob Gas Drainage During Longwall Mining, by Steven J. Schatzel, Gerald L. Finfinger, and Joseph Cervik. 1982. 14 pp. 15 figs. Gas drainage through surface boreholes has been the conventional means of methane control for U.S. longwall gobs. However, these vertical boreholes are becoming so costly, and the surface rights so difficult to obtain, that the Bureau of Mines is developing underground gob gas drainage as an alternate means of methane control for U.S. longwalls. Holes are drilled into the roof over the panel and on retreating longwalls, towards the working face from a location inby the face. As the longwall retreats, an increasing portion of the hole intercepts the fracture system over the caved gob. A surface exhauster maintains a vacuum on a pipeline paralleling the panel and draws the methane mixture out of the mine. Auxiliary systems of gob gas drainage during longwall mining will be essential for an increasing number of coal mines. Deep and gassy mines often find ventilation insufficient for adequate dilution of methane in bleeder entries. Although this cross-measure method of degasification has been used successfully in Europe, some of the European techniques cannot be directly applied to U.S. mines. This is the first study of its kind in this country.

RI 8645. Subsidence Over Four Room-and-Pillar Sections in Southwestern Pennsylvania, by Noel N. Moebs. 1982. 23 pp. 15 figs. The Bureau of Mines measured surface subsidence above four small coal mine room-and-pillar sections in southwestern Pennsylvania, to obtain preliminary information on the magnitude and character of selected parameters, such as angle of draw and maximum subsidence, which are essential to the development of subsidence prediction methods. Data varied widely at the four sites; this is attributed to local geologic and mining conditions. Surface deformation at each site was of a magnitude normally associated with severe structural damage.

RI 8646. Separation of Copper-Nickel Mattes From Duluth Gabbro Concentrates by Flotation and Magnetic Methods, by Robert B. Schluter. 1982. 14 pp. 8 figs. The Bureau of Mines investigated separating copper-nickel mattes to recover a copper-rich fraction suitable for processing by conventional copper metallurgical processes and a nickel-rich fraction suitable for processing in a hydrometallurgical nickel circuit. Distribution of cobalt and precious metals between the copper and nickel fractions was also determined. A matte containing 65 pct Cu, 9 pct Ni, 4 pct Fe, and 20 pct S was separated into a copper fraction that comprised 80 pct of the matte weight and contained 70 pct Cu and <1.5 pct Ni, plus a nickel fraction that contained 40 pct Ni and 30 pct Cu. Recoveries of copper and nickel into their respective fractions were 90 pct and 87 pct. These results were obtained in a laboratory flotation cell at a matte grind of 90 pct minus 500 mesh and a pH of 12.4, using 1.7 pounds DPG (diphenylguanidine) per ton of matte as collector and frother. Magnetic separation was used to remove metallic iron-nickel alloy from the copper fractions. Distribution of cobalt was about 70 pct to the nickel fraction and 30 pct to the copper fraction. Silver reported predominately to the copper fraction, while Au, Pt, and Pd were essentially entirely recovered in the nickel fraction.

RI 8647. Thermodynamics of Calcination of Calcite, by H. C. Ko, N. Ahmad, and Y. A. Chang. 1982. 9 pp. Heats of solution of calcium carbonate (calcite) and calcium oxide in hydrochloric acid were determined by solution calorimetry. Combination of these two heats yields a value of 42.643 ± 0.024 kcal/mole for the enthalpy of calcination of calcite at 298.15 K. Literature data on $\Delta H^\circ_{298.15}$ of calcination of calcite were reviewed and compared. Thermodynamic properties for the calcination process were calculated from 298.15 to 1,500 K using Gibbs energy functions. This research was undertaken by the Bureau of Mines as an effort to provide thermodynamic data for the advancement of minerals technology, energy conservation, and environmental preservation.

RI 8648. Results of EPA Extraction Procedure Toxicity Test Applied to Copper Reverberatory Slags, by E. A. Johnson, L. L. Oden, and P. E. Sanker. 1982. 16 pp. 4 figs. As part of its effort to reduce the environmental impact associated with mining and metallurgical operations, the Bureau of Mines used a modified form of the Environmental Protection Agency's Extraction Procedure toxicity test on copper reverberatory slags that contained low, medium, and high levels of the impurity elements As, Pb, Sb, Bi, and Zn. All tests resulted in extracts that did not exceed those limits published in the May 19, 1980, Federal Register; therefore, these solid wastes were designated as nonhazardous for most landfill disposal situations. However, arsenic and lead levels disturbingly close to the allowable limits—and even higher levels of copper and zinc, for which there are no established limits—leached from the high-impurity-element granulated slags. These slags should be handled in such a way so as to minimize the possibility of water contamination. One baghouse dust was tested according to the EPA procedure and found to exceed the extract limits by a factor of 10. This solid waste may be considered hazardous.

RI 8649. Silver Recovery From Cyanide Tailings Using an Acidic NaCl-$FeCl_2$ Leachant, by P. R. Bremner. 1982. 7 pp. In keeping with its mission to maximize mineral and metal recovery from domestic sources, the Bureau of Mines investigated a method to extract silver from tailings not amenable to cyanidation. Results of a laboratory study on the recovery of silver from cyanide tailings containing 1.7 ounces of silver per ton by leaching with an acidic ferrous chloride-sodium chloride solution are presented. The effects of reagent concentration and reaction time on the leaching of silver were investigated. A leaching solution containing 5 wt-pct NaCl, 2.5 wt-pct $FeCl_2$, and 1.2 wt-pct HCl (for acidity) extracted 82 pct of the silver from the tailings during a 24-hour leach. The amount of HCl consumed during the leach was 46 pounds of HCl per ton of feed. Only 23 pct of the silver was extracted by conventional cyanidation. Ninety-nine percent of the silver was recovered from the pregnant solution by cementation onto iron powder.

RI 8650. Corrosion Resistance of Ceramic Materials to Hydrochloric Acid (20 Wt-Pct at 50° C), by James P. Bennett. 1982. 11 pp. 5 figs. To improve construction materials for emerging chemical and metallurgical technologies, the Bureau of Mines is investigating the acid resistance of ceramic materials. In the study described here, eight commercial ceramic materials comprising two red shale, two fire clay, a silica, a silicon carbide, a carbon, and a high-alumina brick were evaluated. Samples were exposed to 20 wt-pct HCl at 50° C for 110 days. The test apparatus designed to evaluate the materials is described. Changes in chemical and mineralogical composition, cold crushing strength, volume, and weight, and leach rates of Al, Ca, Fe, K, Mg, Na, Si, and Ti ions were monitored. In general, the statistically significant physical property changes that occurred were small. In many cases, no changes were detected.

RI 8651. Safe, Effective Hangup Clearance for Underground Mines, by David P. Lindroth and Sterling J. Anderson. 1982. 12 pp. 9 figs. The Bureau of Mines has developed and successfully tested a hangup clearance module for use in clearing hangups in underground mine chutes and ore passes. The Bureau's tests showed that the hangup clearance module can be effectively used to clear mine hangups. Furthermore, it is believed that clearance using this module is quicker, safer, and more efficient than the method currently used. The hangup clearance module uses a ballistic disk explosive charge that can clear hangups located as far as 50 feet (15.2 m) from the position where the charge is detonated. Mine personnel can therefore set up the module and the charge it contains without being exposed to dangerous areas. This report describes the principles of operation of the module, provides data and drawings for its construction, and gives instructions for its setup and use. The report summarizes the development of the module, briefly discusses preliminary and underground tests, and lists the current and potential applications of the hangup clearance module to underground mining.

RI 8652. Case History of a Pilot-Scale Acidic In Situ Uranium Leaching Experiment, by Michael T. Nigbor, William H. Engelmann, and Daryl R. Tweeton. 1982. 81 pp. 84 figs. The Bureau of Mines assisted the Rocky Mountain Energy Co. in a pilot-scale in situ leaching experiment at Casper, Wyo., to determine if sulfuric acid can be used as a cost-effective alternative lixiviant (leachant) for uranium in situ leaching. This experiment, which lasted more than 2 years, is the first fully documented pilot-scale operation in which the leaching-restoration cycle was completed using sulfuric acid instead of the more common carbonate-bicarbonate leachant. This report describes activities at the experimental site, presents extensive geochemical data from startup to site restoration, compares laboratory and field experiments, and discusses the environmental aspects of acid leaching. The data showed that sulfuric acid is apparently an effective leaching solution. Three to five grams of acid per liter of ground water resulted in a production solution grade of 80 to 100 ppm uranium. Restoration was successful, but required extended flushing. The pH was the last chemical parameter to return to baseline, requiring about 350 days. This was longer than was predicted in laboratory simulations. The data also showed that mobilization of toxic elements such as selenium, arsenic, radium, thorium, and molybdenum stayed within reasonable limits and quickly fell back to preleach concentrations during restoration.

RI 8653. Restoration of Surface Vegetation on Uranium Wastes at Uravan, Colo., by L. J. Froisland, P. L. Placek, and M. B. Shirts. 1982. 13 pp. 7 figs. The Bureau of Mines conducted a 4-year research program at Uravan, Colo., on a 2–1/2-acre reclamation plot on the slope of a uranium tailings pile that had been covered with mine waste rock. The purpose of this study was to determine the effects of plant species, type of irrigation, type of fertilizers, and use of dust control chemicals on plant growth and surface coverage. Best grass coverage, nearly 100 percent with 240 plants per square foot, was developed in a section that was seeded with crested wheatgrass, fertilized with sewage sludge, and sprinkler irrigated. For comparison, a section that had been treated with commercial fertilizers developed 3.1 crested wheatgrass plants per square foot and 24 percent coverage without irrigation, and 8 plants per square foot and 75 percent coverage with irrigation. Results of spraying a dust control chemical were inconclusive. Russian-thistle invaded all test sections and ranged in density from 0.6 to 7.3 plants per square foot.

RI 8654. An Iron-Aluminum-Molybdenum Alloy as a Chromium-Free Stainless Steel Substitute, by J. S. Dunning. 1982. 13 pp. 4 figs. The Bureau of Mines investigated a series of Fe-Al-Mo alloys strengthened by ZrC (zirconium carbide) precipitates as chromium-free substitutes for stainless steels. Melting and fabrication methods were devised, and the effects of minor additions of columbium (niobium) and cerium on the mechanical properties and oxidation resistance were determined. Zirconium carbides could not be controlled reliably to produce fine precipitate dispersions. A more reliable carbide strengthening mechanism is required if the high-temperature strengths of types 304 and 316 stainless steels are to be duplicated. Workability and oxidation resistance of the alloy series were excellent.

RI 8655. Copper Losses and the Distribution of Impurity Elements Between Matte and Silica-Saturated Iron Silicate Slags at 1,250° C, by E. A. Johnson, P. E. Sanker, L. L. Oden, and J. B. See. 1982. 18 pp. 14 figs. The Bureau of Mines determined the effect of slag additives on copper solubility and the distribution of typical impurity elements between copper-iron matte and silica-saturated fayalite (iron silicate) slag at 1,250° C, in CO-CO_2 atmospheres with 10 pct SO_2. Small additions (<10 pct) of CaO,

Al_2O_3, and MgO were shown to decrease copper solubility of the slag. Additions of CaO increased the solubility of bismuth and tellurium in the slag at lower matte grades. Al_2O_3 additions decreased the solubility of tellurium in the slag, but increased that of bismuth at lower matte grades. MgO additions increased the solubility of both at lower matte grades. With no additives, matte grade did not affect the solubility of bismuth in slags, whereas increasing matte grade resulted in a slight decrease in the tellurium solubility in slag. Additions of CaO or As_2O_3 alone to the slag increased selenium and arsenic distribution to the matte, but had little or no effect on antimony distribution; whereas small MgO additions decreased antimony distribution to the matte but had no effect on arsenic and selenium distribution. In slags with no additives, selenium distribution to the matte increased with increasing matte grade, while that of antimony decreased and that of arsenic was unchanged.

RI 8656. Electrochemical Studies of Platinum-Group Metals in Molten Alkali Metal Cyanides, by D. R. Flinn and C. L. Manger. 1982. 16 pp. 9 figs. The Bureau of Mines has studied the electrochemical parameters important to the preparation of coatings of the platinum-group metals. Using molten mixtures of sodium and potassium cyanides in an inert atmosphere, techniques have been developed that permit the preparation of baths for platinum, rhodium, and iridium electrodeposition. Cyclic voltametric and slow sweep rate linear polarization techniques have been utilized to determine optimum potential and current values for preparation of plating baths and for the electrodeposition of coatings. Techniques are described for the deposition of platinum and rhodium coatings at near 100 percent anode and cathode current efficiencies, and for iridium at approximately 80-percent efficiency. Palladium deposition from these molten cyanide baths remains unsatisfactory. The chemistry of the palladium-containing cyanide bath is discussed. Examples of scanning electron microscope photomicrographs of typical platinum coatings are presented. Techniques are described for the preparation of platinum coatings on large objects.

RI 8657. Laboratory Testing of Chemical Oxygen Self-Rescuers for Ruggedness and Reliability, by Jerry W. Stengel, Nicholas Kyriazi, and Sarah L. Benz. 1982. 21 pp. 12 figs. The Bureau of Mines subjected two manufacturers' chemical oxygen (KO_2) self-rescue breathing apparatus to a series of laboratory environmental treatments designed to stimulate various conditions in underground coal mines. The environmental treatments consisted of extremes of temperature, shock, and vibration. The tests were designed to be used as predictors of the ability of the self-rescuers to survive those environmental insults with no degradation in their protection to the wearer. Based on the severity of the treatments, simulating conditions more severe than offered by the mining environment, the two apparatus tested should be able to withstand the abuse offered by the mining environment and still function as intended in an emergency. Correlation of these tests with results of long-term field evaluations is needed to provide confidence in the laboratory tests as predictors.

RI 8658. Superheated Drop Vaporization: Halon 1301, by John C. Edwards and Henry E. Perlee. 1982. 19 pp. 6 figs. The Bureau of Mines has developed a time-dependent droplet vaporization model (in the absence of forced convection) that can be applied to the vaporization of liquid Halon 1301 droplets (vapor pressure at 300 K = 14 atm) sprayed from an extinguisher. It was found that rapid surface vaporization quickly lowers the droplets' surface temperature very near to the boiling temperature, and the vaporization becomes diffusion controlled. Although the lifetime of the droplet is proportional to the square of the initial radius of the droplet, the elapsed time prior to complete droplet vaporization is not proportional to the square of the droplet radius, as an equilibrium model would indicate.

RI 8659. Recovery of Cadmium, Zinc, and Lead From Lead Smelter Flue Dusts, by V. R. Miller, T. L. Hebble, and D. L. Paulson. 1982. 12 pp. 6 figs. The Bureau of Mines has developed a technique to separate and recover the three major components, Pb, Zn, and Cd, from lead smelter flue dust. This research was conducted as part of the Bureau's effort to reduce environmental conflicts and occupational hazards associated with mineral-processing operations and to recover valuable constituents in emissions and effluents. The laboratory process utilizes sulfation roasting of the flue dust followed by water leaching to extract over 95 pct of the cadmium and zinc. Ninety-nine percent of the cadmium was recovered from solution by cementing with zinc dust, and zinc was electrowon from the resulting solution after purification. Zinc electrolysis was carried out in a 1-liter cell at 35° C with a cathode-current density of 8 A/dm^2 in a solution containing 65 g/l Zn^{++} and 180 g/l H_2SO_4. Current efficiencies of 80 pct were obtained. The leached residue consisted largely of $PbSO_4$, which was converted to $PbCO_3$ and leached with H_2SiF_6 to produce $PbSiF_6$ electrolyte. Ninety-five percent of the lead contained in the residue was converted to electrolyte. Lead was electrowon from solutions containing 70 g/l Pb^{++} and 90 g/l H_2SiF_6 using a lead cathode, PbO_2-coated titanium anodes at 28° C, and a current density of 1.6. A/dm^2. Current efficiencies approaching 92 pct were obtained. Accessory minerals such as cobalt and nickel were separated into purification residues and liquor.

RI 8660. Determination of Geologic Features Associated With Linears, by Jacqueline H. Jansky and Paul W. Jeran. 1982. 8 pp. 5 figs. The Bureau of Mines conducted a study to determine the relationship between geologic features and linears. Cleats, kettlebottoms, and roof rolls were mapped and superimposed on the linear plots for a coal mine in West Virginia. No clear relationships were evident. This may be due, in part, to the mining practice of leaving head coal, which obscures geologic features that may exist in the roof. Future studies should concentrate on mines where roof is extensively exposed.

RI 8661. Anion Characterization of Florida Phosphate Rock Mining Materials and U.S. Cement Kiln Dust by Ion Chromatography, by Gary W. Kramer and Benjamin W. Haynes. 1982. 8 pp. 2 figs. The Bureau of Mines has developed a rapid analytical method for the determination of anions by ion chromatography (IC) in phosphate rock mining materials and cement kiln dust (CKD). The procedure employs an Na_2CO_3 fusion of the sample, followed by a water extraction that allows direct injection of the sample into an ion chromatograph without separator column poisoning by the transition metal ions. Fluoride (F^-) and phosphate (PO_4^{3-}) were determined in 24 phosphate rock processing and waste material samples by the IC

method. The results were compared with a pyrohydrolytic distillation-titration method for F^- and a colorimetric procedure for PO_4^{3-}. Excellent analytical agreement was obtained for F^- and PO_4^{3-} values determined by IC and the comparable wet chemical methods. Fluoride values ranged from 0.3 wt-pct in the filter cake to 3.6 wt-pct in phosphate rock concentrate. Phosphate values ranged from 1.2 wt-pct in the filter cake to 33.8 wt-pct in the rock concentrate. Fluoride, chloride, phosphate, nitrate, and sulfate in several CKD samples were determined by the IC method and standard wet chemical techniques. Excellent agreement was obtained between the two methods for all anions. A total of 113 CKD samples from all areas of the United States was analyzed by the IC method. Fluoride values ranged from < 0.01 to 0.36 wt-pct. Chloride values ranged from < 0.01 to 12.5 wt-pct. Sulfate values ranged from 0.41 to 31.6 wt-pct. Phosphate and nitrate were detected in only about 25 pct of the samples at > 0.02 wt-pct. Maximum phosphate and nitrate values were 1.0 and 1.6 wt-pct, respectively.

RI 8662. Superplasticity in Commercial and Experimental Compositions of Magnesium Alloy Sheet, by M. M. Tilman and L. A. Neumeier. 1982. 29 pp. 17 figs. The Bureau of Mines conducted research to evaluate superplastic behavior in commercial magnesium-base alloys AZ61A, ZK60A, ZW3, AZ31B, ZW1, and an experimental Mg-12 pct Al alloy. Strain-rate sensitivity indices (m-values), maximum elongations, and effects of superplastic elongation on tensile properties were determined on fine-grained sheet. Inert-gas-pressure hemisphere-forming tests were conducted on selected sheet stock of the five alloys. Formability trials on AZ31B alloy sheet were conducted on industrial equipment for comparison with commercial superplastic forming of Zn-Al alloy. Closed-die-forming tests were performed on extruded ZK60A rod. All alloys exhibited well over 100-pct elongation, indicating superplasticity, at temperatures and strain rates near the maximum m-values. Tensile properties were generally reduced following 100-pct superplastic elongation, but not to an extent that would preclude use of the commercial alloys in the superplastically deformed condition. The potential for industrial superplastic forming of AZ31B sheet was indicated by hemisphere forming in the laboratory and substantiated in industrial forming trials.

RI 8663. Effect of the Diurnal Cycle and Fan Shutdowns on Radon Concentration in an Experimental Uranium Mine, by Connie S. Musulin, John C. Franklin, and V. W. Thomas. 1982. 13 pp. 12 figs. Radon concentrations in shallow uranium mines such as the Bureau of Mines experimental research mine are affected by barometric pressure changes. The radon concentrations show a significant correlation with absolute pressure, but over a period of days, a steady rise or fall in barometric pressure will result in noncorrelation of data. Fan shutdowns also affect radon concentrations, and an equation was derived to determine the time required for the radon concentration to return to normal after a fan shutdown, whether the ventilation is blowing or exhausting.

RI 8664. Radon Emanation From Stopes Backfilled With Cemented Uranium Mill Tailings, by J. C. Franklin, R. A. Washington, J. C. Kerkering, H. Montone, and R. Regan. 1982. 8 pp. 3 figs. An experiment was conducted by the U.S. Bureau of Mines and the Canada Centre for Mineral and Energy Technology (CANMET) to measure the emanation rate of radon from cemented unclassified mill tailings in two dewatered stopes of a uranium mine at Elliot Lake, Ontario, Canada. The radon was monitored upstream and downstream and in both stopes to determine the concentration in the stopes and the amount exhausted from both stopes. The emanation rate was determined to be 0.55 $pCi/cm^2\ sec^{-1}$ from the mill tailings, which is approximately 1,000 times higher than the average flux in the mine before backfilling.

RI 8665. Probability of Encountering Coalbed Discontinuities During Vertical and Horizontal Borehole Drilling, by David W. Houseknecht. 1982. 21 pp. 11 figs. Probabilities of encountering coalbed discontinuities during vertical or horizontal drilling in a specific coalbed can be estimated based on analysis of mined-out areas of the coalbed where the size, shape, orientation, and distribution of discontinuities are known. The resultant probability estimates can be applied to cost-risk evaluations of drilling programs proposed for exploratory, developmental, or methane drainage purposes in undeveloped areas of that coalbed. Data compiled from mine maps of the Beckley Coalbed in southern West Virginia were used to estimate the probabilities that discontinuities would be encountered in two illustrative hypothetical drilling programs—one for drilling vertical boreholes and the other for drilling horizontal boreholes. Analysis based on a mined-out area of the Beckley Coalbed indicated that vertical methane drainage boreholes spaced 1,000 feet apart in a square grid pattern would each have a 29-percent probability of encountering a discontinuity in a geologically unexplored area of the coalbed. It was also determined that exploratory vertical drilling could locate most of the discontinuities if a borehole spacing of 2,500 feet were used. For horizontal drainage boreholes in the Beckley Coalbed, the analysis indicated a linear relationship between hole length and the probability of encountering a discontinuity.

RI 8666. Electrokinetic Densification of Solids in a Coal Mine Sediment Pond—A Feasibility Study (In Two Parts). 1. Laboratory and Field Tests, by R. H. Sprute and D. J. Kelsh. 1982. 32 pp. 15 figs. This report describes a feasibility study to consolidate coal waste sludge in a 100-acre pond by applying direct current between floating and buried electrodes. The study was conducted by the Bureau of Mines under a cooperative agreement with Washington Irrigation and Development Co., located near Centralia, Wash. Part 1 covers results of laboratory tests at the Bureau's Spokane Research Center and a small-scale field test at the cooperator's coal preparation plant in western Washington. The process is efficient and cost-effective when power is applied at low current density. A proposed system, fully described in part 2, has electrodes covering 21 acres of pond surface radially arranged around a central power platform. Densification of pond contents would require 2 to 3 years of treatment. Total cost of equipment, labor, and material is approximately $500,000.

RI 8667. Weathering of a Base-Metal Sulfide Leaching Residue, by T. G. Carnahan and M. A. Lucas. 1982. 11 pp. 12 figs. The Bureau of Mines conducted laboratory-scale weathering research on a leach residue containing elemental sulfur and mixed metal sulfides. Experiments were performed to determine pH and impurity element concentrations in the effluents as functions of time

and to determine the effects on effluent concentrations of mixing the residue with dolomite tailing material. Four 800-day tests were conducted simultaneously. Soluble metal concentrations, especially zinc and copper, were excessive in the effluents from washed and unwashed samples of the residue. Concentrations of up to 20 g/l of Zn and 12 g/l of Cu were obtained. The pH values of the unwashed and washed residue effluents at the completion of the experiments were 2.8 and 1.9, respectively. Sulfuric acid from oxidation of pyrite caused the pH decrease. Mixing unwashed residue with dolomite tailing to maintain a near-neutral pH minimized the heavy metals content in the effluents. The pH in the dolomite tests increased slowly after the first 360 days and attained values of 7.8 and 8.2, respectively, for tailing containing 1 pct leach residue and for tailing devoid of leach residue. Dissolved zinc and copper did not exceed 0.10 g/l of Zn and 0.001 g/l of Cu.

RI 8668. Recovery of Ultrafine Barite From Mill Wastes, by W. E. Lamont and G. V. Sullivan. 1982. 12 pp. 6 figs. The Bureau of Mines conducted flotation tests on a mixture of barite waste materials from Nevada in which essentially all of the barite values were finer than 20 micrometers. Flotation variables investigated in these tests were the effects of (1) sodium silicate as a pulp dispersant, (2) sodium hydroxide as a pH modifier, (3) increased amounts of sodium cetyl sulfate, (4) conditioning time, and (5) solids content during conditioning. The optimum flotation conditions were achieved by adding 2.5 pounds of sodium silicate and 10 pounds of sodium cetyl sulfate per ton of feed and conditioning the pulp for 20 minutes at a 35-percent solids content. Using these conditions, a concentrate was produced that contained 94.7 percent $BaSO_4$, with an attendant recovery of 90.9 percent of the barite in the feed. In addition to the flotation tests, a selective barite flocculation process was developed to treat extremely fine barite. A barite concentrate containing 96.5 percent $BaSO_4$ with an attendant recovery of 82.1 percent of the barite was produced by selective flocculation. A process patent application has been filed based on this process.

RI 8669. Degasification of the Mary Lee Coalbed, Brookwood, Ala., by John H. Perry, Leonard J. Prosser, Jr., and Joseph Cervik. 1982. 13 pp. 13 figs. The Bureau of Mines has developed several techniques for draining methane from coalbeds in advance of mining. Drilling long horizontal holes from an underground location is one such technique, which was successfully demonstrated in the Pittsburgh and Sunnyside Coalbeds. The same technique has now been applied in the Mary Lee Coalbed at Jim Walter Resources, Inc.'s No. 4 Mine, Brookwood, Ala., where two holes were drilled horizontally—one to a depth of 1,010 feet (308 m) and the other to 540 feet (165 m). The 1,010-foot (308-m) hole proved successful in degasifying a portion of the Mary Lee Coalbed. The hole drained methane for 1 year, during which time the initial gas flow of 200,000 ft^3/d (5,663 m^3/d) declined to 65,000 ft^3/d (1,840 m^3/d). Total gas production was 40×10^6 ft^3 (1.1×10^6 m^3). The gas was of commercial quality, with 98 pct methane and a heat rating of 990 Btu/ft^3 (36.89 Mj/m^3). The methane emissions from the faces of the mine section advancing into the degasified zone were reduced by 60 pct. The 540-foot (165-m) hole was terminated prematurely when it became impossible to maintain an open hole. Because of caving, very little gas was drained through this hole.

RI 8670. Firing an Iron Ore Pelletizing Kiln With Low-Btu Gas From Lignite, by John C. Nigro. 1982. 22 pp. 7 figs. This Bureau of Mines report summarizes the performance characteristics of a 30-day around-the-clock gasification-pelletizing test conducted in October and November of 1980 with North Dakota Indianhead lignite. Gasification was conducted in a commercial-size, 6.5-ft-diam, single-stage, fixed-bed, atmospheric pressure producer with a rated capacity of about 30 million Btu/hr. Iron oxide pellets made from a commercial hematite concentrate were fired with the low-Btu gas in a 2.8-ft-diam by 35-ft-long pilot plant rotary kiln at a rate of 900 lb of pellets per hour. Gasifier operations at fuel feed rates up to 3 tons of lignite per hour and hematite pellet induration with raw 160-Btu/std ft^3 lignite gas are described.

RI 8671. Thermodynamic Data for Arsenic Sulfide Reactions, by A. D. Mah. 1982. 85 pp. Thermodynamic data on compounds of arsenic and sulfur were critically evaluated by the Bureau of Mines. Changes of standard enthalpy and Gibbs energy, and logarithms of the equilibrium constants were tabulated as a function of temperature for reactions involving these compounds.

RI 8672. Sludge Disposal From Acid Mine Drainage Treatment, by T. E. Ackman. 1982. 25 pp. 7 figs. The Bureau of Mines conducted a study of current trends in methods employed by the coal industry to dispose of acid mine drainage (AMD) treatment sludge. Thirty-three AMD treatment plants, operated by 11 Pennsylvania coal companies, were randomly surveyed. These plants provided data for calculating sludge volumes, as well as information on sludge settling, transportation, and disposal. Onsite visits allowed observation of problems associated with the various methods of sludge disposal: (1) disposal into a deep mine, (2) permanent retention in ponds, (3) disposal at an active coal refuse area, and (4) onsite burial. Method 1 is the most frequently used and the most environmentally sound. It is apparent, based on this representative sampling of AMD treatment plants, that the magnitude of sludge production is such that an aggressive and directed effort in reduction of sludge volume is seriously needed. The areas of major concern are (1) the amount of surface land required for sludge storage and disposal, (2) reclamation of these disturbed surface areas, and (3) effective and efficient means of removing, transporting, and disposing of AMD sludge. In this report, an engineering approach to the practical problems associated with the existing disposal methods is presented, together with recommendations for future research.

RI 8673. Recovery of High-Grade Barite From Waste Pond Materials, by W. E. Lamont and G. V. Sullivan. 1982. 13 pp. The Bureau of Mines studied the potential for recovering marketable barite concentrates that meet oil well drilling-mud specifications from barite waste pond materials. The study was conducted as part of the Bureau's research program to conserve domestic mineral resources by advancing mineral recycling technology. The samples, which were obtained from Georgia, Nevada, Missouri, and Illinois, varied widely in character, particle size, and barite content. The samples were treated with sodium silicate and sodium cetyl-stearyl sulfate and then floated. The flotation flowsheet was

modified to reject barren coarse and/or slime fractions from some of the samples, and one feed sample had to be scrubbed prior to flotation to remove residual flotation reagents. The cleaned concentrates had $BaSO_4$ contents ranging from 95.0 to 96.9 percent, while recovering 81.2 to 95.9 percent of the barite in the feed. The specific gravity of each concentrate exceeded the specification of 4.2. The removal of the flotation reagents from the flotation concentrate was not investigated. This research was conducted under a memorandum of agreement between the Bureau of Mines, U.S. Department of the Interior, and the University of Alabama.

RI 8674. Size and Shape Characterization of Fibrous Zeolites by Electron Microscopy, by Kim B. Shedd, Robert L. Virta, and Ann G. Wylie. 1982. 20 pp. 10 figs. The U.S. Bureau of Mines Particulate Mineralogy Unit examined the habits of six zeolite minerals commonly occurring in domestic zeolite deposits. Mineral habit is of interest because current theory on the potential for sarcoma production in test animals emphasizes the size and shape of mineral particles, without regard to composition or structure. A scanning electron microscopic study revealed that, of these six minerals, only mordenite and erionite crystallized in acicular to fibrous habits. The fibrous varieties of these two minerals were characterized by size and shape on the transmission electron microscope, and their dimensions were compared with those of asbestos and amphibole cleavage fragments. When comminuted, these two minerals possess "fibrosity indices" similar to those of amphibole cleavage fragments. One sample, a rare woolly erionite, has uniform widths, large aspect ratios, and a "fibrosity index" similar to those of asbestos.

RI 8675. Degasification Study From an Air Shaft in the Beckley Coalbed, by Tobias W. Goodman, Joseph Cervik, and George N. Aul. 1982. 19 pp. 19 figs. The Bureau of Mines conducted research to degasify a virgin block of coal in the Beckley Coalbed using long horizontal holes drilled in an array from the bottom of a ventilation air shaft. Eight horizontal holes and an in situ pressure hole were drilled in a radial pattern to depths ranging from 418 to 910 ft (127 to 277 m) and 205 ft (62 m), respectively. The investigation showed the shaft was in a basin saturated with water, which resulted in low gas flows from holes. The in situ pressure at 200 ft (61 m) into the coalbed was 79 psig (544.6 KN/m^2). The average gas and water flows for the eight holes were 94,100 ft^3/day (2,665 m^3/day) and 13 gal/min (49.3 l/min). After 514 days of degasification, 18.7 million ft^3 (0.53 million m^3) of gas had been drained. Methane face emissions, which were measured as a section advanced toward the shaft, were reduced about 77 pct, emphasizing the value of drainage by this technique. All holes were grouted before the area around the shaft was mined.

RI 8676. Chromium Recovery From Nickel-Cobalt Laterite and Laterite Leach Residue, by D. E. Kirby, D. R. George, and C. B. Daellenbach. 1982. 22 pp. 7 figs. In line with the Bureau of Mines goal of providing technology to maintain a supply of minerals adequate to meet national economic and strategic needs, a method for recovering chromite from lateritic material was investigated. Laterites are a large resource of Ni, Co, and Cr, critical metals of which the United States has insufficient domestic sources. A roast-leach method was developed by the Bureau to extract nickel and cobalt from domestic laterites. A concurrent effort was made to recover chromium from either unprocessed laterites or the leach residues. This report characterizes laterites and laterite leach residues. It describes a chromite recovery procedure using conventional industrial beneficiation equipment for sizing, low-intensity magnetic separation, and gravity concentration. Concentrates containing 20.0 to 22.4 pct Cr (29.0 to 32.7 pct Cr_2O_3) and with a 1.6:1 to 1.9:1 Cr-Fe ratio were recovered from laterites and residues containing 1.3 to 2.5 pct Cr with recoveries exceeding 50 pct. Because of their low grade and fine size, these concentrates would be suitable for preparing chromium chemicals. The direct beneficiation of laterites for chromite recovery resulted in the minerals containing nickel and cobalt concentrating in slime products. No iron oxide coproducts of acceptable grade were recovered from either laterites or residues.

RI 8677. Sand Bed Dewatering of Alumina Miniplant Tailings, by R. L. Rickel, P. J. Barrett, and D. M. Starrett. 1982. 10 pp. 4 figs. The Bureau of Mines, as part of its minerals environmental technology research, conducted a study of mine waste tailings disposal. Part of the investigation evaluated the sand bed dewatering technique for disposal of alumina miniplant tailings as a means to increase consolidation rates and contain effluents. The technique employs a bed of sand resting on an impervious bottom. The tailings slurry is impounded over the sand layer and is dewatered through bottom drain piping. The study employed a single 10-ft-high, 6-in-diam, clear polyvinyl chloride (PVC) column, and thickener wastes from the acid leaching of calcined kaolin clay. Results showed a consolidation rate of 41 in in 186 days for a total volume reduction of 37 pct. Sand bed dewatering was an efficient technique for solid consolidation and effluent containment when compared with data obtained from other dewatering studies.

RI 8678. Direct Flotation of Potash From Carnallite, by D. G. Foot, Jr., C. E. Jordan, and J. L. Huiatt. 1982. 11 pp. 4 figs. The Bureau of Mines devised a direct flotation method for recovering potash from carnallite ($KCl \cdot MgCl_2 \cdot 6H_2O$) ore characterized by a high content of water-insoluble impurities. The method includes (1) a decomposition leach of the carnallite, (2) flocculation-depression of the insoluble slimes, (3) potash rougher, cleaner, and recleaner flotation, and (4) final product leaching. The technique eliminates the necessity for removing the water-insoluble slimes by mechanical or flotation desliming. Laboratory results demonstrated that the direct flotation procedure, when compared with conventional techniques, yielded equivalent or improved flotation results with equal or less reagent consumption. Locked-cycle testing of the direct flotation method recovered 87.8 pct of the potassium in the flotation feed in a final product containing 60.6 pct K_2O. A flowsheet incorporating the carnallite leaching-potash flotation procedure is presented.

RI 8679. Hydrometallurgical Treatment of Arsenic-Containing Lead-Smelter Flue Dust, by P. A. Bloom, J. H. Maysilles, and H. Dolezal. 1982. 12 pp. 3 figs. Arsenic-containing flue dusts are currently being stockpiled by several nonferrous smelters in the United States. These stockpiles are a source of environmental concern since the dusts can be transported by wind and contain water-soluble arsenic. The stockpiles also represent an alternate source of metals. To provide a quality environment, the Bureau of Mines investigated a process to make

environmentally acceptable the discard of arsenic obtained from the treatment of arsenical flue dust. The process includes (1) leaching arsenic from a lead smelter copper dross flue dust, (2) fixing arsenic as an insoluble compound, and (3) recovering other metal values. Overall results of acid-leaching tests on lead-smelter flue dusts showed that H_2SO_4 dissolved 80 to 90 percent of the As, Zn, and Cd, and up to 86 percent of the In. Pb, Ag, and Au remain in the residue, which can be recycled to the smelter. Indium was recovered from the strong acid leach solution by solvent extraction; arsenic was fixed in a stable form by precipitation with $Fe_2(SO_4)_3$ and CaO or $CaCO_3$.

RI 8680. Operation of a Mineral Recovery Unit on Brine From the Salton Sea Known Geothermal Resource Area, by L. E. Schultze and D. J. Bauer. 1982. 12 pp. 4 figs. The Bureau of Mines operated a mineral recovery unit to recover metal values from post-flash geothermal brines from the Salton Sea known geothermal resource area as part of its research into the use of plentiful resources. The brine was available for metals recovery after its heat content had been used to generate electricity. The brine source was treated with lime to precipitate the contained iron, manganese, lead, and zinc before injection of the heat-depleted brine into the underground reservoir. Data are presented on the effects of process variables, such as rate and method of lime addition and air oxidation versus air exclusion. Variations in precipitation of metal values, composition of precipitates, effectiveness of slurry thickeners, and methods of treating the precipitates to recover metal values are discussed.

RI 8681. Beneficiation of a Phosphate Ore Produced by Borehole Mining, by B. E. Davis, T. O. Llewellyn, and G. V. Sullivan. 1982. 10 pp. As part of its program to increase the domestic availability of critical minerals, the Bureau of Mines conducted characterization and beneficiation studies on a St. Johns County, Fla., phosphate ore that was mined by borehole mining. Results revealed that the ore from this test mine was mostly sand-size carbonate-fluorapatite and quartz and contained 24.6 percent P_2O_5. Concentration by various flotation techniques produced phosphate concentrates that ranged, in percent, from 30.0 to 31.4 P_2O_5, 0.73 to 0.80 MgO, and 2.8 to 7.2 acid insoluble. Recovery of the phosphate from the ore ranged from 89.4 to 96.3 percent.

RI 8682. Failure Analysis of Diesel Exhaust-Gas Water Scrubbers, by Robert W. Waytulonis, Sean D. Smith, and Lito C. Mejia. 1982. 19 pp. 13 figs. The Federal Bureau of Mines contacted 29 organizations—mine maintenance departments and equipment manufacturers—concerning service experience and construction of diesel exhaust-gas water scrubbers. Scrubbers are used primarily on mobile diesel-powered mining equipment subject to 30 CFR 36. Because the scrubbers cool exhaust gas and act as flame arresters, their failure would compromise safety in underground mines. Scrubber maintenance problems and frequency and modes of failure were identified, and construction materials and techniques were evaluated. Three failed scrubbers were randomly selected from two cooperating mines, and their modes of failure were determined. In conjunction with failure analyses, mine water and scrubber water solution samples were chemically analyzed to characterize corrosive properties. Sludge and mineral deposits and different types of corrosion and metal fatigue were identified as problems leading to scrubber failure. The corrosion process is explained; maintenance practices, construction materials, and manufacturing methods that could be used to reduce premature failures and allow longer effective scrubber life are identified; and basic changes in scrubber design are suggested. If type 304 stainless steel is used throughout the scrubber and regular maintenance is performed, long, dependable service can be expected. Other materials such as 304L, 316, or other more exotic steel alloys may be necessary under certain conditions.

RI 8683. Determination of Sulfates in Diesel Exhaust, by Robert W. Freedman and Frederick A. Sharp. 1982. 7 pp. 3 figs. This report describes sampling and analytical procedures used for measurement of sulfates in diesel tailpipes and in the diluted exhaust within dilution tunnels. A variety of methods exist for sulfate analysis for such systems, including ion exchange. Two chemical methods used by the Bureau of Mines are described in detail. These are based upon spectrophotometric measurement of chloranilic acid using barium chloranilate. The procedures are rapid and relatively inexpensive. In general, ion exchange is preferred by many analysts for sulfate analysis. However, it is more complex and expensive than chloranilic acid procedures, which are adequate for exhaust analysis.

RI 8684. Application of a Photodiode Array Optical Spectrometer to the Study of the Incendivity of Light Alloys Impacting on Rusted Steel, by T. J. Driscoll, D. R. Flinn, and W. C. Lederer. 1982. 17 pp. 8 figs. Methane-air mixtures can ignite as a result of sparking or rubbing of materials, particularly by impact involving light alloys and rusted steel where an exothermic thermite reaction can occur. This report reviews the published literature and describes a new method utilized by the Bureau of Mines for studying the processes occurring during collisions of light metals with rusted steels. The method involves measuring the spectra of sparks and explosions in methane-air mixtures using a photodiode array. Initial results obtained using magnesium and aluminum alloy 6061-T651 projectiles striking rusted steel are reported. These results indicate that the continuous parts of the spectra show a larger intensity for incendive sparks compared with non-incendive sparks, with the largest relative change in the higher energy, ultraviolet region. An unexpected shift of the intensity maximum for the continuous parts of the spectra towards the infrared region was observed for the more incendive sparks. Evaluation of rusted steel samples with electron microscopy, energy-dispersive X-ray spectrography, and Auger electron spectroscopy after they had been impacted by aluminum alloys indicated that aluminum was transferred to the steel in the form of islands that became larger as a function of increasing projectile velocity.

RI 8685. Refractory Properties of Brick Produced From Beneficiated Chrome-Containing Furnace Linings, by Arthur V. Petty, Jr. 1982. 16 pp. 8 figs. In Bureau of Mines research on recycling chrome-containing refractory wastes, used refractories from argon-oxygen decarburization and electric steelmaking furnaces were beneficiated. By means of dry magnetic separation on minus 6-mesh crushed wastes, a concentrate was produced. After minor adjustments to the particle size distribution, full-size refractory brick were dry-pressed by a commercial producer and fired to 1,450° and 1,730° C. Standard testing procedures were used to determine

the cold-crushing strength, modulus of rupture at 25°, 1,300°, and 1,500° C, hot load, thermal shock resistance, thermal expansion, and slag resistance. Optical and electron microscopy were used to determine grain-bonding mechanisms, and energy-dispersive analysis of X-rays was used to determine elemental distribution. The test results indicate that the beneficiated material could be used to produce a refractory product suitable for moderate-temperature applications.

RI 8686. Molybdenum Removal From Concentrator Waste Water, by R. O. Dannenberg, A. E. Petersen, P. B. Altringer, and P. T. Brooks. 1982. 16 pp. 6 figs. The Bureau of Mines conducted laboratory batch and small-scale continuous tests to remove traces of dissolved molybdenum from water simulating waste discharged from a molybdenum concentrator. Molybdenum concentrations, initially ranging from 2 to 10 ppm, were decreased to 0.5 ppm or less by coprecipitation of the molybdenum with freshly precipitated ferric hydroxide. The precipitate was separated as a froth by dissolved-air flotation for subsequent disposal. Although the treated water met current environmental standards for contained molybdenum, contained particulate iron might have to be removed by filtration for the water to be acceptable. Estimated costs of treating concentrator effluent water were 55 cents, 57 cents, and 64 cents per 1,000 gal at initial molybdenum concentrations of 2, 4, and 10 ppm, respectively.

RI 8687. Introduction of Sulfur Into Copper Converter Slags To Produce Copper Matte, by J. I. Paige and W. E. Anable. 1982. 16 pp. 7 figs. As part of a continuing effort to develop technology that maximizes mineral and metal recovery from domestic resources, the Bureau of Mines investigated a method to totally utilize copper converter slags without recycling them back through the matte smelting furnace. The research was directed toward (1) recovering the contained copper in converting slags by producing a recyclable copper-iron matte, (2) carbothermically reducing the slags to recover the iron, and (3) producing slag wool from the depleted slags. This report deals with the reduction of three industrial converting slags, containing 2.0 to 7.3 wt-pct Cu, in an 800-kVA electric arc furnace to produce a recyclable copper-iron matte. The addition of sufficient iron pyrite to provide 29 to 113 pct of the stoichiometric sulfur (based on producing 40-pct-Cu matte) produced a recyclable matte (36 to 61 pct Cu) at an energy consumption of 520 to 700 kWh per ton of solid material charged. The expected energy saving for treating molten slag is an electric furnace (5- to 9-MVA range) is about 400 kWh per ton of molten slag treated.

RI 8688. Enthalpies of Formation of $ZnO \cdot 2ZnSO_4$ and $CoSO_4 \cdot 6H_2O$, by H. C. Ko and R. R. Brown. 1982. 6 pp. As part of the Bureau of Mines effort to provide thermodynamic data for the advancement of mineral technology, the standard enthalpies of formation for $ZnO \cdot 2ZnSO_4$ and $CoSO_4 \cdot 6H_2O$ were determined by HCl acid solution calorimetry. The values are -550.31 ± 0.28 and -641.33 ± 0.15 kcal/mol, respectively.

RI 8689. Flotation of Rare Earths From Bastnäsite Ore, by E. Morrice and M. M. Wong. 1982. 13 pp. 17 figs. As part of its efforts to maximize process efficiency and decrease energy requirements in mineral processes, the Federal Bureau of Mines has investigated methods for beneficiating bastnäsite ores from Mountain Pass, Calif. The results of a bench-scale study on the flotation of bastnäsite ore are presented. Flotation at a pulp temperature of 40° to 45° C yielded a cleaner concentrate containing 58.7 pct RE_2O_3 at a rare-earth recovery of 67 pct. These results are comparable to those reported for the commercial beneficiation method in which the pulp is heated to boiling before flotation. An attempt was also made to recover a barite flotation concentrate from the bastnäsite rougher tailing. Concentrates containing only 70 pct barite were obtained.

RI 8690. Recovery of Zinc and Sulfur From Sphalerite Concentrates by Reaction With Sulfuric Acid, by H. H. Dewing, S. E. Lay, and A. A. Cochran. 1982. 16 pp. 7 figs. The Bureau of Mines constructed a process research unit (PRU) to demonstrate new technology for extracting zinc from sphalerite concentrates. Up to 9 kg/hr of sphalerite (ZnS) concentrate was reacted at ambient pressure in the PRU with 80 pct sulfuric acid at 160° to 180° C to produce zinc sulfate and elemental sulfur. The PRU consisted of a three-stage glass reactor system: a 4-liter premix stage in which feed was slurried with 78 to 82 pct H_2SO_4, a 40-liter stirred reactor, and a 150-liter settling stage in which high reaction conversions were effected and excess H_2SO_4 for recycle was separated from insoluble $ZnSO_4$ and sulfur. Evolution of sulfur-containing gases was minimized by subsurface addition of acid feed slurry to the stirred reactor and by exclusion of air from the reactor to prevent the oxidation of elemental sulfur. Conversion of zinc to zinc sulfate averaged over 99 pct at the optimum acid concentration of 80 pct. Total sulfur losses (primarily SO_2) were less than 2 pct of the sulfur in the sphalerite. Elemental sulfur remained in the insoluble portion of the settled reactor product after leaching with simulated spent zinc electrolyte containing sulfuric acid. The sulfur residue contained 75 to 89 pct sulfur. Neutral zinc sulfate, required for zinc electrowinning processes, was separated from the sulfuric acid leach solution by crystallization at $-15°$ C as zinc sulfate heptahydrate ($ZnSO_4 \cdot 7H_2O$). The crystallization operation simultaneously effected a partial concentration of the recycled electrolyte solution by removing water.

RI 8691. Software Techniques in Microseismic Data Acquisition, by John P. Coughlin. 1982. 51 pp. 3 figs. Software techniques developed by the Bureau of Mines Denver Research Center for real-time microseismic data analysis are presented. These techniques focus on the simple acquisition of P-wave arrival times and their use in event location. The paper discusses in detail software techniques to separate microseismic events from mining noise such as drilling and from very large events such as rock bursts. Incorporation of these techniques has enhanced the reliability and accuracy of computer-based monitoring of microseismic activity in ongoing research by the Bureau.

RI 8692. Acoustic Emission Source Location—A Mathematical Analysis, by Francis R. Redfern and Robert D. Munson. 1982. 27 pp. 4 figs. Newton's method of solving a nonlinear equation is employed to develop a least-squares acoustic emission source location method in which the spatial residuals of the location equations are minimized. These residuals, related to the distances from the least-squares source location perpendicular to the surfaces described by the location equations, permit location error to be estimated to first order along the spatial axes. The solutions obtained by this method are the

best spatial solutions to the location equations in the least-squares sense. Also presented is a procedure by which the geometrical control of a transducer array can be evaluated using the rate of change of source location with fractional velocity change.

RI 8693. Magnet Properties of Alloys Containing Lanthanum, Cobalt, Copper, and Magnesium, by J. W. Walkiewicz and M. M. Wong. 1982. 16 pp. 10 figs. One of the objectives of the Bureau of Mines is to develop substitution technology for scarce materials. In accordance with this goal, alloys containing lanthanum, cobalt, copper, and magnesium were investigated for fabrication of rare-earth-cobalt (RE-Co) permanent magnets. A complete substitution of lanthanum for samarium and a partial substitution of copper for cobalt was accomplished. Magnets of La-Co and La-Co-Cu-Mg alloys were fabricated by powder metallurgy techniques and evaluated. A maximum intrinsic coercivity of 23.2 kOe was obtained with a La-Co-Cu-Mg alloy. In comparison, maximum values of 9.3 kOe and 11.6 kOe were obtained with La-Co and La-Co-Cu alloys, respectively. The substitution of copper and magnesium for part of the cobalt resulted in a large increase of intrinsic coercivity, similar to the results of Bureau research with mischmetal-Co-Cu-Mg alloys. Unlike the mischmetal-Co-Cu-Mg magnets, the La-Co-Cu-Mg magnets showed signs of physical deterioration on exposure to air. The effects of fabrication parameters on the magnetic properties of the La-Co-Cu-Mg alloys were also determined.

RI 8694. Aluminum Extraction From Anorthosite by Leaching With Hydrochloric Acid and Fluoride, by P. R. Bremner, J. A. Eisele, and D. J. Bauer. 1982. 7 pp. 4 figs. The United States is more than 90 pct dependent on imported bauxite as a source for aluminum, but it has vast nonbauxitic aluminum resources, such as kaolinite, anorthosite, alunite, etc. As part of a program to devise processes for treating these resources, the Bureau of Mines investigated a bench-scale leaching process using hydrochloric acid (HCl) and fluoride to extract aluminum from Wyoming anorthosite. HCl and fluoride-to-aluminum (F/Al) mole ratios were studied with respect to aluminum extraction for single-stage, cocurrent, and countercurrent leaching modes. Using 95 pct stoichiometric HCl and a F/Al mole ratio of 0.27, 90 pct of the aluminum was extracted by countercurrent leaching. Single-stage leaching with the same amount of acid and fluoride extracted 48 pct of the aluminum. Three fluoride sources, CaF_2, Na_2SiF_6, and H_2SiF_6, were used and gave similar results on aluminum extractions.

RI 8695. Vanadium Roast-Leach Dissolution From Western Phosphate Tailings, by J. H. Russell, D. G. Collins, and A. R. Rule. 1982. 19 pp. 4 figs. As part of its efforts to maximize resource recovery, the Bureau of Mines conducted studies to recover valuable byproducts from Western phosphate beneficiation tailings. Potential byproducts include phosphorus, vanadium, and uranium. The objective was to determine roasting and leaching conditions for maximum dissolution of vanadium from tailings containing approximately 13 pct P_2O_5 and 0.23 pct V. Sulfuric acid leaching tests were conducted with the tailings either as a dilute suspension, dried, or in a roasted condition with or without NaCl added during roasting. More than 90 pct of the vanadium was dissolved by roasting at 850° C for 120 min with 8-pct NaCl and leaching at 75° C for 120 min with an excess of 2*N* H_2SO_4. By roasting without NaCl and avoiding the difficulties of the chloride impurity, nearly 80-pct vanadium dissolution was achieved with an 800° C roast for 180 min. Quadratic regression equations were derived to relate vanadium dissolution to roasting and leaching conditions.

RI 8696. Chemical Equilibria in Chlorination of Clay, by A. D. Mah. 1982. 43 pp. To assist Bureau of Mines research in extractive metallurgy and to add to the thermodynamic data base useful to others, energy calculations were made for 63 reactions relating to investigations on the production of anhydrous aluminum chloride from chlorination of clay.

RI 8697. Recovery of Iron and Copper From Copper Smelting Furnace Slags by Carbon Injection, by J. I. Paige, D. L. Paulson, and W. L. Hunter. 1982. 19 pp. 7 figs. The Bureau of Mines, U.S. Department of the Interior, conducts research on methods to minimize the requirements for mineral raw materials through conservation, substitution, and increased minerals and metals recovery from primary and secondary domestic resources. To further this goal, prior Bureau research had devised a pyrometallurgical technique (RI 8211) to recover metallic iron and copper from molten copper smelting furnace slags by carbothermic reduction. As a continuation of this Bureau research on the carbon injection technique, reverberatory and electric furnace slags were treated in an 800-kva electric arc furnace by simultaneously top feeding the slag and injecting coke breeze into the bottom of the molten bath. Results of the tests show that 76 to 89 pct of the copper and up to 48 pct of the iron contained in the smelting furnace slag were recovered in a metallic phase, while 56 to 82 pct of the carbon injected into the system was utilized as the reductant. Laboratory evaluation has shown that the metal product, which contains 86.9 to 95.0 wt-pct iron and 1.3 to 4.1 wt-pct copper, will be a satisfactory medium for recovering copper by cementation. The expected energy consumption for the process is 110 kwhr per ton of molten slag treated and 520 kwhr per ton of solid material charged.

RI 8698. Economic Analysis of Surface Mining Mobile Equipment Fire Protection Systems, by William H. Pomroy, Neil Goodwin, and Frank Lynch. 1982. 23 pp. 11 figs. The Bureau of Mines, through a 4-year program of combined in-house and contract research, has developed the necessary hardware and software technology to provide rugged, reliable automatic fire protection for surface mining mobile equipment. One element of this program was a continuing effort to help foster rapid mining industry acceptance of the technology by keeping end user costs reasonable. This report is an analysis of the economic impact of surface mining mobile equipment fires and the cost benefit of utilizing automatic fire protection systems to abate these losses.

RI 8699. An Evaluation of Used Aluminum Smelter Potlining as a Substitute for Fluorspar in Basic Oxygen Steelmaking, by Victor R. Spironello and Ishwarlal D. Shah. 1982. 11 pp. 3 figs. The Bureau of Mines has conducted studies of the slags related to ferrous technology to evaluate experimentally acceptable substitutes for the auxiliary flux, mineral fluorspar, in steelmaking operations. Comparative heats were made in a 1/4-ton, pilot-scale, basic oxygen furnace (BOF) to evaluate a waste material known as "used potlining." Used potlining is recovered from alumina reduction cells after its useful

life and contains significant levels of fluorine and sodium in various compounds. This material in both lump and pelletized form provided adequately fluid slags, based on observations made during BOF operation. No adverse effects were found on furnace performance, metal and slag chemistry, the strength of the steel produced, or the environment. Fluorine recovery in the slag was about the same as that obtained when using fluorspar, as were the losses to the scrubber water and solids. No difference was observed in furnace-refractory attack, as determined by the level of magnesia in the slag. The sodium recovered in the slag apparently also contributed to fluidity, since the fluorine input was at about two-thirds that of the fluorspar. Used potlining was determined experimentally to be a satisfactory substitute for fluorspar in basic oxygen steelmaking.

RI 8700. Methodology for Determining Occluded Gas Contents in Domal Rock Salt, by David M. Hyman. 1982. 11 pp. 2 figs. The Bureau of Mines has developed two experimental designs for determining the volumes and relative proportions of the various gas species, particularly methane (CH_4), occluded in rock salt. To date, the rock salt samples analyzed have been relatively small (400- to 1,000-gram) grab samples from Louisiana gulf coast domal salt mines. The results obtained are comparable to results in Polish domal salt mines, in terms of occluded gas volumes per mass of rock salt. The notable difference between the Louisiana and Polish occluded gas mixtures is in the relative proportions of the individual gas species. The two methods used by the Bureau are ball-mill crushing and dissolution. Of the two, the dissolution method appears to be more versatile because it can be performed in situ. The relevance and applicability of data on the occluded gas contents of rock salt are dependent on sample size, sample collection method, geologic context of the sample, and the correlation with gas emissions that occur as a result of mining-induced fractures and pressure differentials.

RI 8701. A Case History of a Major Rock Burst, by Fred Leighton. 1982. 14 pp. 9 figs. The Bureau of Mines monitored a rock-burst-prone pillar in a metallic ore vein, up to and through failure, to measure its reactions to increasing loads, as it was mined. Three parameters were monitored: the stress changes at chosen points within the pillar, the displacement characteristics of the drift above the pillar, and the microseismic activity in and around the pillar. In descending order of effectiveness, the microseismic technique, vibrating wire stress measurements, and displacement measurements reflected the pillar reactions, and all showed good correlation to one another. A major rock burst in the pillar, which destroyed about 100 feet of drift above the pillar, occurred at the end of this study. This burst was preceded by a large anomaly in the microseismic activity in the failure area.

RI 8702. Electromagnetic Surface Fields Due to a Magnetic Dipole Buried in a Three-Layered Earth, by Steven M. Shope. 1982. 22 pp. 7 figs. The Bureau of Mines electromagnetic trapped miner location and communications system requires a thorough understanding of through-the-earth electromagnetic wave propagation. An earth model incorporating a magnetic dipole buried in a three-layered earth has been developed. The dipole source is located in the second subsurface layer. By application of proper limiting values, the three-layered model is reduced to two different two-layered models and eventually to the homogeneous half-space model. The solutions are in the form of infinite integrals. A numerical analysis was carried out and a computer program written to evaluate the surface magnetic fields. Numerical values for the magnetic field at the point above the source are presented in a variety of models.

RI 8703. Design Criteria for Sheathed Permissible Explosive Charge for Open Shooting in Flammable Atmospheres, by Richard J. Mainiero and J. Edmund Hay. 1982. 12 pp. 10 figs. The Bureau of Mines conducted research to evaluate the optimum design for a rock-breaking explosive charge that could be fired unconfined in a gassy or dusty coal mine without the danger of igniting the flammable atmosphere. Charges of various shapes, with and without cavities, were tested in a gallery using 3- by 3- by 1-ft concrete blocks as simulated boulders. For these tests the optimum charge, in terms of cost, weight, and convenience in handling, consisted of a flat 1-½-lb charge of permissible explosive seven-eighths of an inch thick and 7 in in diameter encased in a ½-in thick layer of fine salt (NaCl). This work demonstrated that it should be possible to produce an inexpensive explosive rock-breaker charge that would be safe to use in underground coal mines.

RI 8704. Electrochemical Determination of Thermodynamic Properties of Manganomanganic Oxide and Manganese Sesquioxide, by Seth C. Schaefer. 1982. 17 pp. 7 figs. The Bureau of Mines investigated thermodynamic properties of Mn_3O_4 (manganomanganic oxide) and Mn_2O_3 (manganese sesquioxide). The standard Gibbs energies of formation ($\Delta Gf°$) of Mn_3O_4 and Mn_2O_3 from their lower oxides were determined with high-temperature galvanic cells using stabilized ZrO_2 (zirconia) as the electrolyte.

RI 8705. Calcination of Aluminum Nitrate Nonahydrate in a Fluidized Bed, by Jack C. White, Jack L. Henry, and Davis E. Traut. 1982. 23 pp. 19 figs. As part of an investigation of the production of alumina by the nitric acid leaching of kaolinitic clay, the Bureau of Mines designed, built, and tested a fluidized-bed system for the calcination of aluminum nitrate nonahydrate to alumina, while recovering nitric acid. The calciner consisted of an 8-in-square by 36-in-tall vessel containing 18 in of fluidized solids. Molten aluminum nitrate, sprayed directly into the fluidized solids, formed sandy, granular alumina by growth of successive layers on fluidized particles. Solids were fluidized in a dense bed at temperatures of 250° to 500° C with steam, air, or mixtures thereof. Decomposition of nitrate ranged from 4 to 10 pct during single-pass steam or air fluidization, respectively. Alumina dust losses and low throughput are significant unsolved problem areas.

RI 8706. The Solubility of Methane, Carbon Dioxide, and Oxygen in Brines From 0° to 300° C, by Stephen D. Cramer. 1982. 17 pp. 10 figs. The solubility of methane, carbon dioxide, and oxygen was measured in brines at temperatures from 0° to 300° C as part of Federal Bureau of Mines research on the corrosion of metals in high-temperature geothermal and mineral processing environments. Solubilities were measured by the technique of extracting pure gas, dissolved at pressures where Henry's law was applicable, from known volumes of brine. The results were smoothed with respect to temperature. The solubility, expressed in terms of the Henry's law constant, reaches a maximum at temperatures ranging from 60° to 100° C for methane and oxygen, and from 160° to 170° C for carbon dioxide. The Henry's law constant increases, that is, gases are salted out of the brines, in the presence of dissolved

salts. Salting-out coefficients are strongly dependent upon temperature. The temperature dependence of the Henry's law constant for geothermal brines is different from that for sodium chloride brines owing to the more complex chemistry of the geothermal brines. The solubility of oxygen and carbon dioxide in brines exposed to air saturated with water vapor and at a total pressure of 760 mm Hg is reported for temperatures from 0° C to the normal boiling point.

RI 8707. Purification of Cl_2-O_2 Leach Liquors by Zinc Cementation, by G. B. Atkinson, J. E. Murphy, and J. A. Eisele. 1982. 8 pp. 4 figs. To develop technology to help assure an ample domestic supply of zinc, the Bureau of Mines is investigating an aqueous chlorine-oxygen leaching process for treating complex sulfide concentrates. This report discusses the purification of aqueous Cl_2-O_2 leaching solutions by utilizing zinc cementation to remove Cd, Co, Cu, Ni, and Pb. Additional processing of the purified solution is necessary to produce $ZnCl_2$ crystals suitable for molten-salt zinc electrowinning cells. The effects of solution temperature, reaction time, zinc dust concentration, $ZnCl_2$ concentration, and degree of agitation on the removal of impurities were investigated for both simulated and actual leaching solutions. Zinc dust addition to a leaching solution at 30° C decreased the Cd, Cu, Ni, and Pb concentrations to acceptable levels of less than 3 mg/l each. By increasing the solution temperature to 75° C, the cobalt content was decreased to less than 5 mg/l, an acceptable level for producing electrolytic cell-grade $ZnCl_2$. Impurity removal rates from $ZnCl_2$ solutions are Pb>Cu=Cd>Ni>>Co. An increase in the solution temperature increases the rate of removal for these metal impurities.

RI 8708. Inhibition and Extinction of Coal Dust and Methane Explosions, by Martin Hertzberg, Kenneth L. Cashdollar, Charles P. Lazzara, and Alex C. Smith. 1982. 29 pp. 16 figs. The Bureau of Mines 8-liter flammability system was used to study the effectiveness of a variety of powdered inhibitors in preventing the propagation of explosions of coal dust or methane in air. Over 35 different chemical additives were evaluated against Pittsburgh seam pulverized coal. The least effective inhibitors were the carbonates, which required mass additions in the range of two to three parts inhibitor to one part of coal dust in order to prevent propagation. The most effective inhibitors were the derivatives of ammonium phosphate, which were effective quenching agents at additions of only one part inhibitor to four parts of coal dust. Alkali halide powders were of intermediate effectiveness. These laboratory-scale results are in good agreement with full-scale mine experiments in all cases where detailed comparisons have been made. Data were also obtained for the effectiveness of several of the same powdered inhibitors against methane-air explosions. Their relative order of effectiveness and the concentration ranges required for quenching the gas explosion are comparable to those measured for coal dust explosions. Data are also presented for the effectiveness of N_2 and CF_3Br addition. Some preliminary data are also presented for powder addition to methane burner flames. Those data are compared with other burner data and evaluated in terms of their relevance to explosion tests.

RI 8709. Flammability of Mixed Gases, by D. S. Burgess, A. L. Furno, J. M. Kuchta, and K. E. Mura. 1982. 20 pp. 19 figs. About 100 tests of flammability were carried out with H_2, CH_4, and CO in mixtures with air using the Federal Bureau of Mines 12-ft-diameter spherical pressure vessel as an explosion test chamber. The LeChatelier approximation gave slightly conservative estimates of the limits of downward flame propagation (onset of significant pressure rise) using the following measured values for the individual gases, in percent: H_2, 8.5; CH_4, 5.25; CO, 13.0. No justification could be offered for using the LeChatelier law for upward flame propagation limits and indeed reported data suggest that calculated values would not be conservative. The observed upward limit for methane-air mixtures (4.85 pct) was less than the widely accepted lean limit for this fuel; those for lean hydrogen-air mixtures and carbon monoxide-air mixtures did not differ from the lowest accepted values. Diffusional effects on the propagation of single, binary, and ternary fuel mixtures are discussed.

RI 8710. A Novel Bromine Calorimetric Determination of the Formation Enthalpies of Sulfides, by J. M. Stuve 1982. 5 pp. A novel calorimetric solution technique, recently developed at the Bureau of Mines, was tested using synthetic samples of chalcocite (Cu_2S) and covellite (CuS). The solution of these refractory sulfides was accomplished by oxidation with bromine in a moderately acidic, aqueous solution. The resulting values for the standard enthalpies of formation ($\Delta Hf°$, 298.15) for Cu_2S(c) and CuS(c) were −18.1 ±1.1 kcal/mol and −13.3 ±1.1 kcal/mol, respectively. These values are in good agreement with published formation values derived from other methods of physicochemical measurement.

RI 8711. Performance Evaluation of Electromagnetic Techniques for the Location of Trapped Miners, by John Durkin. 1982. 30 pp. 36 figs. The Bureau of Mines has conducted field studies in coal mines throughout the United States to determine the effectiveness of electromagnetic techniques in locating miners trapped underground following a mine accident. Data from these tests have been used to generate models of expected signal and noise distributions as found above mines throughout the coalfields. These distributions have aided in placing the expected performance of a through-the-earth electromagnetic communications technique into a probabilistic framework. Results show that at a 10-pct false alarm rate, the expected probability of detecting a miner's signal from a depth of 1,000 ft is 54 pct; at 500 ft it is 95 pct. These depths exceed the actual depths of 90 pct and 50 pct, respectively, of U.S. coal mines. Sensitivity studies have shown that at a depth of 1,000 ft, for every 3 db of improvement in signal-to-noise ratio, the probability of detection increases 6 to 8 pct.

RI 8712. Alumina Miniplant Operations—Production of Misted Raw Kaolin Feed, by John L. Schaller, Don B. Hunter, and Dwight L. Sawyer, Jr. 1982. 20 pp. 12 figs. The Bureau of Mines, U.S. Department of the Interior, has investigated the extraction of alumina from domestic kaolin clay by leaching with boiling 26 wt-pct hydrochloric acid. Acid leaching of crushed calcined kaolin feed yields slurries that are slow settling and difficult to filter because of the presence of fine particles generated in crushing, calcining, and leaching. Laboratory research showed that tumbling and moistening crushed raw kaolin on a pelletizing disk caused the fines to agglomerate on the surfaces of the larger particles, while the sharp edges and corners of the larger particles were rounded off. Minus 16-mesh crushed raw kaolin was misted on a 36-in-diam, 8-in-deep pelletizing disk at rates of 175 to 250 lb/hr, and

was calcined in either a rotary or a fluidized-bed calciner; negligible degradation occurred. The physical properties of the misted calcined kaolin were evaluated in the leaching system of the clay-hydrochloric acid miniplant. Only minor attrition occurred during leaching, and the slurry was readily filtered on a continuous belt filter.

RI 8713. Atmospheric Pressure Desilication of Leach Liquors From Lime-Sinter Processing of Anorthosite, by Masami Hayashi. 1982. 14 pp. 9 figs. The Bureau of Mines conducted laboratory studies to investigate methods for desilicating sodium aluminate solution derived from leaching a limestone-anorthosite sinter with 10-pct Na_2CO_3 solution. Desilication tests were made at atmospheric pressure to determine the effects of time and additions of lime and desilication residues. A two-stage, countercurrent desilication procedure was developed to reduce the SiO_2 content sufficiently to meet specifications for cell-grade Al_2O_3. Both stages were conducted at boiling temperatures at atmospheric pressure. Reagent lime was charged as desilication seed to the partially desilicated solution in the second stage, and a product (desilication residue) precipitated by the lime addition was charged to the freshly leached solution in the first stage. Average Al_2O_3 loss in the desilication circuit was 5.8 pct, and the product solution contained less than 0.04 g/l SiO_2. Complete precipitation of Al_2O_3 by carbonation resulted in a hydrate containing less than 0.01 pct SiO_2. Calcination of this hydrate would produce Al_2O_3 meeting the 0.015 pct SiO_2 specification for cell-grade material.

RI 8714. Lime-Sinter Processing of Anorthosite for the Recovery of Alumina, by V. E. Edlund. 1982. 21 pp. 5 figs. As part of a research program for recovering alumina from domestic nonbauxitic resources, the Bureau of Mines investigated a lime-sinter, caustic leach technology for anorthosite. This report discusses the unit operations—feed preparation, sintering, and leaching. Acceptable pellets for the bench-scale sintering studies were prepared from mixtures of minus 200-mesh anorthosite and limestone using water alone as the pelletizing agent. Heating pellets at 1,270° to 1,360° C for periods of 0.5 to 2 hr, followed by a 15-min soaking period at 700° C and cooling to room temperature, produced a sinter that dusted to more than 90 pct minus 65 mesh. The weight ratio of limestone to anorthosite was critical in producing sinter exhibiting good dusting and leaching characteristics. A ratio of 2.0 was optimum for the bulk samples of anorthosite and limestone used in this research. Leach solutions from lower ratio sinters were unstable; gelation became progressively more severe with higher ratio sinters. Leaching the dusted sinter with 10-pct Na_2CO_3 at 60° C extracted 85 to 90 pct of the alumina in a product solution containing about 50 g/l Al_2O_3. Leach residue in contact with pregnant solution tended to set up as a rigid gel as a result of cementation, compaction, and gelation. The presence of a calcium-sodium zeolite [$(Ca, Na_2)_6 \cdot (Al_2SiO_4)_{12} \cdot 27\text{–}30H_2O$] in the ungelled residues seemed to be the main difference between gelled and ungelled residues.

RI 8715. Statistical Approach to the Analysis of Bias and Precision in Reusable Gas-Detecting Devices, by R. Emmett Hughlett and George H. Schnakenberg, Jr. 1982. 27 pp. 13 figs. The Bureau of Mines has developed a statistical approach to the laboratory evaluation of response bias and precision in gas detectors. The techniques described employ a computerized analysis and a new method of data presentation called composite graphing. The underlying theory, its practical application to the data, and the experimental equipment and procedure are described.

RI 8716. Recovery of Scheelite and Byproduct Sphalerite From Western U.S. Tactite Ores, by J. M. Gomes, A. E. Raddatz, and M. M. Wong. 1982. 9 pp. 2 figs. Bench-scale flotation tests were conducted on two western tactite ores to study the recovery of tungsten and zinc minerals. The investigation, which is part of the Bureau of Mines ongoing program to develop methods for beneficiating minerals and metals from domestic low-grade ores, demonstrated the feasibility of producing scheelite, sphalerite, and their bulk concentrates. Sphalerite concentrates containing 51 to 53 pct Zn and less than 0.11 pct WO_3 were selectively recovered prior to scheelite flotation. Zinc recovery ranged from 85 to 91 pct. Scheelite concentrates containing 17 to 25 pct WO_3 were then recovered from the ore; tungsten recoveries ranged from 88 to 94 pct. Bulk flotation concentrates containing 84 to 91 pct of the WO_3 and 87 to 95 pct of the zinc also were prepared. More than 98 pct of the WO_3 in a bulk concentrate containing 9 pct WO_3 was extracted by autoclave leaching with a soda solution. The zinc remained in the leached residue.

RI 8717. Recovery of Platinum-Group Metals From Stillwater Complex, Mont., Flotation Concentrates by Matte Smelting and Leaching, by E. G. Baglin, J. M. Gomes, and M. M. Wong. 1982. 15 pp. 6 figs. As part of an effort to decrease U.S. dependence on imports of critical and strategic metals, the Bureau of Mines investigated three leaching methods for extracting the base metals and recovering platinum-group metals (PGM) from matte prepared from Stillwater Complex flotation concentrates. Because of a limited supply of natural material, synthetic matte of composition similar to matte prepared from natural concentrates was used to devise the extraction sequences. The validity of the sequences was verified with matte prepared from Stillwater concentrates. In two-stage matte leaching, first-stage H_2SO_4 leaching extracted 99 pct of the nickel and iron from the matte but negligible amounts of copper and PGM. Second-stage oxidative leaching with $Fe_2(SO_4)_3$ or $FeCl_3$ solubilized more than 98 pct of the copper and no precious metals. Sequential leaching, in which acid and oxidizing lixiviants were added sequentially to the matte without an intervening filtration step, extracted 99 pct of the Fe, Ni, and Cu. A roasting-leaching technique, in which the residue from first-stage leaching was roasted between 360° and 500° C before a second leaching with H_2SO_4, solubilized 98 pct of the copper. The three leaching methods yielded high-grade PGM residues containing more than 98 pct of the PGM in the matte.

RI 8718. Method for Producing Zirconyl Sulfate Solution From Zircon Sand, by D. J. MacDonald, R. A. Guidotti, and H. G. Henry. 1982. 13 pp. 4 figs. The Bureau of Mines has carried out investigations on a method for producing zirconyl sulfate solution from zircon sand, comprising (1) reacting zircon sand with molten NaOH, (2) leaching the resultant fusion frit with water to remove sodium silicate and to convert sodium zirconate to hydrous zirconium oxide, and (3) leaching the hydrous zirconium oxide from unreacted sand with hot, dilute H_2SO_4 to produce crude zirconyl sulfate solution. The following conditions were found to be suitable: reacting 0.6 kg of NaOH per kilogram of zircon sand for 10 min at 600° C; leaching the

frit with 3 to 4 liters of water per kilogram of solids; leaching the residue with 5.1 liters of water and 1.25 liters of 98-pct H_2SO_4 per kilogram of original solids for 10 min at 90° C; and filtering or decanting to recover unreacted zircon sand. A preliminary cost estimate is included.

RI 8719. Stability Relationships Between Petalite ($LiAlSi_4O_{10}$) and Spodumene ($LiAlSi_2O_6$), by Kenneth O. Bennington. 1982. 15 pp. This investigation is part of the Bureau of Mines research effort directed at advancing mineral technology and minimizing energy requirements for extractive metallurgy. The emplacement of the primary minerals petalite ($LiAlSi_4O_{10}$) and spodumene ($LiAlSi_2O_6$) in the lithium pegmatites is examined on the basis of their Gibbs energies of formation determined from lithium metasilicate and oxides, using a series of proposed reactions. The reaction between spodumene, quartz, and petalite ($LiAlSi_2O_6 + 2SiO_2 \rightleftarrows LiAlSi_4O_{10}$) apparently does not take place in nature but may be proved experimentally.

RI 8720. Recovery of Tungsten From a Hydrothermally Altered Deposit, by A. E. Raddatz, J. M. Gomes, J. J. Sjoberg, and M. M. Wong. 1982. 14 pp. 8 figs. The Bureau of Mines is investigating methods for recovering tungsten from domestic resources. A calcine-quench-leach (CQL) technique was developed for the extraction of tungsten from the Golconda, Nev., hot springs ores. The deposit contains disseminated tungsten that cannot be beneficiated by conventional techniques and must be treated by hydrometallurgical methods. The CQL procedure consists of calcining the ore at 900° C for 3 hours, quenching in a solution containing 1.5 parts of Na_2CO_3 and 1.5 parts of NaOH per part of WO_3 in the ore and at a solution-to-ore ratio of 3 to 1, leaching at 200° C and at 250 psig for 3 hours, and filtering and washing the residue. A series of closed-circuit batch tests showed that 92 pct of the tungsten was extracted from a sample containing 2.32 wt-pct WO_3. The pregnant solution contained 11 g/l WO_3.

RI 8722. Laboratory Testing of a Radial-Axial Loading Splitting Tool, by Sterling J. Anderson and David E. Swanson. 1982. 26 pp. 21 figs. To define the technical competence and capabilities of a nonexplosive excavation concept, the Bureau of Mines conducted reduced-scale laboratory tests of a mechanical excavation tool called a rock splitter. Hydraulically actuated splitters, capable of generating both radial and axial loads on a predrilled hole, were designed and fabricated. Through paired variable testing and drifting simulation, reduced-scale splitter performance was evaluated in concrete. Testing proved that the rock splitter is capable of excavating within the highly confined drift setting and that it offers a distinct advantage over splitters that can generate radial loads only.

RI 8723. Investigation of Methane Emissions From an Advancing Face in the Belle Isle Domal Salt Mine, Louisiana, by A. T. Iannacchione, G. L. Finfinger, T. M. Kohler, and D. M. Hyman. 1982. 24 pp. 32 figs. The Bureau of Mines measured methane emission rates from an advancing salt face ranging from 15 to 56 ft^3/ton (0.5 to 1.8 m^3/t). Small room size, use of a continuous miner, and a well-defined ventilation system made possible air velocity and methane concentration measurements. These measurements, representing data from 18 production days, were conducted in an area of abnormally low-grade salt. Methane emissions occurred primarily during the advance of the salt face by continuous miner.

RI 8724. In-Plant Recycling of Stainless and Other Specialty Steelmaking Wastes, by L. W. Higley, Jr., R. L. Crosby, and L. A. Neumeier. 1982. 16 pp. 5 figs. It is estimated that well over 20 million lb of chromium and 8 million lb of nickel, plus other metal values, are diverted annually to furnace dusts, mill scale, and contaminated swarfs in the domestic stainless and other specialty steelmaking industry. Little inroad has been made toward the in-plant recycling of these wastes to reclaim the metal values. The Bureau of Mines has devised a process for recovering about 90 pct of the chromium and molybdenum and well over 90 pct of the nickel and iron from stainless steelmaking furnace dusts, swarf, and mill scale. Other metals such as manganese are also recovered. Initial laboratory results were confirmed and expanded to include a wide variation of stainless steelmaking waste mixtures. Later experiments have included specialty steelmaking wastes other than from stainless steelmaking. Significantly, the ease of technology transfer has been demonstrated by a number of industrial-sized (19-ton) commercial electric furnace heats, in which the pelletized wastes represented some 10 to 20 pct of the furnace charge, replacing part of the normal scrap charge. Results of these successful large-scale trials are presented. Some information is also presented on incorporation into the pellets of chromium-bearing particulate wastes originating from other than steelmaking production. Cost evaluation indicates the process is economically attractive.

RI 8725. Laboratory Studies on the Treatment of Ferric Chloride Stripping Liquor From a Clay-Hydrochloric Acid Leaching Process, by Robert M. Doerr. 1982. 7 pp. In a process being investigated by the Bureau of Mines for recovering alumina from domestic nonbauxitic resources, calcined kaolinitic clay is leached with hydrochloric acid. Iron impurity in the clay is coleached and is removed in a solvent extraction step prior to crystallization of aluminum chloride hexahydrate, which is subsequently thermally decomposed to alumina. The $FeCl_3$-HCl stripping liquor from the solvent extraction step is unsuitable for discharging to the environment; furthermore, economics requires recovery of the contained chloride values. In the present research, it was shown that the stripping liquor can be reacted with calcined clay to yield $AlCl_3$ in solution, plus precipitated iron oxides, residual silica, and unreacted excess clay as mixed solids. For the recovery of the $AlCl_3$ solution, the slurry could be separated or returned to the clay-HCl process stream at the solids washing step that follows primary HCl leaching of the clay. For the range 20° to 99° C, the time (t) (10^3 sec) required to react the waste liquor with excess clay, for essentially complete iron precipitation, depends on the absolute temperature (T) chosen, according to the expression

$$t = e^{[9{,}000/T = 23.5]}.$$

Alumina was tried as a reagent alternative to clay but was not very effective, even under pressure and at high temperatures.

RI 8726. Fire and Explosion Properties of Oil Shale, by J. K. Richmond, M. J. Sapko, and L. F. Miller. 1982. 39 pp. 43 figs. This is a progress report summarizing more than 5 years of a long-range Bureau of Mines research program. The purpose of this program has been to investigate the fire and explosion properties of Green River oil shale in

the Bureau's Experimental Mine, in laboratories, and in the field. The lean limits of explosibility of oil shale dust, by small- and large-scale tests, are reported as a function of grade, ignition source, and particle size. A limited number of laboratory tests on the autoignition of oil shale dust layers and the spontaneous combustion tendencies of oil shale are described. Moderate-scale rubble fire tests were conducted to determine flame spread rates as a function of ventilation flow. With the aid of a system to continuously monitor methane emissions in a deep oil shale mine, the characteristics of the methane flow are reported as a function of ventilation and blasting procedures, and are compared with gas yields from core samples. Tentative predictions as to the emission of the methane to be expected in deep oil shale mines, far from the outcrop, are offered. Brief reference is made to a parallel investigation into the fire and explosion hazards of oil shale mining and processing by a Bureau contractor; detailed results of the latter investigation are to be found in the contractor's reports.

RI 8727. Reactivity of ANFO With Pyrite Containing Weathering Products—Evaluation of Additional Inhibitors, by Yael Miron, Thomas C. Ruhe, and J. Edmund Hay. 1982. 14 pp. 8 figs. Ammonium nitrate-fuel oil (ANFO) blasting agents may undergo an exothermic reaction when they contact warm ore bodies that contain pyrite and its weathering products. The reaction is very fast at temperatures above 80° C. Urea, when present in sufficient amounts, inhibits this reaction at temperatures below 180° C. But urea-ammonium nitrate mixtures are very hygroscopic and, in certain climates, may be difficult to handle in the field. Reaction-inhibiting characteristics of three compounds were reported by the Bureau of Mines in 1979. Recently, the Bureau investigated the reaction-inhibiting qualities of five additional compounds. Mixtures of ANFO, pyrite, weathering product, and prospective inhibitors were slowly heated, under conditions simulating a hot borehole, to determine prospective inhibitor capability at temperatures up to ~175° C. Small-scale thermal tests of the same mixtures were used for verification and clarification of results. Two organic compounds, phthalimide and xanthine, similar in structure to urea, failed to inhibit the reaction. Zinc oxide and calcium carbonate were found inferior to urea, though zinc oxide raised the onset of reaction from 80° C to about 140° C. Only magnesium oxide was found to be similar to urea in its inhibitory ability at temperatures below 175° C. Based on results from analysis of quenched residues, the use of more than 5 wt-pct magnesium oxide is recommended.

RI 8728. Application of Carbonate-Silica Flotation Techniques to Western Phosphate Materials, by A. R. Rule, D. E. Larson, and C. B. Daellenbach. 1982. 13 pp. 4 figs. In cooperation with a Western phosphate producer, the Bureau of Mines conducted research to apply its carbonate-silica flotation technology to ore feed from a commercial washing-sizing beneficiation plant. The flotation process includes depression of phosphate minerals with fluosilicic acid and anionic flotation of carbonate minerals, followed immediately by cationic flotation of silica. In laboratory and pilot plant tests the washing-sizing beneficiation plant feed ore was screened at 150 mesh and classified in hydrocyclones at 20 μm. The process was used to remove carbonate and silica impurities from the 150-mesh by 20-μm fraction of the feed ore. The plus 150-mesh fraction met concentrate grade requirements, and the minus 20-μm fraction was considered slime tailings. In laboratory tests conducted by the Bureau, flotation concentrates were produced containing about 0.75 pct MgO and up to 30 pct P_2O_5 with flotation recoveries of 70 to 80 pct P_2O_5. In a 1,000-lb/hr, onsite pilot plant at Simplot's Conda mill, concentrates were produced that were higher in grade and contained fewer impurities than concentrate produced in the existing commercial operation. The overall results show a potential 12- to 15-pct increase in total phosphate recovery if the flotation process is incorporated into the existing washing-sizing plant.

RI 8729. Building Seals by Pneumatic Stowing in Mine Closure Operations, by Slavoljub D. Maksimovic and John C. Draper. 1982. 23 pp. 22 figs. The Bureau of Mines, through a cooperative agreement with Duquesne Light Co. of Pennsylvania, field tested a method of using pneumatic stowing of crushed limestone to construct seals in long-abandoned mine openings that were part of an active mine closed shortly before sealing. A total of 13 openings at 11 sites were backfilled. In pneumatic stowing, material is conveyed through a pipeline and into the mine opening under low air pressure. The stowing equipment consists of a power supply, a blower, a feeder to inject material into the pipeline, and nozzle for directing the placement. Material is ejected from the nozzle at high velocity, creating a high-compaction fill upon impact. The fill material used was well-graded limestone aggregate up to 1½ inches in diameter, with sufficient fines. This fill was modified at five locations by the addition of portland cement, expansive cement, and/or bentonite. The pneumatic stowing method is safer and faster than conventional methods, is cost competitive, and eliminates or reduces the exposure of workers to possible hazards since the nozzle can be kept outside the mine opening. The equipment is mobile, but some modifications in the technique would improve performance. The technique was used at remote locations where other methods could not be used without disturbing the environment.

RI 8730. Sealing Openings in Abandoned Mines by Pneumatic Stowing, by Slavoljub D. Maksimovic and Jennings R. Lipscomb. 1982. 26 pp. 18 figs. The Bureau of Mines, through a memorandum of agreement with the State of Ohio, tested a method of constructing seals in abandoned mine openings in Ohio by means of pneumatic stowing of crushed limestone and gravel with sand. A total of five openings and one shaft were backfilled. Pneumatic stowing uses compressed air to convey material through a pipeline and into the mine opening. The stowing equipment consists of a power supply, a blower, a feeder to inject the material into the pipeline through an airlock, and a nozzle for directing the placement. Material is ejected from the nozzle at high velocity, creating a high-compaction fill upon impact. Well-graded aggregate up to 2 inches in diameter and having sufficient fines is used as fill. The stowing method is safer and faster than conventional methods, is cost competitive, prevents trespass into abandoned mine openings, and eliminates or reduces the exposure of workers to possible hazards since the discharge nozzle can be kept at the mouth of the opening The equipment is mobile, and, with some modification, the technique could be widely used for sealing abandoned and active mine openings, even in remote locations and during severe weather conditions.

RI 8731. Recovery of Phosphate From Florida Phosphate Operations Slimes, by C. E. Jordan, C. W.

Smith, G. V. Sullivan, and B. E. Davis. 1982. 13 pp. 5 figs. The Bureau of Mines conducted tests on seven samples of Florida phosphate operations slimes to develop a method to recover phosphate presently being discarded because of its small grain size. A system of hydrocyclones and hydroseparators was used to recover up to 96 pct of the plus 400-mesh material from the slimes. This plus 400-mesh material was subjected to fatty acid flotation, and concentrates containing up to 33.4 pct P_2O_5 were produced. As much as 88 pct of the phosphate (P_2O_5) was recovered from the plus 400-mesh material, and up to 29.6 pct was recovered from the total slimes. Research at the Tuscaloosa Research Center is carried out under a memorandum of agreement between the U.S. Department of the Interior, Bureau of Mines, and the University of Alabama.

RI 8732. Influence of Selected Additives and CaO:SiO_2 Ratio on High-Temperature Strength of MgO Refractories, by Nancy S. Raymon. 1982. 8 pp. The Bureau of Mines investigated the effect of controlled additions of selected metal oxides, as well as the adjustment of the calcia-to-silica ratio on the high-temperature strength of refractory-grade periclase. Increases in the hot flexural strength of some periclase materials in the range of threefold to fourfold were obtained with additions of ZrO_2 and by adjustments of the CaO:SiO_2 ratio to the 2.5 to 3.0 level. Results show that for each periclase refractory raw material, there exists a combination of level of ZrO_2 addition and an adjustment to the CaO:SiO_2 ratio that optimizes the hot flexural strength of each of these materials. Data also indicate that the improved hot strengths can be attributed to the high-temperature secondary phases formed between the different levels of periclase impurities and the additives, resulting in improved intergranular high-temperature bond strength. Research at the Tuscaloosa Research Center is carried out under a memorandum of agreement between the Bureau of Mines, U.S. Department of the Interior, and the University of Alabama.

RI 8733. Recovery of Sulfur and Accessory Metals From a Leaching Process Residue, by K. P. V. Lei, T. G. Carnahan, and J. A. Eisele. 1982. 14 pp. 5 figs. The Bureau of Mines, as part of its research effort to minimize the generation of hydrometallurgical waste, investigated a sodium sulfide leaching-electrolysis procedure for treating hydrometallurgical residues for elemental sulfur and base-metals recovery. Research was conducted on a leaching residue from a lead concentrate. The following procedure was developed. 1. The elemental sulfur was dissolved as polysulfide with a Na_2S solution. 2. The resultant metal sulfide bearing residue was oxidatively acid leached in a cationic membrane electrolysis cell; the metals were solubilized at the anode, and a base was generated at the cathode. 3. The elemental sulfur was recovered from the polysulfide solution by neutralizing with the acid in the anolyte. Byproducts of the neutralization were H_2S and a sodium salt solution. 4. Sodium sulfide was regenerated by reacting the H_2S byproduct with the base in the catholyte. 5. Lead as $PbCl_2$ was recovered from the anode residue by brine leaching, and the other metals were recovered from the sodium salt solution as metal sulfides. 6. The barren filtrate from the metal sulfide precipitation constituted the recycled electrolyte. Ninety-eight percent of the elemental sulfur, 98 pct of the lead, and up to 80 pct of other accessory metals were recovered from a residue obtained from the $FeCl_3$-NaCl leaching of a lead concentrate.

RI 8734. Stripping SO_2-Loaded Citrate Solutions With Pressurized Steam, by R. H. Lien. 1982. 8 pp. 5 figs. The Bureau of Mines has conducted research on a flue gas desulfurization (FGD) process as part of its goal of minimizing the undesirable environmental impacts associated with sulfur dioxide (SO_2) bearing waste gases. This FGD process, referred to as the modified citrate process, involves absorption of SO_2 in a buffered citric acid solution. The absorbed SO_2 is subsequently stripped from the solution using steam, which regenerates the solution and produces a wet SO_2 product. This product can be further processed to make sulfuric acid or liquid SO_2. Economic evaluations showed the process to be expensive when the stripper was operated at or near ambient pressures because of the large amounts of steam required for solution regeneration. Research was directed at reducing steam consumption in the stripper. The effect of stripper pressure on steam consumption was investigated. A process research unit (PRU) was operated with the stripper pressurized in the range of 5 to 150 psig. Test results showed that steam consumption decreased with increased stripper pressure. For example, when operating the PRU stripper at 150 psig, 4.1 grams of steam per gram of SO_2 was required to remove 90 pct of the SO_2 from a 1.0-vol-pct-SO_2 gas. This compares to 7.1 grams of steam per gram of SO_2 required for 90-pct SO_2 recovery at 5 psig.

RI 8735. Sulfur Hexafluoride as a Mine Ventilation Research Tool—Recent Field Applications, by Robert J. Timko and Edward D. Thimons. 1982. 15 pp. 12 figs. Sulfur hexafluoride (SF_6) is an odorless, colorless, nontoxic gas that has found acceptance as a tracer gas in research on ventilation patterns, measurement of air leak rates, respirable dust reductions due to bagging hood modifications, and the study of airflows relating to gob boreholes. Following a short review of the SF_6 sampling technique, this report describes recent Bureau of Mines projects in which SF_6 was used successfully as a tracer gas, enabling researchers to acquire representative data quickly and inexpensively.

RI 8736. Alumina Miniplant Operations—Calcination of Kaolin in a Direct-Fired Rotary Kiln, by Theodore L. Turner, Dwight L. Sawyer, Jr., Don B. Hunter, and Earle B. Amey III. 1982. 24 pp. 7 figs. This Bureau of Mines report describes calcination of kaolinitic clay in a direct-fired 2½- by 24-ft rotary kiln at 750° and 775° C. Methods for preparing kaolin feed materials and characterization of calcined products are discussed. Approximately 99 pct of the alumina in a typical eastern Georgia kaolin was soluble in HCl after calcination at either 750° or 775° C.

RI 8737. Physical Beneficiation of Titanium Plant Solid Wastes: Recovery of Titanium Minerals and Coke, by J. I. Paige, R. E. Mussler, and G. W. Elger. 1982. 23 pp. 9 figs. The Bureau of Mines studied methods for recovering unreacted titanium minerals and petroleum coke from titanium chlorination plant wastes prior to neutralization treatment with lime. The objective was to recover valuable raw materials and to reduce the amount of waste materials that must be treated for disposal. Samples of solid wastes were physically beneficiated by gravity concentration (tabling) to recover titanium minerals containing 69.0 to 92.4 wt-pct TiO_2 and by selective carbon flotation to recover petroleum coke containing 94.0 to 96.8 wt-pct C. Laboratory data indicate that the recovered titanium mineral would decrease the amount of solid waste to be

disposed of from 32.8 to 53.9 wt-pct. The recovery of coke would further decrease the amount by an additional 32.9 wt-pct. Preliminary tests conducted on recovering vanadium, chromium, and columbium from liquors obtained by leaching chlorination residues also have shown that (1) 97 pct of the vanadium was extracted from leach liquors in a two-stage solvent extraction procedure and (2) 58 pct of the columbium and 40 pct of the chromium were separated from the leach liquors by an ion exchange technique using a strong acid resin.

RI 8738. Effects of a Fan Shutdown on Radon Concentration in a Positive Pressure Ventilated Mine, by Connie S. Musulin, John C. Franklin, and F. Andrew Roberts. 1982. 10 pp. 5 figs. The Bureau of Mines conducted an experiment at Exxon Mineral Co.'s Buffalo Shaft Operation to determine the time required for radon concentrations to return to a base average after fan shutdowns. Shutdown times ranging from 5 min to 16 hr were evaluated. An equation was derived to calculate a ratio that determines the time required for the radon concentration to return to the average level that existed in the mine prior to shutdown. For fan shutdowns of 15 min or more, underground personnel should be evacuated to areas with natural downcast ventilation. For shutdowns of less than 1 hr, personnel should not return to the working area until the elapsed time is four times the shutdown, or until the working area is resampled and found safe. If the mine is not in production during weekends, the downcast fans can be turned off from midnight Friday until 4 p.m. Sunday, and the radon daughter concentration should be below 1 working level throughout the mine by the start of the shift Monday. This fan shutdown would conserve energy and save the mining company an estimated $21,000 each year.

RI 8739. Application of the Cooper-Eaton Equation to the Compaction Behavior of Phosphatic Clay Waste and Attapulgite, by L. W. Brandt, D. A. Stanley, and B. J. Scheiner. 1982. 9 pp. 6 figs. As part of its objective to expand the body of mineral information as a basis for new technology, the Bureau of Mines conducted research on the fundamental behavior exhibited by phosphate clay waste in settling ponds. A semiempirical equation used to describe the compaction of ceramic powders in a single-acting die was applied to aqueous phosphatic clay waste and attapulgite slurries. This equation,

$$\overset{*}{V} = a_1 e^{-K_1/P} + a_2 e^{-K_2/P},$$

was found to describe the compaction of an attapulgite gel and a phosphate slime gel by a moving screen. $\overset{*}{V}$ is the ratio of the compaction achieved at a given pressure, P, to the compaction achieved at a pressure sufficient to remove all space between particles. The constant a_1 represents the fraction of compaction achieved at low pressure by rearrangement of flocs to higher packing density, and a_2 represents the fraction of compaction achieved at higher pressure resulting from removal of voids within flocs. K_1 and K_2 are constants determined from the experimental data. Both the low-pressure and high-pressure compaction mechanisms were observed in the compaction of the clays. These two compaction mechanisms offer an explanation for the observation that impounded slimes initially dewater rapidly and then dewater at a much slower rate.

RI 8745. Relative Enthalpies of Ni_3S_2, by M. J. Ferrante and N. A. Gokcen. 1982. 8 pp. 1 fig. The Bureau of Mines determined the enthalpies of Ni_3S_2 relative to 298.15 K to provide new thermodynamic data for advancement of mineral science and technology. Enthalpies were measured with a copper-block calorimeter from 298.15 to 1,197 K. A solid-solid transition was found at 834±1 K, with an isothermal heat absorption of 13.32 kcal/mol. The temperature of this solid-solid transition was accurately measured by differential scanning calorimetry. Because Ni_3S_2 does not melt congruently, the heat of fusion of 4.70 kcal/mol was obtained by extrapolation of enthalpy measurements from the solid and liquid phases to approximately 1,064 K. Tabulated values are given for the relative standard enthalpy, heat capacity, entropy, and Gibbs energy function between 298.15 and 1,800 K. Enthalpies are also given in equation form and combined with data from the literature to derive values of standard enthalpies of formation and Gibbs energies of formation. Similar calculations were made for the reaction of crystalline and liquid nickel with gaseous diatomic sulfur for Ni_3S_2(c, l).

INFORMATION CIRCULARS

Sales publication purchases may be made by check or money order payable to the Superintendent, charged to a deposit account at GPO, or charged on a VISA or MasterCard credit card. Address requests to—

Superintendent of Documents
U.S. Government Printing Office
Washington, DC 20402

or call 202-783-3238.

Application for free publications should be made to—

Section of Publications
Bureau of Mines
U.S. Department of the Interior
4800 Forbes Avenue
Pittsburgh, PA 15213

or call 412-621-4500, extension 342.

IC 8862 Land Utilization and Reclamation in the Mining Industry, 1930–80, by Wilton Johnson and James Paone. 1982. 22 pp. 13 figs. This Bureau of Mines study indicates that land utilized by the mining industry for mineral extraction and processing from 1930 through 1980 amounted to 5.7 million acres, or 0.25 percent of the land mass in the United States. Land reclaimed by the industry during the same period was 2.7 million acres, or 47 percent of the land utilized. Land use by the mining industry includes surface land used for excavation or mining, for waste from underground mining, and for wastes from milling or processing operations. Data on land use for disposal of overburden waste from surface coal mines and on areas affected by subsidence associated with underground mining are included for the period 1930–71 only. The 10 leading States in total land used for mining over the 51-year period were, in decreasing order, Pennsylvania, Kentucky, Ohio, Illinois, West Virginia, Florida, Indiana, California, Alabama, and Missouri. Seven mineral commodities accounting for 92 percent of land use are, in decreasing order, bituminous coal, sand and gravel, stone, phosphate rock, clay, copper, and iron ore, all predominately surface mined. Bituminous coal production was responsible for nearly half of the total area utilized. Reclamation of mined lands and waste disposal sites over the reporting period was largely on lands utilized in mining bituminous coal; 75 percent of the land used for bituminous coal production was reclaimed.

IC 8863. Proceedings of Seminar on the Role of Overburden Analysis in Surface Mining, Wheeling, W. Va., May 6–7, 1980. Sponsored by the American Council for Reclamation Research and the Bureau of Mines, compiled by D. G. Simpson and W. T. Plass. 1982. 51 pp. 6 figs. This Bureau of Mines publication contains the texts of the four papers presented at the May 6–7, 1980, seminar on the role of overburden analysis in surface mining. Coverage includes the geologic distribution of pyrite and calcareous material and its relationship to overburden sampling, overburden sampling and analysis, use of soil-overburden data in mine planning and development, and minesoil classification.

IC 8864. The Relation of Geology to Mine Roof Conditions in the Pocahontas No. 3 Coalbed, by Noel N. Moebs and John C. Ferm. 1982. 8 pp. 2 figs. Bureau of Mines studies of mine roof fall problems in the Pocahontas No. 3 Coalbed of southern West Virginia and southwestern Virginia have established that type and sequence of rock are significant factors in roof competence. The poorest conditions occur where the immediate roof consists of slump structures and slickensided rock. The best conditions occur where the roof consists of a sequence that coarsens upward from shale to massive sandy shale. A small manual of color photographs of rock types was devised to aid in identifying drill cores. Proper identifications should enhance the prediction of areas of potential roof problems in advance of mining.

IC 8868. Reduction of Airborne Contaminants From Welding Exhaust at Surface Mines, by G. K. Derby. 1982. 11 pp. 4 figs. The Bureau of Mines studied the problems caused by airborne contaminants from welding exhaust in surface mining operations and investigated equipment designed to reduce existing hazards. Four commercially available welding-fume exhaust units were tested to determine their effectiveness. Results indicated that the four units had the capability of controlling airborne particulate concentrations and bringing them to within allowable exposure limits.

IC 8870. Analyses of Natural Gases, 1917–80, by B. J. Moore. 1982. 1055 pp. 1 fig. This publication contains 12,554 analyses of gas samples from oil and gas wells and natural gas pipelines in 39 States and 24 foreign countries. These gas samples were collected in the period 1917–80 as part of the Bureau of Mines survey for helium occurrences. The gas analyses contained herein were made by several methods over the period covered. Analytical work on samples collected early in the period was done on the Orsat apparatus. The one-cut apparatus and four-cut fractional distillation equipment were added later. In 1949, a mass spectrometer was acquired and used for all gas analyses made after that time. Helium analyses throughout the period covered were made on special helium analytical equipment designed and built by the Bureau of Mines Helium Operations Laboratory. GPO Stock No. 024–004–02089–0. $19.

IC 8871. A Computer Program for Calculating Thermodynamic Properties From Spectroscopic Data, by R. P. Beyer. 1982. 19 pp. A FORTRAN IV computer program has been written to calculate thermodynamic properties over a desired temperature range from spectroscopic data. This program computes heat capacities, enthalpies, and entropies for monatomic, diatomic, linear, and nonlinear polyatomic gases. This research is part of the Bureau of Mines effort to provide thermodynamic data for the advancement of mineral technology.

IC 8872. Minerals Health and Safety In-House and Contract Research, Development, and Demonstration in Fiscal Year 1982, by Staff, Division of Minerals Health and Safety Technology. 1982. 48 pp. This publication summarizes, for potential contractors and all other

interested parties, the research, development, and demonstration of in-house and contract projects programed by the Bureau of Mines for fiscal year 1982 (October 1, 1981-September 30, 1982) under its Minerals Health and Safety Technology program. The objective of these projects is to provide an ordered and sequenced series of advance toward the Bureau's overall goal of providing the systems technology required to create a more healthful and safer working environment for the Nation's mining and minerals processing workers.

IC 8873. Computer Simulation Applied to the Separation of Porous Leach Residue Solids From Liquor by Horizontal Belt Filtration, by Daniel T. Rogers and Roy T. Sorensen, Jr. 1982. 27 pp. 6 figs. The Bureau of Mines, in its alumina miniplant project to investigate alumina recovery from domestic, nonbauxitic ores, has conducted research on the use of a hydrochloric acid leaching, gas sparging crystallization technology. An important element of this research is the efficient separation of undissolved, siliceous residue from $AlCl_3$-bearing leach liquors by continuous, horizontal, countercurrent vacuum belt filtration. In an effort to calculate material balances quickly and to predict material balances based on different belt filtration configurations, the perfect-mixing-cells-in-series model (PMCS) for calculating material balances around belt filters was used. Because of the porous nature of the solids, the model produced erroneous material balances. Therefore a reliable model, the shrinking voids model, was developed postulating the presence of an unwashable voids liquor volume that decreases with decreasing liquor $AlCl_3$ concentration. This volume decrease postulation is equivalent to assuming that dilute liquors flow more freely, causing more voids liquor volume to become washable. Least-squares based computer programs are provided, which are useful not only in producing material balances from plant data but also in predicting balances for untested configurations using the same feed materials. GPO Stock No. 024–004–02092–0. $2.50.

IC 8874. The Depletion Allowance and Domestic Minerals Availability. A Case Study in Copper, by Paul R. Thomas, Robert L. Davidoff, and Melinda M. Quinn. 1982. 15 pp. 8 figs. The Bureau of Mines evaluated the impact of the depletion allowance upon the economic availability of copper from domestic deposits. The potential long-run percentage depletion deduction, cumulated over the life of the properties, was estimated at approximately $2.5 billion for producing properties and up to $11.7 billion for nonproducers. The income transfer, in the form of higher Federal income tax payments if the allowance were repealed, was estimated at $1.5 billion for producing properties and up to $8 billion for nonproducers. The percentage depletion allowance, through its role in determining Federal income tax liability, was found to be very significant in affecting profitability. Repeal of the allowance could result in major domestic copper availability reductions at all price levels, now and in the future, as a result of reduced profit margins for current producers, and postponement of development decisions for nonproducers. It was demonstrated that a 50-percent reduction in the percentage depletion rate applicable to copper would also result in a significant decrease in profitability for nonproducing properties. For producing properties, the percentage depletion rate on copper was shown to be less significant than the income limitation that is placed upon the total amount of the depletion deduction. Repeal of the minimum Federal tax provision was shown to be significant in enhancing profitability for both producing and nonproducing deposits. The report concludes that the percentage depletion allowance operates as an important method of capital recovery and production incentive. GPO Stock No. 024–004–02091–1. $2.25.

IC 8875. Computerized, Remote Monitoring Systems for Underground Coal Mines. Fires and Explosive Atmospheres, by Jeffrey H. Welsh. 1982. 9 pp. This report presents a study on the use of computerized, continuous remote monitoring systems for fire and explosive atmosphere safety in underground coal mines. The effects of these systems on the safety level in mines are investigated, and the relationship between mine safety regulations and computerized, continuous, remote monitoring is analyzed.

IC 8876. Noise and Vibration Control for Surface Mines. Program Document, by Bradley V. Johnson, Richard J. Seibel, and David E. Siskind. 1982. 9 pp. This publication summarizes the in-house and contract research and development projects conducted since 1974 by the Bureau of Mines for the control of noise and vibrations from surface mine blasting.

IC 8877. SIC-Based Demand Information System for Nonfuel Minerals, by George K. Schenck, Balakrishnan K. Nair, and Kung-Lee Wang. 1982. 48 pp. 3 figs. This Bureau of Mines publication describes and evaluates a Standard Industrial Classification (SIC) based end-use data system for minerals that is designed to link the demand for minerals to economic activity in commercial uses. The new data system is two-dimensional. The first dimension of technical product classes (TPC's) measures the consumption of minerals in major primary intermediate products. The second dimension measures the consumption of these TPC's in SIC end-use sectors in sufficient detail to identify the major determinants of demand for each TPC. Intercommodity comparisons are achieved at the level of SIC two-digit major groups. The methodology was developed so that all available sources of information from Government and industry can be utilized at minimum cost. This information will be supplemented with additional data to be obtained by modifying existing Bureau of Mines canvasses so as to elicit additional quantitative responses from mineral producers. The new data system is expected to improve significantly the ability to forecast demand for minerals, and provide an information base that would, for the first time ever, permit resolution of such questions as trends in substitution among materials and the intensity-of-use of materials in end-use sectors. For the 42 TPC's identified in the report, data are available for the new system from current sources or, except for three TPC's that require new canvasses, can be obtained by modification of existing Bureau canvasses. GPO Stock No. 024–004–02098–9. $3.25.

IC 8878. Chemically Bonded Refractories—A Review of the State of the Art, by Rustu S. Kalyoncu. 1982. 20 pp. 2 figs. A major goal of the Bureau of Mines is to conserve the Nation's mineral resources by developing improved performance materials. In support of this mission, a survey of the state of the art of chemically bonded refractories has been made, covering the scientific literature, government reports, and patents. This review includes research and development results for phosphate, silicate, oxychloride, oxysulfate, and other bonding agents used in refractories manufacture. A

significant finding of the review was that references on bonding mechanisms, bond formation kinetics, and other important process parameters and conditions were few and universally vague. As a result, recommendations are made to expand research efforts to investigate the kinetics and mechanisms of reactions in chemically bonded refractories.

IC 8879. State Severance Taxes: A Summary and an Analysis of the Impact of Rate Changes on Copper Recovery Costs, by Phillip N. Yasnowsky and Annette P. Graham. 1982. 23 pp. This Bureau of Mines report summarizes State severance taxes imposed on minerals and mineral fuels, provides a hypothetical example of how a State severance tax affects selected components of a firm's income statement, and uses the Bureau's Minerals Availability System (MAS) to estimate the effect of assumed changes in State severance tax rates on copper recovery cost at given levels of potential copper availability. A reduction of the rates to zero or a doubling of them results in changes in costs that are of the same order of magnitude as the cost of transporting copper to the United States from major foreign producing countries. GPO Stock No. 024–004–02099–7. $3.

IC 8880. Some Design Factors for Windows and Lenses Used in Explosion-Proof Enclosures, by Lawrence W. Scott. 1982. 9 pp. This Bureau of Mines report presents several factors that currently enter into the design, manufacture, and testing of windows and lenses used in explosion-proof enclosures. Emphasis is also given to the sealing concepts for lenses. Criteria for adhesives and sealants are suggested based on the survivability of an explosion-proof enclosure as a structure, rather than upon the minimum material properties of its constituents. Procedures for surface preparation of adherends are also discussed.

IC 8881. Minerals Data Source Directory, compiled by the Minerals Data Working Group, Interagency Minerals Information Coordinating Committee. 1982. 296 pp. The Minerals Data Source Directory is a compilation of descriptive information on the availability, content, and location of minerals data in the Federal Government. It is intended to assist Government personnel and the general public in locating and acquiring minerals information. Included in the Directory are descriptions of data bases, publications, information systems, and information offices containing data pertaining to all aspects of mineral production, consumption, trade, and related information. These mineral data sources include the Federal agencies such as the Department of the Interior's Bureau of Mines and Geological Survey whose major mission is the collection and dissemination of mineral information. Also included are agencies such as the Departments of Agriculture, Commerce, Labor, State, and Treasury, and the Central Intelligence Agency, whose primary mission is the collection of data in nonmineral subject areas, but in which the mineral industry is a component. GPO Stock No. 024–004–02097–1. $8.

IC 8882. Reliability of Computerized Mine-Monitoring Systems, by Raymond M. Kacmar. 1982. 10 pp. 1 fig. This paper describes the Bureau of Mines research program on the reliability of computerized mine-monitoring systems. The basic concepts of computerized monitoring are introduced along with its advantages and limitations. Current Bureau projects covering mine-monitoring systems are described, and some of the major areas of concern that should be addressed by future projects are outlined.

IC 8883. Vibration Qualification of Electronic Instrumentation for Underground Coal Mining Machinery, by Roy C. Bartholomae, Bruce S. Murray, and Richard Madden. 1982. 9 pp. 6 figs. An accurate characterization of the vibration environment and a vibration qualification test derived from it will be a very useful tool for manufacturers of instrumentation for use on underground coal mining equipment. Recognizing this, the Bureau of Mines sponsored a study wherein vibration levels were measured on mining equipment to form a basis for developing the required vibration test. The data base was composed of 160 samples taken at different positions on a variety of underground machinery. The data were analyzed and presented in a format typical of military vibration qualification tests. The form was shown to be virtually identical to the swept sine test envelope specified in MIL-STD-810B for tracked vehicles.

IC 8884. Accomplishments in Waste Utilization. A Summary of the Seventh Mineral Waste Utilization Symposium, compiled by S. A. Bortz and R. S. DeCesare. 1982. 88 pp. 15 figs. With IIT Research Institute as a cosponsor, this Seventh Mineral Waste Utilization Symposium was funded by the Bureau of Mines through its Division of Mineral Resources Technology. Environmental scientists and engineers from five countries (Canada, Netherlands, Austria, England, Guatemala) besides the United States participated in the symposium, which was held October 20–21, 1980, at the Chicago campus of IIT Research Institute. Of the 25 papers presented on the reclamation and recycling of mining and mineral wastes, municipal solid waste, industrial waste, and scrap metal, 21 are summarized herein.

IC 8885. Characterization of U.S. Cement Kiln Dust, by Benjamin W. Haynes and Gary W. Kramer. 1982. 19 pp. Cement kiln dust (CKD) produced in the contiguous United States and Hawaii was characterized as part of the Bureau of Mines program in minerals environmental technology. The mineralogical and chemical composition was determined for 113 CKD samples from 102 plants that normally send CKD waste to landfill. Characterization included the determination of 28 elements, 7 anion species, carbon dioxide, noncarbonate carbon, and chemically bound water. Mercury was determined in 16 samples. Interelement correlation coefficients were determined for 23 elements, 5 anions, CO_2, noncarbonate carbon, and chemically bound water. To assess the hazardous waste potential of CKD, the U.S. Environmental Protection Agency Extraction Procedure (EP) toxicity test was performed on all 113 CKD samples. All but one sample were in compliance with the test; the noncomplying sample slightly exceeded the EP toxicity test criterion for lead.

IC 8886. Mine Illumination. Proceedings: Second International Mine Lighting Conference of the International Commission on Illumination (CIE), compiled by K. L. Whitehead and W. H. Lewis. 1982. 337 pp. 116 figs. The U.S. Bureau of Mines, U.S. Department of Labor, and United States National Committee of the CIE hosted the TC4.10 Mine Lighting Committee Meeting and Second International CIE Mine Lighting Conference at the MSHA Academy in Beckley, W. Va., October 12–16, 1981. This was the first time the meeting and conference had been held in the United States. The TC4.10 Mine Lighting Com-

mittee, chaired by Dr. Adam Peretiatkowicz of Poland, was attended by 15 committee members and 6 guests representing 8 countries. Discussion during the meeting covered mine lighting instrumentation, opencast (surface mine) lighting, and lighting sources. The committee also reviewed a draft of proposed lighting terminology and suggested changes to make the definitions more acceptable to representatives of the nations present. The mine lighting conference features 20 papers presented by 18 speakers representing 6 countries. The papers covered all phases of mine lighting, including research, hardware development and application, personnel acceptance, and requirements for system maintenance. The conference attracted 126 attendees and included displays by 8 lighting hardware manufacturers and 4 mining machine manufacturers. Papers from the conference are being published by the Government Printing Office, with copies presented to the conference attendees. Copies will be available to others interested through the National Technical Information Service. During the TC4.10 meetings and conference, committee members toured three mining equipment assembly plants, and six of the foreign representatives visited a longwall installation in an underground mine. Planning and administrative services for the meeting and conference were handled by Bituminous Coal Research, Inc., under Bureau of Mines contract H0318038.

IC 8887. The Bureau of Mines Minerals Availability System: An Update of Information Circular 8654, by Herbert R. Babitzke, Aldo F. Barsotti, Joseph S. Coffman, Jerrold G. Thompson, and Harold J. Bennett. 1982. 54 pp. 13 figs. The Minerals Availability System (MAS) was formally established by the Bureau of Mines in May 1975 to provide current appraisals of the engineering and economic availability of nonfuel minerals for consideration in the formulation of both domestic and foreign minerals policy. Domestic mineral property reports are developed by the Bureau's four Field Operations Centers, and foreign data are obtained under contract. This site-specific information is subsequently subjected to engineering verification and economic evaluation, and the results are analyzed and published as Minerals Availability System Appraisals. The deposit-specific data are also entered into the computerized MAS data base, where a subset of this information, the Mineral Industry Location System (MILS), is available to the public in the form of computer graphics and listings. Other MAS products are also described. The Bureau's MAS personnel are frequently involved in special engineering and mineral economic projects for other Federal and State agencies. MAS personnel also work closely with the private sector, both in the area of mining and processing cost estimation, and as a source of nonproprietary mineral deposit information.

IC 8888. Preliminary Testing of a Prototype Portable X-Ray Fluorescence Spectrometer, by Lowell L. Patten, Neal B. Anderson, and John J. Stevenson. 1982. 33 pp. 15 figs. The Federal Bureau of Mines participated with the National Aeronautics and Space Administration and Martin Marietta Aerospace in developing, building, and testing a portable X-ray fluorescence spectrometer for use as an analyzer in mineral-resource investigative work. The prototype battery-powered spectrometer, measuring 11 by 12 by 5 inches and weighing only about 15 pounds, was designed specifically for field use. The spectrometer has two gas-proportional counters and two radioactive sources, ^{109}Cd and ^{55}Fe. Preliminary field and laboratory tests on rock specimens and rock pulps have demonstrated the capability of the spectrometer to detect 33 elements, to date. Characterisics of the system present some limitations, however, and further improvements are recommended.

IC 8889. Manganese Availability—Domestic. A Minerals Availability System Appraisal, by Catherine C. Kilgore and Paul R. Thomas. 1982. 14 pp. 4 figs. The Bureau of Mines investigated the availability of manganese from known domestic occurrences. Eight of these deposits were found to have demonstrated resources totaling 420 metric tons with an average grade of 10 percent contained manganese. They were found to be submarginally subeconomic. Economic evaluations of the eight deposits resulted in incentive prices ranging from $8 to almost $35 per long ton unit (22.4 pounds) of contained manganese. Comparing these prices with the current market value of $1.70 per long ton unit of manganese clearly illustrates the submarginal nature of the domestic ores analyzed. These domestic resources would probably not be developed except in the case of an extreme national emergency. Production from the eight deposits would take 3 to 6 years to develop, and the final product would be manganese ore concentrate, which could be used in the production of ferromanganese. If preproduction development began in 1981, annual production would peak in 1987 with 900,000 metric tons of recoverable manganese. Thereafter, production would see a steady decline unless additional resources were located or technologic improvements were made to allow processing of lower grade material, or unless mining and processing of ocean manganese nodules began to take place. GPO Stock No. 024–004–02100–4. $3.

IC 8890. Analyses of Natural Gases, 1981, by Richard D. Miller and Floyd R. Hertweck, Jr. 1982. 84 pp. 1 fig. This Bureau of Mines publication contains analyses and related source data for 224 natural gas samples from 18 States. Of the total, 191 samples were collected during calendar year 1981. The remaining 33 samples were collected during previous years, but releases granting permission to publish were not received until 1981. All samples were obtained and analyzed as part of Bureau of Mines investigations of the occurrences of helium in natural gases of countries with free market economies. This survey has been conducted since 1917. The analyses published herein were made by the mass spectrometer and special helium apparatus described previously. GPO Stock No. 024–004–02102–1. $5.

IC 8891. Premining Investigations for Hardrock Mines. Proceedings: Bureau of Mines Technology Transfer Seminar, Denver, Colo., September 25, 1981, compiled by Staff, Bureau of Mines. 1982. 95 pp. 77 figs. These proceedings consist of papers presented at a Bureau of Mines Technology Transfer Seminar in September 1981 for the purpose of disseminating recent advances in mining technology in the area of premining research. The introduction and descriptive papers discuss techniques and instrumentation used in premining research for metal and nonmetal mining and shaft design and borehole control for premine planning.

IC 8892. A Feasibility Study of the Use of Surface Redox Measurements To Detect Subsurface Methane, Coal

Burns, and Hydrothermal Deposits, by Richard G. Burdick and Terry L. Radich. 1982. 15 pp. 16 figs. The Bureau of Mines conducted this research to determine the feasibility of using soil redox measurements, a relatively new method in mining geophysics, to locate or define a variety of conditions that are hazardous or otherwise of interest to the mining industry. The method was used in three widely separated areas in an attempt to define subsurface concentrations of methane, the edges of coal-burn areas, and a hydrothermal vein set. Both a description of the method used and test cases are given in this report.

IC 8893. Underground Coal Mine Power Systems. Proceedings: Bureau of Mines Technology Transfer Seminar, Pittsburgh, Pa., September 16, 1982, compiled by Staff, Bureau of Mines. 1982. 88 pp. 50 figs. This Bureau of Mines publication presents an overview of mine electrical power systems research currently being conducted by the Bureau. The papers, given at a Technology Transfer Seminar, emphasize the increasing importance of research related to the safety considerations of underground coal mine electrical systems. Selected topics are included that summarize results of research in the areas of electrical shock prevention, explosion-proof enclosures and load centers, discriminating circuit breakers, and trailing cables. Other topics discussed at the seminar are published as separate sections of the Bureau of Mines Handbook "Application Notes—Mine Electrical Power Systems."

IC 8894. How To Evaluate Longwall Dust Sources With Gravimetric Personal Samplers, by Steven J. Page, Robert A. Jankowski, and Fred N. Kissell. 1982. 14 pp. 3 figs. Longwall double-drum shearers frequently have difficulty complying with the 2.0 mg/m^3 dust standard and, therefore, require the use of effective dust controls. However, before dust controls can be implemented effectively, the major individual dust sources must be determined and their relative severity evaluated. The Bureau of Mines has recently developed a sampling strategy, based upon short-term gravimetric sampling, that can identify the major dust sources contributing to the shearer operator's exposure. This technique utilizes approved gravimetric sampling equipment already available to all mine operators and can be performed by two people in 2 days. Five examples, including data analysis, are discussed with respect to various cutting sequences. In addition, typical dust source contributions obtained from studies of double-drum shearer operations regularly in compliance are included. Mine operators can thereby compare their dust source evaluation results with those from these longwalls.

IC 8895. Chromium Availability—Domestic. A Minerals Availability System Appraisal, by Jim F. Lemons, Jr., Edward H. Boyle, Jr., and Catherine C. Kilgore. 1982. 14 pp. 7 figs. The Bureau of Mines Minerals Availability System collected and analyzed data for 34 nonlaterite and 9 nickeliferous laterite domestic chromite deposits in order to assess their viability as sources of chromium under present technologic and economic conditions. These 43 deposits, none currently in production, contain approximately 6.3 and 22.3 million metric tons of Cr_2O_3 at the demonstrated and identified resource levels, respectively. Approximately 4.6 and 15.6 million metric tons of Cr_2O_3 are recoverable at the demonstrated and identified levels, respectively, for the 34 nonlaterite deposits. None of these resources are economically recoverable at January 1981 market prices. Production of metallurgical-grade chromite (market price $128 to $144) would require a minimum chromite market price of $237 per metric ton. Chemical-grade chromite production (market price $74 to $85) would require a chromite market price in excess of $188 per metric ton. From the 34 nonlaterite deposits, roughly 5.4 and 17.6 million metric tons of ferrochrome could be produced at the demonstrated and identified resource levels, respectively; however, a minimum market price of $770 per metric ton of ferrochrome would be required to stimulate production. The nine nickeliferous laterite deposits were not evaluated through production stages because of uncertainties in process technology and cost.

IC 8896. Surface Subsidence Over Longwall Panels in the Western United States. Monitoring Program and Preliminary Results at the Deer Creek Mine, Utah, by Frederick K. Allgaier. 1982. 24 pp. 20 figs. This is the first in a series of progress reports on the longwall subsidence research program at the Bureau of Mines Denver Research Center. As part of this program, the Bureau and the Utah Power and Light Co. are cooperating on a study conducted at the Deer Creek Mine, which is directed toward developing the capability to estimate the surface subsidence resulting from longwall mining in a geologic, topographic, and mining environment common to coalfields in the Western United States. A monitoring network has been established at the Deer Creek Mine to measure subsidence over four adjacent longwall panels. To date, two panels have been mined. Subsidence began as the first panel was mined and continued for 1 year following completion of the panel, during which time the adjacent panel was mined. A maximum of 2.7 feet of subsidence occurred over the two longwall panels mined at a depth of 1,500 feet. Because of the length of time that subsidence continued after mining, the final subsidence profiles and angle of draw have not yet been determined.

IC 8897. Platinum Availability—Market Economy Countries. A Minerals Availability System Appraisal, by T. F. Anstett, D. I. Bleiwas, and C. Sheng-Fogg. 1982. 16 pp. 11 figs. The Bureau of Mines investigated the availability of platinum from known major deposits in market economy countries. Fifteen of these deposits contain demonstrated resources totaling 302 million troy ounces of platinum. Detailed geologic, engineering, and cost evaluations were performed on each deposit to determine its potential for platinum production. There are large amounts of demonstrated platinum potentially available from market economy deposits that were not analyzed owing to lack of adequate data or to technological limitations. These include 297 million troy ounces contained in the UG2 and Platreef of the Bushveld Complex, South Africa. This analysis indicates that about 110 million troy ounces (2.3 million ounces annually) of platinum are potentially available at the January 1980 producer price of $420 per troy ounce, nearly all from South Africa. An additional 85 million troy ounces occurring in Zimbabwean deposits would become available only through more than a quadrupling of that price. In order to meet projected world demand of 3.5 million troy ounces in 1990, platinum price may have to increase. Only one domestic deposit, the Salmon River in Alaska, is capable of producing platinum at $420 per troy ounce. Regardless of price, at assumed production capacities, domestic deposits could supply less than 10 percent of annual U.S. requirements.

IC 8898. Site-Specific and Regional Geologic Considerations for Coalbed Gas Drainage, by W. P. Diamond.

1982. 24 pp. 15 figs. The Bureau of Mines has been involved in the drilling of vertical, horizontal, and directional coalbed gas drainage boreholes for mine safety since 1964. In that time, boreholes have been drilled in most of the major coal regions of the United States under a wide variety of geologic conditions. Many of the geologic conditions that occur in the coal measures are detrimental to gas drainage; others may be beneficial. Analytical techniques to determine the gas content of coal samples and evaluate regional trends of gas distribution have been developed. Drilling techniques that maximize the acquisition of coalbed gas data and geologic information have been determined. Although some of the geologic factors influencing the placement and potential success of coalbed gas drainage boreholes have been reported in papers on individual projects, a complete, systematic compilation has not previously been available. The objective of this paper is to provide information on specific geologic factors that should be considered prior to, during, and after the drilling of coalbed gas drainage boreholes. Many of the commonsense considerations that have been learned through many years of Bureau of Mines experience, but have generally not been reported formally, are included for those who may be considering coalbed gas drainage drilling for the first time, or who have not had the opportunity to encounter a substantial number of geologic situations.

IC 8899. Evaluation of a Combined Face Ventilation System Used With a Remotely Operated Mining Machine, by E. Divers, N. Jayaraman, and J. Custer. 1982. 7 pp. 2 figs. This Bureau of Mines report presents results of an underground evaluation to determine the respirable dust and gas control effectiveness of a combined (push-pull) face ventilation system for coal mines. The system utilizes both blowing and exhaust curtain, continuous miners equipped with radio remote control, and flight conveyors. Bureau of Mines tests showed a 97% reduction in respirable dust concentrations from the usual cab position on the continuous miner to the remote control operator's position. This allowed the remote control operator to be well within, and the usual cab position to exceed, Federal respirable dust standards. Tests utilizing a safe tracer gas, sulfur hexafluoride (SF_6), to determine the face ventilation effectiveness of the combined blowing and exhaust system showed that the system also has excellent methane dispersion capability. Where wide entries permit, this combined face ventilation system and use of remote control can be a very effective method for dust and gas control.

IC 8900. Future Trends and Prospects for the Australian Mineral Processing Sector, by L. Nahai and Charlie Wyche. 1982. 41 pp. 2 figs. An important objective of the Australian Government's policies on resources development is to encourage further processing of raw materials domestically, to the extent that this is economically feasible and consistent with sound industrial development. This Bureau of Mines report examines the extent to which Australia is able to pursue this policy in terms of its own competitive advantages and the implications of such a policy for the United States. Such factors as the impact of other competing producers and their advantages, expected world demand, and infrastructural problem—which may limit pursuit of this policy to the fullest extent—are discussed. After a broad review of the resource, economic, social, and environmental factors, the perspective for increased processing is examined for a number of mineral commodities.

IC 8901. Real-Time Calculation of Product-of-Combustion Spread in a Multilevel Mine, by John C. Edwards and Rudolf E. Greuer. 1982. 117 pp. 2 figs. A computer program, developed for the Bureau of Mines under contract, predicts in a quasi-steady-state approximation the ventilation and contaminant concentrations and temperatures when a fire occurs in a multilevel mine. For periods of time in which there is no significant change in the ventilation, yet a fire is producing fumes, a real-time fume concentration throughout the mine is calculated. Multiple and time-variable contaminant sources can be simulated. Recirculation paths that can develop provide a mechanism for increasing the fume concentration in the mine network and are identified by the computer program. This report contains a listing of the Fortran computer program as well as the required format of the input data. Two examples are provided of the real-time spread of smoke from a fuel-rich fire throughout a multilevel mine. The first example considers an operational exhaust fan as well as a booster fan. The second example evaluates the real-time smoke spread following a failure in the exhaust fan; recirculation occurs in this latter case.

IC 8902. A Review of Methods for Identifying Scrap Metals, by R. Newell, R. E. Brown, D. M. Soboroff, and H. V. Makar. 1982. 19 pp. 5 figs. As part of the Bureau of Mines program for conserving domestic mineral resources, a survey was made of the methods used for identifying scrap metals. Because of the large number of alloys currently being scrapped, correct identification of these materials is essential if they are to be recycled effectively. The methods and instruments used to identify scrap metals are described and evaluated. These include object recognition, color, density, magnetic testing, spark testing, chemical spot testing, thermoelectric measurements, eddy current measurements, and elemental analysis by chemical and instrumental methods. Other potential techniques are discussed also. GPO Stock No. 024–004–02105–5. $3.25.

IC 8903. Alarm System for Radiation Working Level, Fan Operation, and Air Door Position, by J. C. Franklin, P. E. Barr, K. D. Weverstad, and C. T. Sheeran. 1982. 17 pp. 8 figs. A 32-channel continuous monitoring system has been developed to monitor radiation working level (WL), fan operation, and air door position. The system consists of a surface receiver unit and an underground transmitter that is connected to the various monitors. A continuous WL monitor used with the system can generate alarms at two different WL readings. One of these levels is variable from 0.00 to 0.99 WL and generates an alarm on the surface receiver. The other level, fixed at 1.0 WL, generates an underground alarm in the vicinity of the monitor. The detectors for fan operation and air door position work on the principle of a completed circuit to the underground transmitter (multiplexer). When the circuit is broken, as is the case when a fan is off or an air door is open, an alarm is generated at the surface receiver. This alarm remains in effect until the circuit is completed, signifying the fan has been turned on or the air door has been closed.

IC 8904. Predicted Characteristics of Waste Materials From the Processing of Manganese Nodules, by Benjamin W. Haynes and Stephen L. Law. 1982. 10 pp. 6 figs. As part of the first-order assessment of po-

tential manganese nodule processing reject waste materials, the Bureau of Mines estimated the physical and chemical characteristics of reject waste materials that would be generated from each of five potential process flowsheets. These processes were chosen because of their economic and technical feasibility for first-generation nodule processing. A brief description of the five processes is given to show process inputs and outputs. The physical characteristics are predicted based on land-based laterite processing where applicable, and where no land-based analog exists, on the basis of process chemistry. The probable chemical characteristics such as element content and compound form are tabulated for each process for 16 elements: As, Ba, Be, Cd, Co, Cr, Cu, Fe, Mn, Mo, Ni, Pb, Sb, Se, Tl, and Zn. These elements were chosen based on their presence on the toxic substance list of priority pollutants, extraction procedure (EP) toxicity criteria, and major and minor elements of economic importance (Co, Fe, Mn, and Mo). Physical and chemical analyses as well as results of the EP toxicity test of one industrially supplied pilot plant reject waste material are presented.

IC 8905. Acid Mine Drainage: Control and Abatement Research, by Ann G. Kim, Bernice S. Heisey, Robert L. P. Kleinmann, and Maurice Deul. 1982. 22 pp. 16 figs. Acid drainage from underground coal mines and coal refuse piles is one of the most persistent industrial pollution problems in the United States. This Bureau of Mines report reviews the acid mine drainage problem generally and describes research currently underway to combat it.

IC 8906. Mineralogical and Elemental Description of Pacific Manganese Nodules, by Benjamin W. Haynes, Stephen L. Law, and David C. Barron. 1982. 60 pp. 65 figs. This Bureau of Mines publication comprises a compilation of the state of the science in Pacific Ocean manganese nodule mineralogy and elemental composition. The report is divided into three sections: morphology, mineralogy, and elemental composition. The nodule morphology section defines what is considered a nodule for the study, and details the external characteristics and internal structure. Nodule mineralogy is discussed in three sections: manganese minerals, iron oxide minerals, and accessory minerals. The major manganese minerals discussed are todorokite, birnessite, and vernadite. The iron oxide minerals are less well known and include feroxyhyte, geothite, and lepidocrocite. Accessory minerals present include quartz, clays, and other silicates and nonsilicates. A discussion on moisture content is also included. The elemental composition section presents data on 74 elements occurring as cations or anions. Summary data, histograms, and interelement correlation coefficients are presented. The elements are grouped as follows: major and minor elements of potential economic interest (8), other major and minor elements (9), elements of environmental interest (8), rare-earth elements (15), precious-metal-group elements (6), radioactive elements (3), other trace elements (17), and anion-forming elements (8). Cross sectional determinations of Ni, Cu, Zn, Co, Pb, Fe, Ce, and Ba are given for a single nodule to show the general tendency of different growth patterns within a nodule because of different element associations and composition. GPO Stock No. 024-004-02109-8. $5.

IC 8907. Postdisaster Survival and Rescue Research. Proceedings: Bureau of Mines Technology Transfer Seminar, Pittsburgh, Pa., November 16, 1982, compiled by Staff, Bureau of Mines. 1982. 91 pp. 82 figs. These proceedings consist of papers presented at a Bureau of Mines technology transfer seminar on postdisaster survival and rescue research: (1) an overview of oxygen self-rescuer technology, (2) laboratory environmental testing of chemical oxygen self-rescuers for ruggedness and reliability, (3) chemical oxygen self-contained self-rescuer escape study, (4) medium frequency radio communication system for mine rescue, (5) finding and communicating with trapped miners, (6) Bureau of Mines borehole probes program, and (7) mine personnel locator and in-mine activity controller. Several technology transfer seminars are held each year to bring the latest results of Bureau research to the attention of the mining industry as quickly as possible.

IC 8908. Health and Safety In-House and Contract Research and Development in Fiscal Year 1983, by Staff, Division of Health and Safety Technology. 1982. 36 pp. This publication summarizes, for potential contractors and all other interested parties, the research and development of in-house and contract projects programed by the Bureau of Mines for fiscal year 1983 (October 1, 1982-September 30, 1983) under its Health and Safety Technology program. The objective of these projects is to provide an ordered and sequenced series of advances toward the Bureau's overall goal of providing the systems technology required to create a more healthful and safer working environment for the Nation's mining and minerals processing workers.

IC 8910. Thermodynamic Properties of Selected Transition Metal Sulfates and Their Hydrates, by Carroll W. DeKock. 1982. 45 pp. 3 figs. Thermodynamic data for selected metal sulfates were critically evaluated and compiled as part of the Bureau of Mines program to provide a scientific base for use in developing new technology and predicting the feasibility of new processes. Values for Cp°, S°, $H^\circ - H^\circ_{298}$, $-(G^\circ - H^\circ_{298})/T$, ΔHf°, ΔGf°, and log Kf as a function of temperature are given in tabular form. Thermodynamic data were compiled for $VOSO_4$, $Cr_2(SO_4)_3$, $MnSO_4$, $FeSO_4$, $Fe_2(SO_4)_3$, $CoSO_4$, $NiSO_4$, Cu_2SO_4, $CuSO_4$, $CuO \cdot CuSO_4$, $ZnSO_4$, and $ZnO \cdot 2ZnSO_4$, together with their stable hydrates.

OPEN FILE REPORTS

An open file report is an unpublished Bureau of Mines report that has been made available as reference material. Any open file report may be inspected during working hours at the locations indicated but may not be removed. If a number prefixed with PB is given, the report may be purchased by check or money order payable to the National Technical Information Service, charged to a deposit account at NTIS, or charged on a VISA, MasterCard, or American Express credit card. Address requests to—

National Technical Information Service
U.S. Department of Commerce
Springfield, VA 22161

or call 703-487-4650.

OFR 1–82. Environmental Test Criteria for the Acceptability of Mine Instrumentation, by Kenneth Trelewicz. June 1981. 137 pp. 18 figs. This report describes a two-phase effort that went into developing environmental test criteria for general mine instrumentation. Phase I consisted of research and mine visits to develop an environmental profile for mine instrumentation that was translated into general and test requirements. A review of existing Government and commercial specifications was performed to determine if they matched the test requirements. Finally, a set of environmental test procedures was developed to test mine instrumentation. Phase II consisted of selecting and purchasing sample mine instrumentation and subjecting them to the previously developed tests to evaluate the criteria for use as an instrumentation test document and to determine the effects of the various criteria on a representative sample of both proven and new developed instrumentation. The test criteria were then modified, based on test results, and are included in the report. Research done under contract J0100040 by Dayton T. Brown, Inc. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; U.S. Department of Energy facilities in Carbondale, Ill., Pittsburgh, Pa., and Morgantown, W. Va.; Mine Safety and Health Administration, Arlington, Va.; National Mine Health and Safety Academy, Beckley, W. Va.; and Office of Surface Mining Library and National Library of Natural Resources, U.S. Department of the Interior, Washington D.C. Order ONLY from NTIS: PB 82–146325; paper copy price code A07.

OFR 2–82. Demonstration of Coal Mine Illumination Systems, by Anthony D. Szpak, William F. Hahn, and Charles S. Skinner. January 1981. 127 pp. 72 figs. The purpose of this program was to demonstrate the feasibility of illuminating various types of underground coal mining machinery as required by the Federal Coal Mine Illumination Standards Part 75.1719 to 75.1719–4 Code of Federal Regulations Title 30. Nine various machines were illuminated and the illumination systems were evaluated for a 3-month period. Factors evaluated were ease of implementation, reliability, ease of maintenance, acceptance by mine workers and operators, illumination degradation, and durability. Research done under contract J0188006 by Booz, Allen & Hamilton Inc. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; U.S. Department of Energy facilities in Carbondale, Ill., Pittsburgh, Pa., and Morgantown, W. Va.; Mine Safety and Health Administration, Arlington, Va.; National Mine Health and Safety Academy, Beckley, W. Va.; and Office of Surface Mining Library and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Order ONLY from NTIS: PB 82–147471; paper copy price code A07.

OFR 3–82. Monitoring of Mine Air Diesel Pollutants: Tailpipe Emissions Measurement Apparatus, Detector Tube Interferences, and Exhaust and Ventilation System Control, by John H. Johnson, David H. Carlson, Edward O. Reinbold, and Mark D. Osborne. July 31, 1980. 267 pp. 109 figs. The objective of this work was to develop and test engineering approaches to the control of air quality for the protection of miners health in dieselized underground mines. A general experimental approach was developed by which instruments could be compared for the measurement of diesel exhaust pollutant concentrations in the 0.5 to 5 threshold limit value (TLV) range. Dräger detector tube diluted exhaust CO, CO_2, NO, and NO_2 measurements were compared with simultaneously taken portable instrument measurements. The effects of two exhaust system configurations on the pollutant concentrations in a deadend heading were studied. Both directed gases toward the crosscut and improved the stratification of the air in the heading. Research done under contract J0199125 by Michigan Technological University. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; U.S. Department of Energy facilities in Carbondale, Ill., Pittsburgh, Pa., and Morgantown, W. Va.; Mine Safety and Health Administration, Arlington, Va.; National Mine Health and Safety Academy, Beckley, W. Va.; and Office of Surface Mining Library and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Order ONLY from NTIS: PB 82–148388; paper copy price code A10.

OFR 4–82. Determination of the Products of the Oxidative Thermal Degradation of Variously Treated Woods and Mine Materials, by K. L. Paciorek, R. H. Kratzer, J. H. Nakahara, and D. H. Harris. July 1980. 182 pp. 91 figs. The objective of this program was to determine the toxic fume and fire hazards of variously treated mine materials compared with virgin or untreated compositions under conditions approximating those likely to be encountered in underground mines. An apparatus was designed and constructed that was capable of simulating varying conditions of temperature, flow, atmosphere in addition to provision for accommodating varying sample thicknesses, total and intermittent product collection, and continuous parameter monitoring. Toxic load

assessments were obtained for all of the test conditions. The fire hazards presented by the conveyor belts were higher than that of the NCX-treated woods; toxic hazards were comparable. Research done under contract J0395008 by Ultrasystems, Inc. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; U.S. Department of Energy facilities in Carbondale, Ill., Pittsburgh, Pa., and Morgantown, W. Va.; Mine Safety and Health Administration, Arlington, Va.; National Mine Health and Safety Academy, Beckley, W. Va.; and Office of Surface Mining Library and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Order ONLY from NTIS: PB 82-146275; paper copy price code A09.

OFR 5-82. High Speed Drill Probe To Detect Abandoned Underground Workings, by Robert W. Gordon and Glen O. Baker. June 1981. 57 pp. 51 figs. This report describes the results and conclusions of the further development of a previously developed lightweight probe drill for use in anthracite mines. The improvements included (1) better hole cleaning due to the development of an air-water mist flushing system, (2) the application of roof drill bits to allow drilling through rock seams and lenses, (3) the development of a quick coupling drill system that reduced total steel change time, and (4) adaptation of a swivel to the drill anchoring system that greatly reduced set-up time between holes. With these improvements, the probe drill drilled the required 11 holes in one shift and gained miner acceptance as a viable underground working tool. The probe drill proved to meet all design requirements of portability, low-weight drilling controllability, structural integrity, and reliability. In addition to drilling the required probe pattern, the probe drill is capable of drilling long holes. By drilling several holes over 80 feet deep the probe drill has the potential for use in robbing pillars and for methane drainage. Research done under contract H0292026 by Hamilton Engineering, Inc. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Juneau, Alaska, Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; U.S. Department of Energy facilities in Pittsburgh, Pa., and Morgantown, W. Va.; Mine Safety and Health Administration, Arlington, Va.; National Mine Health and Safety Academy, Beckley, W. Va.; and Office of Surface Mining Library and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Order ONLY from NTIS: PB 82-146267; paper copy price code A04.

OFR 6-82. Flexible Liner for Use in Advancing Tailgate, by Kenneth C. Ko. November 1980. 191 pp. 82 figs. This report describes an investigation on the technical and economic feasibility of implementing flexible liner-backpacking support systems in an advancing tailgate longwall mine. The system consists of a circular tube constructed of liner plates and flyash backpacking. Flyash is pneumatically stowed into the tailgate. Small amounts of cement may be mixed to improve the support capability of the fill in difficult local ground conditions. Water is added inside the nozzle immediately prior to spraying. Results of theoretical analyses and a field test show that the designed system is technically feasible, and can increase productivity and coal recovery, compared with existing retreat longwall systems. In certain mine layouts, the system can reduce the direct mining costs by a significant amount and would be particularly applicable to deeper coalbeds with bad ground conditions. Research done under contract H0292014 by Kenneth C. Ko & Associates, Inc. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Juneau, Alaska, Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; U.S. Department of Energy facilities in Pittsburgh, Pa., and Morgantown, W. Va.; Mine Safety and Health Administration, Arlington, Va.; National Mine Health and Safety Academy, Beckley, W. Va.; and Office of Surface Mining Library and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Order ONLY from NTIS: PB 82-149352; paper copy price code A09.

OFR 7-82. Developing a New Method for Roof Support Using Sonic Pin-Setting Machines, by Robert L. Morris and John C. Purcupile. Dec. 21, 1977. 95 pp. 42 figs. This report describes the activities conducted in the development and testing of a first-generation sonic pin-setting machine that uses an oscillating force to insert roof pins in a mine roof. A theoretical model was developed and is shown in the report. Research done under contract H0262061 by Carnegie-Mellon University. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsbugh, Pa., Salt Lake City, Utah, and Spokane, Wash.; U.S. Department of Energy facilities in Pittsburgh, Pa., and Morgantown, W. Va.; Mine Safety and Health Administration, Arlington, Va.; National Mine Health and Safety Academy, Beckley, W. Va.; and Office of Surface Mining Library and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Copies of this report will not be available for purchase.

OFR 8(1)-82. Survey of Blasting Effects on Ground Water Supplies in Appalachia. Volume I, by Donelson A. Robertson, James A. Gould, Jeffery A. Straw, and Michael A. Dayton. November 1980. 161 pp. 51 figs. This report presents the results of a survey on blasting effects on ground water supplies in Appalachia. Literature was searched and cases of alleged water well damage were investigated. Occurrence of ground water in Appalachia is primarily in low yield, fractured, water table aquifers. Four test sites were chosen based on geographic and geologic diversity, and wells were drilled at each site. Base line data on water quality, static water level, and drawdown characteristics were obtained before surface mining commenced. Blast-induced ground vibrations were measured at the surface at levels up to 5.44 inches per second maximum resultant particle velocity. Measurements made at the bottom of the wells indicated that vibrations were considerably attenuated at depths of 140 to 160 feet. No direct evidence of change in water quality or well performance was produced by blast vibrations, but removal of downslope support by excavation does cause lateral stress relief which permits the water-bearing fractures to become more open. The additional storage capacity causes the static water level to drop and for well-bore permeability to improve. Static water level recovers if sufficient recharge is available and well performance

is improved. Research done under contract J0285029 by Philip R. Berger and Associates Inc. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; U.S. Department of Energy facilities in Carbondale, Ill., Pittsburgh, Pa., and Morgantown, W. Va.; Mine Safety and Health Administration, Arlington, Va.; National Mine Health and Safety Academy, Beckley, W. Va.; and Office of Surface Mining Library and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Order ONLY from NTIS: PB 82–152125; paper copy price code A08.

OFR 8(2)–82. Survey of Blasting Effects on Ground Water Supplies in Appalachia. Volume II, by Donelson A. Robertson, James A. Gould, Jeffery A. Straw, and Michael A. Dayton. November 1980. 266 pp. This report presents the results of a survey on blasting effects on ground water supplies in Appalachia. Literature was searched and cases of alleged water well damage were investigated. Occurrence of ground water in Appalachia is primarily in low yield, fractured, water table acquifers. Four test sites were chosen based on geographic and geologic diversity, and wells were drilled at each site. Base line data on water quality, static water level, and drawdown characteristics were obtained before surface mining commenced. Blast-induced ground vibrations were measured at the surface at levels up to 5.44 inches per second maximum resultant particle velocity. Measurements made at the bottom of the wells indicated that vibrations were considerably attenuated at depths of 140 to 160 feet. No direct evidence of change in water quality or well performance was produced by blast vibrations, but removal of downslope support by excavation does cause lateral stress relief which permits the water-bearing fractures to become more open. The additional storage capacity causes the static water level to drop and for wellbore permeability to improve. Static water level recovers if sufficient recharge is available and well performance is improved. Volume II contains appendixes B and C. Research done under contract J0285029 by Philip R. Berger and Associates Inc. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; U.S. Department of Energy facilities in Carbondale, Ill., Pittsburgh, Pa., and Morgantown, W. Va.; Mine Safety and Health Administration, Arlington, Va.; National Mine Health and Safety Academy, Beckley, W. Va.; and Office of Surface Mining Library and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Order ONLY from NTIS: PB 82–152133; paper copy price code A12.

OFR 9–82. Methane Telemetry System for Continuous Miners, by Terry S. Cory. June 22, 1979. 96 pp. 23 figs. This report describes a unique radio frequency telemetry system to enable the simultaneous remote monitoring of up to eight methane sensors positioned on a continuous-mining machine. The system employs medium frequency wireless radio transmission and the coupling of induced radio frequency currents into the miner trailing cables. The system is automatic and unattended and provides continuous hard copy recording of the sensor levels. The system employs serial digital transmission of the data under microprocessor control using frequency shift keying modulation. Research done under contract J0166094. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Boulder City and Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; U.S. Department of Energy facilities in Carbondale, Ill., and Morgantown, W. Va.; National Mine Health and Safety Academy, Beckley, W. Va.; and Office of Surface Mining Library and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Order ONLY from NTIS: PB 82–163940; paper copy price code A05.

OFR 10–82. Automatic Trapped Miner Seismic Signal Detection and Analysis System, by Tim F. Dyson. May 21, 1981. 72 pp. 23 figs. The feasibility of employing automated processing and detection techniques in the mine disaster communications problem is demonstrated. Efficient processing methods are developed. The methods have been demonstrated both in a laboratory and in a field environment. Evaluation of existing computer capacity is given along with recommendations for expansion. Research done under contract J0395064 by Sonic Sciences, Inc. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; U.S. Department of Energy facilities in Carbondale, Ill., Pittsburgh, Pa., and Morgantown, W. Va.; Mine Safety and Health Administration, Arlington, Va.; National Mine Health and Safety Academy, Beckley, W. Va.; and Office of Surface Mining Library and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Order ONLY from NTIS: PB 82–161936; paper copy price code A04.

OFR 11(1)–82. Recontouring of Steep-Slope Abandoned Contour Mines. Volume I—Summary, by Daniel I. Carey and Robert L. Lappi. August 1981. 65 pp. 16 figs. Current and potential dragline reclamation usage was evaluated for U.S. coalfields based on data gathered and analyzed during field surveys, literature reviews, and contacts with manufacturers. It was concluded that current mining plans have been adapted to Federal and State strip mine and reclamation laws in ways that limit the potential for dragline reclamation systems at active mine sites. At abandoned conventional contour mine sites in steep-sloping areas, such as central Appalachia, it was found that dragline reclamation systems have great potential application and may be the only practical solution to many reclamation problems. Alternative dragline systems were examined for restoring abandoned sites, and it was concluded that a tower excavator system offered superior characteristics and should be evaluated and developed under field conditions. A testing program was developed to provide a framework for the monitoring and analysis of cost, production, and environmental data during a field demonstration of a tower excavator system. Volume I contains a summary of the report. Research done under contract J0295018 by Mathtech, Inc. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Juneau, Alaska, Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; and Office of Surface Mining Library and National Library of Natural Resources, U.S. De-

partment of the Interior, Washington, D.C. Order ONLY from NTIS: PB 82–168048; paper copy price code A04.

OFR 11(2)–82. Recontouring of Steep-Slope Abandoned Contour Mines. Volume II—Appendices, by Daniel I. Carey and Robert L. Lappi. August 1981. 227 pp. 49 figs. Current and potential dragline reclamation usage was evaluated for U.S. coalfields based on data gathered and analyzed during field surveys, literature reviews, and contacts with manufacturers. It was concluded that current mining plans have been adapted to Federal and State strip mine and reclamation laws in ways that limit the potential for dragline reclamation systems at active mine sites. At abandoned conventional contour mine sites in steep-sloping areas, such as central Appalachia, it was found that dragline reclamation systems have great potential application and may be the only practical solution to many reclamation problems. Alternative dragline systems were examined for restoring abandoned sites, and it was concluded that a tower excavator system offered superior characteristics and should be evaluated and developed under field conditions. A testing program was developed to provide a framework for the monitoring and analysis of cost, production, and environmental data during a field demonstration of a tower excavator system. Volume II contains the appendices. Research done under contract J0295018 by Mathtech, Inc. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Juneau, Alaska, Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; and Office of Surface Mining Library and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Order ONLY from NTIS: PB 82–168055; paper copy price code A11.

OFR 12–82. Irrigation for Reclamation of Strip Mined Lands, by Roger M. Sherman, Jordan A. Kinkead, Gregory J. Campbell, and G. M. Alder. July 1980. 129 pp. 20 figs. Investigation of mine land characteristics, evaluation of irrigation systems, and evaluations by the mining industry determined that irrigation is a feasible method for aiding revegetation of coal mined lands in western arid and semiarid regions. The various regions studied displayed a commonality of characteristics that enables the recommendation of solid-set irrigation. Irrigation should be supplemental by complementing natural precipitation and should be implemented on a temporary basis. For germination, the vegetation requires application of small amounts of water in a gentle, frequent, and timely manner. For the establishment phase of growth, moisture should be applied and stored in the soil previous to germination through preirrigation. The nature of strip mining operations dictates a need for irrigation systems that are physically and operationally flexible, portable, and low in operation requirement. Portable solid-set sprinkler irrigation was identified as a feasible system to meet these requirements. Solid set can apply limited, but useful, quantities of water and has the flexibility to adapt to a variety of field shapes, topography, soil conditions, and irrigation timing requirements. The system also provides a means for wind erosion control and modification of problem soils. Research done under contract J0199088 by Sherman and Sullivan. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; U.S. Department of Energy facilities in Carbondale, Ill., Pittsburgh, Pa., and Morgantown, W. Va.; Mine Safety and Health Administration, Arlington, Va.; National Mine Health and Safety Academy, Beckley, W. Va.; and Office of Surface Mining Library and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Order ONLY from NTIS: PB 82–163395; paper copy price code A07.

OFR 13–82. Engineering Property Changes and Environmental Effects on Coal Mine Wastes Due to Slaking, by Wahler Associates. May 1981. 281 pp. 64 figs. A preliminary review was conducted of the occurrence and importance of slaking in coal refuse dumps. Of 21 disposal sites visited to evaluate environmental problems of aging refuse dumps, 5 were selected for intensive study. Laboratory testing included specific gravity, gradation, maximum and minimum density tests, 9-inch drained triaxial tests, 9- and 10-inch permeability tests, slake-durability tests, and accelerated slaking tests. Some refuse sites had significantly lower shear strengths and permeabilities in old, slaked, or weathered material than in fresh refuse. Testing did not show useful correlations between strength and permeability changes and other material properties that could serve as predictors. Testing of refuse under accelerated slaking conditions showed promise as a comparative tool and as a potential means of preparing artificially aged samples for evaluations of long-term behavior. Research done under contract J0285028. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; U.S. Department of Energy facilities in Carbondale, Ill., Pittsburgh, Pa., and Morgantown, W. Va.; Mine Safety and Health Administration, Arlington, Va.; National Mine Health and Safety Academy, Beckley, W. Va.; and Office of Surface Mining Library and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Order ONLY from NTIS: PB 82–163965; paper copy price code A13.

OFR 14–82. Cableless Electronic Surveying Systems for Horizontal Holes, by Dennis McLaughlin, John Millhiser, and Margaret Bonarek. March 1981. 235 pp. 27 figs. The purpose of this project was to enhance the Bureau of Mines cableless electronic survey system use to aid in the drilling of long boreholes in coal as part of the methane drainage program. The system that was ultimately developed was field tested and demonstrated in actual in-mine drilling activities. The significance of the system, compared with previous drill survey systems, is that it surveys without having to be inserted and removed for each survey point. The system is so designed that it can withstand the shock and vibration experienced by the drill string during drilling. Thus increased productivity is possible and drill operators can determine drill bit positioning in a near real-time environment. Research done under contract H0177069 by ENSCO, Inc. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Juneau, Alaska, Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; U.S. Department of Energy facilities in Pittsburgh, Pa., and Morgantown, W. Va.; Mine Safety and Health Administration, Arlington, Va.; National Mine Health and Safety Academy, Beck-

ley, W. Va.; and Office of Surface Mining Library and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Order ONLY from NTIS: PB 82-164526; paper copy price code A11.

OFR 15(1)-82. Area Terrace Pit Coal Mining Systems. Volume 1—Technical & Economic Evaluation of Terrace Pit Mining Systems, by Fred Leonard, Craig Simon, Mike Stoddard, Mani Verma, Mike White, and Larry Welborn. October 1980. 296 pp. 82 figs. This report is principally concerned with the engineering and economic feasibility of area surface coal mining systems other than draglines. This analysis evaluates shovel trucks, shovel-crusher conveyors, and shovel-rail excavation and haulage systems for an assortment of geologic environments and production rates in the Powder River Basin. Shovel trucks, front-end loader trucks, and shovel-crusher conveyors were studied in a multiseam, dipping geologic area of the Four Corners region. The Texas lignite engineering and economic research involved bucket-wheel excavators (BWE), BWE backhoes, and scraper-backhoe combinations for overburden and coal excavation. The truck-shovel study utilized the most recent computer simulation available in both design and cost analyses. Detailed engineering analyses, followed by in-depth operating costs, result in a complete evaluation of each mining system. Cost comparisons of the different mining systems under similar geologic and production constraints are presented to illustrate the estimated capital investment and production costs per ton of coal and bank cubic yard of overburden. Volume I contains a technical and economic evaluation of terrace pit mining systems. Research done under contract J0275017 by Dames & Moore and PD-NCB Consultants Ltd. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; U.S. Department of Energy facilities in Carbondale, Ill., and Pittsburgh, Pa.; Mine Safety and Health Administration, Arlington, Va.; National Mine Health and Safety Academy, Beckley, W. Va.; and Office of Surface Mining Library and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Order ONLY from NTIS, PB 82-166471; paper copy price code A13.

OFR 15(2)-82. Area Terrace Pit Coal Mining Systems. Volume 2—Appendices, by Fred Leonard, Craig Simon, Mike Stoddard, Mani Verma, Mike White, and Larry Welborn. October 1980. 448 pp. This report is principally concerned with the engineering and economic feasibility of area surface coal mining systems other than draglines. This analysis evaluates shovel trucks, shovel-crusher conveyors, and shovel-rail excavation and haulage systems for an assortment of geologic environments and production rates in the Powder River Basin. Shovel trucks, front-end loader trucks, and shovel-crusher conveyors were studied in a multiseam, dipping geologic area of the Four Corners region. The Texas lignite engineering and economic research involved bucket-wheel excavators (BWE), BWE backhoes, and scraper-backhoe combinations for overburden and coal excavation. The truck-shovel study utilized the most recent computer simulation available in both design and cost analyses. Detailed engineering analyses, followed by in-depth operating costs, result in a complete evaluation of each mining system. Cost comparisons of the different mining systems under similar geologic and production constraints are presented to illustrate the estimated capital investment and production costs per ton of coal and bank cubic yard of overburden. Volume 2 contains the appendices. Research done under contract J0275017 by Dames & Moore and PD-NCB Consultants Ltd. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; U.S. Department of Energy facilities in Carbondale, Ill., and Pittsburgh, Pa.; Mine Safety and Health Administration, Arlington, Va.; National Mine Health and Safety Academy, Beckley, W. Va.; and Office of Surface Mining Library and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Order ONLY from NTIS: PB 82-166489; paper copy price code A19.

OFR 16-82. Low Temperature Tests of Rescue Breathing Apparatus, by Richard L. Burse and Louis D. Strong. July 1981. 113 pp. 54 figs. The U.S. Army Research Institute of Environmental Medicine tested two samples each of three different types of rescue breathing apparatus (RBA) to determine how long both could be worn by operators in subfreezing temperatures. Phase I tests were performed after overnight cold soaking at the test temperature; phase II tests were performed after overnight storage at + 20° C. Successful performance was determined as proper operation for at least one-half the certified duration of the oxygen supply without exhaustion of the oxygen supply, increase of inspired CO_2 above physiologically acceptable levels, or increase in breathing resistance above tolerable levels. In phase I, the Scott "Rescue Pak R" operated successfully at — 20° C, while the Drager 174-A and the McCaa units operated successfully at — 10° C. In phase II, the Scott unit operated successfully at — 25° C, the Drager at — 20° C, and the McCaa at — 15° C. None of the RBA types appeared well designed for use in subfreezing temperatures. Research done under contract J0188026 by U.S. Army Research Institute of Environmental Medicine. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; U.S. Department of Energy facilities in Carbondale, Ill., Pittsburgh, Pa., and Morgantown, W. Va.; Mine Safety and Health Administration, Arlington, Va.; National Mine Health and Safety Academy, Beckley, W. Va.; and Office of Surface Mining Library and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Order ONLY from NTIS: PB 82-172727; paper copy price code A06.

OFR 17-82. Field Survey of Float Dust in Coal Mining Operations, by J. A. Kost, J. F. Colinet, and G. A. Shirey. October 1981. 162 pp. 61 figs. The objectives of this investigation were to determine the amount, size, and deposition of float coal dust generated during the mining and transporting of coal in underground U.S. mining operations. Rock dust distributed by trickle dusters was also sampled. In addition to four belt-transfer points, two continuous and two conventional mining sections were sampled at five mines located in Pennsylvania, West Virginia, Kentucky, and Illinois. Float-dust samples were collected on deposition pans; total airborne dust was collected with MSA model G personal samplers equipped with Unico filter

casettes; Andersen cascade impactors provided relative size distributions of the samples. Production, airflow, and waterflow were monitored to examine their effect on dust levels. Research done under contract J0308030 by Bituminous Coal Research, Inc. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Juneau, Alaska, Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; U.S. Department of Energy, Carbondale, Ill.; Mine Safety and Health Administration, Arlington, Va.; National Mine Health and Safety Academy, Beckley, W. Va.; and Office of Surface Mining Library and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Order ONLY from NTIS: PB 82–172719; paper copy price code A08.

OFR 18–82. Temporary Face Support System, by R. O. Nichols and P. J. Hoet. May 1980. 155 pp. 28 figs. This report presents the engineering design, fabrication, and limited testing of a prototype temporary face support system. The system was designed to provide safer work environment for underground coal mining activities between the face and the last line of supported roof. The report provides operational and functional data on the temporary face support system and contains layouts and engineering drawings of the major elements. Research done under contract H0262058 by Applied Engineering Resources, Inc. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Juneau, Alaska, Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; U.S. Department of Energy facilities in Pittsburgh, Pa., and Morgantown, W. Va.; Mine Safety and Health Administration, Arlington, Va.; National Mine Health and Safety Academy, Beckley, W. Va.; and Office of Surface Mining Library and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Copies of this report will not be available for purchase.

OFR 19–82. ADINA/BM—A General Computer Program for Nonlinear Analysis of Mine Structures, by K. J. Bathe. February 1978. 415 pp. 79 figs. The current version of the computer program Automatic Dynamic Incremental Nonlinear Analysis for the Bureau of Mines (ADINA/BM) for linear and nonlinear, static, and dynamic finite element analysis of mine structures is described. The complete report is divided into four parts. Part A discusses the program solution capabilities, the finite element library, and the logical construction of the program and storage allocations. Part B summarizes the theory and numerical techniques used in the program. Part C presents brief problem descriptions and solution results for some sample solutions that have been transmitted as data cases. Part D contains the user's manual. Research done under contract J0255008 by Massachusetts Institute of Technology. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; U.S. Department of Energy facilities in Carbondale, Ill., Pittsburgh, Pa., and Morgantown, W. Va.; Mine Safety and Health Administration, Arlington, Va.; National Mine Health and Safety Academy, Beckley, W. Va.; and Office of Surface Mining Library and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Order ONLY from NTIS: PB 82–180993; paper copy price code A18.

OFR 20–82. Development of an Impact Rock Breaker Shaft Sinking System, by Stephen H. E. Phillips. June 1981. 87 pp. 10 figs. The primary objective of this project was to demonstrate the feasibility of using a mechanical impact rock breaker to increase shaft sinking rates, reduce costs, and improve the safety and working conditions for shaft sinking. The specific objective was to improve the shaft sinking equipment developed during the initial phase of the project and to further develop it for sustained underground use. This report outlines the modifications that were made to the prototype rectangular shaft sinking equipment that was originally tested at Magma Copper Co.'s 3A shaft at San Manuel, Ariz. Research done under contract H0262021 by Cementation Co. of America Inc. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; U.S. Department of Energy facilities in Carbondale, Ill., and Pittsburgh, Pa.; Mine Safety and Health Administration, Arlington, Va.; National Mine Health and Safety Academy, Beckley, W. Va.; and Office of Surface Mining Library and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Copies of this report will not be available for purchase.

OFR 21–82. Baseline Environmental Monitoring Program for the Bear Creek Hydraulic Borehole Mining Demonstration Test, by Lyda W. Hersloff. April 1981. 24 pp. 5 figs. An environmental monitoring program was established to assess the baseline of parameters that may be impacted by a research and development hydraulic borehole mining operation. Two aquifers were identified at the borehole site with the overlying sand aquifer being distinct from the ore sand aquifer on the basis of radiological parameters. The direction of ground water flow was determined to be north 19° west at a rate of 1.82 feet per year. Tests to determine the effect of backfilling the boreholes indicated that using overburden from the open pit mining operation would not significantly increase the radiological constituents of the ore sand aquifer. Mining measurements of the radon flux from the borehole indicated that the actual release rate of 0.035 picocuries per second was several orders of magnitude less than the calculated estimate by the U.S. Environmental Protection Agency. Finally, a gamma survey conducted at the site indicated that the terrestrial component of background radiation was consistent with that in areas near uranium deposits. Research done under contract J0205029 by Rocky Mountain Energy Co. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Juneau, Alaska, Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; and Office of Surface Mining Library and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Copies of this report wil not be available for purchase.

OFR 22–82. Real-Time Precalculation of the Distribution of Combustion Products and Other Contaminants in the Ventilation System of Mines, by Rudolf E. Greuer. Mar. 15, 1981. 263 pp. 10 figs. Two computer

programs for the real-time calculation of concentration distributions in the ventilation system of underground mines were designed. The programs allow simulation of the movement of fumes or other contaminants with the ventilating air, the calculation of concentrations at any given time and location, and the determination of the total contaminant exposure at different places in the mine. Multiple and time variable contaminant sources can be handled and recirculation is no obstacle. The first program is based on an airflow distribution which has, in the input data, to be stated. The second program has been linked to an existing program for the calculation of airflow distributions. Two versions of the second program are provided to accommodate the two existing programs. Several executed examples demonstrate the program performance. Research done under contract J0285002 by Michigan Technological University. Available for reference at Bureau of Mines facilities in Tusacaloosa, Ala., Juneau, Alaska, Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; Mine Safety and Health Administration, Arlington, Va.; National Mine Health and Safety Academy, Beckley, W. Va.; and Office of Surface Mining Library and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Order ONLY from NTIS: PB 82–183104; paper copy price code A12.

OFR 23–82. Characterization of Accessory Minerals in the Birmingham Red Iron Ores and Eufaula Ferruginous Bauxite Deposits in Alabama, by Richard D. Hagni and Michelle Cooper. Mar. 29, 1981. 127 pp. 20 figs. The character of phosphorus-bearing minerals in the Birmingham red iron ores and iron-bearing minerals in the Eufaula bauxite deposits in Alabama were studied by petrographic, ore microscopic, luminescent microscopic, scanning microscopic, electron microprobe, and X-ray diffraction techniques. Fifteen types of phosphorus-bearing mineral grains were identified in Birmingham iron ores by the characteristic sizes, shapes, and distributions. Size measurements and model and texture analyses permitted an estimate of potential liberation of phosphorus from the iron ores by beneficiation to be 27% in areas of previous mining and 60% in areas of current iron reserves. Fine grinding, selective flocculation, and flotation may constitute the best beneficiation techniques for future research. Hematite and geothite are the most important iron minerals in Eufaula ferruginous bauxites, but pyrite, marcasite, and siderite are important iron minerals in some varieties, and lepidocrocite and ilmenite occur locally in minor quantities. Although simple screening will remove the coarsest iron-bearing grains, research on the utilization of high-gradient magnetic separation to reduce the amounts of iron-bearing grains is recommended. Research done under contract J0100015 by the University of Missouri—Rolla. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Juneau, Alaska, Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; U.S. Department of Energy facilities in Pittsburgh, Pa., and Morgantown, W. Va.; Mine Safety and Health Administration, Arlington, Va.; National Mine Health and Safety Academy, Beckley, W. Va.; and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Order ONLY from NTIS: PB 82–183369; paper copy price code A07.

OFR 24–82. Fugitive Dust Study of an Open Pit Coal Mine, by Virgil Marple, Kenneth Rubow, and Orville Lantto. September 1980. 150 pp. 62 figs. In 1979 the University of Minnesota Mobile Laboratory (UMML), designed for the analysis of airborne particles and gases, was used to study fugitive dust from an open pit coal mine. The analysis consisted of determining the particle size distribution and concentration of dust from various mining operations such as blasting, draglines, loading, roadways, and bottom scrapers. For some operations the particles size distribution and concentrations were determined at varying distances. Details of the dust concentration within the plumes as the plume passed the UMML were measured with an optical particle counter. For line sources, such as roadways, these measurements enabled the calculation of the particle flux at the sampling location. In addition to the standard instruments associated with the UMML, the applicability of some new instruments was investigated. These included a uniform deposit cascade impactor and a flux meter. Finally, a technique in identifying plume origins that utilize elemental X-ray fluorescence analysis of filter samples was shown to be effective. Research done under contract J0295071 by the University of Minnesota. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Juneau, Alaska, Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; and Office of Surface Mining Library and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Order ONLY from NTIS: PB 82–183112; paper copy price code A07.

OFR 25–82. Land Reclamation as Sculpture, by David Allen Jones. Feb. 12, 1981. 101 pp. 10 figs. The 1979 Sculpture Symposium, "Earthworks: Land Reclamation as Sculpture," was held in King County, Wash., to create a new tool in the rehabilitation of technologically abused land. Artists were given the opportunity to design for surplus gravel pits, surface mines, and landfill sites. Phase I of the project was the rehabilitation of an abandoned 4-acre pit in south King County. Phase II was a design symposium where artists were assigned a variety of damaged sites ranging from 200 to 400 acres. The artists were asked to create reclamation plans, conforming to all local and State reclamation standards, in the form of earthwork proposals. This report describes in detail the entire project as conceived, constructed, and completed. Research done under contract J0199134 by King County Arts Commission. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Juneau, Alaska, Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; and Office of Surface Mining Library and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Order ONLY from NTIS: PB 82–183351; paper copy price code A06

OFR 26–82. Feasibility Study of Partial Flooding in Mined Out Areas for Mine Drainage Pollution Abatement. Final Report, by John W. Mentz, John R. Williams, Gerald Ahnell, Terry L. Reed, and George W. Akens. September 1981. 143 pp. 14 figs. This study concentrated on the analyses of two potential means of partially inundating abandoned segments of active underground mines to reduce acid formation. Seal construction techniques were taken through five logical steps and the design details of

both low-wall dams and section seals were discussed. The study showed that both concepts are feasible only in certain mines where the geologic-hydrologic-physical makeup is suitable to contain a mine pool. Low-wall dams in particular were found to have extremely limited applicability as a means of pollution reduction. Section seals, while clearly dependent upon site specific conditions, have a somewhat broader range of utility and are more effective in pollution reduction. Research done under contract J0285026 by Skelly and Loy. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Juneau, Alaska, Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; Mine Safety and Health Administration, Arlington, Va.; National Mine Health and Safety Academy, Beckley, W. Va.; and Office of Surfac Mining Library and National Library of Natural Resources, U.S. Department of the Interior, Washington, ,D.C. Order ONLY from NTIS: PB 82–183401; paper copy price code A07.

OFR 27–82. Propagation of UHF Radio Waves in Limestone Room and Pillar Mines. Summary Report, by Robert L. Lagace and Alfred G. Emslie. January 1979. 43 pp. 12 figs. This report presents a mathematical model for the propagation of UHF radio waves in the large cross section tunnels of a room-and-pillar limestone mine and describes the analysis of a small amount of propagation data obtained. The model and analysis is based on the waveguide mode theory, developed earlier for the transmission of UHF waves in coal mine tunnels, with allowance for propagation losses due to refraction into the tunnel walls. Propagation around corners and through pillars is also examined based on a ray theory approach together with the beneficial effects of placing reflectors at intersections to significantly reduce corner losses. The theory is found to be in fair agreement with the data; however, additional in-mine measurements are needed to provide a more conclusive test of the model. Research done under contract J0387217 by Arthur D. Little, Inc. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; U.S. Department of Energy facilities in Carbondale, Ill., and Pittsburgh, Pa.; Mine Safety and Health Administration, Arlington, Va.; National Mine Health and Safety Academy, Beckley, W. Va.; and Office of Surface Mining Library and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Order ONLY from NTIS: PB 82–190547; paper copy price code A03.

OFR 28–82. Borehole Location System Concept Demonstration Tests, by T. C. Moore, L. H. Rorden, and C. Kwong. May 5, 1978. 69 pp. 16 figs. This report describes the feasibility test of an electromagnetic method for locating boreholes, with or without casing, that have been drilled in conjunction with mining operations but without precisely known locations with respect to the tunnel. The first tests, conducted in cooperation with the Kerr-McGee Corp. near Gallup, N. Mex., in September 1977, demonstrated that accuracies of better than ±5 pct of range and ±1° of bearing can be achieved with a simple system and setup. Subsequent tests on a horizontally drilled pipeline river crossing application, by Titan Contractors of Sacramento, Calif., in January 1978, demonstrated that accuracies of better than 0.5 pct of range and a few tenths of 1° of bearing can be achieved by using refined techniques. The demonstration tests were done at ranges on the order of 100 to 200 feet, but the method is capable of working at much greater distances. Research done under contract J0177074 by Develco, Inc. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; U.S. Department of Energy facilities in Carbondale, Ill., Pittsburgh, Pa., and Spokane, Wash.; Mine Safety and Health Administration, Arlington, Va.; National Mine Health and Safety Academy, Beckley, W. Va.; and Office of Surface Mining Library and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Copies of this report will not be available for purchase.

OFR 29(1)–82. Visual Attention Locations for Operating Continuous Miners, Shuttle Cars, and Scoops. Volume I, by Mark S. Sanders and Gene R. Kelley. Jan. 31, 1981. 142 pp. 22 figs. The primary purpose of this investigation was to determine the visibility requirements for shuttle car and continuous miner operators. Scoops were considered, insofar as they fulfill functions in the mine similar to those carried out by shuttle cars (that is, loading, transporting, and unloading of coal). A second objective was to evaluate the actual field of visibility for a sample machine to develop a simple procedure for visibility evaluation of mobile equipment. A procedure was developed for assessing whether operators in existing machines could be expected to see the visual attention locations. The procedure makes use of a human eye reference measurement instrument (HERMI) designed for this project and an outside-in photographic procedure for documenting compliance with the recommendations. Samples of continuous miners, shuttle cars, and scoops were used to test the procedure and the results are presented. Research done under contract J0387213 by Canyon Research Group, Inc. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; U.S. Department of Energy facilities in Carbondale, Ill., and Pittsburgh, Pa.; Mine Safety and Health Administration, Arlington, Va.; National Mine Health and Safety Academy, Beckley, W. Va.; and Office of Surface Mining Library and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Order ONLY from NTIS: PB 82–187964; paper copy price code A07.

OFR 29(2)–82. Visual Attention Locations for Operating Continuous Miners, Shuttle Cars, and Scoops: A Summary, by Mark S. Sanders. May 1, 1981. 67 pp. 9 figs. This report presents a summary of the work reported in volume I. A task analytic approach was used to define information requirements and visual features that served as sources of information. From this analysis, visual attention locations, containing one or more important visual features, were identified. The procedure makes use of a human eye reference measurement instrument (HERMI) designed for this project and an outside-in photographic procedure for documenting compliance with the recommendations. Samples of the test procedures and the results are presented. Research done under contract J0387213 by Canyon

Research Group, Inc. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; U.S. Department of Energy facilities in Carbondale, Ill., and Pittsburgh, Pa.; Mine Safety and Health Administration, Arlington, Va.; National Mine Health and Safety Academy, Beckley, W. Va.; and Office of Surface Mining Library and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Order ONLY from NTIS: PB 82–187949; paper copy price code A04.

OFR 30–82. In-Mine Tests for Wetting Agent Effectiveness, by J. A. Kost, G. A. Shirey, and C. T. Ford. December 1980. 190 pp. 39 figs. The objective of this research was to determine if the addition of a surfactant (wetting agent) to the water used for dust control in underground coal mines results in the reduction of airborne dust. Laboratory wettability tests (including the capillary rise test, a coal dust sinking test, and zeta potential measurements) were used to select a coal seam surfactant combination for in-mine testing. Four surfactants were selected for underground testing: Surfynol 465, Aerosol MA-80, DC-13, and Dustallay. The underground tests in the Lower Kittanning seam, Indiana County, Pa., involved a Wilcox Mark 20 auger mining system equipped with spray nozzles located on the cutting augers, Conflow venturi sprays, and a spray manifold. Respirable dust samples were provided by MSA model G personal samplers and Simslin II instantaneous dust monitors; total airborne dust samples were provided by MSA model G samplers with UNICO filter cassettes. Based on data obtained from 24 test periods, surfactants, compared with plain water, reduced the airborne respirable dust an average of 27 percent and total airborne dust an average of 36 percent. Research done under contract J0295041 by Bituminous Coal Research, Inc. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; U.S. Department of Energy facilities in Carbondale, Ill., Pittsburgh, Pa., and Morgantown, W. Va.; Mine Safety and Health Administration, Arlington, Va.; National Mine Health and Safety Academy, Beckley, W. Va.; and Office of Surface Mining Library and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Order ONLY from NTIS: PB 82–183344; paper copy price code A09.

OFR 31–82. Materials Requirements and Economic Growth: A Comparison of Consumption Patterns in Industrialized Countries, by S. Victor Radcliffe, Leonard L. Fischman, and Radford Schantz, Jr. Dec. 18, 1981. 333 pp. 49 figs. This study concerns the national consumption of nonenergy materials of all types in relation to economic growth. A quantitative method of measuring materials consumption by industry and consumers was developed for major individual materials and materials as a whole. This method accounted for the net trade flows of materials incorporated in manufactured consumer and capital goods and for the recycling of materials contained in scrap. The principal factors that have determined materials consumption intensities in relation to economic output over the historical development of the advanced industrialized countries were identified by relying on comparison of the experiences of four countries: the Federal Republic of Germany, Japan, the United Kingdom, and the United States. Hypotheses were formulated and tested for the relationships between materials consumption, economic activity, and the level of national well-being. Attention was given to the influence of technological factors and to clarifying the interplay between consumption of materials and energy, and the analysis was extended to developing countries. The correlation of domestic industrial consumption, as measured from input-output tables, to the national income from manufacturing and construction proved significant, and the structure of final demand proved to be a main determinant of demand for materials. Finally, the field of materials demand forecasting was comprehensively and critically surveyed and the study results were applied to improving methods of forecasting future requirements. Research done under contract J0177118 by Resources for the Future. Available for reference at the Bureau of Mines Division of Analytic Studies and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Order ONLY from NTIS: PB 82–196270; paper copy price code A15.

OFR 32–82. Systems Study of Metal and Non-Metal Mine Communications, by Roger G. Long, John D. Foulkes, Philip M. Kay, and Stuart J. Lipoff. August 1979. 231 pp. 77 figs. The purpose of this study was to categorize and characterize underground metal-nonmetal mining operations from the viewpoint of telecommunication requirements and practices. The objectives were to gather and analyze data, identify communication requirements, and recommend systems for operational emergency and post disaster telecommunications. The results represent a major step towards providing effective means for locating workers trapped underground following a mine disaster. Research done under contract J0166093 by Arthur D. Little, Inc. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; U.S. Department of Energy facilities in Carbondale, Ill., and Pittsburgh, Pa.; Mine Safety and Health Administration, Arlington, Va.; National Mine Health and Safety Academy, Beckley, W. Va.; and Office of Surface Mining Library and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Copies of this report will not be available for purchase.

OFR 33–82. Environmental Instrumentation in Mining Air and Water, by Richard C. Moore, Nancy J. Opper, Marion Dodson Paul, and Robert L. Kort. Aug. 28, 1981. 335 pp. 35 figs. The U.S. Bureau of Mines contracted a study to review the air and water monitoring requirements of five Federal environmental acts (the Federal Water Pollution Control Act, the Safe Drinking Water Act, the Clean Air Act, the Surface Mining Control and Reclamation Act, and the Resource Conservation and Recovery Act) and to compile information on currently available monitoring instruments. A literature review of the acts and the associated regulations was conducted to determine applicability to the mining industry as well as any air and water monitoring requirements. In addition, an industry search and literature review was performed to assess the instrumentation available to comply with the monitoring regulations. Based on this research, the instruments are classified by general applicability to air, surface

water, or ground water monitoring, then cataloged by monitoring parameters. A discussion is provided on recommended and innovative monitoring techniques. Research done under contract J0205034 by Hittman Associates, Inc. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; U.S. Department of Energy facilities in Carbondale, Ill., and Pittsburgh, Pa.; Mine Safety and Health Administration, Arlington, Va.; National Mine Health and Safety Academy, Beckley, W. Va.; and Office of Surface Mining Library and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Order ONLY from NTIS: PB 82–187139; paper copy price code A15.

OFR 34–82. Full Scale Model Roof Bolt Test System. Final Report, by Charles W. Maus. Jan. 31, 1980. 157 pp. 44 figs. A full-scale system for testing roof bolts has been furnished to the Bureau of Mines. The system uses a full-size model of a mine entry made from sand and portland cement concrete. A servosystem with hydraulic actuators and load pads provide lateral, vertical, and shear loads to simulate premining and postmining conditions. Instruments embedded in the model determine strains as affected by the installed roof bolts. To insure stability, pressure limit detectors make certain that vertical loads are at a safe level before horizontal loads are applied. Set points provide for interlocks and safety shutdown in the event of pressure or error signal in excess of preset limits. There is a data acquisition system and computer for control and compilation of data. Peripherals include a CRT console, a hard copy unit, and a magnetic tape unit. The control and data system can operate with input determined by the computer, or by manual or auxiliary means. Research done under contract S0271014 by Mine Safety Appliances Co. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; U.S. Department of Energy, Pittsburgh, Pa.; Mine Safety and Health Administration, Arlington, Va.; National Mine Health and Safety Academy, Beckley, W. Va.; and Office of Surface Mining Library and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Order ONLY from NTIS: PB 82–185471; paper copy price code A08.

OFR 35–82. In-Pit Crushing and Conveying With Movable Crushers, by R. N. Johnson. November 1980. 213 pp. 21 figs. This report is a summary of the work performed to evaluate the feasibility and desirability of a movable in-pit crusher combined with conveyors to substantially reduce or eliminate truck or train haulage in large open pit, nonfuel mineral mines. The report includes a background discussion of in-pit crushing concepts, the results of a multimine survey of needs and current haulage characteristics, concepts for a movable in-pit crusher that are in keeping with mine operation stated needs and requirements, descriptions of key areas of technology improvement that must be satisfied to meet mine operator requirements, economic and operational impact of such a system, and recommendations for future work to bring about the general availability of such systems. Research done under contract J0295004 by Gard, Inc. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Juneau, Alaska, Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; U.S. Department of Energy facilities in Carbondale, Ill., Pittsburgh, Pa., and Morgantown, W. Va.; Mine Safety and Health Administration, Arlington, Va.; National Mine Health and Safety Academy, Beckley, W. Va.; and Office of Surface Mining Library and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Order ONLY from NTIS: PB 82–184714; paper copy price code A10.

OFR 36–82. SIC Based End-Use Data Scheme for Information Critical Minerals, by Balakrishnan K. Nair, George K. Schenck, and Fred Demler. September 1978. 464 pp. 21 figs. Management of and policy planning for minerals require reliable information on the flow of materials through the economy. This report describes several case studies of information-critical minerals and evaluates for each mineral the feasibility of implementng a SIC-based, end-use data scheme. The scheme proposed will lead to an improved information base for understanding the sectoral demand for minerals. The objectives of the data base are to improve the forecasting of demand for each mineral and to identify the extent of dependency between economic activity and materials demand. A two-dimensional information system is proposed. The first dimension measures the consumption of minerals in primary intermediate products (technical product classes). The second measures the consumption of technical product classes in SIC-based, end-use sectors. The scheme permits intercommodity comparisons at the SIC two-digit level. Research done under grant G0166213 by Pennsylvania State University. Available for reference at Bureau of Mines facilities in Juneau, Alaska, Denver, Colo., Reno, Nev., Pittsburgh, Pa., and Spokane, Wash.; and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Order ONLY from NTIS; PB 82–188707; paper copy price code A20.

OFR 37–82. Potential Effect of Ferrous Scrap Composition Changes on the Quality of Iron and Steel Castings, by W. L. Swager, H. W. Lownie, Jr., and C. E. Mobley. November 1981. 226 pp. 14 figs. Tramp (undesirable) elements introduced into iron and steel castings through purchased ferrous scrap are evaluated as to their likely degree of future threat to the quality of castings. Conclusions are based on analysis of literature and on nonmail surveys of foundries, scrap processors, trade and technical associations, and others. The existing tramp-element problem is expected to be persistent, but amenable to improved control by foundries and their suppliers. Four recommendations for action are given. Research done under contract J0205002 by Battelle Columbus Laboratories. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Juneau, Alaska, Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; Mine Safety and Health Administration, Arlington, Va.; National Mine Health and Safety Academy, Beckley, W. Va.; and Office of Surface Mining Library and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Order ONLY from NTIS: PB 82–194184; paper copy price code A11.

OFR 38–82. Development of Guidelines for Installation and Maintenance of Mine Illumination Systems, by K. L. Whitehead and J. C. Yingling. April 1981.

290 pp. 34 figs. An examination of 60 mines, 11 illumination hardware manufacturers, and 9 mobile face-equipment manufacturers was conducted to determine the state of the art of mine-illumination hardware, define lighting system installation and maintenance problems, and assess personnel acceptance of lighting. Major problems, with extreme variability in degree, on room-and-pillar installations include damage of exposed components, electrical failures, and reduced lamp life. While most mobile face-equipment operators approved of the machine lighting systems, many complained of glare and other problems. Longwall lighting systems were unanimously accepted by face personnel, and most complaints were minor. Based on the survey, general installation and maintenance guidelines have been established, addressing hardware design aspects, approaches proved effective to minimize problems, and noted improper practices that are detrimental to effective lighting. Research done under contract J0308040 by Bituminous Coal Research, Inc. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; U.S. Department of Energy facilities in Carbondale, Ill., Pittsburgh, Pa., and Morgantown, W. Va.; Mine Safety and Health Administration, Arlington, Va.; National Mine Health and Safety Academy, Beckley, W. Va.; and Office of Surface Mining Library and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Order ONLY from NTIS: PB 82-192022; paper copy price code A13.

OFR 39(1)-82. Study of the Use of Personal Equipment in Low Coal. Use of Personal Equipment in Low Coal: A Review of the Personal Equipment Literature. Phase I Report, by Mark S. Sanders, Barry Beith, and Tyler Blake. Dec. 30, 1978. 100 pp. 1 fig. The objective of this study was to determine optimal personal equipment design for use in low coal based on ergonomic, biomechanic, and safety considerations. To accomplish this, three principal tasks were to (1) summarize the state of the art with respect to personal equipment and its use in low seam coal mines, (2) empirically validate alternative designs for personal equipment, and (3) make recommendations on redesign of personal equipment for low seam coal mines. The report is a summary of the literature dealing with personal protective equipment that is now, or could be used in the underground mining environment. Recommendations for further research and development are included. Research done under contract J0387213 by Canyon Research Group, Inc. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; U.S. Department of Energy facilities in Carbondale, Ill., and Pittsburgh, Pa.; Mine Safety and Health Administration, Arlington, Va.; National Mine Health and Safety Academy, Beckley, W. Va.; and Office of Surface Mining Library and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Order ONLY from NTIS: PB 82-218207; paper copy price code A05.

OFR 39(2)-82. Study of the Use of Personal Equipment in Low Coal. Experiments on Personal Equipment for Low Seam Coal Miners. I. Comparison of 10/60 and Standard Self-Rescue Devices. Phase II Report, No. 1, by Mark Sanders, Gregory Krohn, Kent Volkmer, Daniel Wick, Howard Miller, Tyler Blake, and Barry Beith. Jan. 31, 1980. 26 pp. 8 figs. The objective of this study was to determine optimal personal equipment design for use in low coal based on ergonomic, biomechanic, and safety considerations. This report compares a proposed 10/60 "piggyback" O_2-generating, self-rescue unit with the standard CO self-rescue unit with respect to work task interference. A simulated low seam coal mine was constructed and workers performed locomotion, shoveling, cart pushing, and timbering tasks with the 10/60 and standard self-rescue units attached to their belts. Task completion time was longer on all tasks when wearing the 10/60 units, although only locomotion was statistically significant. The 10/60 units were bumped over 100 pct more often than the standard self-rescuers. It is recommended that the design for the proposed 10/60 units include (1) extra durable containers to withstand the added abuse they are likely to receive by low coal miners and (2) extra consideration toward preventing the devices from slipping on the belts while working. Research done under contract J0387213 by Canyon Research Group, Inc. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; U.S. Department of Energy facilities in Carbondale, Ill., and Pittsburgh, Pa.; Mine Safety and Health Administration, Arlington, Va.; National Mine Health and Safety Academy, Beckley, W. Va.; and Office of Surface Mining Library and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Order ONLY from NTIS: PB 82-218140; paper copy price code A03.

OFR 39(3)-82. Study of the Use of Personal Equipment in Low Coal. Experiments on Personal Equipment for Low Seam Coal Miners: II. Dexterity, Protection and Performance With Padded Gloves. Phase II Report, No. 2, by Gregory Krohn, Mark Sanders, Kent Volkmer, Daniel Wick, Howard Miller, Barry Beith, and Tyler Blake. Jan. 31, 1980. 31 pp. 9 figs. The objective of this study was to determine the optimal personal equipment design for use in low coal based on ergonomic, biomechanic, and safety considerations. This report investigates the effects of adding a layer of extra padding to the palm area of leather gloves typically worn by low seam coal miners. The first study showed that added glove padding provides more potential protection but does not affect manual dexterity. The second study, in a simulated low seam coal mine, showed no significant differences using padded and nonpadded gloves in crawling, shoveling, timbering, and cart pushing task completion times. In general, the workers preferred the padded gloves although they expressed some complaints about awkwardness and loss of sensitivity. It is recommended that the design for padded gloves provide comfort, protection, and maximum hand sensitivity. Research done under contract J0387213 by Canyon Research Group, Inc. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; U.S. Department of Energy facilities in Carbondale, Ill., and Pittsburgh, Pa.; Mine Safety and Health Administration, Arlington, Va.; National Mine Health and Safety Academy, Beckley, W. Va.; and Office of Surface Mining Library and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Order ONLY from NTIS: PB 82-218157; paper copy price code A03.

OFR 39(4)–82. Study of the Use of Personal Equipment in Low Coal. Experiments on Personal Equipment for Low Seam Coal Miners: III. Effect of Size and Weight of Battery Pack Performance. Phase II Report, No. 3, by Mark Sanders, Gregory Krohn, Daniel Wick, Kent Volkmer, and Barry Beith. Jan. 31, 1980. 33 pp. 9 figs. The objective of this study was to determine optimal personal equipment design for use in low coal based on ergonomic, biomechanic, and safety considerations. This report describes three experiments that were conducted to determine the effects of size and weight of battery packs. The first experiment tested the sensitivity of task measures; that is, workers performed locomotion, shoveling, cart pushing, and timbering tasks to detect variations in the size and weight of battery packs. The results showed that only locomotion was sensitive to size and weight variations. The second experiment focused on locomotion tasks and tested the effects of varying size and weight on task completion time. The third experiment compared the battery pack presently in use with a radically different configuration of power cells. The most important findings were that changes in weight affected locomotion times but changes in size and configuration had small and inconsistent effects. Workers indicated a strong preference for a battery pack belt concept. Research done under contract J0387213 by Canyon Research Group, Inc. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah., and Spokane, Wash.; U.S. Department of Energy facilities in Carbondale, Ill., and Pittsburgh, Pa.; Mine Safety and Health Administration, Arlington, Va.; National Mine Health and Safety Academy, Beckley, W. Va.; and Office of Surface Mining Library and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Order ONLY from NTIS: PB 82–218165; paper copy price code A03.

OFR 39(5)–82. Study of the Use of Personal Equipment in Low Coal. Experiments on Personal Equipment for Low Seam Coal Miners: IV. Incorporating Coiled Cord Into Cap Lamp Battery Cords. Phase II Report, No. 4, by Tyler Blake, Mark Sanders, Gregory Krohn, Daniel Wick, Kent Volkmer, and Barry Beith. Jan. 31, 1980. 30 pp. 9 figs. The objective of this study was to determine optimal personal equipment design for use in low coal based on ergonomic, biomechanic, and safety considerations. This report describes a study designed to evaluate a proposed modification in the cap lamp battery cord intended to reduce the incidence of snagging and catching of the cord. A three-phase evaluation was performed comparing a prototype with the standard, currently available cord. In the first evaluation a "pull test" was performed to measure the reaction time of workers and the maximum force delivered to the helmet. The second evaluation was a body conformity experiment wherein the cords were studied to determine whether they conformed differently to workers bodies. The third evaluation involved workers performing common manual tasks in a low seam coal mine simulator. The results demonstrated significant safety advantages of incorporating coiled cords into the design of the cap cord. The coil cord presented a lesser snagging hazard, allowed the wearer more time to respond to a snag, and transmitted lower levels of force to the helmet when snagged. Research done under contract J0387213 by Canyon Research Group, Inc. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; U.S. Department of Energy facilities in Carbondale, Ill., and Pittsburgh, Pa.; Mine Safety and Health Administration, Arlington, Va.; National Mine Health and Safety Academy, Beckley, W. Va.; and Office of Surface Mining Library and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Order ONLY from NTIS: PB 82–218173; paper copy price code A03.

OFR 39(6)–82. Study of the Use of Personal Equipment in Low Coal. Experiments on Personal Equipment for Low Seam Coal Miners. V. Effect of Reflectorized Outer Garments on Detection and Conspicuity of Miners. Phase II Report, No. 5, by Barry Beith and Mark Sanders. Jan. 31, 1980. 43 pp. 14 figs. The objective of this study was to determine optimal personal equipment design for use in low coal based on ergonomic, biomechanic, and safety considerations. This report details a study that was designed to assess the effect of retroreflective material on the detection and form recognition of workers in a mining environment. The study involves a one-fifth-scale simulation of the perceptual task found in underground low seam coal mines. Under this simulation, different configurations of retroreflective material are examined in various body positions at three different locations in the visual field. The first experiment compares three different retroreflective configurations with the current cap only reflectorization currently used by miners. The second experiment attempts to determine an optimum cost-effective configuration. Research done under contract J0387213 by Canyon Research Group, Inc. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; U.S. Department of Energy facilities in Carbondale, Ill., and Pittsburgh, Pa.; Mine Safety and Health Administration, Arlington, Va.; National Mine Health and Safety Academy, Beckley, W. Va.; and Office of Surface Mining Library and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Order ONLY from NTIS: PB 82–218181; paper copy price code A03.

OFR 39(7)–82. Study of the Use of Personal Equipment in Low Coal. Experiments on Personal Equipment for Low Seam Coal Miners. VI. Comparison Bumping Hazards With High and Low Profile Helmets. Phase II Report, No. 6, by Mark Sanders, Daniel Wick, and Gregory Krohn. Jan. 31, 1980. 29 pp. 10 figs. The objective of this study was to determine optimal personal equipment design for use in low coal based on ergonomic, biomechanic, and safety considerations. This report describes an experiment that was conducted to compare the relative bumping hazards of a low- and high-profile hard hat (helmet) in a low seam mining environment. The study was specifically designed to assess the effect of lowering the helmet profile on frequency of head impacts. This involved workers performing four low coal mining tasks wearing the low- and high-profile helmets in a low seam simulator (36- to 48-inch heights). The results indicated that a low-profile helmet could reduce bumping frequency approximately 25 pct, and as much as 80 pct in selected tasks. It was beyond the scope of the study to measure the impact force, thus it was not possible to estimate the effect of the low-profile helmet on severity of impacts underground. Research done under contract J0387213 by Canyon

Research Group, Inc. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; U.S. Department of Energy facilities in Carbondale, Ill., and Pittsburgh, Pa.; Mine Safety and Health Administration, Arlington, Va.; National Mine Health and Safety Academy, Beckley, W. Va.; and Office of Surface Mining Library and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Order ONLY from NTIS: PB 82-218199; paper copy price code A03.

OFR 40(1)-82. Development of Methods for Reclaiming Tailings Ponds and Dams. Volume I, by Robert D. Perry and Frank C. Kresse. June 1981. 34 pp. This report describes methods of reclaiming abandoned or inactive tailings ponds and dams. The investigated sites were selected tailings deposits adjacent to metal mines in the Southwestern United States and the Pacific Northwest. The basic data developed for each site consisted of a review of existing literature, a site visit that included sampling of the tailings and surrounding materials, laboratory and engineering studies, and development of reclamation plans. Laboratory tests determined the gold and silver content of each deposit and the chemistry of the tailings and surrounding materials. Reclamation plans that include approximate costs were developed for five deposit sites ranging from 52,000 to 103 million tons. Conclusions on the remaining potential of each site are based on the tailings assay and other technical data. This study concludes that remining as a reclamation tool is feasible at certain sites. Research done under contract J0199117 by Harding-Lawson Associates. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; U.S. Department of Energy facilities in Carbondale, Ill., and Pittsburgh, Pa.; Mine Safety and Health Administration, Arlington, Va.; National Mine Health and Safety Academy, Beckley, W. Va.; and Office of Surface Mining Library and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Order ONLY from NTIS: PB 82-195736; paper copy price code A03.

OFR 40(2)-82. Development of Methods for Reclaiming Abandoned Tailings Ponds and Dams. Volume II, by Robert D. Perry and Frank C. Kresse. June 1981. 378 pp. 23 figs. This report describes the methods of reclaiming abandoned or inactive tailings ponds and dams. The investigated sites were selected tailings deposits adjacent to metal mines in the Southwestern United States and the Pacific Northwest. The basic data developed for each site consisted of a review of existing literature, a site visit that included sampling of the tailings and surrounding materials, laboratory and engineering studies, and development of reclamation plans. Volume II contains the appendixes. Research done under contract J0199117 by Harding-Lawson Associates. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; U.S. Department of Energy facilities in Carbondale, Ill., and Pittsburgh, Pa.; Mine Safety and Health Administration, Arlington, Va.; National Mine Health and Safety Academy, Beckley, W. Va.; and Office of Surface Mining Library and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Copies of this report will not be available for purchase.

OFR 41(1)-82. Control of Shale Roof Deterioration With Air Tempering. Volume I—Field and Laboratory Investigations, by R. A. Cummings, M. M. Singh, S. E. Sharp, and A. W. Laurito. Jan. 9, 1981. 164 pp. 72 figs. Certain roof shales in coal mines deteriorate upon exposure to the atmosphere, causing difficulties in the mining operations and adding to the cost. This report presents the results of field investigations in a West Virginia mine and laboratory studies on the effects of atmospheric moisture on roof shales. Based on these observations, a conceptual procedure is presented on how shale deterioration might be predicted during exploration. Guidelines are given detailing how air tempering or conditioning chambers may be designed to reduce moisture effects. Recommendations for further studies are included. Research done under contract J0188028 by Engineers International Inc. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; Mine Safety and Health Administration, Arlington, Va.; National Mine Health and Safety Academy, Beckley, W. Va.; and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Order ONLY from NTIS; PB 82-199985; paper copy price code A08.

OFR 41(2)-82. Control of Shale Roof Deterioration With Air Tempering. Volume II—Annotated Bibliography, by R. A. Cummings, M. M. Singh, S. E. Sharp, and A. W. Laurito. Jan. 9, 1981. 64 pp. 23 figs. This is the first documented study and assessment of air tempering or conditioning chambers as a means of reducing roof disintegration caused by moisture and humidity. Volume I contains the results of field and laboratory investigations. Volume II contains an annotated bibliography. Research done under contract J0188028 by Engineers International, Inc. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Denver, Colo., Avandale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; Mine Safety and Health Administration, Arlington, Va.; National Mine Health and Safety Academy, Beckley, W. Va.; and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Order ONLY from NTIS: PB 82-199993; paper copy price code A04.

OFR 42-82. Hoist Signaling Monitor and Display System, by Arnis Mangolds. Sept. 30, 1981. 93 pp. 10 figs. This report documents the work performed and the results obtained under a contract that included a mine and manufacturer survey to determine the functional requirements, problem areas, and state of the art of shaft communications. An interest in improved hoist communications was noted during the survey; areas of particular concern were increasing the reliability and decreasing the required maintenance. The manually operated bell-horn system of signaling the hoistroom was also deemed confusing and could result in risks of hazardous actions and inefficient operation. Several designs have been conceptually developed that include environmental protection of cage-mounted communication equipment, an on-board charging system

to reduce battery handling, a level-to-hoistroom request display, and a monitoring system. The designs are configured to allow their simple adaptation into existing commercial or mine-constructed communication networks. Research done under contract J0308048 by Foster-Miller Associates, Inc. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; U.S. Department of Energy facilities in Carbondale, Ill., and Pittsburgh, Pa.; Mine Safety and Health Administration, Arlington, Va.; National Mine Health and Safety Academy, Beckley, W. Va.; and Office of Surface Mining Library and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Order ONLY from NTIS: PB 82–198557; paper copy price code A05.

OFR 43–82. Development of a Mobile, Hi-Rise Work Platform, by Edward E. Tate and Bennett O. Blout. April 1981. 56 pp. 9 figs. This report describes the design, development, and manufacture of a prototype roof bolting machine for high rise applications. The machine is designed to traverse a 32-inch entry and rebolt a roof fall area to a height of 28 feet and 10 inches. A chronology of the project, an explanation of design problems, and a description of the solutions are covered. It is concluded that the equipment as designed is suitable for the purpose intended and further testing is recommended. Research done under contract H0252074 by Barnes & Reinecke, Inc. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; U.S. Department of Energy, Pittsburgh, Pa.; and Office of Surface Mining Library and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Copies of this report will not be available for purchase.

OFR 44–82. Underground Mine Disaster Survival and Rescue: An Evaluation of Research Accomplishments and Needs, by the Commission on Sociotechnical Systems, National Academy of Sciences. 1981. 122 pp. 4 figs. Postdisaster survival and rescue research is a small component of the Bureau of Mines health and safety research program. The objectives of this study were to evaluate the Bureau's postdisaster research program and to recommend future efforts in this area. A definition of a disaster survival and rescue system that provides a frame of reference for the evaluation of research accomplishments and the assessment of future needs was developed and the essential components of a research and development program in the postdisaster area was outlined. It was found that to develop a more effective capability for postdisaster survival and rescue, the need for a systems approach to preparing for disaster response and special considerations that apply to government-sponsored research and development leading to the design of escape, survival, and rescue equipment must be considered. Research done under contract J0100014. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; U.S. Department of Energy facilities in Carbondale, Ill., and Pittsburgh, Pa.; Mine Safety and Health Administration, Arlington, Va.; National Mine Health and Safety Academy, Beckley, W. Va.; and Office of Surface Mining Library and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Copies of this report will not be available for purchase.

OFR 45–82. Fundamentals of Chromite Flotation, by Ross W. Smith. June 30, 1981. 57 pp. 34 figs. Microflotation and surface chemical studies were conducted on chromite, and some of the minerals usually associated with such chromites, from the Stillwater Complex, Mont. Considering the chromite, it was found that aging the ground mineral in air or heating it markedly affected its flotation behavior. Much of the effects could be attributed to oxidation reactions involving surface chromium and iron species. Strongly acid pretreating the mineral appeared to reverse these effects. It can be concluded that the manner in which the mineral (or ore) is pretreated is of utmost importance in its flotation. Work carried out on associated gangue minerals determined how the minerals are likely to behave in a flotation environment and how certain foreign ions derived from chromite ore can affect the surface characteristics of the ions and presumably their behavior in a flotation circuit. Research done under grant G0274005 by the University of Nevada. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Juneau, Alaska, Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Order ONLY from NTIS: PB 82–197492; paper copy price code A04.

OFR 46–82. Dust Control for Cutter Machines, by Dennis J. Grigal, Michael D. Blom, and David F. Johnson. December 1981. 122 pp. 52 figs. The purpose of this program was to investigate the feasibility of wet and dry dust control techniques for controlling respirable dust generated by an underground mining cutter machine; to recommend the most practical wet and dry dust control system; and to fabricate, retrofit, and test the recommended dust control system. The program was divided into three phases. During phase I, three wet and two dry prototype dust control systems were designed. Because of a contract amendment, all work was suspended on the wet control system; therefore, phase II consisted of fabricating and laboratory testing one dry dust collection system. Laboratory tests included dust pickup capability and filter life. Phase III consisted of a field evaluation of the dry dust control system retrofitted to a Joy 15RU cutter machine in a salt mine. For the mine faces analyzed, reduction of dust concentration averaged 67 pct, with a system airflow of 4,000 ft^3/min. Filter life was unsatisfactory. A self-cleaning dry dust collector was recommended as more suitable for cutter machine application because of the large quantity of dust. Research done under contract H0387010 by Donaldson Co., Inc. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; U.S. Department of Energy facilities in Carbondale, Ill., and Morgantown, W. Va.; Mine Safety and Health Administration, Arlington, Va.; National Mine Health and Safety Academy, Beckley, W. Va.; and Office of Surface Mining Library and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C.

Order ONLY from NTIS: PB 82–202706; paper copy price code A06.

OFR 47–82. Reliability and Effectiveness Analysis of the USBM Electromagnetic Location System for Coal Mines, Final Report, by R. F. Kehrman, A. J. Farstad, and D. Kalvels. Dec. 1, 1978. 153 pp. 23 figs. Voice frequency electromagnetic trapped miner location devices were tested for reliability and effectiveness in 93 coal mines. Tests included uplink pulsed carrier waves, downlink pulsed carrier waves, and downlink voice evaluations. Frequencies were 630, 1,050, 1,950, and 3,030 hertz. Overburden depths ranged from 70 to 1,550 feet. Successful communications were established at 91 of the 93 mines. Data indicate the transmitters and receivers will operate in practically all coal mine environments. Reliability and accuracy as location devices appear to depend on noise, depth, and presence of metallic objects that distort the magnetic field. In addition, theoretical models appear to define best case situations in terms of noise and conductivity. Minor hardware problems were encountered, mostly involving battery contacts, switches, and antenna cables on the receivers. No hardware problems occurred with the transmitters. Research done under contract J0166060 by Westinghouse Electric Corp. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; U.S. Department of Energy facilities in Carbondale, Ill., and Pittsburgh, Pa.; Mine Safety and Health Administration, Arlington, Va.; National Mine Health and Safety Academy, Beckley, W. Va.; and Office of Surface Mining Library and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Order ONLY from NTIS: PB 82–201385; paper copy price code A08.

OFR 48–82. Detailed Design and Demonstration of Underground Disposal of Coal Mining Wastes. Phase I, by Foster-Miller Associates, Inc. April 1981. 87 pp. 28 figs. This report presents a design for a pneumatic underground disposal system for coal mine waste. This particular design is only applicable for use at the Hawk's Nest Mine in Somerset, Colo. Calculations, sketches, drawings, and estimated costs necessary to implement this design are presented in the report. Research done under contract J0205056. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Juneau, Alaska, Denver, Colo., Avondale, Md., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; U.S. Department of Energy facilities in Carbondale, Ill., and Pittsburgh, Pa.; Mine Safety and Health Administration, Arlington, Va.; National Mine Health and Safety Academy, Beckley, W. Va.; and Office of Surface Mining Library and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Copies of this report will not be available for purchase.

OFR 49–82. Innovative Techniques in Trolley Line Power Distribution, by B. Gillenwater and J. McCoy. May 1981. 79 pp. 23 figs. This report describes the results of investigations into four specific areas related to trolley wire power distribution in coal mines. Prototype devices or designs were developed in each area. In addition, a brief survey was made in an attempt to assess the future of mine trolley systems, and data were collected and reviewed in an attempt to analyze the nature of trolley wire related accidents. Other options for decreasing the risks associated with trolley systems that arose during the study are briefly discussed in the appendices. These include insulating equipment and miners from return and/or energized conductors and use of a segmented trolley wire with local control of current-delivering capability. Research done under contract J0188083 by Foster-Miller Associates, Inc. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; U.S. Department of Energy facilities in Carbondale, Ill., and Pittsburgh, Pa.; Mine Safety and Health Administration, Arlington, Va.; National Mine Health and Safety Academy, Beckley, W. Va.; and Office of Surface Mining Library and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Order ONLY from NTIS: PB 82–201815; paper copy price code A05.

OFR 50–82. Comparisons of Structural Stability for Entry Configurations and Ground Support for Longwall Panel Development, by D. E. Van Dillen and R. W. Fellner. February 1981. 225 pp. 55 figs. Seven configurations for panel entries of a longwall coal mine are compared and ranked according to structural stability. These entry configurations are analyzed using three-dimensional finite element modeling. The models include large dimensions to minimize boundary effects, elastoplastic constitutive relations, and simulated excavation and construction of support systems. The stability criteria are formulated in a quantitative manner to facilitate the ranking of the entry configurations. These criteria are based on the expected volume of caved rock in the entry openings. The stability ranking is applied to the entry excavation phase, the headgate phase, and the tailgate phase of the entry life cycle. Parametric variations are applied using two-dimensional finite element models to determine the sensitivity to changes in mining and design parameters. Research done under contract J0285014 by Agbabian Associates. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; U.S. Department of Energy facilities in Carbondale, Ill., and Pittsburgh, Pa.; Mine Safety and Health Administration, Arlington, Va.; National Mine Health and Safety Academy, Beckley, W. Va.; and Office of Surface Mining Library and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Order ONLY from NTIS: PB 82–201864; paper copy price code A10.

OFR 51–82. Technology for Environmental Noise Control in Surface Mines. Final Report, by Michael A. Staiano, William Benson, and Timothy A. Gates. August 1981. 122 pp. 18 figs. The objective of this study was to determine the magnitude and sources of environmental noise from mining operations near populated areas, to describe monitoring techniques, and to identify applicable existing noise abatement techniques. Noise surveys of a representative sample of mines and quarries were conducted and noise levels at site boundaries and near specific equipment and ensembles of equipment were measured. Noise exposures in terms of annual day-night sound level were calculated for the boundary noise measurement locations. In addition, the relative sound level contributions were estimated for the mining equipment noise sources affecting the boundary locations. Noise abatement methods falling into

three categories were analyzed: equipment practices, operational-administrative practices, and equipment quieting. Selected applications of noise abatement methods were evaluated in hypothetical situations with emphasis upon machinery selection and use. Procedures for measuring noise around mining operations are provided. Research done under contract J0100001 by ORI, Inc. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; U.S. Department of Energy facilities in Carbondale, Ill., and Pittsburgh, Pa.; Mine Safety and Health Administration, Arlington, Va.; National Mine Health and Safety Academy, Beckley, W. Va.; and Office of Surface Mining Library and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Copies of this report will not be available for purchase.

OFR 52–82. Mine Grounding Systems: Development of Tests and Criteria To Evaluate Grounding Systems, by Wils L. Cooley and Robert L. McConnell. September 1979. 150 pp. 57 figs. This report covers tests and criteria for the establishment of safe grounding systems for coal mines. The work deals primarily with underground mines, but much is applicable to surface mines as well. Included is an extensive guide to grounding and bonding procedures for mine surface substations. Xit-Rods (chemically charged, hollow-rod electrodes that generate their own moisture and metallic salts and uses the resulting electrolyte as the interface medium between the conducting surface of the rods and outwardly in the soil and lowers resistance) are evaluated and shown to deviate from manufacturers claims. An analysis shows that very long cables are difficult to monitor using audiofrequency ground-check techniques. A method is developed to detect failing cable splices without removing the cable from service. Simulation and measurement are compared for a technique to detect bad rail bonds, and an assessment is made of grounding techniques for dc face equipment. Research done under grant G0188087 by the West Virginia University. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; U.S. Department of Energy facilities in Carbondale, Ill., and Pittsburgh, Pa.; Mine Safety and Health Administration, Arlington, Va.; National Mine Health and Safety Academy, Beckley, W. Va.; and Office of Surface Mining Library and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Order ONLY from NTIS: PB 82–209719; paper copy price code A07.

OFR 53–82. Modify and Evaluate a Self-Propelled Battery Powered Scoop, by William F. Hahn and Gary L. Bowen. Sept. 5, 1980. 73 pp. 32 figs. Previous field evaluations showed that the major cause of illumination system downtime was physical damage due to machine collisions with coal surfaces or other operating equipment. To insure good system reliability, durable mechanical protection of the illumination hardware must be incorporated into the machine structure. This required protection can best be integrated into mining equipment during design and fabrication of new machinery. The purpose of this study was to determine the best method to integrate an approved lighting system into a low seam battery-powered scoop and evaluate its performance. The report documents the work performed and the results obtained. Research done under contract H0387007 by Booz, Allen & Hamilton Inc. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; U.S. Department of Energy facilities in Carbondale, Ill., and Pittsburgh, Pa.; Mine Safety and Health Administration, Arlington, Va.; National Mine Health and Safety Academy, Beckley, W. Va.; and Office of Surface Mining Library and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Order ONLY from NTIS: PB 82–209727; paper copy price code A04.

OFR 54–82. Safety and Cost Benefits From Improved Highwall Blasting Practice, by F. S. Kendorski and M. F. Dunn. February 1981. 171 pp. 63 figs. This report presents the results of a program to improve unstable highwall conditions through better blasting practices in Appalachian strip coal mines using existing and proven technology. The objectives were better borehole blasting agent distribution and optimization of burden, spacing, and delay periods allowing satisfactory breakage with minimal backbreak. At a selected field site, geologic conditions were examined with regard to joint orientation and spacing, and resulting slope stability considerations. A test series of eight blasts was completed and the resultant highwall was monitored by repetitive photography. The study of drilling and blasting economics along with equipment performance led to an economic model of blast parameters and the identification of blast design cost and benefits. Research done under contract H0282011 by Engineers International, Inc. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Juneau, Alaska, Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; U.S. Department of Energy facilities in Carbondale, Ill., Pittsburgh, Pa., and Morgantown, W. Va.; Mine Safety and Health Administration, Arlington, Va.; National Mine Health and Safety Academy, Beckley, W. Va.; and Office of Surface Mining Library and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Order ONLY from NTIS: PB 82–205691; paper copy price code A08.

OFR 55–82. Design and Testing of Joining Sleeves for Trailing Cable Ground and Pilot Wires, by Walter Frank, Jr. August 1979. 121 pp. 88 figs. The purpose of this work was to develop a ground and pilot connector that will significantly improve mine trailing cable splice performance. The connector design includes connectors for splicing ground and pilot conductors. A distinction is made between connectors suitable for splicing round and flat ground and pilot conductors. A discussion on the suitability of round cable for trailing cable applications is included. A field test was conducted to confirm ground and pilot connector laboratory data. The tests proved the viability of the connector designs and recommended installation techniques in a mine environment. Research done under contract H0377042 by the Burndy Corp. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; U.S. Department of Energy facilities in Carbondale, Ill., and Pittsburgh, Pa.; Mine Safety

and Health Administration, Arlington, Va.; National Mine Health and Safety Academy, Beckley, W. Va.; and Office of Surface Mining Library and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Order ONLY from NTIS: PB 82–205725; paper copy price code A06.

OFR 56–82. Evaluation of Roof Trusses, Phase I, by Clark P. Mangelsdorf. February 1979. 111 pp. 66 figs. The objective of this program was to evaluate a number of roof support systems that have some physical similarity to the truss introduced by the Birmingham Bolt Co. in 1966. The report is in two parts: Part I is a state-of-the-art study of roof truss technology as of January 1979. Included are a history of the truss concept, a review of analysis techniques, a record of hardware available and equipment used in its installation, and examples of user experience. Part II is concerned with a study of the role of friction in the behavior of a roof truss. Research done under grant G0166088 by the University of Pittsburgh. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; U.S. Department of Energy, Pittsburgh, Pa.; Mine Safety and Health Administration, Arlington, Va.; National Mine Health and Safety Academy, Beckley, W. Va.; and Office of Surface Mining Library and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Order ONLY from NTIS: PB 82–209768; paper copy price code A06.

OFR 57–82. Undercut and Fill System for Pitching Coal, by Arnis Mangolds and Allan Fisk. June 1981. 94 pp. 21 figs. A study of the technical and economic feasibility of using a unique undercut and fill system developed by Bureau of Mines engineers to mine steeply pitching coal is discussed. The undercut and fill system combines hydraulic coal cutting with unassisted gravity fluming of the coal slurry. Mining occurs across strike and the extended entry is backfilled to provide uniform strata control and an impermeable water and air barrier. Subsequent mining occurs beneath the previously filled stope such that the roof consists of a solid, controlled back. In addition to providing positive roof and hanging wall support, the backfill system eliminates subsidence potential, postmining drainage, and the danger of spontaneous combustion from naturally drafting air currents. A throughflowing ventilation system permits passage of return air through the production face through ducting located at the backfill-coal junction thus providing a constant supply of fresh air at the face, eliminating the need for brattice cloths, and provides an additional excapeway for miners. Research done under contract J0295028 by Foster-Miller Associates, Inc. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; U.S. Department of Energy facilities in Carbondale, Ill., and Pittsburgh, Pa.; Mine Safety and Health Administration, Arlington, Va.; National Mine Health and Safety Academy, Beckley, W. Va.; and Office of Surface Mining Library and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Order ONLY from NTIS: PB 82–200486; paper copy price code A05.

OFR 58–82. Pilot Scale On-Site Evaluation of Activated Carbon for Rapid Oxidation of Ferrous Iron in Acid Mine Water, by Anthony E. Perrotti and Alvin J. Snyder. October 1981. 69 pp. 19 figs. A pilot plant for evaluating rapid oxidation of ferrous iron under acidic conditions was designed, fabricated, and operated at a typical mine site for 6 months. The effect of activated carbon as a catalyst on the oxidation reaction was tested using three fluidized carbon bed reactors in series. Test runs for iron oxidation were made at various pH levels with and without the presence of activated carbon. Runs were extended to evaluate the changes in oxidation rate in relation to carbon life. Results of the study indicated that initial enhancement of the oxidation of ferrous iron was not sustained. The increased removal of ferrous iron concentration was found to be due to adsorption by the carbon rather than due to catalysis. Research done under contract J0395036 by R. I. Analytical Laboratories, Inc. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Juneau, Alaska, Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; U.S. Department of Energy facilities in Carbondale, Ill., Pittsburgh, Pa., and Morgantown, W. Va.; Mine Safety and Health Administration, Arlington, Va.; National Mine Health and Safety Academy, Beckley, W. Va.; and Office of Surface Mining Library and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Order ONLY from NTIS: PB 82–200494; paper copy price code A04.

OFR 59–82. Design of a Portable Gas Analyzer for Monitoring During Mine Fires, by Clayton J. Bossart. May 10, 1978. 54 pp. 22 figs. The design and fabrication of an engineering model and three prototypes of a portable gas analyzer and sampling system is described. The design provides a battery-operated system that will indicate the degree of explosivity of return air and in the air beyond the seal during the course of fighting, sealing, and quenching a mine fire. Performance tests, design criticisms, and recommendations for designs are included. Research done under contract H0155094 by Mine Safety Appliances Co. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; U.S. Department of Energy facilities in Carbondale, Ill., and Pittsburgh, Pa.; Mine Safety and Health Administration, Arlington, Va.; National Mine Health and Safety Academy, Beckley, W. Va.; and Office of Surface Mining Library and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Order ONLY from NTIS: PB 82–202748; paper copy price code A04.

OFR 60–82. TDRM Testing, by Eugene W. Bartel, Michael Fox, Edward Borgoyn, and Perry Wingfield. November 1980. 212 pp. 83 figs. This report describes the testing of the time domain reflectometry microcomputer (TDRM) system. The automated time domain reflectometry (ATDR) software is described and attempts to implement the same assembly language program in a higher level language (PLM) are documented along with two versions of the PLM program. One PLM program uses a data filtering approach to limit noise and the other uses data averaging to reduce noise. The field tests of the analog and digital ATDR units are described along with the hardware modifications that resulted. Tests

indicate that the digital units are more consistent and less confusing to operate than the analog units. The results indicate that the digital units can locate an abnormality in a test cable to within 5% of the true location (provided the cable phase velocity is known). The digital units can consistently locate shunt faults less than 300 ohms and series faults greater than 30 ohms. Research done under contract J0377021 by Carnegie-Mellon University. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; U.S. Department of Energy facilities in Carbondale, Ill., and Pittsburgh, Pa.; Mine Safety and Health Administration, Arlington, Va.; National Mine Health and Safety Academy, Beckley, W. Va.; and Office of Surface Mining Library and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Copies of this report will not be available for purchase.

OFR 61–82. Design and Develop Feasible Lighting System for Conventional Slope Under Construction, by William F. Hahn and Charles G. Howard. September 1981. 83 pp. 16 figs. This report describes an illumination system suitable for use in a slope under construction. Simulator work was performed using actual lighting hardware to verify adequate light levels to meet MSHA proposed regulation (as published in the Federal Register, January 13, 1977). The sequence of operating activities for two different slope driving sites are discussed and lighting requirements are defined for each. Research done under contract H0377051 by Booz, Allen & Hamilton Inc. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; U.S. Department of Energy facilities in Carbondale, Ill., and Pittsburgh, Pa.; Mine Safety and Health Administration, Arlington, Va.; National Mine Health and Safety Academy, Beckley, W. Va.; and Office of Surface Mining Library and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Copies of this report will not be available for purchase.

OFR 62–82. Integration of Quieting Technology Into New Mantrip Vehicles, by V. Ferrari and A. Galaitsis. October 1981. 164 pp. 74 figs. This report presents the three-phase program to design, fabricate, test, and demonstrate economical and practical methods of reducing noise levels on underground coal mining portal buses (mantrip vehicles). The noise-control treatments applied to a production-model portal bus were as follows: (1) Wheel-rail vibrations were isolated from the vehicle frame by inserting elastomeric materials between suspension components. (2) Vibration-induced noise was reduced by replacing all large sheet metal panels, except floor plates, with damped steel panels. (3) Motor noise was reduced by tight-fitting covers made from damped steel and lined with sound-absorbing material and elastomeric motor mounts. (4) The standard spur gears used in the traction drive system were replaced with helical gearsets. The program reduced the average sound level to below 85 dbA for typical operating conditions. Research done under contract J0199068 by ESD Corp. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; U.S. Department of Energy facilities in Carbondale, Ill., and Pittsburgh, Pa.; Mine Safety and Health Administration, Arlington, Va.; National Mine Health and Safety Academy, Beckley, W. Va.; and Office of Surface Mining Library and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Order ONLY from NTIS: PB 82–203241; paper copy price code A08.

OFR 63–82. Electromagnetic Propagation in Low Coal Mines of Medium Frequencies, by Terry S. Cory. June 12, 1978. 96 pp. 42 figs. This report covers magnetic field strength measurements versus range and frequency in low to medium coal mines. Both quasi-conductor-free and conductor-proximity areas were investigated. The program covered five mines, four seams, six measurement sets, and three geographic areas. The results are summarized in terms of maximum communication range expected per seam and noise condition. Scatter gain is further explored as a simple measure of energy coupled to conductors. Research done under contract H0377053 by Rockwell International. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane Wash.; U.S. Department of Energy, Pittsburgh, Pa.; Mine Safety and Health Administration, Arlington, Va.; National Mine Health and Safety Academy, Beckley, W. Va.; and Office of Surface Mining Library and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Order ONLY from NTIS: PB 82–202656; paper copy price code A05.

OFR 64–82. Taconite Crusher Noise Reduction—Study of Acoustical Enclosure for Symons 7 Foot, Standard Head, Extra-Heavy Duty Cone Crusher, by James A. Morgan. September 1980. 40 pp. 9 figs. The objective of this study was to evaluate the acoustical and cost effectiveness and the operational practicality of prefabricated acoustical enclosures applied to a taconite crusher. The enclosures were designed for durability, ease of assembly, and ease of access for crusher maintenance. Field measurements of noise were made on the periphery of enclosures on a secondary crusher at the Jackson County Iron Co. in Black River Falls, Wis. Noise reduction achieved by the enclosures was sufficient to permit reduction of crusher room noise to 90 dbA, provided that other sources are appropriately treated and acoustical adsorption is provided in the crusher room. Secondary crusher noise was reduced 10 to 15 dbA by the enclosures. Research done under contract H0387016 by Industrial Acoustics Co., Inc. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; U.S. Department of Energy facilities in Carbondale, Ill., and Pittsburgh, Pa.; Mine Safety and Health Administration, Arlington, Va.; National Mine Health and Safety Academy, Beckley, W. Va.; and Office of Surface Mining Library and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Order ONLY from NTIS: PB 82–202649; paper copy price code A03.

OFR 65–82. Silencing the Flame Channelling Process. Project Orion. Volume II, by James A. Browning. Dec. 30, 1981. 16 pp. 5 figs. A continuous channeling method was designed that reduces oper-

ating sound levels in drill channeling machines to 100 db. This new method relies on a small-diameter, oxygen-enriched burner to produce narrow channels. Sound intensities are reduced substantially compared with conventional channel widths. Sound intensities are reduced further by a water spray directed immediately above the flame. Baffles placed along the top of the channel will reduce sound levels to below 90 db. Cutting rates are greater than those of existing channeling burners with costs per unit of channel area substantially reduced for those cases where oxygen costs are reasonable. Research done under contract H0387017 by Browning Engineering Corp. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; U.S. Department of Energy facilities in Carbondale, Ill., and Pittsburgh, Pa.; Mine Safety and Health Administration, Arlington, Va.; National Mine Health and Safety Academy, Beckley, W. Va.; and Office of Surface Mining Library and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Order ONLY from NTIS: PB 82–202664; paper copy price code A02.

OFR 66–82. Hybrid Computer System for Optimization of Extraction Procedures in Tabular Coal Deposits, by Michael P. Hardy and Mark C. Christianson. February 1977. 70 pp. 40 figs. The hybrid computer facility at the University of Minnesota was designed to analyze three-dimensional pillar stresses in coal mines. This report describes recent improvements and applications that include expansion of the capability to model nonlinear seam behavior, installation of a color video output display monitor, and further development of software capabilities. To demonstrate the capability of the system, the influence of nonlinear seam behavior response on the occurrence of coal mine bumps was fully investigated. Then the effect of improper mining sequence on bump occurrences was demonstrated. Also, the system was applied to the analysis of a series of practical coal mine problems. Mines in three coal seams were analyzed to investigate the parameters that contribute to the occurrence of coal mine bumps. Research done under contract H0252035 by the University of Minnesota. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; Mine Safety and Health Administration, Arlington, Va.; National Mine Health and Safety Academy, Beckley, W. Va.; and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Order ONLY from NTIS: PB 82–204868; paper copy price code A04.

OFR 67–82. Field Evaluation of Resiliently Clad Screen Decks, by Michael V. Markel. March 1981. 37 pp. 15 figs. This report describes the field evaluation of a composite material developed for use in coal screening applications. Tests were performed at the River King preparation plant of Peabody Coal Co. because it provided parallel process flow and met standard coal-cleaning requirements. Comparisons could be made between the adjacent resilient and steel screen decks under similar operating conditions. Noise reductions of 1 to 6 dbA were realized in the near field. Although the test period did not determine resilient screen life, indications are favorable for their longevity. Research done under contract J0100047 by B. F. Goodrich Co. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; U.S. Department of Energy facilities in Carbondale, Ill., and Pittsburgh, Pa.; Mine Safety and Health Administration, Arlington, Va.; National Mine Health and Safety Academy, Beckley, W. Va.; and Office of Surface Mining Library and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Order ONLY from NTIS: PB 82–204876; paper copy price code A03.

OFR 68–82. New Procedure for Recovering Nickel and Cobalt From Western Laterites. Economic Feasibility, by Mineral Sciences Div., UOP Inc. January 1982. 169 pp. 12 figs. Bureau of Mines roast-leach laterite processing technology was studied on a pilot plant scale. Data were scaled-up and incorporated into an economic feasibility study for a 5,000-ton-per-day grassroots processing facility. Estimated capital cost (± 30 pct) for a mine and plant is $367 million with an estimated $103 million per year operating cost. The study indicated that low-grade domestic laterite may be processed with marginal profitability. Research done under contract J0285021. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Juneau, Alaska, Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; and Office of Surface Mining Library and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Order ONLY from NTIS: PB 82–245945; paper copy price code A08.

OFR 69–82. An Assessment of a Proposed Plant for Producing Direct Reduced Iron on the Minnesota Iron Range, by John J. Henn, Frank A. Peters, and Robert S. Kaplan. March 1982. 23 pp. 1 fig. The Bureau of Mines conducted a study of the cost of installing and operating both a natural gas- and a coal-based direct-reduction plant on the Mesabi iron range in Minnesota. The accuracy of the capital and operating costs are ±25 and ±15 percent, respectively. Product from the plants would be direct-reduced iron (DRI) pellets containing approximately 84 percent metallic iron. The pellets would compete with No. 1 bundle scrap in the Chicago, Ill., area. Because the quality of DRI is higher than scrap, the DRI will command a higher price, which has been estimated at approximately $10 per net ton (2,000 pounds) above the price of No. 1 bundles. An economic evaluation of installing a gas- or coal-based plant near an existing iron oxide pellet plant on the Mesabi iron range indicates that currently it is not economically viable. Available for reference at Bureau of Mines facilities in Twin Cities, Minn., Rolla, Mo., and Pittsburgh, Pa.; U.S. Department of Energy in Carbondale, Ill.; and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Copies of this report will not be available for purchase.

OFR 70–82. Keep Alive Mercury Mine Lighting System, by J. C. Engel and G. F. Saletta. June 15, 1979. 57 pp. 20 figs. Recent innovations in mine safety include the use of mercury vapor lamps for mine vehicle illumination. Such lamps, however, extinguish whenever the line voltage at the machine momentarily sags or is interrupted. The lamps must then cool for several minutes before they will

restart. By supplying reduced high-frequency power to the lamps from an auxiliary source, it is possible to maintain ionization in the arc tubes preventing the lamps from extinguishing. Essentially an auxiliary high-frequency supply, the keep alive system provides additional power to the lamps automatically whenever the lamps are in danger of dropping out. With this system, the lamps can be dimmed for periods up to 3 minutes by interrupting the 60-Hz power to the conventional ballasts. Each unit, housed in a steel explosion-proof enclosure with a volume of approximately 0.6 ft^3, is capable of servicing up to six 175-watt H-39 mercury lamps and two 100-watt H-75 reflector flood lamps. Research done under contract H0366074 by Westinghouse Electric Corp. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; U.S. Department of Energy facilities in Carbondale, Ill., and Pittsburgh, Pa.; Mine Safety and Health Administration, Arlington, Va.; National Mine Health and Safety Academy, Beckley, W. Va.; and Office of Surface Mining Library and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Copies of this report will not be available for purchase.

OFR 71–82. Feasibility Study of Coal Dust Measurement by Light Reflectance Photometry, by Irvin Pritts and Gregory A. Bertone. May 1981. 36 pp. 15 figs. This report describes the design, fabrication, and testing of a prototype instrument that demonstrates the feasibility of determining respirable coal dust concentrations by light reflectance photometry. Coal dust is collected on a filter and the amount collected is continuously monitored by reflectance photometry. Light emission and detection is accomplished by reflective object sensors, which have both light source and detector in one chip. The use of a pulsed light source insures low drift characteristics of the measuring circuitry. The collection of the respirable coal dust on filters facilitates accurate calibration and also allows measurement verification by well-accepted gravimetric methods. Research done under contract J0395082 by Mine Safety Appliances Co. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; U.S. Department of Energy facilities in Carbondale, Ill., and Pittsburgh, Pa.; Mine Safety and Health Administration, Arlington, Va.; National Mine Health and Safety Academy, Beckley, W. Va.; and Office of Surface Mining Library and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Order ONLY from NTIS. PB 82–213927; paper copy price code A03.

OFR 72–82. Research Study of Coal Mine Rock Reinforcement, by T. A. Lang and J. A. Bischoff. January 1981. 227 pp. 79 figs. Concepts and equations have been developed to quantitatively determine stability of a rock-bolted coal mine roof as a structural (beam-arch) member consisting of reinforced rock units. The equations took into account rock-bolt tension, length, spacing, and orientation; size of opening; strength and physical properties of the rock; and loads from distressed rock. Using sensitivity analyses and the results from relevant previous analytical and physical model investigations, the equations were critically reviewed. It was concluded that the equations can essentially be validated by using small-scale physical models and the full size mine entry model at the Bureau of Mines Spokane Research Center. Research done under contract J0295072 by Leeds, Hill and Jewett, Inc. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Juneau, Alaska, Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; U.S. Department of Energy facilities in Carbondale, Ill., Pittsburgh, Pa., and Morgantown, W. Va.; Mine Safety and Health Administration, Arlington, Va.; National Mine Health and Safety Academy, Beckley, W. Va.; and Office of Surface Mining Library and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Order ONLY from NTIS: PB 82–218041; paper copy price code A11.

OFR 73–82. Development of an Automatic Fire Protection System for Surface Vehicles. Final Report—Volume I, by W. D. Lease. Jan. 31, 1981. 74 pp. 24 figs. Automatic fire protection systems were designed, installed, and tested to protect three basic types of surface mining equipment: a large, rubber-tired front-end loader; a large and a small blast-hole drill; and a haul truck. The systems were tested after several months of installation and successfully discharged. The systems proved to be practical from the standpoint of protection, reliability, ease of maintenance, and cost effectiveness. Research done under contract H0262049 by Lease "AFEX", Inc. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Boulder City and Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; U.S. Department of Energy facilities in Carbondale, Ill., and Morgantown, W. Va.; and Office of Surface Mining Library and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Order ONLY from NTIS: PB 82–215765; paper copy price code A04.

OFR 74–82. The Price-Responsiveness of Secondary Silver, by Thomas W. Wolfe, Bruce P. Malashevich, Clark Chandler, Clarisse Morgan, Brian Rubenking, and Vincent Honnold. March 1982. 146 pp. 3 figs. The objective of this research was to determine the volume of silver that might reasonably be expected to be supplied from secondary sources in the future by establishing and analyzing the price-supply relationship. It was determined that there are very large unreported U.S. stocks of silver bullion, coin, and sterling silver, which, under certain conditions, can become an important increment to the future market supply. The price-elasticity of supply of silver refined from both new and old scrap in the aggregate is relatively low—at 0.3. The supply of silver refined from coins, however, is highly price-elastic with an elasticity calculated at 1.6 to 2.7. It was also found that U.S. capacity to process and refine secondary silver has increased and that the infrastructure of the market is in a strong position to expedite the flow of silver from reserve stocks of coin and other high-grade scrap in the event of a substantial rise in demand and price. However, the availability of this incremental supply for industrial use will also be influenced by private investors in silver bullion, whose behavior can either offset or enhance the flow of secondary supply from other sources. Research done under contract J0113080 by Economic Consulting Services Inc. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Juneau, Alaska, Den-

ver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; Federal Emergency Material Administration–General Services Administration, Washington, D.C.; Office of the Under Secretary of Defense for Research and Engineering Acquisitions Management–Industrial Resources, U.S. Department of Defense; and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Order ONLY from NTIS: PB 82–208422; paper copy price code A07.

OFR 75–82. Abandoned Mine Reclamation. A Case Study at Live Oak, Florida, by T. A. Herbert and R. G. Turner. May 30, 1981. 115 pp. 34 figs. A 2,338-acre mine site near Live Oak, Fla., was studied to determine the potential for reclamation and development. Present land uses of the area surrounding the abandoned mine were analyzed along with locations of abandoned cuts, spoil piles and tailings, and land ownership patterns. An abandoned economic analysis of the surrounding five-county area was conducted to determine what types of industries might relocate at the mine site. Methods commonly used to reclaim abandoned mines were discussed along with possible interim and end land uses; financial incentives available from the Federal, State, and local sources were discussed. Seven planning scenarios were developed, identifying 861 acres as suitable for industrial and commercial development and 964 acres as suitable for woodlands and agriculture. It was estimated that reclamation of industrial sites would cost $1.13 million and reclamation of areas to woodland-agriculture would cost $142,000. Research done under contract J0295007 by the Center for Resource Development. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; and Office of Surface Mining Library and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Order ONLY from NTIS: PB 82–213901; paper copy price code A06.

OFR 76–82. The Effect of In Situ Retorting on Oil Shale Pillars, by L. Ozdemir, D. Ropchan, R. Miller, F. D. Wang, T. Sladek, C. Young, J. DuBow, and D. Fausett. October 1981. 387 pp. 155 figs. An investigation was made to determine the mechanical properties of oil shale at elevated temperatures and confining pressures, the thermal properties at elevated temperatures, and to provide mathematical models for mine design for in situ oil shale retorting. A review of current activity in in situ retorting is included with a comprehensive list of references. Tests were run at temperatures from 20° to 500° C and confining pressures to 1,500 psi with shale of 10 to 30 gal per ton. A major loss of strength occurred in heating at 140° C with a partial regain from 380° to 500° C. Higher grade shale had a lower compressive strength. Elastic properties showed large variations. Brazilian tensile strength showed a similar temperature sensitivity as the compressive strength. Equations were developed for each property in terms of grade, temperature, and pressure. Thermal, electrical, and acoustical properties showed anomalies through the temperature range. Creep is a major factor in overall deformation of heated shale. Oil shale was found to be an excellent insulator. Loss of pillar support area at 800 hr of heating would be about 10 pct. Good correlation was found between a finite element model using the developed properties and an in situ heater test. Research done under contract H0262031 by the Colorado School of Mines. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; U.S. Department of Energy, Carbondale, Ill., and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Order ONLY from NTIS: PB 82–214099; paper copy price code A17.

OFR 77–82. Fiber Optics Technology for Underground Mine Communication Systems, by David Bendersky, John E. Golob, Vern W. Klein, and Dan R. Keyes. January 1982. 171 pp. 26 figs. This report covers the activities of a feasibility study of fiber optics technology for use in mines. The objective of the study was to evaluate, both technically and cost-wise, the possible use of fiber optic technology for underground mine communication and monitoring systems. The first phase of the study was devoted to the collection of information on the present underground mine communication systems and monitoring techniques and the status of applicable fiber optic technology. In the second phase, a communication and monitoring system for a hypothetical underground coal mine was designed and the costs were estimated. The significant findings and conclusions are presented. Research done under contract J0113003 by the Midwest Research Institute. Available for reference at Bureau of Mines facilities in Tuscaloosa, AL, Denver, CO, Avondale, MD, Twin Cities, MN, Rolla, MO, Reno, NV, Albany, OR, Pittsburgh, PA, Salt Lake City, UT, and Spokane, WA; U.S. Department of Energy, Pittsburgh, PA; Mine Safety and Health Administration, Arlington, VA; National Mine Health and Safety Academy, Beckley, WV; and Office of Surface Mining Library and National Library of Natural Resources, U.S. Department of the Interior, Washington, DC. Order ONLY from NTIS: PB 83–175562; paper copy price code A08.

OFR 78–82. Benefit-Cost Analysis of Health and Safety Research and Development Projects in Coal, Metal and Non-Metal Mining, by R. P. Davis, G. R. Brown, and W. J. Douglas. May 1981. 108 pp. 14 figs. This report describes the development of an analytical procedure for evaluating the potential economic effects on the mining industry of Bureau of Mines sponsored health and safety projects. A number of economic measures were utilized, most of which involve discounted cash flow analysis. Problems were encountered in attempting to collect data that was both consistent and accurate in validating the modeling procedure. As a consequence, the benefit-cost procedure applies parametric analysis in evaluating projects. By varying parameters that have a high degree of uncertainty over a range of expected values, a corresponding set of benefit-cost indices can be obtained. The Benefit-Cost Index represents the economic output per unit of investment in the proposed technology by the mining industry sector. The Benefit-Cost Analysis Model, version 1 (BCAM/1) is a computerized procedure that has been installed at the Bureau's Pittsburgh Research Center computer facility. Research done under contract J0199042 by Ketron, Inc. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Juneau, Alaska, Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; U.S. Department of Energy facilities in Pittsburgh, Pa., and Morgantown, W. Va.; Mine Safety and

Health Administration, Arlington, Va.; National Mine Health and Safety Academy, Beckley, W. Va.; and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Order ONLY from NTIS: PB 82-218660; paper copy price code A06.

OFR 79–82. Bound Liquid Ion Exchange Membranes for the Extraction of Cobalt From Lateritic Leach Solutions, by Larry D. Nichols, Arthur S. Obermayer, and Marie B. Allen. Feb. 25, 1982. 59 pp. 6 figs. Poroplastic membranes containing ion exchange liquids were studied for separating cobalt from nickel-containing solutions similar to ammoniacal laterite leaches. The driving force for cobalt transport was differences in pH and composition between the leach and extraction streams. Using a diketone ion exchange liquid, a leach pH of 6.5 to 7.0, and a strip pH of 2.3, cobalt was extracted from a 750-ppm solution containing 2,500 ppm of nickel at rates ranging from 1 to 10 $\mu g/cm^2 \cdot min$ in single membrane cells. Rates were variable, with evidence that cross-membrane flow patterns were a key factor; a reproducible rate of 30 $\mu g/cm^2 \cdot min$ would be economically viable. Loss of transport, observed after several days of continuous operation, was restored by flushing membranes with fresh ion exchange liquid. A major effort was devoted to preparing thin, leak-free membranes; the resulting membranes endured operating conditions without mechanical failure. Research done under contract J0295056 by Moleculon Research Corp. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Juneau, Alaska, Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; and Office of Surface Mining Library and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Order ONLY from NTIS: PB 82–218652; paper copy price code A04.

OFR 80–82. Mine Personnel Locator and Mine Activity Controller. Final Report, by A. J. Farstad, L. R. Robinson, and G. H. Saum. Dec. 17, 1981. 187 pp. 47 figs. Recent advances in microcomputer technology have opened the way for systems that can track the location of underground mining personnel from the surface. A computerized system was designed that is capable of not only tracking the location of the miner but also of monitoring underground parameters, communicating between work stations, and sounding alarms when underground conditions are judged to be unsafe. In this report the locations of underground personnel are detected by a network of underground terminals that routinely emit radiofrequency (RF) pulses to interrogate miniature transponders worn by the miners. Each transponder is uniquely programed to delay its response so that the RF terminal can identify the individual transponders by the time slots in which the responding pulses are received. The underground terminals are then interrogated by the host computer on the surface that keeps a running account on underground mine conditions and personnel. The underground portion of the system is designed to operate even during mine emergencies, deriving its power from rechargeable battery supplies that are float charged during normal operation. Research done under contract J0205059 by Nelson and Johnson Engineering, Inc. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Juneau, Alaska, Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; Mine Safety and Health Administration in Denver, Colo., Pittsburgh, Pa., and Arlington, Va.; National Mine Health and Safety Academy, Beckley, W. Va.; and Office of Surface Mining Library and National Library of Natural Resources U.S. Department of the Interior, Washington, D.C. Order ONLY from NTIS: PB 82–235979; paper copy price code A09.

OFR 81–82. Assessment of Induction Fan Effectiveness, by Ted A. Lewtas. March 1980. 62 pp. 12 figs. The work performed in this program was based on prior efforts using induction (jet) fans to ventilate dead headings with the objective of refining the attachments to maximize fan effectiveness and to study the influence on the effectiveness of fan proximity to drift walls. Detailed anemometer surveys were designed to delineate the size and shape of the jet created by an induction fan, and tracer gas was used to determine the quality of fresh air that an induction fan can deliver to the face of a drift and the fan's effectiveness in removing contaminants from the drift. Fan locations of 2 and 4 feet from the drift wall and at the drift center line were evaluated in the laboratory and all mine testing was done with the fan as close to the wall as possible. It was concluded that (1) an aerodynamic nozzle increases jet penetration and any tubing length up to 15 feet, (2) locating the fan near the drift wall increases jet penetration, (3) airflow straighteners are ineffective in increasing penetration, and (4) induction fan installations in general are ineffective in removing contaminants from dead headings without sufficient main ventilation flow. Research done under contract J0387223 by Foster-Miller Associates, Inc. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; U.S. Department of Energy facilities in Carbondale, Ill., and Pittsburgh, Pa.; National Mine Health and Safety Academy, Beckley, W. Va.; and Office of Surface Mining Library and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Order ONLY from NTIS: PB 82–235987; paper copy price code A04.

OFR 82–82. Study To Develop Data for Review of Metal and Non-Metal Mine Methane Hazard Classification, by Alastair Lumsden and Richard Talbot. April 1982. 153 pp. The objective of this study was to assemble the largest possible body of information concerning the regulatory and classification process applying to the incidence of methane gas in metal and nonmetal mines in a number of foreign countries. An extensive literature search was performed to identify countries with appropriate experience. Of the 20 countries that were approached, 16 responded with information of varying degrees of detail. Eight of the 16 countries—Australia, the Republic of South Africa, the Federal Republic of Germany, Yugoslavia, France, Spain, Italy, and the United Kingdom—were visited to obtain firsthand information from industry representatives and the regulatory agencies. The results of the 8-month study are presented. Research done under contract J0100060 by Golder Associates. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; U.S. Department of Energy facilities in Carbondale, Ill., and Pittsburgh, Pa.; Mine Safety and Health Administration, Arlington, Va.; Na-

tional Mine Health and Safety Academy, Beckley, W. Va.; and Office of Surface Mining Library and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Copies of this report will not be available for purchase.

OFR 83–82. Time Domain Reflectrometry Microcomputer (TDRM) Testing. Volume II, by Eugene W. Bartel, Perry Wingfield, and Martie Leister. August 1981. 23 pp. 3 figs. The calibration of the automated digital time domain deflectometer (ADTDR) units has been a persistent problem since the first tests that were reported in Bureau of Mines Open File Report 60–82. Several problems appear to center around the high-speed ECL logic timing circuitry board; therefore, tests were conducted in this area to isolate the malfunction and to evaluate potential methods for accurate placement. Research done under contract J0377021 by Carnegie-Mellon University. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; U.S. Department of Energy facilities in Carbondale, Ill., and Pittsburgh, Pa.; Mine Safety and Health Administration, Arlington, Va.; National Mine Health and Safety Academy, Beckley, W. Va.; and Office of Surface Mining Library and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Order ONLY from NTIS: PB 82–243940; paper copy price code A02.

OFR 84–82. Feasibility of Water Injection for Particulate Removal in Large Turbocharged Diesel Engines, by R. N. Hambright, R. W. Burrahm, and V. O. Markworth. Nov. 13, 1981. 216 pp. 115 figs. Gaseous and particulate exhaust emissions are characterized for a 1,200-bhp, two-stroke cycle diesel; a 1,000-bhp, four-stroke cycle precombustion chamber diesel; and a 900-bhp, four-stroke cycle, direct injection diesel using steady-state modal testing and a versatile exhaust dilution-collection system. In addition, a 150-bhp, four-stroke cycle, precombustion chamber, turbocharged diesel was characterized for use in experimental water injection evaluations. Water injection downstream of the turbocharger compressor and upstream of the turbocharger exhaust turbine are evaluated for their particulate removal effectiveness on a small turbocharged diesel engine. The water droplets are inertially separated using cyclone separators designed for minimum pressure drop and cutsize. Up to 50 percent of the total particulate mass generated was removed using a combination of both inlet and exhaust water injection techniques. Research done under contract J0100036 by Southwest Research Institute. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Juneau, Alaska, Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; Mine Safety and Health Administration, Arlington, Va.; National Mine Health and Safety Academy, Beckley, W. Va.; and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Order ONLY from NTIS: PB 82–243932; paper copy price code A10.

OFR 85–82. Development of Continuous Spiral Drill and Blast Tunneler. Phase IV, by Carl R. Peterson, Allan T. Fisk, and Robert G. Lundquist. December 1978. 95 pp. 26 figs. A long-recognized goal in high-speed tunneling and mining has been the development of a continuous drill and blast excavation capability. This report presents the results of tests conducted on an integrated drill-load-shoot system in which the explosive and initiator are loaded directly through the drill steel as the latter is withdrawn from the hole. Research done under contract H0252047 by Rapidex, Inc. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; U.S. Department of Energy facilities in Carbondale, Ill., and Pittsburgh, Pa.; Mine Safety and Health Administration, Arlington, Va.; National Mine Health and Safety Academy, Beckley, W. Va.; and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Order ONLY from NTIS: PB 82–243957; paper copy price code A05.

OFR 86–82. A Clean Internal Combustion Engine for Underground Mining Machinery. A Technical Assessment and Program Plan. Final Phase I Report, by Ned Baker, Lee Houston, Frank Lynch, Lars Olavson, and Gary Sandrock. Dec. 31, 1981. 232 pp. 81 figs. This study assesses the feasibility of employing hydride-fueled internal combustion engines to power mobile underground mining machinery. Problems are identified and a solution and a development plan are proposed with the objective of constructing, testing, and demonstrating a nonpolluting engine suitable for underground use. Research done under contract H0202034 by EIMCO Mining Machinery International. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Juneau, Alaska, Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; Mine Safety and Health Administration, Arlington, Va.; National Mine Health and Safety Academy, Beckley, W. Va.; and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Order ONLY from NTIS: PB 82–244724; paper copy price code A11.

OFR 87–82. Poisoning of Catalytic Methane Sensors, by M. Kawahata and R. Lazzaro. September 1981. 156 pp. 62 figs. Methane sensors using the principle of catalytic oxidation of methane are employed for the determination of methane content in ambient air of coal mines. Certain foreign gases or vapors in the air poison the catalyst of the sensors affecting the sensor response. After a literature search of poison compounds of platinum and palladium oxidation catalysts, experimental studies of catalyst poison kinetics were made for three siloxane compounds, tributyl phosphate, monobromotrifluoromethane, and hydrogen sulfide, that were selected as poison vapors. The concentration range of the poison vapors was varied from 3,000 to 0.1 ppb (v/v). Three siloxane vapors produced strong catalyst poison effect followed by tributyl phosphate, hydrogen sulfide, and monobromotrifluoromethane for the high concentration level of the poison vapors. Threshold poison vapor concentrations, where effect of the poison vapors on the sensor is minimal, were determined experimentally. Experimental studies were made further for a prevention method of catalyst poison by adsorption techniques. The use of activated carbon cloth inserted on the sensor head prevented catalyst poisoning efficiently. Research done under contract J0100003 by Environment/One Corp. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg.,

Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; U.S. Department of Energy, Pittsburgh, Pa.; Mine Safety and Health Administration, Arlington, Va.; National Mine Health and Safety Academy, Beckley, W. Va.; and Office of Surface Mining Library and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Order ONLY from NTIS: PB 82–243973; paper copy price code A08.

OFR 88–82. Survey of Safety Procedures for Guarding Blast Affected Areas, by Jerry Bennett. Oct. 19, 1981. 74 pp. 19 figs. This report describes the results of a survey of current blast area guarding procedures at surface and underground metal and nonmetal mines. Five case histories of blast guarding methods considered to represent the best systems in use in the U.S. mining industry are featured. Elements of an effective blast guarding system are presented along with recommendations for improvements in current blast guarding practices. Industrial and military surveillance and detection technology was reviewed to determine whether parallel technology exists for immediate application to blasting site security. While it is concluded that immediate transfer of industrial security technology is limited, a number of recommendations are presented for new research to adapt some of that technology for application to the mining environment. Two research areas (computerized personnel tracking and blast area intrusion detection using infrared, microwave, or E-field type detection systems) that are considered to offer the most potential for improved blast guarding areas are presented. Research done under contract J0205019 by Mining & Marketing Associates, Inc. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; Mine Safety and Health Administration, Arlington, Va.; National Mine Health and Safety Academy, Beckley, W. Va.; and Office of Surface Mining Library and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Order ONLY from NTIS: PB 82–246042; paper copy price code A04.

OFR 89–82. Trolley Carrier Phone Mine Communications. Adaptive Volume Control and Use of a Dedicated Wire or a Low Impedance Line for Improved Carrier Phone Communications in Mines. by Robert L. Lagace, Dennis C. Jeffreys, Richard H. Spencer, and James M. Williams. February 1979. 146 pp. 58 figs. This report presents the results of a program that was initiated to study, implement, and test the operation of an adaptive volume control circuit for the loudspeaker of a mine trolley carrier phone. The design goal was for the control to sense the ambient noise conditions and to operate the communications equipment such that the sound output would be loud under noisy conditions, and quieter under quiet conditions, thereby resulting in an understandable and nonstartling volume level under all normal operation conditions. Research done under contract J0377098 by Arthur D. Little, Inc. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; U.S. Department of Energy facilities in Carbondale, Ill., and Pittsburgh, Pa.; Mine Safety and Health Administration, Arlington, Va.; National Mine Health and Safety Academy, Beckley, W. Va.; and Office of Surface Mining Library and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Order ONLY from NTIS: PB 82–246034; paper copy price code A07.

OFR 90–82. Analysis of Groundwater Criteria and Recent Restoration Attempts After In Situ Uranium Leaching, by Grant Buma, Paul H. Johnson, Gerhard K. Bienek, C. Gordon Watson, Harold Noyes, and Regina Capuano. October 1981. 304 pp. 24 figs. Groundwater restoration is an important aspect of in situ uranium leaching. Information on the effectiveness of the current technology, costs, and the current State and Federal Government permitting regulations is of vital importance to in situ leach operators and firms considering in situ leaching. This study describes (1) all recent restoration attempts at commercial in situ leaching operations, (2) restoration costs reported by the industry, (3) empirical equations that predict the amount of groundwater flushing required to meet the current restoration criteria, and (4) in situ uranium permit requirements for the States of Texas, Wyoming, New Mexico, Utah, Montana, Colorado, and South Dakota, and Federal requirements. Research done under contract J0295019 by Resource Engineering & Development, Inc. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Juneau, Alaska, Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.;U.S. Department of Energy facilities in Carbondale, Ill., and Pittsburgh, Pa.; Mine Safety and Health Administration, Arlington, Va.; National Mine Health and Safety Academy, Beckley, W. Va.; and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Order ONLY from NTIS: PB 82–246018; paper copy price code A14.

OFR 91–82. Analysis of Coal Mine Electrical Accidents, by W. L. Cooley, B. S. Tenney, and Z. Elrazaz. November 1981. 242 pp. 33 figs. Electrical accidents occurring in coal mines from 1975 through 1979 were categorized and analyzed. The data were searched for common electrical hazards, common activities by those injured, and common negligent or careless behavior. The accident data were combined with mine production statistics to form a normalized electrical accident rate. It was found that some mines have consistently more lost workdays per work-hour than other mines. Bureau of Mines electrical safety research contracts were reviewed to determine whether the research effort was directed toward those areas that are related to the most accidents; in some cases it was not. A method was devised and utilized to estimate the relative cost to the mining industry to implement certain safety measures developed through Bureau research and the potential safety benefits. MSHA regulations were reviewed for effectiveness in preventing electrical accidents and suggestions were made for discontinuing, clarifying, or otherwise modifying the regulations. Research done under contract J0100096 by West Virginia University. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; U.S. Department of Energy facilities in Carbondale, Ill., and Pittsburgh, Pa.; Mine Safety and Health Administration, Arlington, Va.; National Mine Health and Safety Academy, Beckley, W. Va.; and Office of Surface

Mining Library and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Order ONLY from NTIS: PB 82–244740; paper copy price code A11.

OFR 92–82. Feasibility of Using Cemented Backfill in Active Underground Coal Mines To Prevent Subsidence, by D. V. Gaffney, M. M. Stewart, N. K. Chakravorti, and R. M. Hays. December 1981. 218 pp. 36 figs. This report presents the results of a three-phase investigation of the feasibility of using cemented coal waste in active underground coal mines to prevent mine subsidence. Coal waste was broadly defined to include waste from both coal preparation plants and coal-fired powerplants. Underground systems with potential for cemented backfill were determined through identification of current mining methods and available technologies for cemented backfilling and consideration of materials and systems constraints upon mining and backfilling integration. Technical concerns including operation, health and safety, materials utilization, environmental impact, applicability, and technical status were assessed for six systems that were identified as potentially feasible. Two of these systems were conceptualized in a hypothetical case history and developed to further assess their operational and economic feasibility. Comparisons of costs among both systems and with costs of surface disposal are presented. The conclusions concerning the present feasibility of using cemented backfill in active coal mines and potential avenues for further research are also presented. Research done under contract J0295001 by Michael Baker, Jr., Inc. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Juneau, Alaska, Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; National Mine Health and Safety Academy, Beckley, W. Va.; and Office of Surface Mining Library and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Order ONLY from NTIS: PB 82–244252; paper copy price code A11.

OFR 93–82. Development of a Continuous Methane Monitor, by Irvin G. Burough. November 1981. 45 pp. 18 figs. Two prototype continuous methane monitors capable of being mounted on a mining machine were designed and built for in-mine safety use. The monitors incorporated a nondispersive infrared optical-electronic analyzer design in which the response to the sample gas was achieved by synchronous detection and measurement of the amplitude oscillations of the transmitted energy from an infrared source caused by the pressure modulation of the sample gas within the optical cell. Zero and span stability were to be achieved by the amplitude modulating of the infrared source and using the detected signal to correct for optical-electronic system variation. This design effort was to simplify and reduce the cost of the major components while eliminating the need for daily calibration. Research done under contract H0377072 by Andros Analyzers Inc. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; U.S. Department of Energy facilities in Carbondale, Ill., and Pittsburgh, Pa.; Mine Safety and Health Administration, Arlington, Va.; National Mine Health and Safety Academy, Beckley, W. Va.; and Office of Surface Mining Library and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Order ONLY from NTIS: PB 82–244245; paper copy price code A03.

OFR 94–82. Illumination of Electric Powered, Mobile Surface Mining Equipment, by David D. Hottinger. Jan. 9, 1981. 117 pp. 77 figs. Only a minimum amount of illumination is generally provided for many types of mobile surface mining equipment. This condition presents a hazard to personnel working on and around such equipment. To reduce the hazard, MSHA has proposed safety regulations requiring minimum levels of illumination for hazardous zones on and in the immediate area surrounding surface mining equipment. This report describes a Bureau of Mines sponsored project demonstrating the feasibility and effectiveness of providing dragline illumination in compliance with the proposed MSHA regulations. Descriptions of the computer-aided design, onsite installation, and field evaluation of individual lighting systems for each of three different size draglines are presented. Research done under contract H0387004 by Phoenix Products Co., Inc. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; U.S. Department of Energy facilities in Carbondale, Ill., and Pittsburgh, Pa.; Mine Safety and Health Administration, Arlington, Va.; National Mine Health and Safety Academy, Beckley, W. Va.; and Office of Surface Mining Library and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Order ONLY from NTIS: PB 82–244237; paper copy price code A06.

OFR 95–82. Development and Prototype Production of a Trapped Miner Signalling Transmitter/Transceiver, by Charles H. Simmons. June 1981. 82 pp. 24 figs. Two versions of a VF transceiver to aid in locating trapped miners were developed and tested. A belt-worn model was produced in both transmitter and transceiver forms. In addition, a quantity of the belt-worn models were fabricated using aluminum wire instead of copper to reduce unit weight. Ten prototypes of a battery cap model VF transceiver were also fabricated demonstrating further unit size and weight reduction while maintaining electrical performance. Although both versions of the VF transceiver are similar electrically, and both are constructed using conventional manufacturing techniques, the battery cap model realizes a lower total weight, smaller volume, and lower production cost than the belt-worn version. Samples of both versions were tested environmentally, and the test data are included in this report. Research done under contract J0395017 by General Instrument Corp., Government Systems Div. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; U.S. Department of Energy facilities in Carbondale, Ill., and Pittsburgh, Pa.; Mine Safety and Health Administration, Arlington, Va.; National Mine Health and Safety Academy, Beckley, W. Va.; and Office of Surface Mining Library and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Order ONLY from NTIS: PB 82–244260; paper copy price code A05.

OFR 96–82. Thixogelled Halon/Dry Powder Fire Supressants, by W. B. Tarpley, Jr., L. H. Lemon, and

A. L. Tuno. April 1981. 46 pp. 3 figs. This program was conducted to demonstrate the unique advantages of suppressing methane ignition in underground mines by use of a thixogel fire extinguishing system, which stably suspends dry powder extinguishing agent in thixotropically gelled liquefied gas extinguishant. The project demonstrated thixogel system advantages of (1) the capability to disperse state-of-the-art powders in thixogelled Halons, (2) a nonagglomerating stability for dependable expulsion, (3) stability in storage for long shelf life, (4) virtually instantaneous dispersion, (5) expansive cloud formation, (6) reach and reforming ground obstacles, (7) at least twice the extinguishant effectiveness, and (8) compatibility of use with Fenwal bottles and MSHA canisters. The demonstration showed the thixogel system to be a superior explosion-fire suppressant for coal face cutters and triggered barriers as well as for motorized equipment, electrical equipment, etc. Research done under contract H0395081 by Energy & Minerals Research Co. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Juneau, Alaska, Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; U.S. Department of Energy, Pittsburgh, Pa.; Mine Safety and Health Administration, Arlington, Va.; National Mine Health and Safety Academy, Beckley, W. Va.; and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Order ONLY from NTIS: PB 82–245937; paper copy price code A03.

OFR 97–82. Cost and Sensitivities Analysis for Uranium In Situ Leach Mining, by George W. Toth and John R. Annett. March 1981. 344 pp. 24 figs. This report presents the results of an assessment of uranium in situ leach mining costs through the application of process engineering and discounted cash flow analysis procedures. A computerized costing technique was developed to facilitate rapid cost analyses. Applications of the cost model will generate mine life capital and operating costs as well as solve for economic production cost per pound U_3O_8. Conversely, rate of return may be determined subject to a known selling price. The data bases of the cost model were designed to reflect variations in Texas versus Wyoming site applications. The results of applying the model under numerous ore deposit, operating, well field, and extraction plant conditions for Texas and Wyoming are summarized in the report. Sensitivity analyses of changes in key project parameters have also been tested and are included. Research done under contract J0199112 by NUS Corp. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Order ONLY from NTIS: PB 82–243965; paper copy price code A15.

OFR 98–82. Compaction Criteria for Coal Waste Embankments, by N. S. Shah, S. K. Saxena, J. S. Rao, K. C. Singhal, and D. E. Lourie. August 1981. 200 pp. 98 figs. The purpose of this study is to evaluate the costs and resulting effects on the engineering properties of coal waste materials, utilizing different compaction methods, equipment passes, and lift thickness. The report describes a comprehensive literature search into the compaction of coal waste materials, field compaction programs, laboratory investigations, analysis of test data and conclusions, and recommendations for establishing the compaction criteria. Research done under contract J0100031 by Globetrotters Engineering Corp. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; U.S. Department of Energy facilities in Carbondale, Ill., and Pittsburgh, Pa., Mine Safety and Health Administration, Arlington, Va.; National Mine Health and Safety Academy, Beckley, W. Va.; and Office of Surface Mining Library and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Order ONLY from NTIS: PB 82–244708; paper copy price code A09.

OFR 99–82. Detection of Trapped Miner Electromagnetic Signals Above Coal Mines, by Robert L. Lagace, James M. Dobbie, Thomas E. Doerfler, William S. Hawes, and Richard H. Spencer. July 1980. 281 pp. 44 figs. This report assesses the expected detectability, on the surface above mines, of electromagnetic signals produced in the 630- to 3,030-Hz frequency band by a rescue transmitter activated by miners trapped underground. The assessment is based on a statistical analysis of experimental signal and noise data taken at coal mine sites distributed over the U.S. underground coalfields. Regression analyses are performed to characterize the signal transmission behavior of overburdens as a function of depth and frequency. The predicted signal behavior is then combined with experimentally based distributions of the background noise, and aural detection characteristics of signals in noise, to generate curves of the expected probability of detection for trapped miner signals versus overburden depth and operating frequency. The implications of the results and associated recommendations are presented regarding the detectability of trapped miners, sensitivity analyses and confirmatory tests, and operational utilization considerations for the trapped miners and the search and rescue teams on the surface. Research done under contract J0188037 by Arthur D. Little, Inc. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; U.S. Department of Energy facilities in Carbondale, Ill., and Pittsburgh, Pa.; Mine Safety and Health Administration, Arlington, Va.; National Mine Health and Safety Academy, Beckley, W. Va.; and Office of Surface Mining Library and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Order ONLY from NTIS: PB 82–244732; paper copy price code A13.

OFR 100(1)–82. Partial Listings of Coal Waste Embankments, Surface and Underground Openings. Final Report, by G. Ahnell, J. D. Hervol, J. W. Mentz, R. E. McClure, T. L. Reed, and C. Yuill. Feb. 2, 1982. 130 pp. 41 figs. Throughout portions of four heavily mined Appalachian States subdivided by the Mine Safety and Health Administration as (1) district 3, northern West Virginia and Maryland, (2) district 4, southern West Virginia, (3) district 5, Virginia, and (4) district 6, eastern Kentucky, active coal mine waste embankments associated with mechanical and/or chemical coal processing facilities of various levels of coal preparation were inventoried. For each site plant specifications, disposal techniques, embankment characteristics, and coal source data were accumulated. Mapping at 1:24,000 and 1:250,000 scale and disposal site characterization

forms were developed to present the findings. Associated abandoned surface and underground openings near each site were also indicated as well as locational data for each site and the area environmental conditions. A state-of-the-art review of coal preparation, waste disposal, and alternative uses of coal waste is included. Research done under contract J0205001 by Skelly and Loy. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; U.S. Department of Energy facilities in Carbondale, Ill., and Pittsburgh, Pa.; Mine Safety and Health Administration, Arlington, Va.; National Mine Health and Safety Academy, Beckley, W. Va.; and Office of Surface Mining Library and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Order ONLY from NTIS: PB 82-244286; paper copy price code A07.

OFR 100(2)-82. Partial Listings of Coal Waste Embankments, Surface and Underground Openings. Final Report. Appendix Volume I, by G. Ahnell, J. D. Hervol, J. W. Mentz, R. E. McClure, T. L. Reed, and C. Yuill. Feb. 2, 1982. 245 pp. 1 fig. Volume 2 of this three-volume report contains brief descriptions of the terms and codes used for each of the inventoried sites in Mine Safety and Health Administration districts 3, 4, 5, and 6. Detailed site mapping and the disposal site characterization forms for districts 3 and 4 are included. Research done under contract J0205001 by Skelly and Loy. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; U.S. Department of Energy facilities in Carbondale, Ill., and Pittsburgh, Pa.; Mine Safety and Health Administration, Arlington, Va.; National Mine Health and Safety Academy, Beckley, W. Va.; and Office of Surface Mining Library and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Order ONLY from NTIS: PB 82-244294; paper copy price code A11.

OFR 100(3)-82. Partial Listing of Coal Waste Embankments, Surface and Underground Openings. Final Report. Appendix Volume II, by G. Ahnell, J. D. Hervol, J. W. Mentz, R. E. McClure, T. L. Reed, and C. Yuill. Feb. 2, 1982. 232 pp. 1 fig. Volume 3 of this three-volume report contains brief descriptions of the terms and codes used for each of the inventoried sites in Mine Safety and Health Administration districts 3, 4, 5, and 6. Detailed site mapping and the disposal site characterization forms for districts 5 and 6 are included. Research done under contract J0205001 by Skelly and Loy. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; U.S. Department of Energy facilities in Carbondale, Ill., and Pittsburgh, Pa.; Mine Safety and Health Administration, Arlington, Va.; National Mine Health and Safety Academy, Beckley, W. Va.; and Office of Surface Mining Library and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Order ONLY from NTIS: PB 82-244302; paper copy price code A11.

OFR 101-82. Detailed Design and Demonstration of Underground Disposal of Coal Mining Wastes. Phase I Report, by GEX Colorado Inc. June 1981. 61 pp. 35 figs. This report presents a detailed design of an underground coal waste disposal system that was developed for a specific mine. Along with the design, an instrumentation plan and a monitoring system were developed to measure and record the performance of the underground disposal operation as well as the effect of underground disposal on the total mine environment. Research done under contract J0205069. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Juneau, Alaska, Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; U.S. Department of Energy facilities in Carbondale, Ill., and Pittsburgh, Pa.; Mine Safety and Health Administration, Arlington, Va.; National Mine Health and Safety Academy, Beckley, W. Va.; and Office of Surface Mining Library and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Copies of this report will not be available for purchase.

OFR 102-82. Development and Testing of Self-Drilling Roof Bolts, by F. S. Kendorski, S. D. Singh, and M. M. Singh. August 1979. 225 pp. 80 figs. This report presents the results of a search for viable roof bolt concepts, detailed development, design, and manufacture of such bolts that drill their own holes. Testing in the laboratory and in the field in two different coal mines of three self-drilling roof bolts is described. Three new types of bolts, a spring-actuated mechanical expansion shell, a slot and wedge, and a self-contained resin anchor bolt, that drill their own holes and then anchor in a continuous operation were designed and tested. Such bolts, when fully developed for mine use, would allow safer and remote installation of ground support and increase productivity. Research done under contract H0272022 by Engineers International, Inc. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; U.S. Department of Energy facilities in Carbondale, Ill., and Pittsburgh, Pa.; Mine Safety and Health Administration, Arlington, Va.; National Mine Health and Safety Academy, Beckley, W. Va.; and Office of Surface Mining Library and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Copies of this report will not be available for purchase.

OFR 103(1)-82. Feasibility of Water Diversion and Overburden Dewatering. Volume I: Technical Report, by Michael L. Clar, John J. Ferrandino, and Connie Bosma. April 1981. 231 pp. 71 figs. This report presents the results of a study to determine the feasibility of water diversion and overburden dewatering for underground coal mines in the Appalachian region. An assessment of the impact of mine water with respect to health and safety, production, environment, and costs is included. Sources of water inflow into underground mines are described. The report contains a summary description and evaluation of techniques that can be used to reduce the amount of water entering underground coal mines. A review of engineering practices currently used to prevent the movement of ground and surface water in active coal workings is included. The major emphasis is on the identification of the geologic and hydrologic condition of the site, onsite inspection of the methods used, and an evaluation of their technical and cost effectiveness. Research

done under contract J0395059 by Hittman Associates, Inc. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Juneau, Alaska, Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; Mine Safety and Health Administration, Arlington, Va.; National Mine Health and Safety Academy, Beckley, W. Va.; and Office of Surface Mining Library and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Copies of this report will not be available for purchase.

OFR 103(2)–82. Feasibility of Water Diversion and Overburden Dewatering. Volume II: Annotated Bibliography, by Michael L. Clar, John J. Ferrandino, and Connie Bosma. April 1981. 113 pp. This volume is an annotated bibliography of published literature pertaining to the occurrence and control of surface and ground water in underground coal mines. The literature was used to develop volume I of this report, which assesses the feasibility of water diversion and overburden dewatering for underground coal mines in the Appalachian region. Each abstract is followed by subject descriptors. The abstracts are listed alphabetically by title and are numbered consecutively. The numbers are used in the subject index to assist in locating the appropriate articles. Research done under contract J0395059 by Hittman Associates, Inc. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Juneau, Alaska, Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; Mine Safety and Health Administration, Arlington, Va.; National Mine Health and Safety Academy, Beckley, W. Va.; and Office of Surface Mining Library and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Copies of this report will not be available for purchase.

OFR 104–82. Exploratory Studies of Flame and Explosion Quenching. Volume I, by L. Douglas Smoot and M. Duane Horton. Aug. 31, 1979. 317 pp. 108 figs. This research program was a theoretical and experimental study of laminar flame propagation in pure methane air and coal dust air mixtures, and in such mixtures containing suppressant additives. The flames studied included methane air, coal dust air, coal dust air with size, volatiles content and concentration as variables, and coal dust air plus $KHCO_3$, KNO_3, KBr, NaCl, or $CaCO_3$. A variety of measurements were made of burning velocities, flammability limits, and flame structure. In support of the experimental work, a generalized flame propagation model was developed to describe the propagation in premixed, laminar gaseous, and particle-laden flames. Research done under grant G0177034 by Brigham Young University. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; U.S. Department of Energy facilities in Carbondale, Ill., Pittsburgh, Pa., and Morgantown, W. Va.; Mine Safety and Health Administration, Arlington, Va.; National Mine Health and Safety Academy, Beckley, W. Va.; and Office of Surface Mining Library and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Copies of this report will not be available for purchase.

OFR 105–82. Diesel Exhaust Emissions From Engines for Use in Underground Mines, by B. H. Eccleston, D. E. Seizinger, and J. M. Clingenpeel. April 1981. 42 pp. 12 figs. Experimental data were obtained from two medium-duty diesel engines derated to qualify for use in underground mines. Gaseous and particulate emissions from these engines were measured and results provide information on the effect of exhaust treatment devices on the emissions. The devices in the study were a catalyst, a particulate trap, and an exhaust gas cooler of the water scrubber type. Emission levels of carbon monoxide and hydrocarbons were observed to be very low in comparison with emission levels of comparable engines in full-rated operation. Oxides of nitrogen and benzo(a)pyrene content of the exhaust also were found to be somewhat low in comparison with previous findings. For particulate reduction, the combination of a particulate trap and a scrubber was observed to be the most effective combination tried; in some cases, over 60 pct particulate reduction was effected by the trap-scrubber combination. Research done under contract J0166023 by the Bartlesville Energy Technology Center, U.S. Department of Energy. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; U.S. Department of Energy facilities in Carbondale, Ill., and Pittsburgh, Pa.; Mine Safety and Health Administration, Arlington, Va.; National Mine Health and Safety Academy, Beckley, W. Va.; and Office of Surface Mining Library and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Copies of this report will not be available for purchase.

OFR 106–82. Dredge Safety Hazard Analysis, by Louis Schaffer, William Patterson, and Catherine Davis. Apr. 27, 1981. 104 pp. 37 figs. A literature review concerning dredging hazards and dredge safety practices and an examination of MSHA accident and injury statistics on dredge mining in the United States provided the background for an analysis that was completed by visits to 31 dredge operations, dredge manufacturers, and dredging experts. The principal hazards are discussed and countermeasures are suggested in several areas. Drowning is the single largest fatal injury category. Special emphasis is given to the design, care, and use requirements of personal flotation devices. Research done under contract J0199072 by Woodward Associates, Inc. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; U.S. Department of Energy facilities in Carbondale, Ill., and Pittsburgh, Pa.; Mine Safety and Health Administration, Arlington, Va.; National Mine Health and Safety Academy, Beckley, W. Va.; and Office of Surface Mining Library and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Order ONLY from NTIS: PB 82–244229; paper copy price code A06.

OFR 107–82. Machine Lighting Design for Coal Mine Applications, by William F. Hahn, Stanley Ryba, and Anthony D. Szpak. March 1982. 127 pp. 76 figs. This project focused effort on three separate areas including the demonstration of a low seam longwall illumination system, design of illumination systems for low coal auger miners, and an assess-

ment of machine lighting systems for machinery used to mine low seam coal. Results indicated illumination systems can be purchased by mine operators of low coal seams. The systems can be supplied with equipment as factory integrated systems or they can be retrofitted to the machines or longwall equipment. Research done under contract J0308009 by Booz, Allen & Hamilton Inc. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; U.S. Department of Energy, Pittsburgh, Pa.; Mine Safety and Health Administration, Arlington, Va.; National Mine Health and Safety Academy, Beckley, W. Va.; and Office of Surface Mining Library and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Order ONLY from NTIS: PB 82–257205; paper copy price code A07.

OFR 108–82. Feasibility and Applicability of Hydraulic Mining and Transport in Underground Noncoal Mines, by William C. Cooley. September 1981. 126 pp. 11 figs. This study identifies and evaluates deposits of noncoal minerals in the United States that are most amenable to be mined underground and transported hydraulically. A method was developed to screen and compare mineral deposits including economic comparisons. The most applicable minerals for hydraulic mining by borehole monitor jets from underground entries are soft uranium sandstones in locations where water is available. This method, with hydrotransport, could improve the safety, health, and economy of underground uranium mines. Soft oil-bearing sandstone could be mined and transported by this method more safely than by other underground mining methods. Many minerals are too hard to be mined by monitor jet but are amenable to hydraulic transport and hoisting. Uranium sandstone is of interest because of potentially improved health and safety in transport and lower transport cost. Increases in mine output for potash and trona can be achieved most economically by adding hydraulic hoisting when existing skip capacity is at its limit. Research is recommended to obtain site-specific data on the feasibility of mining uranium ores by monitor jets. Research done under contract J0205027 by Terraspace, Inc. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Juneau, Alaska, Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; U.S. Department of Energy, Pittsburgh, Pa.; Mine Safety and Health Administration, Arlington, Va.; National Mine Health and Safety Academy, Beckley, W. Va.; and Office of Surface Mining Library and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Order ONLY from NTIS: PB 82–250598; paper copy price code A07.

OFR 109–82. Bound Liquid Ion Exchange Membranes for Recovery of Chromium From Wastewater, by Larry D. Nichols, Arthur S. Obermayer, and Marie B. Allen. Oct. 28, 1980. 35 pp. 11 figs. The objective of this program was to investigate the feasibility of bound-liquid ion-exchange membrane systems for removal and recovery of chromate from plating rinse waters, thereby conserving an important resource and minimizing harmful chromate effluent levels. Experimental techniques employed liquid-liquid extraction and simple membrane immersion to assess candidate ion-exchange liquids, followed by chromate transport measurements in membrane test cells using simulated chromate rinse solutions. The transport process is chemically driven by passage of some counter-ion in the opposite direction; counter-ions studied included basic chloride, phosphate, and carbonate solutions. Chloride and carbonate are both effective, and the latter is preferable from a chromate-reuse standpoint. Measured transport rates are in a range suitable for practical use, but membrane lifetimes were limited by a phase-inversion process in which water droplets nucleate within the membrane and eventually halt ion exchange. This phase-inversion process, shown by solutions of quaternary amine in ion-exchange reagents in aromatic kerosines whether or not chromate is present, must be prevented to render chromate recovery systems feasible. Research done under contract J0295056 by Moleculon Research Corp. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Boulder City and Reno, Nev., Albany, Oreg., and Salt Lake City, Utah, and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Order ONLY from NTIS: PB 82–250580; paper copy price code A03.

OFR 110–82. Inventory of Waste Embankments of Surface and Underground Openings: Metal/Nonmetal Active Mines, by Eric Nordhausen, Frank Wojtasiak, Norman Dausinger, Barbara Howie, and William Derrenbacher. December 1981. 254 pp. 16 figs. This report and associated deliverables is the culmination of a comprehensive literature survey, data collection, and identification of over 500 metal-nonmetal active mines, mills, and smelters (over 50,000 tons per year production) in the contiguous 48 States. The purpose was to compile an inventory of the waste tonnages, thus forming a data base for future research and development in improving waste management and disposal techniques in the metal-nonmetal mining industry. The study specifically excluded any commodity that leaves basically no waste when mined and/or milled. The study provided for locating, mapping, encodating, and digitizing all of the mine, mill, and smelter information made available throughout the Nation as well as the climatological, land use, topographical, ecological, and vegetative data. Mine, mill, and smelter information also included acreage and/or volume, mining methods, primary ore and gangue minerals, waste composition and haulage, and methods and distance hauled. A discussion is provided concerning present and potential uses of various types of tailings as well as recommending possible research and development of problem areas in waste disposal techniques and management. Research done under contract J0199054 by Mountain States Research and Development, Inc. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; U.S. Department of Energy facilities in Carbondale, Ill., and Pittsburgh, Pa.; Mine Safety and Health Administration, Arlington, Va.; National Mine Health and Safety Academy, Beckley, W. Va.; and Office of Surface Mining Library and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Order ONLY from NTIS: PB 82–249939; paper copy price code A12.

OFR 111–82. Development of a Call Alert System for Paging Mine Personnel, by John Trombly, Stuart Lipoff, and Paul O'Brien. August 1978.

65 pp. 21 figs. This report presents system objectives and design criteria for an in-mine ultralow frequency radio paging system. Coding formats, frequency, and bandwidth selection criteria leading to the system design are discussed. The prototype call alert transmitter and pocket page receiver is functionally described. The report includes circuit descriptions, schematics, parts lists, printed circuit fabrication, and assembly drawings. The report concludes with an estimate of the manufacturing cost for each assembly. Research done under contract H0262026 by Arthur D. Little, Inc. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; U.S. Department of Energy facilities in Carbondale, Ill., and Pittsburgh, Pa.; Mine Safety and Health Administration, Arlington, Va.; National Mine Health and Safety Academy, Beckley, W. Va.; and Office of Surface Mining Library and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Order ONLY from NTIS: PB 82-251562; paper copy price code A04.

OFR 112(1)–82. Safety Analysis of the Impactor Shaft Sinking System, by C. A. Geffen, P. M. Daling, L. J. Defferding, J. J. Jacobsen, J. M. Oylear, S. H. E. Phillips, and D. P. Williams. March 1982. 394 pp. 48 figs. This report presents the results of an investigation on the safety of the impactor shaft-sinking system in comparison with conventional shaft-sinking technology. A detailed study of the impactor system was performed to identify and recommend design changes for optimum safety conditions. A comparison of the impactor machine and its support systems with conventional shaft sinking was made on the basis of relative risk levels. Risk incorporates measures of both the frequency and the potential consequence of accidents. An evaluation of the component operations of the impactor shaft-sinking system was performed using a Failure Modes and Effects Analysis (FMEA) methodology. The results of this analysis show generally that the impactor shaft-sinking system is safer than conventional shaft sinking. The potential risk of conventional shaft-sinking operations could be reduced by an average of over 35 percent with use of the impactor shaft-sinking system. Design change recommendations to further improve the safety of the impactor system include a revised fire suppression system, improved access to and from the operator cabs, reliable noise attenuation measures, and improved communication systems. Research done under contract J0100002 by Battelle, Pacific Northwest Laboratories. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; Mine Safety and Health Administration, Arlington, Va.; National Mine Health and Safety Academy, Beckley, W. Va.; and Office of Surface Mining Library and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Order ONLY from NTIS: PB 82-249699; paper copy price code A17.

OFR 112(2)–82. Safety Analysis of the Impactor Shaft Sinking System. Safety Manual, by P. M. Daling and C. A. Geffen. March 1982. 158 pp. 16 figs. This safety manual was developed for the impactor shaft-sinking system by combining the safety output of the comparative safety assessment and the Failure Modes and Effects Analysis (FMEA) with the application of Management Oversight and Risk Tree (MORT) techniques. MORT is a formal, disciplined logic that is used to systematically relate and integrate a wide variety of safety concepts. Research done under contract J0100002 by Battelle, Pacific Northwest Laboratories. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; Mine Safety and Health Administration, Arlington, Va.; National Mine Health and Safety Academy, Beckley, W. Va.; and Office of Surface Mining Library and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Order ONLY from NTIS: PB 82-249657; paper copy price code A08.

OFR 113–82. Final Design Report on a Remote Controlled Hi-Roof Bolting Machine for Use in High Roof Areas of Coal Mines, by W. Hermanson and R. Wachtler. July 1979. 114 pp. 41 figs. This report covers work done on the preliminary design of a remote controlled high roof bolting machine. The design program involved the investigation and analysis of roof fall characteristics to determine the feasibility of developing a remote control high roof bolting machine. Several conceptual machine designs were generated and evaluated. Trade studies were made and preliminary evaluation meetings were held to determine the most promising concept to be carried through to the preliminary design stage. Visits were made to several coal mines to observe and to become familiar with typical problems associated with roof fall and overcast areas. Results of the observations and further studies of data indicated that drilling and bolting from vertical to horizontal angles would be required to cover most roof fall areas. Research done under contract J0285009 by the Bendix Corp. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; U.S. Department of Energy facilities in Carbondale, Ill., and Pittsburgh, Pa.; Mine Safety and Health Administration, Arlington, Va.; National Mine Health and Safety Academy, Beckley, W. Va.; and Office of Surface Mining Library and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Copies of this report will not be available for purchase.

OFR 114–82. A Directory of Computer Programs Applicable to U.S. Mining Practices and Problems (Period 1970–1981), by Richard L. Sanford and Michael R. Parrott. February 1982. 520 pp. 2 figs. This report summarizes the results of an update on a previous Bureau of Mines grant and includes 5 additional years of computer program development. The directory includes a sampling of computer usage in operating and manufacturing companies, consulting firms, computer companies, research organizations, universities, and various governmental agencies. References to computer applications throughout the industry are presented as well as comments on program availability. The work on the updated directory concentrated on programs that are available to the public and are well documented. Research done under contract J0205067 by the Uni-

versity of Alabama. Available for reference at Bureau of Mines facilities in Juneau, Alaska, Denver, Colo., Pittsburgh, Pa., and Spokane, Wash.; and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Order ONLY from NTIS: PB 82–253030; paper copy price code A22.

OFR 115–82. Electromagnetic Location Systems for Metal/Non Metal Mines, by A. J. Farstad and R. F. Kehrman. Jan. 15, 1979. 119 pp. 15 figs. Characteristics of metal-nonmetal mines were evaluated to determine the suitability of applying the Bureau of Mines electromagnetic (EM) location system to the problem of locating trapped miners. Statistical distributions of mine depths and overburden conductivities show that the existing Bureau EM system is inadequate for most metal-nonmetal mines. Alternate approaches to trapped miner location in deep mines were identified, and subsequent field tests were conducted at six mines to evaluate their feasibility. The approach considered to be the most promising is one that uses the existing backpack transmitting system, modified slightly for a dual frequency output, in conjunction with a sophisticated signal processing receiver on the surface. The main advantage of staying with a "through-the-earth" approach is that the underground equipment can be kept simple, easily maintained, lightweight, and inexpensive. Research done under contract J0166100 by Westinghouse Electric Corp. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; U.S. Department of Energy, Pittsburgh, Pa.; Mine Safety and Health Administration, Arlington, Va.; National Mine Health and Safety Academy, Beckley, W. Va.; and Office of Surface Mining Library and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Order ONLY from NTIS: PB 82–254525; paper copy price code AO6.

OFR 116–82. Sedimentological Controls on Distribution and Quality of Knobloch, Anderson, and Dietz Coals in Parts of Southeastern Montana, by Mark A. Sholes, Gary Cole, David Fine, John Daniel, and Robert Matson. May 1982. 105 pp. 66 figs. This report covers sedimentologic and resource evaluations of the Anderson, Dietz No. 1, and Dietz No. 2 coals in the Pearl School, Decker, and Holmes Ranch Quadrangles and of the Knobloch coal in the Willow Crossing, Coleman Draw, King Mountain, and Yager Butte Quadrangles. Portions of this study on the Anderson and Dietz coal were previously published. In this study, the interpretations and conclusions drawn from the two study areas will be integrated and an attempt will be made to assess the applicability of the interpretations and conclusions to other areas and coals in the Powder River Basin of Montana. Research done under grant G5195026 by the Montana College of Mineral Science and Technology. Available for reference at the National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Copies of this report will not be available for purchase.

OFR 117–82. Techniques for Consistent Forecasting of Future Demand for Major Minerals Using an Input-Output Framework, by Wassily Leontief, James Koo, Silvia Nasar, and Ira Sohn. June 1982. 583 pp. 103 figs. The objective of this study was to project a set of future production and consumption levels of 26 major nonfuel minerals for the U.S. and world economy to 2030 under alternative assumptions regarding future U.S. and world economic growth and structural change. The main methodological tools used were the 1972 Input-Output Table of the U.S. Economy and a revised version of the U.N. World Input-Output Model. The report includes a discussion of the role of resources in the economy, a review of past U.S. minerals policy, and a short summary of previous studies undertaken to project future minerals requirements. The first part of the report concentrates exclusively on alternative projections of future levels of minerals production and consumption in the United States to 2000, while the second part integrates the 26 nonfuel minerals into a global framework to 2030. Questions regarding future regional and global resource depletion are in the last chapter. Research done under contract J0188147 by the Institute for Economic Analysis, New York University. Available for reference at the National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Copies of this report will not be available for purchase.

OFR 118–82. Evaluation of Ceramic and Refractory Grade Raw Materials in Alabama: Gibbsite in Saprolites of East-Central Alabama, by Mirza A. Beg. Apr. 15, 1982. 80 pp. 10 figs. Gibbsite, a major source of alumina, occurs in the northern and inner sections of the Piedmont province of Alabama in soils and saprolite derived from amphibolites, granites, feldspathic hornblende gneiss, and other gneissic rocks. The major occurrences of gibbsite are in areas underlain by hornblende gneiss in Chambers and Randolph Counties. This region provides the proper physiographic and mineralogical setting for large areas containing up to 25 percent saprolitic gibbsite. These areas provide potential sources of alumina that could be used to meet the U.S. future needs. Narrow zones and pockets rich in gibbsite also occur in soil and saprolite derived from areally restricted feldspar-rich zones of narrow linear amphibolites in the inner Piedmont and feldsphatic zones in various granites distributed throughout the Piedmont. Research done under contract J0113073 by the Geological Survey of Alabama. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Juneau, Alaska, Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Order ONLY from NTIS: PB 82–251984; paper copy price code A05.

OFR 119–82. Technology Exchange Seminar. Mining Information Systems, compiled by Alfred Weiss. April 1982. 342 pp. 173 figs. Information systems technology—computers, telecommunications, software, etc.—has been adapted in many productive and profitable uses in the minerals industry. A recent study for the Bureau of Mines found that opportunities exist for making even more extensive use of proven applications of the technology as well as for the development of new applications during the 1980's. A 2-day seminar was held to bring these opportunities to the attention of the industry and the public to facilitate technology transfer. This report is a compilation of the papers presented during the proceedings of the seminar. Research done under contract J0113093 by

Mineral Systems Inc. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Juneau, Alaska, Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Order ONLY from NTIS: PB 82–251943; paper copy price code A15.

OFR 120–82. Noise Abatement of Vibrating Screens. Using Non-Metallic Decks and Vibration Treatments, by K. Hennings. January 1980. 63 pp. 32 figs. Noise from vibrating screens is generated in two ways: (1) noise due to the material being processed, and (2) noise from the screen itself. Nonmetallic decks have reduced material noise. The noise reduction and change in screening performance was quantified for six nonmetallic decks using dolomite, granite, and coal as the materials. The nonmetallic decks were from 2 to 7 dbA quieter and from −1 to +10 percent less efficient compared with a steel wire cloth deck of the same open area. Damping the sidewalls and isolating the drive mechanisms has reduced the noise in the screen itself. Tests of four prototype damping treatments gave reductions up to 4.9 dbA, and the mechanism isolators gave an additional reduction of 2.1 dbA. Laboratory tests were conducted on samples of the treatments in a corrosive salt spray to simulate coal plant wash water up to 25,000 hours, and full-size treatments were run on a full-size screen for 5,000 hours. Research done under contract H0387018 by Allis-Chalmers Corp. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; U.S. Department of Energy, Pittsburgh, Pa.; Mine Safety and Health Administration, Arlington, Va.; National Mine Health and Safety Academy, Beckley, W. Va.; and Office of Surface Mining Library and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Order ONLY from NTIS: PB 82–251919; paper copy price code AO4.

OFR 121(1)–82. Health and Safety Analysis on Support Walls. Volume 1, by Daniel R. Walton, Svend B. Rondum, Peter W. Kauffman, and Steven A. Hawkins. August 1980. 207 pp. 38 figs. This report documents support wall equipment and material characteristics, dimensions, and power and site requirements in underground mines. The report provides labor requirements data and identifies the health and safety issues associated with support wall use and construction. Potential applications for support walls such as advancing and retreating longwall, single entry, room and pillar, mains and submains, and stoppings are delineated, and an economic assessment is presented of the viability of employing support wall technology to increase the recovery rate on retreating longwalls, or to employ advancing longwall in deeply lying seams or difficult conditions. The sensitivity of mining costs to changes in key support wall parameters is also presented. Research done under contract J0295036 by Management Engineers Inc. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; U.S. Department of Energy, Pittsburgh, Pa.; Mine Safety and Health Administration, Arlington, Va.; National Mine Health and Safety Academy, Beckley, W. Va.; and Office of Surface Mining Library and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Order ONLY from NTIS: PB 82–251950; paper copy price code A10.

OFR 121(2)–82. Health and Safety Analysis on Support Walls. Volume 2. Steel Supports Design Criteria. A Summary of European Data, by Steven A. Hawkins. August 1980. 61 pp. 21 figs. This report presents the results of a 5-month study to collect data on the use of steel support for ground control in European underground coal mines. The report summarizes European steel support design practices and describes the applicability of steel supports to U.S. mining conditions. Research done under contract J0295036 by Management Engineers Inc. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; U.S. Department of Energy, Pittsburgh, Pa.; Mine Safety and Health Administration, Arlington, Va.; National Mine Health and Safety Academy, Beckley, W. Va.; and Office of Surface Mining Library and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Order ONLY from NTIS: PB 82–251968; paper copy price code A04.

OFR 122–82. Study of Parameters Which Influence the Energy Utilization Efficiency in the Grinding of Gabbro Ores, by S. Raghavan. Feb. 11, 1981. 34 pp. 11 figs. An investigation of the possibility of improving the grinding characteristics of gabbro ore containing copper and nickel sulfides through a thermal shock treatment technique was conducted. The results indicate that the breakage characteristics of the gabbro ore particles can be significantly improved by preheating the ore particles to a temperature around 400° C followed by rapid water quenching. For a given power input and feed size, the thermally treated material produces a product of much finer distribution than untreated material. An assessment of the improvement in grindability was made by calculating feed size selection functions for untreated and heat-treated materials. Research done under grant G0188143 by the University of Arizona. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; U.S. Department of Energy, Pittsburgh, Pa.; Mine Safety and Health Administration, Arlington, Va.; National Mine Health and Safety Academy, Beckley, W. Va.; and Office of Surface Mining Library and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Order ONLY from NTIS: PB 82–251935; paper copy price code A03.

OFR 123–82. Conversion of Shale and Slate Wastes to Glass and Glass-Ceramic Products, by J. D. MacKenzie. Oct. 20, 1980. 32 pp. 11 figs. Experiments were conducted to convert spent oil shale, waste slate, and copper slag into glass and glass-ceramic products. Spent oil shale was easily melted at 1,300° C and converted into glass wool for insulation application. Glass-ceramics were prepared by the use of domestic chrome ore as a nucleating agent. Waste slate from Vermont was readily melted when mixed with limestone. The resultant glass fibers were highly resistant to alkali attack. Iron metal was recovered from copper slags by the

use of coal powder as a reducing agent in the molten slag. The lowering of the iron content resulted in a melt that was glass-forming. Combinations of spent oil shale and copper slag also yielded useful glass and glass ceramic compositions. Research done under grant G0166020 by the University of California, Los Angeles. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Juneau, Alaska, Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Order ONLY from NTIS: PB 82–251976; paper copy price code A03.

OFR 124–82. Development of Substitutes for Asbestos, by John D. Mackenzie. November 1981. 28 pp. 12 figs. Experiments were conducted to determine the feasibility of using waste slate and limestone as a substitute for asbestos when producing glass powders and fibers. Glasses were made from mixtures of Vermont slate and limestone. The alkali resistance of the glass powders and the glass fibers was superior to that of glass powders and glass fibers based on compositions containing large amounts of zirconia. Some of the present glass compositions have alkali-resistance almost as good as that of chrysotile asbestos. Because of the low cost, ready availability in the United States, low melting temperatures, and ease of rendering into glass fibers, waste slate and limestone can be considered as substitutes for asbestos for many cement-type applications. Research done under contract J0199056 by the University of California, Los Angeles. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Juneau, Alaska, Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Order ONLY from NTIS: PB 82–252016; paper copy price code A03.

OFR 125–82. Flotation and Selective Agglomeration of Western Coals, by Douglas W. Fuerstenau. May 1982. 125 pp. 41 figs. This report presents the results of an investigation undertaken to provide a basis for improving the beneficiation of raw coals, with particular attention to the processing of fine western coals by two surface chemical methods, froth flotation and selective oil agglomeration. Nine western coals from Utah, Colorado, and Wyoming, ranging from subbituminous, class C, to high-volatile bituminous, class A, were selected for study and were characterized with respect to chemical composition, physical structure, and wettability. Excellent correspondence was found between chemical composition, particularly the concentration of active oxygen functional groups, and the flotation response of the nine coals. In addition, it was shown that hydrophobic interactions also have an important role in the adsorption of frothers on coals. A process involving a combination of oil agglomeration followed by froth flotation, using viscous oils at dosage rates less than 1 percent, was demonstrated to have potential for cleaning "black water" from coal operations. Research done under grant G5105058 by the University of California. Available for reference at the Office of Surface Mining Library and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Order ONLY from NTIS: PB 82–255480; paper copy price code A07.

OFR 126–82. Visual Methane Indicator for Underground Coal Mines, by Robert P. Bruno. September 1979. 147 pp. 86 figs. The objective of this investigation was to develop a hand-held device to remotely detect the presence of concentrations of methane gas in underground coal mines. Convenient "mapping" of methane from a remote location would allow rapid and safe corrective procedures for working personnel. Modified, commercially available equipment was evaluated both in the laboratory and in a working mine. Although readings were obtained and the general principle of operation demonstrated, the power levels necessary and the protective enclosures required would raise the weight of the instrument beyond practical limits of portability. Based on currently available technology, it was concluded that a practical, portable, hand-held visual methane indicator is beyond the state of the art. Research done under contract H0166084 by Foster-Miller Associates, Inc. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; U.S. Department of Energy, Pittsburgh, Pa.; Mine Safety and Health Administration, Arlington, Va.; National Mine Health and Safety Academy, Beckley, W. Va.; and Office of Surface Mining Library and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Order ONLY from NTIS: PB 82–255464; paper copy price code A07.

OFR 127–82. Improved Visibility Systems for Large Haulage Vehicles. Volume II, by James L. Eirls, Slade F. Hulbert, and A. L. Foote. January 1982. 122 pp. 70 figs. The objective of this project was to improve a driver's field of view for large trucks used in the mining industry. Rearward viewing was enhanced by improving the rearview mirror designs. Rear vision was accomplished using a closed-circuit television system. Views ahead, to the right, and downward were obtained with a blind area viewer (BAV). The BAV is a unique combination of fresnel lenses housed in a shielded, environmentally protected enclosure that produces an image of the area in front of and downward 70° and to either side of the BAV 30°. The improved visibility devices were evaluated by long-term, in-mine testing. The right side mirror (RSM) and BAV provide the greatest improvements for the least cost and are commercially available. Application of the RSM and BAV should achieve a reduction in accident potential and greater vehicle productivity by enlarging and improving the equipment operator's visibility and making previously blind areas and hazardous situations detectable. Research done under contract H0262022 by Tracor MBA. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; U.S. Department of Energy, Pittsburgh, Pa.; Mine Safety and Health Administration, Arlington, Va.; National Mine Health and Safety Academy, Beckley, W. Va.; and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Order ONLY from NTIS: PB 82–251927; paper copy price code A06.

OFR 128–82. Contamination of Ground and Surface Waters By Uranium Mining and Milling. Volume I. Biological Processes for Concentrating Trace Elements From Uranium Mine Waters, by Corale L. Brierley and James A. Brierley. October 1981. 104 pp. 1 fig. Waste-

water from uranium mines in the Ambrosia Lake district near Grants, N. Mex., contains uranium, selenium, radium, and molybdenum. A novel treatment process for waters from two mines, sections 35 and 36, to reduce the concentrations of the trace contaminants was developed. Particulates are settled by ponding and the waters are passed through an ion exchange resin to remove uranium; barium chloride is added to precipitate sulfate and radium from the mine waters. The mine waters are subsequently passed through three consecutive algae ponds prior to discharge. Water, sediment, and biological samples were collected over a 4-year period and analyzed to assess the role of biological agents in removal of inorganic trace contaminants from the mine waters. Research done under contract J0295033 by New Mexico Bureau of Mines and Mineral Resources. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Juneau, Alaska, Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; and Office of Surface Mining Library and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Order ONLY from NTIS: PB 82–251992; paper copy price code A06.

OFR 129–82. Preparation and Evaluation of Self-Regenerative Carbon Monoxide Detection Gels, by G. N. Schrauzer and K. E. Shuler. Nov. 1, 1978. 36 pp. 9 figs. The objective of this investigation was to develop a carbon monoxide detecting substance to be used in badges that respond quickly to carbon monoxide by a definite color change. Carbon monoxide devices that use silica-gel were impregnated with metal salts. When carbon monoxide is present the detection gel (with the treated silica-gel) changes from yellow to blue-green or blue. The detection gel regenerates, that is, returns to its original yellow color within 4 to 24 hours after removal from air containing carbon monoxide. The detection gel exhibits a threshold response that can be adjusted over a wide range of carbon monoxide concentrations, typically from 50 to 500 ppm in air. Research done under grant G0177012 by the University of California. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; U.S. Department of Energy, Pittsburgh, Pa.; Mine Safety and Health Administration, Arlington, Va.; National Mine Health and Safety Academy, Beckley, W. Va.; and Office of Surface Mining Library and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Copies of this report will not be available for purchase.

OFR 130–82. Bureau of Mines Practices in Fire Assaying, by W. L. Barry. February 1982. 18 pp. 31 figs. This report reviews the practices of analyzing for precious metals at the Reno Research Center, U.S. Bureau of Mines. A general description of fire assaying, the physical layout of a fire assay laboratory, and the use of fire assaying in combination with atomic absorption, induction coupled plasma, and emission spectroscopy is reviewed. The combination of techniques significantly decreases the detection limits for precious metal analyses and simplifies the analysis of the platinum-group metals. Methods of protecting personnel from ingestion of lead are also discussed. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Juneau, Alaska, Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; and the National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Copies of this report will not be available for purchase.

OFR 131–82. Development and Testing Results of Output Torque Indicator for Underground Mine Roof Bolting Machine, by C. J. H. Brest van Kempen and Robert M. Sweet. February 1978. 197 pp. 51 figs. The objective of this investigation was to provide thrust and torque control and visual output torque readout systems to an existing mine roof bolting machine and to test the consistency of torques obtained under actual field conditions. A Lee Norse TD1 roof bolter was modified by adding a simple torque sensing device to the drill rotation mechanism and a pneumatic logic control circuit that measures torque and controls the hydraulic circuit to the rotation motor. The modification controls and indicates the final installation torque of mine roof bolts. Over 5,000 mechanical roof bolts were installed in an operating coal mine. The installed torque of these bolts were within an error band (standard deviation) of 8 pct. Research done under contract H0262006 by Eimco Mining Machinery Div. of Envirotech Corp. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; U.S. Department of Energy, Pittsburgh, Pa.; Mine Safety and Health Administration, Arlington, Va.; National Mine Health and Safety Academy, Beckley, W. Va.; and Office of Surface Mining Library and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Copies of this report will not be available for purchase.

OFR 132–82. OFFCAT. Oscillating Full Face Cutting and Transporting System for Longwall Mining and Pillar Reclaiming, by James M. Wisner, Mukund D. Gangal, John F. Abel, Jr., and William G. Pariseau. June 1977. 257 pp. 88 figs. The oscillating full-face cutting and transporting (OFFCAT) system for longwall and pillar reclaiming was proposed as a mining system that would make a substantial improvement in production, productivity, and safety for U.S. coal mines. The OFFCAT system consists of several subsystems. A cutter assembly stretches across the full coal face and is powered by a reciprocating actuator in each entry gate. An armored face conveyor removes coal from the face to the section belt by a stage conveyor. Shields protect the face area from falling rock. As the face advances, an actuator in each entry pulls all of the shields forward simultaneously. No workers are at the face during operation. An initial technical and economic feasibility analysis showed that the OFFCAT system is technically feasible and has high promise for reducing capital investment and dollars per ton cost of coal, increasing production and face productivity, and maintaining a safe working environment. Research done under contract J0265036 by Ingersoll-Rand Research, Inc. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; U.S. Department of Energy facilities in Carbondale, Ill., and Pittsburgh, Pa.; Mine Safety and Health Administration, Arlington, Va.; Na-

tional Mine Health and Safety Academy, Beckley, W. Va.; and Office of Surface Mining Library and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Copies of this report will not be available for purchase.

OFR 133–82. Smelter Emission Controls: The Impact on Mining and the Market for Acid, by Michael Rieber, Erika M. L. Asante, Takato Hiraki, David B. Jennings, Douglas R. Knutson, Benjamin A. Okech, and Mark C. Roberts. March 1982. 687 pp. 18 figs. This report presents an overview of Federal and State regulations affecting SO_2 emissions from nonferrous metal smelters. Compliance strategies provide a study basis, and individual smelter requirements are reviewed. The report contains an overview of U.S. copper reserves and quality; mine and smelter productivity; facility ownership, capacity, and production; and acid and concentrate transport costs. Prior copper pricing practices were analyzed with respect to industry structure, current competitiveness, solvency, and possible response to Federal aid. Research done under grant G5105013 by the University of Arizona. Available for reference at the Office of Surface Mining Library and the National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Order ONLY from NTIS: PB 83–134866; paper copy price code A99.

OFR 134–82. Projections of Coal Demand From the Northern Great Plains Through the Year 2010, by John Duffield, Arnold J. Silverman, Bradley D. Harr, Michael H. Lee, Danny S. Parker, and Donald Snow. May 1982. 658 pp. 36 figs. The objective of this study was to identify most of the key economic and policy linkages that will determine the future level of the Northern Great Plains coal production. The basic model used here is the economic model of spatial markets; a different strategy than the linear programing approach most often used in the large national coal models. The results indicate a level of future coal production for the Northern Great Plains considerably lower than that predicted by the national coal model. Research done under grant G5105076 by Montana College of Mineral Science and Technology. Available for reference at the Office of Surface Mining Library and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Copies of this report will not be available for purchase.

OFR 135–82. Microprocessor TDR, by W. C. Blanchard. April 1980. 143 pp. 55 figs. Time domain reflectometry (TDR) is a remote sensing technique that uses active backscatter. The technique is applicable to testing for faults and multiple partial faults on cables. The battery-operated hardware developed during this study tailored this technique for testing mining equipment trailing electrical cables. Processing of the backscatter is accomplished using a microprocessor. The visual output from the hardware to the operator is the type, magnitude, and distance to the cable fault in a numerical format. Research done under contract H0366020 by the Bendix Corp. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; U.S. Department of Energy facilities in Carbondale, Ill., and Pittsburgh, Pa.; Mine Safety and Health Administration, Arlington, Va.; National Mine Health and Safety Academy, Beckley, W. Va.; and Office of Surface Mining Library and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Order ONLY from NTIS: PB 82–262460; paper copy price code A07.

OFR 136(1)–82. Coal Mine Dust Control. Cost Versus Effectiveness—Survey. Volume 1 of II, by Terry Muldoon, Dave Monaghan, and Rich Kline. November 1981. 188 pp. 36 figs. This report presents the results of a survey of the cost and effectiveness of dust control techniques used in underground coal mines. Respirable dust control techniques for longwalls, continuous miners, and secondary sources are evaluated and compared by cost and percent dust reduction. Where sufficient data are available, the relative effectiveness of various controls are plotted against relative present worth. The results indicate that existing data do not adequately document the effectiveness or costs of the various techniques. Research done under contract J0395115 by Foster-Miller Associates, Inc. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; Mine Safety and Health Administration, Arlington, Va.; National Mine Health and Safety Academy, Beckley, W. Va.; and Office of Surface Mining Library and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Order ONLY from NTIS: PB 83–100545; paper copy price code A09.

OFR 136(2)–82. Coal Mine Dust Control. Cost Versus Effectiveness—Field Sampling Manual. Volume II of II, by Steve Ruggieri, Terry Muldoon, Will Schroeder, and Rich Kline. November 1981. 101 pp. 39 figs. This manual specifies standard procedures for gathering and analyzing respirable dust data. The procedures were developed based on experience from numerous field surveys aimed at evaluating respirable dust conditions and control techniques. The procedures were then successfully used on an actual field evaluation of longwall dust control using water sprays at a western U.S. coal mine. Although the manual focuses on standardized procedures for longwall production faces, the procedures can be modified and adapted for other mining systems, including continuous miner and conventional sections. The procedures can be applied to identify the primary sources of respirable dust on a particular face and to objectively determine the effectiveness of a particular control method under the conditions in the study area. The manual also suggests a general approach that will maximize the value to the industry of the data collected by independent researchers or mine engineers. Research done under contract J0395115 by Foster-Miller Associates, Inc. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; Mine Safety and Health Administration, Arlington, Va.; National Mine Health and Safety Academy, Beckley, W. Va.; and Office of Surface Mining Library and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Order ONLY from NTIS: PB 83–101030; paper copy price code A06.

OFR 137–82. Development of Improved Detection Instruments for Toxic Gas Contaminants in Mining Atmospheres, by J. A. Kosek and A. B. LaConti. January 1982. 54 pp. 17 figs. The objective of

this investigation was to develop improved sensor cells for use in direct-reading detectors and diffusion-exposure meters. A pumped CO sensor cell was developed that has a shorter response time, improved temperature cycle characteristics, and improved linearity and stability at high CO concentrations. Diffusion CO sensor cells showed good response-level stability and linearity up to 1,000 ppm. In addition, a new sensor cell catalyst was developed for NO_2 sensor cells that has a much shorter response time and improved response stability characteristics. Research done under contract H0395132 by the General Electric Co. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; U.S. Department of Energy facilities in Carbondale, Ill., and Pittsburgh, Pa.; Mine Safety and Health Administration, Arlington, Va.; National Mine Health and Safety Academy, Beckley, W. Va.; and Office of Surface Mining Library and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Order ONLY from NTIS: PB 82–256223; paper copy price code A04.

OFR 138–82. Borehole Mining of Phosphate Ores, by Lowell E. Scott. August 1981. 217 pp. 56 figs. This report presents the results of a technical, economic, and environmental feasibility study of phosphate ore recovery by the hydraulic borehole mining method. The experiments resulted in the recovery of 1,696 tons of ore from three boreholes during a 65-hour operating period. The experiments were conducted with the hydraulic borehole mining tool operating submerged in borehole 1, in air in borehole 2, and submerged again but with an air-shielded cutting jet in borehole 3. A continuous monitoring program was conducted throughout the mining operation and for a period of 2 months after completion to assess the impact of the hydraulic borehole mining method on the environment. Environmental impact was assessed in terms of site ground subsidence, changes in ground water quality, and changes in radiological profile. The study indicated in-air mining to be technically feasible but not economically viable owing to the incidence of cavity roof failure. Submerged mining was shown to be both technically and economically feasible, particularly with the tool in the air-shielded cutting jet. The environmental monitoring program demonstrated hydraulic borehole mining to have a minor effect on the environment. Research done under contract J0205038 by Flow Industries, Inc. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Juneau, Alaska, Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Order ONLY from NTIS: PB 82–257841; paper copy price code A10.

OFR 139(1)–82. Development of Materials and Strategies for Pre-Shift Equipment Inspection. Volume I. Technical, by Louis Schaffer, Ernest J. Conway, Earl Johnson, and Catherine Davis. Dec. 27, 1979. 139 pp. 8 figs. This report describes the development of training materials for the operation of surface mining machines and the evaluation of the materials in the field. The objective was to determine the effectiveness and acceptability in surface mines of training aides designed to teach procedures for preshift inspection. Materials for nine mobile machine types were evaluated. A 10th module on personal protection equipment for operators was also evaluated. The "modules" are slides with synchronized sound on tape, student workbooks, and checklists. Research done under contract H0377101 by Woodward Associates, Inc. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; U.S. Department of Energy, Pittsburgh, Pa.; Mine Safety and Health Administration, Arlington, Va.; National Mine Health and Safety Academy, Beckley, W. Va.; and Office of Surface Mining Library and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Order ONLY from NTIS: PB 82–259219; paper copy price code A07.

OFR 139(2)–82. Development of Materials and Strategies for Pre-Shift Equipment Inspection. Volume II. Appendices, by Louis Schaffer, Ernest J. Conway, Earl Johnson, and Catherine Davis. Dec. 27, 1979. 242 pp. 122 figs. Volume II of the Development of Materials and Strategies for Pre-Shift Inspection program contains examples of training module scripts and workbooks developed for the operation of surface mining machines and examples of the written tests employed during the field evaluation. Research done under contract H0377101 by Woodward Associates, Inc. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Denver, Colo., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; U.S. Department of Energy, Pittsburgh, Pa.; Mine Safety and Health Administration, Arlington, Va.; National Mine Health and Safety Academy, Beckley, W. Va.; and Office of Surface Mining Library and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Order ONLY from NTIS: PB 82–259227; paper copy price code A11.

OFR 139(3)–82. Development of Materials and Strategies for Pre-Shift Equipment Inspection. Volume III. Review of Sand and Gravel Operations and Training Needs, by Mary Ann Bennett and Louis Schaffer. Dec. 27, 1979. 40 pp. 7 figs. Volume III of the Development of Materials and Strategies for Preshift Equipment Inspection program describes a review of selected plants in the sand and gravel and crushed stone industries, conducted with the objective of identifying the preshift inspection and other training needs not covered by materials presently available. An analysis of the data acquired to characterize the work practices is included as well as recommendations for the development of training materials. Research done under contract H0377101 by Woodward Associates, Inc. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; U.S. Department of Energy, Pittsburgh, Pa.; Mine Safety and Health Administration, Arlington, Va.; National Mine Health and Safety Academy, Beckley, W. Va.; and Office of Surface Mining Library and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Order ONLY from NTIS: PB 83–110965; paper copy price code A03.

OFR 140–82. Develop Data for Review of Metal and Nonmetal Mine Methane Hazard Classification. Summary of Phase II Visits to Gassy Metal/Nonmetal Mines in Europe. October–November 1981, by Alastair M. Lumsden. April 1982. 77 pp. 4 figs. A number of

gassy mines in France, the Federal Republic of Germany, Spain, the United Kingdom, and Poland were visited to obtain information on the ways mine operators and regulatory agencies deal with flammable and/or toxic gases in the work environment of underground mines. Meetings were held with technical experts of various mine staffs and with representatives of regulatory agencies. Details of gas types, sources, and intensities; types of occurrences; geologic environments; historical overviews; and remedial measures and their effectiveness and impact on operations were obtained. This report presents the results of these meetings and visits. Research done under contract J0100060 by Golder Associates, Inc. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; Mine Safety and Health Administration, Arlington, Va.; National Mine Health and Safety Academy, Beckley, W. Va.; and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Copies of this report will not be available for purchase.

OFR 141–82. Development of an Inclusion Gaged Sleeve for Use on a Cylindrical Pressure Cell, by L. Ozdemir and F. D. Wang. Mar. 1, 1981. 66 pp. 53 figs. This report describes a research program for the development of an inclusion-gaged sleeve for use on a cylindrical pressure cell. An extended laboratory test showed the full-gage model had superior performance over the three-gage model in terms of linearity, ease of application, and reliability. Although shallow-gage embedments produced a close reading to theoretical, deeper embedments were more advantageous from a viewpoint of adequate gage protection while the error generated from increased depth of embedment could be mathematically factored out. Research done under contract H0282020 by the Colorado School of Mines. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Juneau, Alaska, Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; U.S. Department of Energy facilities in Carbondale, Ill., Pittsburgh, Pa., and Morgantown, W. Va.; Mine Safety and Health Administration, Arlington, Va.; National Mine Health and Safety Academy, Beckley, W. Va.; and Office of Surface Mining Library and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Copies of this report will not be available for purchase.

OFR 142–82. State of the Art of Solution Mining for Salt, Potash and Soda Ash, by Michael T. Nigbor. September 1981. 90 pp. 15 figs. This report was designed to acquaint Bureau of Mines personnel with the state of the art of solution mining for three nonmetallic commodities—salt, potash, and soda ash. The basic geologic and market position of each commodity is described and the current mining practices and research areas are outlined. Research needs and programs to alleviate them are identified. A glossary of terms used in the solution mining industry is included as well as a selected bibliography. Research done by the Denver Research Center. Available for reference at Bureau of Mines facilities in Denver, Colo., Twin Cities, Minn., and Pittsburgh, Pa.; and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Copies of this report will not be available for purchase.

OFR 143–82. By-Product Recovery From Copper-Nickel Bearing Duluth Gabbro, by I. Iwasaki, A. S. Malicsi, J. S. Walker, P. J. Ryan, T. Sabelin, R. J. Lipp, K. A. Natarajan, K. A. Smith, and S. C. Riemer. May 1, 1982. 283 pp. 73 figs. The purpose of this investigation was to recover potential byproducts flotation tailings of copper- and nickel-bearing Duluth gabbro, to isolate residual sulfide and fibrous minerals for utilization or disposal in an environmentally acceptable way, and to extract aluminum from plagioclase concentrate by chlorination. Research done under grants G5105072 and G5195023 by the University of Minnesota. Available for reference at the Bureau of Mines Twin Cities Research Center in Minnesota; the Office of the Assistant Director, Minerals and Materials Research, Bureau of Mines, and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Copies of this report will not be available for purchase.

OFR 144–82. Social, Economic and Legal Consequences of Blasting in Strip Mines and Quarries, by Michael Radnor, Durward Hofler, Catherine Aimone, Dimitrios Atmatzidis, Richard Lamm, Sumantra Mukherji, Elizabeth Olmsted, and Regan Romei. May 31, 1981. 350 pp. 51 figs. The purpose of this study was to (1) examine the social and economic impacts of surface mine blasting in relation to variations in conditions of terrain and geology, population density and type, levels of ground motion, and air blast; (2) consider technical, legal, and government policy issues; and (3) examine the potential, nature, and extent of surface mine blasting impacts and the regulations on both communities and surface mining companies. Phase one of the study included a workshop with a panel representing various concerned groups; field testing of social, legal, and technical-cost research design; and the development of a list of variables and indicators. Phase two consisted of a series of empirical studies and technical analyses. Field research teams collected onsite data from mine companies, local communities, and government agencies. A sample of current surface mine permits were analyzed for density patterns and technical analyses were developed concerning annoyance and damage classification. The report presents a summary of the findings of the study. Research done under contract J0285036 by Northwestern University. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; U.S. Department of Energy facilities in Carbondale, Ill., and Pittsburgh, Pa.; and Office of Surface Mining Library and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Copies of this report will not be available for purchase.

OFR 145–82. Guidebook for Dust Control in Underground Mining, by J. A. Kost, J. C. Yingling, and B. J. Mondics. December 1981. 206 pp. 83 figs. This dust-control manual, prepared for use by mine operations personnel, summarizes state-of-the-art control techniques for mining operations including dust sampling and use of personal protective devices. The manual outlines the advantages and disadvantages of control techniques, design and operating specifications, and implementation and maintenance guidelines. A list of selected references is included as well as the results of the work performed while preparing the manual. Research done

under contract J0199046 by Bituminous Coal Research, Inc. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Juneau, Alaska, Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; U.S. Department of Energy facilities in Carbondale, Ill., Pittsburgh, Pa., and Morgantown, W. Va.; Mine Safety and Health Administration, Arlington, Va.; National Mine Health and Safety Academy, Beckley, W. Va.; and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Order ONLY from NTIS: PB 83–109207; paper copy price code A10.

OFR 146(1)–82. Sprayfan System—Installation and Operation Manual—Volume II, by Steven K. Ruggieri. October 1981. 59 pp. 14 figs. This report describes the use of the sprayfan auxiliary ventilation system for methane and dust control on continuous miner sections. The sprayfan auxiliary ventilation system is a modified water spray system that directs intake air to and across the front of a continuous miner to prevent buildup of methane gas and dust concentrations. The report describes the practical aspects of the system including (1) description and capabilities, (2) design, (3) installation, (4) operation, and (5) maintenance. Research done under contract H0230023 by Foster-Miller Associates, Inc. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; U.S. Department of Energy, Pittsburgh, Pa.; Mine Safety and Health Administration, Arlington, Va.; National Mine Health and Safety Academy, Beckley, W. Va.; and Office of Surface Mining Library and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Order ONLY from NTIS: PB 83–120261; paper copy price code A04.

OFR 146(2)–82. Sprayfan System—Results of Mine Testing—Volume III, by W. E. Schroeder. October 1981. 96 pp. 33 figs. Two underground installations of the sprayfan system are described and evaluated. The report describes (1) a simple method to determine the most economical application of ventilation for face methane control, (2) the effect of place variables (primary ventilation, auxiliary ventilation, seam height, etc.) on methane concentrations, and (3) the correlation of methane concentrations with brattice setback. The results are used to suggest a safer and more economical approach to face methane control. Research done under contract H0230023 by Foster-Miller Associates, Inc. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; U.S. Department of Energy, Pittsburgh, Pa.; Mine Safety and Health Administration, Arlington, Va.; National Mine Health and Safety Academy, Beckley, W. Va.; and Office of Surface Mining Library and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Order ONLY from NTIS: PB 83–120279; paper copy price code A05.

OFR 147–82. State Input-Output Tables for 1977 Emphasizing the Mineral Industries: Arizona and Florida, by Everard M. Lofting and H. Craig Davis. February 1980. 93 pp. Detailed State input-output tables emphasizing the mineral industries of Arizona and Florida were simulated for 1977 using nonsurvey State economic data and a 1977 U.S. transactions table showing the mineral subindustries. The State tables were simulated by the Simple Location Quotient technique in which national technical coefficients are adjusted to simulate the State technologies. Similarly, national value-added coefficients were used to generate estimates of State value added for detailed industries. Type I and Type II employment and income multipliers were calculated and an analysis of the simulated results was carried out for each of the States under study. Research done under grant G0177119 by Dry Lands Research Institute, University of California. Available for reference at Bureau of Mines facilities in Juneau, Alaska, Denver, Colo., Pittsburgh, Pa., and Spokane, Wash.; and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Order ONLY from NTIS: PB 83–104661; paper copy price code E05.

OFR 148–82. Input-Output Structure of the U.S. Mineral Industries for 1972 With RAS Update to 1977, by Everard M. Lofting and Werner O. Schink. October 1981. 65 pp. The detailed interindustry transactions table for 1972 showing the 38 mineral subindustries as specified by the 1972 SIC codes is presented along with the updated table for 1977. The principal features of the updating technique and the data and procedures are discussed. The output multipliers and the Type I and Type II income and employment multipliers are calculated and presented comparatively for each of the interindustry tables. Research done under contract J0188156 by Dry Lands Research Institute, University of California. Available for reference at Bureau of Mines facilities in Juneau, Alaska, Denver, Colo., Pittsburgh, Pa., and Spokane, Wash.; and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Order ONLY from NTIS: PB 83–104679; paper copy price code E04.

OFR 149–82. Radiation Monitoring for Uranium Miners: Evaluation and Optimization, by Keith J. Schiager, Thomas B. Borak, and Janet A. Johnson. Nov. 18, 1981. 137 pp. 11 figs. Radiological health risks to uranium miners are reviewed. Radiation measurement methods and monitoring systems that are now, or soon could be, available are reviewed with respect to their reliability and cost for determining annual exposures. Criteria for optimization of radiation monitoring programs are presented and applied to the current exposure conditions and available monitoring methods. The following recommendations are offered: (1) Personal thermoluminescent dosimeters for gamma exposures should be provided to all underground employees in uranium mines. (2) Exposures to long-lived radionuclides in respirable dust and to airborne radon progeny should be measured by randomized grab sampling. (3) Regulations of the Mine Safety and Health Administration should place greater emphasis on exposure reduction, as opposed to documentation. Research done under contract J0295026 by Alara, Inc. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Juneau, Alaska, Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg, Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; Mine Safety and Health Administration, Arlington, Va.; National Mine Health and Safety Academy, Beckley, W. Va.; and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Order ONLY from NTIS: PB 83–102681; paper copy price code A07.

OFR 150–82. Development of Ambient Cure Polyimide Foam, by P. A. Hogenson and C. L. Hamermesh. May 1978. 38 pp. 12 figs. The objective of this investigation was to develop a sprayable ambient curing polyimide foam for application to mine passageways. The first phase involved development of ambient cure foam formulations, evaluation of foam properties, selection of appropriate spray equipment, and test samples. The second phase involved development of continuous spray application, demonstration of reproducibility of properties, and spray application on a vertical surface. The program resulted in an ambient cure polyimide foam that can be dispensed by conventional spray equipment and that has excellent fire resistance and low flame spread. This composition can serve as the basis for the development of a practical, relatively low-cost, fire-resistant foam for mine applications. Research done under contracts H0166070 and NAS2–9469 by Rockwell International Corp. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Denver, Colo., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; Mine Safety and Health Administration, Arlington, Va.; National Mine Health and Safety Academy, Beckley, W. Va.; and Office of Surface Mining Library and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Order ONLY from NTIS: PB 83–110197; paper copy price code A03.

OFR 151–82. Extraction of Chromium From Low-Grade Chromium-Bearing Ores, by Dhanesh Chandra, Charles B. Magee, and LaRose Leffler. May 1982. 164 pp. 46 figs. In an effort to utilize domestic low-grade resources to extract chromium, Mouat chromite concentrates from Stillwater Complex, Mont., were subjected to a sodium hydroxide or caustic soda roast and water leach bench-scale method. Although the soda roasting method has been known for quite some time, there are some problems associated with the roasting, particularly with lower grade chromites with lattice and gangue impurities. Using advanced electron-optical and X-ray microanalytical and macroanalytical techniques, the mechanisms occurring in the soda roasting step have been revealed. The roasting step is the key to this overall process, and the rate-limiting steps have been identified, allowing substantial improvements in chromium extraction yields. Research done under grant G0284009 by the University of Denver, Denver Research Institute. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Juneau, Alaska, Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Order ONLY from NTIS: PB 83–106781; paper copy price code A08.

OFR 152–82. Develop a Mechanical Scaling Bar, by J. S. Megahan. March 1982. 37 pp. 15 figs. This report covers the design, fabrication, and testing of a hand-held scaling bar that will make scaling safer, more effective, and less fatiguing for operators when removing loose rock from mine floors and walls. Discussions covering a survey of mine conditions and currently used hand-scaling bar types are included. Research done under contract H0282004 by Foster-Miller Associates, Inc. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Juneau, Alaska, Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; U.S. Department of Energy, Morgantown, W. Va.; National Mine Health and Safety Academy, Beckley, W. Va.; and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Copies of this report will not be available for purchase.

OFR 153(1)–82. Bureau of Mines Oil Shale Data Bank. Part I—Bibliography. Volume 1, by Richard E. Thill, Don N. West, Karen S. Radcliffe, and Orin M. Peterson. August 1982. 559 pp. 3 figs. The Bureau of Mines Oil Shale Data Bank (OSDB) was created in 1976 to serve as a centralized source for the storage, retrieval, and dissemination of technical literature, patents, and information on research projects in oil shale. Thousands of bibliographic references, patents, and research projects relating to the mining of oil shale have been identified, abstracted, and indexed according to selected keyword topics. The resulting data bank listings are contained in three sections, each with a separate keyword breakdown for use in rapidly identifying references pertaining to a specific subject. All references cited in the OSDB were published prior to an established cut-off date of May 1, 1981. This report contains the bibliographic listing B1 through B2713. Research done by the Bureau of Mines. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Juneau, Alaska, Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; National Mine Health and Safety Academy, Beckley, W. Va.; and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Copies of this report will not be available for purchase.

OFR 153(2)–82. Bureau of Mines Oil Shale Data Bank. Part I—Bibliography. Volume 2, by Richard E. Thill, Don N. West, Karen S. Radcliffe, and Orin M. Peterson. August 1982. 552 pp. 3 figs. The Bureau of Mines Oil Shale Data Bank listing contain thousands of bibliographic references, patents, and recent research projects to assist in planning and coordinating oil shale research and for producing safe and environmentally acceptable mining and processing technologies. This report contains the bibliographic listing B2714 through B2030. Research done by the Bureau of Mines. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Juneau, Alaska, Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; National Mine Health and Safety Academy, Beckley, W. Va.;and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Copies of this report will not be available for purchase.

OFR 153(3)–82. Bureau of Mines Oil Shale Data Bank. Part II—Patents, by Richard E. Thill, Don N. West, Karen S. Radcliffe, and Orin M. Peterson. August 1982. 147 pp. 3 figs. The Bureau of Mines Oil Shale Data Bank listings contain thousands of bibliographic references, patents, and recent research projects to assist in planning and coordinating oil shale research and for producing safe and environmentally acceptable mining and processing technologies. This report contains a listing of patents pertaining to oil shale research. Research done by the Bureau of Mines. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Juneau, Alaska, Denver, Colo., Avon-

dale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; National Mine Health and Safety Academy, Beckley, W. Va.; and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Copies of this report will not be available for purchase.

OFR 153(4)–82. Bureau of Mines Oil Shale Data Bank. Part III—Recent Research Projects, by Richard E. Thill, Don N. West, Karen S. Radcliffe, and Orin M. Peterson. August 1982. 596 pp. 3 figs. The Bureau of Mines Oil Shale Data Bank listings contain thousands of bibliographic references, patents, and recent research projects to assist in planning and coordinating oil shale research and for producing safe and environmentally acceptable mining and processing technologies. This report describes recent research projects that are continuing or that have been completed in recent years. Research done by the Bureau of Mines. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Juneau, Alaska, Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; National Mine Health and Safety Academy, Beckley, W. Va.; and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Copies of this report will not be available for purchase.

OFR 154–82. Lightweight Rescue Breathing Apparatus. Final Report, by Elmer E. Buban and William C. Koenemund. December 1981. 58 pp. 13 figs. A lightweight compressed oxygen rescue breathing apparatus (RBA) for rescue and recovery missions in mine rescue work was developed for the Bureau of Mines. The RBA is a positive-pressure, closed-circuit system that lasts 4 hours. The weight of the complete RBA, including an optional cooler, is slightly over 30 pounds. Weight reduction over currently available RBA's is achieved by using lithium hydroxide for scrubbing CO_2 instead of conventional chemicals and using a composite glass fiber-aluminum shell cylinder for oxygen storage instead of a steel cylinder. Positive pressure is maintained in the breathing circuit at all times by applying a constant spring force to the breathing bag. The harness was designed to reduce the work of the wearer by redistributing the weight of the RBA to the wearer's hips. Research done under contract H0262041 by Mine Safety Appliances Co. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Juneau, Alaska, Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; Mine Safety and Health Administration, Arlington, Va.; National Mine Health and Safety Academy, Beckley, W. Va.; and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Order ONLY from NTIS: PB 83–107730; paper copy price code A04.

OFR 155–82. Longwall Mining Principles for Safely Working Steep Coal Seams, by Roger F. J. Adam, William J. Douglas, and Bryan J. Reese. June 30, 1981. 161 pp. 61 figs. This report summarizes the principles of safely working steep coal seams using longwall mining methods. The report presents the state of the art and identifies the problems that result from seam inclination. Details are given on foreign longwall faces achieving good records of safety and productivity when mining on 30° to 50° inclined seams. Recommendations for further research are suggested. Research done under contract J0205010 by Ketron, Inc. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Juneau, Alaska, Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; U.S. Department of Energy, Pittsburgh, Pa.; Mine Safety and Health Administration, Arlington, Va.; National Mine Health and Safety Academy, Beckley, W. Va.; and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Order ONLY from NTIS: PB 83–117887; paper copy price code A08.

OFR 156–82. A Communication and Monitoring System for an Underground Coal Mine, Iron Ore Mine, and Deep Underground Silver Mine, by Alan A. Bergeron, R. L. Collins, and J. L. Michels. November 1981. 293 pp. 98 figs. Advanced communication and monitoring systems were developed and demonstrated in three underground mines representing different mining techniques, geographical areas, and material mined. The first was a large coal mine in western Pennsylvania using room-and-pillar techniques and continuous mining methods. The system developed provided private telephone channels, environmental monitoring, and control of underground equipment, all on a single coaxial cable, with all system operations under the direction of a minicomputer. The second was a magnetite ore mine in eastern Pennsylvania that used block caving mining techniques. A radio system was developed that provided two-way communications between trackless vehicles and roving personnel. A unique system of uhf-vhf repeaters combined with a "leaky-feeder" transmission line offered operational and emergency features not previously found in mine communication systems. The third was a deep silver mine in the Cour d'Alene district of Idaho. This system utilizes a single wire pair to provide up to 14 voice channels. A combination of PBX, telephone carrier systems, and intercom offered private conversations, selective signaling, and emergency backup communications. Research done under contracts S0133035 and J0377076 by Rockwell International. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; Mine Safety and Health Administration, Arlington, Va.; National Mine Health and Safety Academy, Beckley, W. Va.; and Office of Surface Mining Library and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Order ONLY from NTIS: PB 83–115865; paper copy price code A13.

OFR 157–82. Development of Lightweight Hydraulic Supports, by Paul T. Alexander. May 1982. 94 pp. 10 figs. After evaluating preceding studies and designs of lightweight supports, the all-hydraulic and the hydromechanical concepts were selected for detailed design and fabrication. Further analysis and testing showed that the all-hydraulic design was economically justified and met all the crucial engineering, manufacturing, and design criteria identified during the evaluation. Following Bureau of Mines approval of the detailed design, four all-hydraulic support models were fabricated. When functional and structural testing was completed, 40 additional units were constructed and distributed for in-mine testing. The units were acceptable by three demonstration mines. The wide-

spread interest in supports for seam heights greater than 8 feet led to expansion of the design data package. Four basic models were designed to cover the new height range, but no hardware has yet been fabricated. Research done under contract H0282042 by ESD Corp. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Juneau, Alaska, Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; Mine Safety and Health Administration, Arlington, Va.; National Mine Health and Safety Academy, Beckley, W. Va.; and Office of Surface Mining Library and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Order ONLY from NTIS: PB 83–115840; paper copy price code A05.

OFR 158–82. A Mass Spectrometric Study of the Vapor Transport Reactions of Importance in the Carbo-Chlorination of Kaolinitic Clays, by John P. Hager and Harry S. Patsos. May 14, 1982. 236 pp. 13 figs. This study investigated the formation of vapor complexes between aluminum chloride and the chlorides of iron, potassium, and sodium using a Knudsen cell mass spectrometer. Fundamental thermodynamic data were determined from the mass spectrometric experiments. An equation relating vapor pressure of a species inside the Knudsen cell to mass spectrometric ion current was derived from viscous flow conditions. A technique was also developed for the correction of the ion current of a species of a certain mass due to the presence of isotopes with the same mass of nearby species in the mass spectrum. Research done under contract J0199151 by the Colorado School of Mines. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Boulder City and Reno, Nev., Albany, Oreg., and Salt Lake City, Utah; and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Order ONLY from NTIS: PB 83–115857; paper copy price code A11.

OFR 159–82. Automatic Fire Protection System for Mobile Underground Metal Mining Equipment. Vol. II. Long Term Validation Testing, by Lyle A. McDonald and Gene R. Reid. February 1981. 242 pp. 160 figs. The objective of this investigation was the development and in-mine testing of an automatic fire control system (AFCS) for mobile underground metal mining equipment. Volume I of this report described the tasks through the development of a first generation prototype AFCS that was installed on a ST-2B-LHD vehicle at the Hecla Lakeshore project at Casa Grande, Ariz., and on the demonstration of system performance on the vehicle in underground fire tests. Volume II primarily concerns the long-term validation testing of the prototype AFCS. Validation testing was performed on the demonstration system plus six additional subsequent generation prototype systems on vehicles in four mines. In addition, work was done to determine the possible personnel exposure hazard presented by multipurpose dry chemical fire extinquishants. Research done under contract H0252038 by The Ansul Co. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Juneau, Alaska, Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; Mine Safety and Health Administration, Arlington, Va.; National Mine Health and Safety Academy, Beckley, W. Va.; and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Order ONLY from NTIS: PB 83–114876; paper copy price code A11.

OFR 160–82. Improved Fire Protection System for Underground Fueling Areas. Volume II, by Lyle McDonald, Dennis Kennedy, and Gene Reid. October 1981. 111 pp. 12 figs. The objectives of this investigation were to (1) develop safe practice guidelines that will minimize the chance of fires in underground fueling areas and (2) to develop a low-cost, reliable, automatic fire control system (AFCS) for underground fueling areas. Volume I of the report covered the period from June 21, 1976, to September 30, 1977, and included (1) the preparation of safe practice guidelines for underground fueling areas; (2) preparation of recommended AFCS design concepts for underground fueling areas; and (3) the design, fabrication, and in-mine fire test of an AFCS at Pine Creek Mine, Bishop, Calif. Volume II of the report covers the period from September 30, 1977, to September 30, 1981, and includes (1) a long-term validation test of the AFCS in the Pine Creek Mine, (2) a study of the environmental effects of aqueous film-forming foam, (3) the design and installation of a system at AMAX Buick Mine, Boss, Mo., (4) the design of a system for enclosed fuel areas, and (5) the design of a system for semipermanent fueling areas. Research done under contract H0262023 by The Ansul Co. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Juneau, Alaska, Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; National Mine Health and Safety Academy, Beckley, W. Va.; and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Order ONLY from NTIS: PB 83–114744; paper copy price code A06.

OFR 161(1)–82. Probabilistic Modeling of Tailings Embankment Designs. Volume I. Model Development and Verification, by Loren R. Anderson, David S. Bowles, Ronald V. Canfield, and Kevan D. Sharp. January 1982. 233 pp. 57 figs. Traditionally, evaluation of the safety of slopes has been based on computing a safety factor against failure. In computing the safety factor, the geometry of the slope, the soil parameters, and the pore pressures were treated as deterministic quantities although they were known to be random variables. A pseudo-three-dimensional probabilistic slope stability model has been developed that treats shear strength as a random variable. The model uses the probability of a slope failure as an assessment of slope reliability. The model can accommodate zoned embankments of soil in which the strength is described by the Mohr-Coulomb strength envelope. Autocorrelation functions are used to describe the spatial correlation of the strength parameters, c and tan ϕ. Model error can also be included in the analysis. Examples are presented to illustrate the influence of the choice of the soil strength variability parameters on the probability of failure. The results show that the critical failure surface based on the minimum safety factor are not necessarily the failure surface that will yield the maximum probability of failure. The analysis of the tailings dam shows that variance reduction can be large and that the model error is the dominant source of uncertainty for the embankment analyzed. Research done under contract J0295029 by Utah State Uni-

versity. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; Mine Safety and Health Administration, Arlington, Va.; National Mine Health and Safety Academy, Beckley, W. Va.; and Office of Surface Mining Library and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Order ONLY from NTIS: PB 83-122598; paper copy price code A11.

OFR 161(2)-82. Probabilistic Modeling of Tailings Embankment Designs. Volume I. Appendix I. Cone Penetrometer Records, by Loren R. Anderson, David S. Bowles, Ronald V. Canfield, and Kevan D. Sharp. January 1982. 64 pp. 59 figs. Volume I, Appendix I of this six-volume report contains the results of the first phase of the electric cone penetrometer tests performed at Copper City No. 2 tailings dam near Globe, Ariz. The report includes computer-processed logs of all field soundings as well as a brief discussion of the equipment and procedures. Research done under contract J0295029 by Utah State University. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; Mine Safety and Health Administration, Arlington, Va.; National Mine Health and Safety Academy, Beckley, W. Va.; and Office of Surface Mining Library and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Copies of this report will not be available for purchase.

OFR 161(3)-82. Probabilistic Modeling of Tailings Embankment Designs. Volume I. Appendix J. Cone Penetrometer Records, by Loren R. Anderson, David S. Bowles, Ronald V. Canfield, and Kevan D. Sharp. January 1982. 33 pp. 29 figs. Volume I, Appendix J of this six-volume report contains the results of the second phase of the electric cone penetrometer tests performed at Copper City No. 2 tailings dam near Miami, Ariz. The report includes computer-processed sounding logs as well as brief descriptions of equipment and procedures used on the project. Research done under contract J0295029 by Utah State University. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; Mine Safety and Health Administration, Arlington, Va.; National Mine Health and Safety Academy, Beckley, W. Va.; and Office of Surface Mining Library and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Copies of this report will not be available for purchase.

OFR 161(4)-82. Probabilistic Modeling of Tailings Embankment Designs. Volume II. Model Application and Verification, by Loren R. Anderson, David S. Bowles, Ronald V. Canfield, and Kevan D. Sharp. January 1982. 43 pp. 15 figs. A probabilistic slope stability computer model was developed at Utah State University and evaluated by CH2M Hill Consulting Engineers as a design and analysis tool. Volume I of this report describes the model and volumes III and IV are users manuals for the computer programs. Volume II (this report) includes a description of a field investigation and stability analysis of an existing tailings dam. Based on the results, the tailings dam was evaluated for redesign using probabilistic considerations. Conclusions are made regarding the usefulness of the model as a design tool. Research done under contract J0295029 by Utah State University. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; Mine Safety and Health Administration, Arlington, Va.; National Mine Health and Safety Academy, Beckley, W. Va.; and Office of Surface Mining Library and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Order ONLY from NTIS: PB 83-122606; paper copy price code A03.

OFR 161(5)-82. Probabilistic Modeling of Tailings Embankment Designs. Volume III. User's Manual for Probabilistic Slope Stability Computer Program, PROBISH, by Loren R. Anderson, David S. Bowles, Ronald V. Canfield, and Kevan D. Sharp. January 1982. 66 pp. 16 figs. Volume III of this six-volume report is a user's manual for the probabilistic slope stability program PROBISH. PROBISH is an interactive program that is essentially self-tutorial. The program prompts the user for the required input data as it is needed and allows corrections of mistyped data before analysis is initiated. The program computes safety factor probable width of failing and probability of failure for a given circular failure surface. Four example problems are included. Research done under contract J0295029 by Utah State University. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; Mine Safety and Health Administration, Arlington, Va.; National Mine Health and Safety Academy, Beckley, W. Va.; and Office of Surface Mining Library and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Copies of this report will not be available for purchase.

OFR 161(6)-82. Probabilistic Modeling of Tailings Embankment Designs. Volume IV. User's Manual for Cone Penetrometer Data Analysis Computer Programs, HORZ and VERT, by Loren R. Anderson, David S. Bowles, Ronald V. Canfield, and Kevan D. Sharp. January 1982. 45 pp. 5 figs. Volume IV of this six-volume report is a user's manual for the cone penetrometer data analysis computer programs VERT and HORZ. The programs are interactive and prompt the users for input data and allow corrections and modifications to be made. The programs read data from the results of cone penetrometer soundings and convert the data to values of tan ϕ. Mean, standard deviation, skew, kurtosis, linear trends, and autocorrelation are computed by the programs. Research done under contract J0295029 by Utah State University. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; Mine Safety and Health Administration, Arlington, Va.; National Mine Health and Safety Academy, Beckley, W. Va.; and Office of Surface Mining Library and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Copies of this report will not be available for purchase.

OFR 162–82. Kinetic Studies Relevant to the Suppression of Coal Dust Explosions by Powdered Inhibitors, by Carol L. Steen and Eric M. Suuberg. September 1981. 49 pp. 6 figs. This report presents a summary of data on the kinetic behavior of four proposed explosion inhibitor dusts—rock dust (calcium carbonate), Purple-K (potassium bicarbonate), ABC powder (monoammonium phosphate), and BCD powder (sodium chloride). All four materials were tested under conditions chosen to be similar to those that might be encountered in coal dust explosions. As expected, the principal products of rock dust decomposition are CO_2 and CaO. Contrary to what is expected from literature data, the CO_2 is the only gaseous product observed during Purple-K decomposition. It appears that the BCD powder did little more than vaporize. The ABC powder gave a complex mixture of decomposition products. The strategy for later work on modeling the rate processes is outlined. Research done under contract J0308032 by Carnegie-Mellon University. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Copies of this report will not be available for purchase.

OFR 163–82. Development and Implementation of an Instructor Course, "Training the Trainer—An Update", by Robert T. Reeder and Rodney S. Fowler. November 1981. 153 pp. 14 figs. This manual was designed to aid mine instructors in presenting mandatory classes in the area of health and safety training and retraining of miners. The objective is to prepare students to be able to (1) develop and prepare a lesson plan for classroom use; (2) tailor material for class presentation; (3) select and prepare appropriate training aids to accompany presentations; (4) demonstrate the proper method of presentation to conduct a period of instruction given the topic, class background, time constraints, and physical properties of the classroom; (5) present a period of instruction before other course participants during microteaching; (6) employ good communication techniques during the microteaching period; and (7) prepare a personal critique and critique other course participants for techniques of instruction. The report includes recommendations for future research. Research done under contract J0205065 by the Colorado School of Mines. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; Mine Safety and Health Administration, Arlington, Va.; National Mine Health and Safety Academy, Beckley, W. Va.; and Office of Surface Mining Library and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Copies of this report will not be available for purchase.

OFR 164–82. Engineering Evaluation of Radon Daughter Removal Techniques, by Donald B. Lindsay, J. Ronald Lawter, and Indrakumar Jashnani. April 1978. 208 pp. 44 figs. This report presents the findings of an investigation of a number of techniques for cleaning ambient air with special emphasis on their applicability to the removal of the short-lived radioactive decay products of 222-radon, the so-called "radon daughters" that have been identified with the induction of lung cancer in underground uranium miners. The purpose of the study was to review the requirements for control of radon daughter concentrations in mine air, and to examine all techniques whose feasibility has been demonstrated in principle and that would be capable of meeting those requirements. The study included a review of all pertinent literature, both technical and proprietary, on the subject of the control of miner exposure to the radon daughters and in the area of potentially applicable air-cleaning technology. Information about the nature of the problem and about the experience of the uranium mining industry in applying air-cleaning methods to its solution was obtained by visiting mines where such methods are in use and by correspondence and telephone conversations with other industry sources. Information on performance characteristics and costs of applicable air-cleaning methods was obtained from an experienced engineering staff and by visits, interviews, and correspondence with manufacturers of industrial air-cleaning equipment. Research done under contract J0265011 by Arthur D. Little, Inc. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; National Mine Health and Safety Academy, Beckley, W. Va.; and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Order ONLY from NTIS: PB 83–114868; paper copy price code A10.

OFR 165–82. Predicting Suspended Solids Removal in Pilot Size Sediment Ponds Using Chemical Flocculation, by J. S. Tapp, B. J. Barfield, and M. L. Griffin. May 1981. 471 pp. 149 figs. Laboratory- and pilot-scale tests were conducted to evaluate the effectiveness of chemical-induced coagulation-flocculation on total suspended solids removal in mine sediment ponds and to evaluate commonly used procedures for designing the ponds. Laboratory-scale jar tests were conducted at total suspended solids concentrations ranging from 2,000 to 200,000 mg/l. Constant- and variable-flow pilot-scale test runs were made in a 4-foot-wide by 20-foot-long model pond at total suspended solids concentrations ranging from 2,000 to 200,000 mg/l. The laboratory- and pilot-scale tests showed that chemical coagulation-flocculation produced suspended solids removal to a concentration of approximately one order of magnitude less than when no chemical was added. The tests also showed that commonly used lumped design procedures DEPOSITS model and the overflow rate equations were not generally capable of predicting effluent suspended-solids concentrations similar to those measured. Research done under grants G5115004 and G5105003 by the University of Kentucky. Available for reference at the Office of the Assistant Director, Mining Research, Bureau of Mines, Washington, D.C.; Bureau of Mines facilities in Tuscaloosa, Ala., Twin Cities, Minn., and Boulder City, Nev.; and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Copies of this report will not be available for purchase.

OFR 166(1)–82. Selective Placement of Strip Mine Overburden in the United States. I. Contract Report, by J. Lyall Workman. October 1981. 292 pp. 48 figs. The selective placement of coal strip mine overburden is examined. Physical and chemical properties of spoil detrimental to revegetation and ground water are detailed. Five mining methods, already used in the industry, that are capable of

selectively handling waste are examined. Technical and economic comparisons are made for the systems when applied to realistic mine settings. The same analysis is conducted for five novel methods capable of selectively handling waste. Comparisons are made between novel and existing methods. Suggestions for new and modified equipment are outlined and recommendations for further research are provided. Research done under contract J0199040 by Marston & Marston, Inc. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Juneau, Alaska, Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; U.S. Department of Energy, Pittsburgh, Pa.; and Office of Surface Mining Library and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Order ONLY from NTIS: PB 83–115873; paper copy price code A13.

OFR 166(2)–82. Selective Placement of Strip Mine Overburden in the United States. II. Appendices, by J. Lyall Workman. October 1981. 196 pp. 4 figs. The selective placement of coal strip mine overburden is examined. Physical and chemical properties of spoil detrimental to revegetation and ground water are detailed. Volume I of the report contains the technical and economic comparisons of selected systems when applied to realistic mine settings. Volume II contains the appendices. Research done under contract J0199040 by Marston & Marston, Inc. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Juneau, Alaska, Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; U.S. Department of Energy, Pittsburgh, Pa.; and Office of Surface Mining Library and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Order ONLY from NTIS: PB 83–115881; paper copy price code A09.

OFR 167–82. Selective Placement of Strip Mine Overburden in Montana. V. Summary Report, by D. J. Dollhopf, J. D. Goering, C. J. Levine, B. J. Bauman, D. W. Hedberg, and R. L. Hodder. June 1981. 211 pp. 68 figs. The objective of this study was to investigate the means of establishing nonpolluted ground water and root zone systems in areas where surface mining intercepts physiochemically unsuitable overburden materials Overburden may need to be sampled on a 60-m grid to delineate materials unsuitable for reclamation and to accurately implement selective handling operations. Unsuitable overburden materials were buried successfully in a dragline operation with a minimum of delays, but costs were increased 12 to 53 pct. After 3 years the buried material remains above the reestablished aquifer and below the root zone. It was shown that some unsuitable overburden materials do not have to be special handled. At least a portion of the postmine aquifer had hydraulic conductivity rates lower than the premine system, indicating the reestablished aquifer may, in part, conduct ground water very slowly. Postmine ground water chemical quality in spoil materials had poorer quality compared with premine ground water. Research done under contract H0262032 by the Montana State University. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Juneau, Alaska, Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; U.S. Department of Energy, Pittsburgh, Pa.; and Office of Surface Mining Library and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Order ONLY from NTIS: PB 83–114884; paper copy price code A10.

OFR 168–82. Equipping a Shaft and Mining Bulk Samples of Oil Shale, Nahcolite and Dawsonite, by R. W. Amstutz. April 1981. 81 pp. 31 figs. A 5-year program was planned for environmental research and geotechnical test work at the Oil Shale Mining Environmental Research Facility in the central Piceance Creek Basin, Rio Blanco County, Colo. The facility consisted of a small-diameter lined shaft that would be equipped with a head frame, a hoist, and a surface plant to provide access to the deep, thick deposits of oil shale and the associated saline minerals including nahcolite and dawsonite. The objective of the research was to determine the potential effects of oil shale extraction upon the natural environment and the living and working environment, and to develop the technology required to resolve or mitigate the adverse effects. This report describes the equipping of the shaft and the mining of bulk samples of oil shale, nahcolite, and dawsonite from two levels. Research done under contract S0271009 by Williams Brothers Engineering Co. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; U.S. Department of Energy facilities in Carbondale, Ill., and Pittsburgh, Pa.; Mine Safety and Health Administration, Arlington, Va.; National Mine Health and Safety Academy, Beckley, W. Va.; and Office of Surface Mining Library and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Order ONLY from NTIS: PB 83–114173; paper copy price code A05.

OFR 169–82. Guideline Manual for Front-End Loader Load-and-Carry Applications, by James W. Martin, Thomas J. Martin, Donald W. Gentry, Matthew J. Hrebar, Karl R. Nelson, and Thomas P. Bennett. May 1981. 253 pp. 52 figs. This user's manual analyzes the application, selection, and performance of front-end loaders in mining operations that can effectively utilize front-end loader load-and-carry capability. All aspects of the application are considered starting with a discussion of the load-and-carry system and alternate material handling methods. Site conditions such as the geology of the formation, material characteristics, alternative mine plans, and working conditions are identified. Selection considerations include machine design characteristics, production capabilities, ownership, and operating costs. Typical operating practices and safety procedures are discussed. Comprehensive machine specifications, together with a series of checklists and worksheets, are included for preliminary analysis. Research done under contract J0205045 by Martin Consultants, Inc. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; U.S. Department of Energy, Pittsburgh, Pa.; and Office of Surface Mining Library and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Order ONLY from NTIS: PB 83–115014; paper copy price code A12.

OFR 170–82. Standardization of Controls for Roof Bolter Machines. Phase I. Human Factors Engineer-

ing Analysis, by Martin Helander, Ernest J. Conway, William Elliott, and Richard Curtin. October 1980. 192 pp. 24 figs. The objective of this study is to propose standardized arrangements for controls in roof bolters. It is expected that standardized control arrangements would increase safety, minimize training requirements, and promote productivity. This report provides a human factors analysis of roof bolter controls. Preliminary standards for control design include the adoption of design criteria such as functional grouping of controls; sequencing controls according to order of operation; standardizing control motion directions; and standardizing actuation force requirements, control sizes, and interspacing. The proposed control arrangements were reviewed by roof bolter manufacturers and MSHA roof control experts; the responses were favorable. Research done under contract H0292007 by Canyon Research Group, Inc. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; National Mine Health and Safety Academy, Beckley, W. Va.; and Office of Surface Mining Library and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Order ONLY from NTIS: PB 83–119149; paper copy price code A09.

OFR 171–82. Boulder Handling and Blasting for Greater Safety and Efficiency in Crushers, by Michael F. Dunn, Francis S. Kendorski, and Swapan Bhattacharya. November 1981. 122 pp. 39 figs. A study was carried out to identify and develop improved techniques to alleviate a major cause of accidents and work stoppages when an oversize rock or boulder lodges in the throat of a crusher. The configurations and operations of various crusher types and sources of boulders in a mining operation are described and a detailed review is made of mining, quarrying, and construction regulations for all States, Canada, and the Federal Government for applicable provisions. Representative mines were visited and other operations were contacted to determine boulder handling techniques where it was found that blasting techniques included mudcapping, bombs, and blockholing, often done crudely and inefficiently with poor practices. Various mechanical systems were used such as hooks on overhead cranes, impact hammers, and grapplers. Safety analyses of all methods pointed out the hazards associated with blasting in the open and the dangers of entering a crusher. Boulder blasting can be done in a safer fashion if a planned step-by-step procedure is followed and inherently safer blasting products such as exploding bridge wire blasting caps and improved blockholing techniques are followed. Research done under contract J0100007 by Engineers International, Inc. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; U.S. Department of Energy facilities in Carbondale, Ill., and Pittsburgh, Pa.; Mine Safety and Health Administration, Arlington, Va.; National Mine Health and Safety Academy, Beckley, W. Va.; and Office of Surface Mining Library and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Order ONLY from NTIS: PB 83–119388; paper copy price code A06.

OFR 172–82. Sealant Tests to Control Radon Emanation in a Uranium Mine, by Donald B. Lindsay, James E. Oberholtzer, and Clifford H. Summers. December 1981. 90 pp. 13 figs. This report describes a field-test program to determine the effectiveness of a polymeric wall sealant to reduce the escape of naturally occurring radioactive gas radon from the walls of an underground uranium mine into the ventilation air. A 75-foot-long, dead-end drift with a surface area of about 6,000 ft^2 was used as the test site in which the average natural radon flux from the normally dry rock was 16 fCi/cm^2-s. The effect on radon emanation of wetting the walls with water to a depth of 3 inches was tested, after which the rock was completely covered with a coating of dry-mix concrete to provide a base for the sealant, an acrylic latex. Sealant was applied in two coats to about 0.25 mm thick. An overall reduction of average radon flux of about 75 pct was achieved. Radon production and other environmental values were measured continuously and automatically by a Bureau of Mines data acquisition system. A commercial microcomputer was programed to convert raw data to engineering units and to perform other useful operations while recording all data on magnetic diskettes. Direct measurements of radon flux from the rock surface were made by a charcoal adsorption technique. Research done under contract J0199041 by Arthur D. Little, Inc. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Juneau, Alaska, Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; Mine Safety and Health Administration, Arlington, Va.; National Mine Health and Safety Academy, Beckley, W. Va.; and Office of Surface Mining Library and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Order ONLY from NTIS: PB 83–122762; paper copy price code A05.

OFR 173–82. Development of Improved Topsoil Handling Techniques, by Michael Mancuso, Edward Lesney, and Thomas Simpson. Mar. 23, 1981. 313 pp. 17 figs. This report summarizes the problems of topsoil handling as related to present requirements of law and current equipment availability. The most prevalent topsoiling systems are reviewed along with a listing of advantages, disadvantages, and best features of each system. Seven mining regions are included along with an analysis of prevailing land use, types of soils, and attendant physical, chemical, and biological characteristics. There are several probable areas of future research outlined that can benefit mining, minimize the social impact of mined lands, and speed the return of mined lands to more productive long-term use. Research done under contract J0295047 by Skelly and Loy. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Juneau, Alaska, Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; U.S. Department of Energy, Pittsburgh, Pa.; and Office of Surface Mining Library and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Order ONLY from NTIS: PB 83–120154; paper copy price code A14.

OFR 174–82. Impact of Surface Mining on Soil Compaction in the Midwestern U.S.A., by Steve C. Albrecht and E. Raymond Thompson. Feb. 28, 1982. 318 pp. 70 figs. The objective of this study is to assess the impact of surface mining on soil compaction in the Midwest. The study revolves around a unique field sampling program targeted at four

mine sites utilizing four distinct types of soil movement of midwestern prime farmlands. Through the preparation of a report for use as a guidebook, an assessment is made of the degree to which surface mining operations contribute to the soil compaction problem. The report is formulated through the use of field study data as well as information gathered in an intense literature review. The report centers on applying collected data to practical field applications. Research done under contract J0208016 by Hittman Associates, Inc. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Juneau, Alaska, Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; and Office of Surface Mining Library and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Order ONLY from NTIS: PB 83–120170; paper copy price code A14.

OFR 175–82. Alternative Power-Line Proximity-Warning Techniques, by Frederick H. Raab. January 1982. 79 pp. 23 figs. The performance requirements for a powerline proximity-warning (PLPW) system include high probability of detection at a dependable alarm range, low probability of false alarm, no setup or calibration, and little maintenance or adjustment. These requirements can be met by a system that explicitly measures range to the line. Candidate techniques include microwave radar, optical radar, and sonar. The six specific concepts that appear to be technically feasible in the PLPW application are (1) microwave gated-pulse radar, (2) microwave chirp FM-CW (frequency-modulated, continuous-wave) radar, (3) baseband pulse radar, (4) optical chirp FM-CW radar, (5) optical gated-pulse radar, and (6) sonar. The performance of both optical-radar techniques is degraded by dirt and grime on the transmitter and receiver apertures. Proper operation in a construction environment necessitates either daily maintenance or a windshield wiper. The former is expensive and bothersome, while the latter reduces reliability. Baseband radar appears well suited to the PLPW application. The cost is expected to be comparable with that of an electric field PLPW system. Development and testing of an experimental model are therefore recommended. Research done under contract J0318064 by Green Mountain Radio Research Co. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; National Mine Health and Safety Academy, Beckley, W. Va.; and Office of Surface Mining Library and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Order ONLY from NTIS: PB 83–122754; paper copy price code A05.

OFR 176–82. Development of a DC Current Limiting Interrupting System for Mines, by Howard B. Hamilton. January 1982. 105 pp. 45 figs. A switching system for high fault current, 300- and 600-volt dc trolley and haulage systems, as used in the mining industry are presented. The system consists of paralleled main and auxiliary contactor circuits with a liquid metal current limiting device (CLD) in series with the auxiliary contactor. Upon detection of a fault, the current is commutated into the CLD circuit. The liquid metal vaporizes, increasing the CLD resistance and considerably decreasing the actual current to be interrupted. This system will materially reduce the wear and tear on contactors because of the reduced interrupting requirement. The CLD is pressurized; when the current is interrupted, liquid metal flows back into the bore, thus it is resetting. Electrical and mechanical design principles, that were found satisfactory in field tests, are presented as well as material for use. Research done under contract H0395047 by the University of Pittsburgh. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; Mine Safety and Health Administration, Arlington, Va.; National Mine Health and Safety Academy, Beckley, W. Va.; and Office of Surface Mining Library and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Order ONLY from NTIS: PB 83–120147; paper copy price code A06.

OFR 177–82. Wood Products Use in Coal Mining, by Christopher D. Risbrudt and Robert Chamberlin. Apr. 1, 1982. 58 pp. Because of the important role of wood products in coal mining, and the relative lack of information on quantities and types used, this study had several objectives. First, to provide an estimate of the present use of wood products in coal mining, with emphasis on underground mines where wood usage is greatest. Second, to gain information on the availability of wood products, and any associated problems, to the coal mining industry. Third, to estimate the cost of wood products peculiar to mining. Fourth, to make projections of future consumption of wood products used in mining. In this study, over 220 mines provided data by questionnaire. Wood use per ton of underground coal was found to vary substantially by mining process and region. Research done under contract J0205049 by the U.S. Department of Agriculture, Forest Service. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Juneau, Alaska, Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; Mine Safety and Health Administration, Arlington, Va.; and Office of Surface Mining Library and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Order ONLY from NTIS: PB 83–119370; paper copy price code A04.

OFR 178(1)–82. Mine Power Systems. Volume I, by Lloyd A Morley. Jan. 31, 1982. 568 pp. 353 figs. This seven-chapter document is the first volume of a two-volume report that presents a comprehensive outline of coal mine electrical power systems from theory to practice. Together, the two volumes contain the vital aspects that go into planning and designing a mine power system. After a short introductory chapter, chapter 2 discusses the history of electrical use in mining and introduces typical mine power system arrangements. Chapters 3–5 supply basic information on electrical theory, circuit analysis, and motors. Chapters 6–7 detail unique aspects of mine power systems. Elements of surface and underground use are included in all chapters. An index concludes volume I and is cross referenced to both report volumes. Research done under contract J0155009 by the Pennsylvania State University. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; Mine Safety and Health Administration, Arlington, Va.; National Mine Health and Safety Academy, Beckley, W. Va.; and Office of Surface Mining Library and

National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Order ONLY from NTIS: PB 83–120378; paper copy price code A24.

OFR 178(2)–82. Mine Power Systems. Volume II, by Lloyd A. Morley. Jan. 31, 1982. 534 pp. 280 figs. This eight-chapter document is the second volume of a two-volume report that presents a comprehensive outline of coal mine electrical power systems from theory to practice. Together, the two volumes contain the vital aspects that go into planning and designing a mine power system. Building upon volume I, the subject of protective equipment and relaying starts volume II, first as an introduction in chapter 8, then by a treatment of device selection in chapter 9. Chapter 10 continues system protection in terms of transients and overvoltages. Chapter 11 describes the design of major power equipment, including power centers, switchhouses, and substations. Solid-state applications in mining are given in chapter 12, and batteries and battery charging are discussed in chapter 13. Chapter 14 covers electrical equipment in hazardous locations of mining operations. The report concludes with chapter 15, a discussion of electrical maintenance as well as some specific mine electrical problems. Information on surface and underground use is included in all chapters. An index finishes the documentation and is cross-referenced to both report volumes. Research done under contract J0155009 by the Pennsylvania State University. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; Mine Safety and Health Administration, Arlington, Va.; National Mine Health and Safety Academy, Beckley, W. Va.; and Office of Surface Mining Library and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Order ONLY from NTIS: PB 83–120386; paper copy price code A23.

OFR 179–82. A Training Program for Fighting Small Fires in the Mining Industry, by William Laird, Suresh Bhatt, Tata Bajpayee, Zita Glasgow, and Daniel Frezza. February 1982. 89 pp. 4 figs. The objective of this project was to evaluate a 1-day, on-site training program that would enable miners to make rapid judgments on whether to attempt to extinguish small fires in mines and how best to use the firefighting equipment on hand. Project activities included the analysis of fire report data to define and delineate physical and behavioral variables that affect firefighting activities. These activities culminated in a description of the tasks involved in extinguishing small fires under various mine conditions. The course consists of slides, audiocassettes, case studies, and actual practice using fire extinguishers. Research done under contract J0395060 by Gates Engineering Co. and Applied Science Associates, Inc. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; Mine Safety and Health Administration, Arlington, Va.; National Mine Health and Safety Academy, Beckley, W. Va.; and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Order ONLY from NTIS: 83–170639; paper copy price code A05.

OFR 180–82. Guidelines for Environmental Monitoring in Underground Coal Mines. Phase 1 Report, by H. A. Wright, R. Madden, and M. N. Rubin. June 1982. 177 pp. 7 figs. This report assesses the economic, legal, institutional, and technical factors that affect the current and future status of implementation of mine monitoring systems in the United States. It begins with a description of a poll of the Mining Production Research Committee and the Mine Monitoring and Communications Committee of Bituminous Coal Research that was conducted to establish industry monitoring needs and constraints. Existing systems in the United States and foreign countries are then reviewed and compared with the requirements set forth by the industry committees. At the same time, State and Federal mining laws are reviewed, and equipment presently available from suppliers of mine monitoring systems and components is discussed. A framework for cost-benefit analysis is established and a series of case examples for various monitoring functions are presented. The total values of the market for mine monitoring systems in 1980 and 1990 are estimated on the basis of industry statistics and system cost estimates. Research done under contract J0100039 by Bolt Beranek and Newman Inc. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; U.S. Department of Energy, Pittsburgh, Pa.; Mine Safety and Health Administration, Arlington, Va.; National Mine Health and Safety Academy, Beckley, W. Va.; and Office of Surface Mining Library and National Library for Natural Resources, U.S. Department of the Interior, Washington, D.C. Order ONLY from NTIS: PB 83–147777; paper copy price code A09.

OFR 181–82. In-Place Leaching of Uranium, Copper, and Evaporites, by T. G. Carnahan. November 1982. 34 pp. 7 figs. In-place leaching is being actively utilized to extract uranium, copper, and evaporites from low-grade and difficult-to-mine ores. This report discusses in-place leaching technology, its advantages and disadvantages, and gives an overview of past, current, and envisioned in-place leaching operations in the United States. Application of in-place leaching to uranium ores has been particularly successful. The sandstone ores are contained above and below by impermeable shales, and the uranium ore minerals are easily leached with oxidizing acid or base solutions. Copper is recovered from subgrade rock by dump or in-place leaching with acidified ferric sulfate solutions. The leaching solution migrates down through the rock and dissolves copper. The solution is collected from the base of the dumps, and copper is recovered by solvent extraction-electrowinning or by cementation on detinned steel cans. Solution mining of evaporites is being conducted commercially for the extraction of sodium chloride and potassium chloride. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Juneau, Alaska, Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; Office of Surface Mining Library and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C.; and Office of the Assistant Director—Minerals and Materials Research, U.S. Bureau of Mines, Washington, D.C. Order ONLY from NTIS: PB 83–138859; paper copy price code A03.

OFR 182–82. Burial of Potentially Toxic Surface Mine Spoil, by L. B. Phelps, L. W. Saperstein,

W. B. Wells, and D. Yeung. October 1981. 343 pp. 134 figs. A method is presented for the burial of potentially toxic spoil in high-density zones or packages within spoil piles. Such burial could reduce the outflow of pollutants and thus minimize contamination of ground water flows. Laboratory model studies using ammonium bromide tracer were performed to quantify the expected outflow mixing that could be achieved through package construction in spoils. Field drilling and geophysical density logging of spoils was carried out at three sites in Pennsylvania and Ohio to obtain a range of field spoil bulk-density measurements and spoil samples. These data are analyzed to determine the relationships between spoil density and the controlling factors of lithology, depth, age, particle size distribution, and mining method. A separate series of spoil permeability tests were performed in the laboratory to investigate the relationship between permeability and its related parameters. Research results are applied to the toxic package method to suggest guidelines for package size, shape, density, and placement for future field prototype development. Research done under contract J0188136 by the Pennsylvania State University. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Juneau, Alaska, Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; U.S. Department of Energy, Pittsburgh, Pa.; and Office of Surface Mining Library and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Order ONLY from NTIS: PB 83–136051; paper copy price code A15.

OFR 183–82. Development of Systematic Waste Disposal Plans for Metal and Nonmetal Mines, by G. W. Center, R. M. Wood, L. C. Richardson, D. W. Evans, D. J. Shosky, W. R. Killiam, E. W. Finke, and J. P. Schmid. June 1982. 643 pp. 121 figs. This manual is intended to assist Federal, State, and local regulatory and planning agencies, the mining industry, and consulting engineers in determining the regulatory, environmental, technical, and economic constraints influencing the site selection, planning, construction-operation, and reclamation phases of a waste disposal facility. The information presented shows that factors affecting an individual site may be simple or very complex. The manual discusses methods for making future land use decisions; determining regulatory requirements; evaluating physical, chemical, and structural properties of the disposed waste; and selecting appropriate waste disposal methods and control techniques. Procedures and guides in the manual will assist in assessing the complexities of waste disposal on a site-specific basis. The major types of waste disposal systems are discussed and evaluated in terms of advantages and disadvantages and applicability to varying site conditions and waste characteristics. Appropriate references following each chapter provide more detailed data on material presented in the text. Research done under contract J0208033 by Goodson & Associates, Inc. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Juneau, Alaska, Denver, Colo., Avondale, Md., Twin Cities, Minn, Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; Mine Safety and Health Administration, Arlington, Va.; National Mine Health and Safety Academy, Beckley, W. Va.; and Office of Surface Mining Library and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Order ONLY from NTIS: PB 83–138065; paper copy price code A99.

OFR 184–82. The Effects of Moisture on Radon Emanation, Including the Effects on Diffusion, by Burton J. Thamer, Kirk K. Nielson, and Karen Felthauser. November 1981. 213 pp. 47 figs. Radon emanation coefficients of 0.02 to 0.55 were measured at moisture contents ranging from dry to saturation in 18 different ores. The emanation coefficients rose from a minimum when dry to a plateau usually starting at 5 to 20 percent of saturation. A model, using measured pore-size distributions, suggested that the radium mineralization may be confined to annular layers about 0.02 micrometer thick around pores. Radon's diffusion coefficient was determined as a function of moisture. The techniques involved comparing a disk's exhalation as a function of time whether or not the disk had a distributed source. The model was free of approximations and included the effects of porosity and adsorption. An increase of diffusion coefficient with moisture for one or two ores was explained in terms of a model's equation for the diffusion coefficient in terms of both volume and surface diffusion. Radon's adsorption coefficient was determined on a uranium ore. Research done under contract H0292024 by Ford, Bacon & Davis Utah, Inc. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; U.S. Department of Energy, Pittsburgh, Pa.; and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Order ONLY from NTIS: PB 83–136358; paper copy price code A10.

OFR 185–82. Biological Oxidation of Iron (II) by T. Ferrooxidans in a Sequencing Batch Reactor, by T. L. Theis, L. H. Ketchum, Jr., and R. L. Irvine. August 1982. 141 pp. 38 figs. The use of a suspended growth system of *T. ferrooxidans* attached in a film to individual particles of bentonite and operated as a sequencing batch reactor has proved to be a practical way of oxidizing ferrous iron in acid mine drainage. This component, followed by limestone neutralization, is both a technically and economically feasible approach to the treatment of these wastewaters in comparison with existing and proposed methods. The advantages, in addition to less expense, are greater safety, acceptable treatment at a lower pH, lower solids buildup, less danger of overtreatment, and greater flexibility in operational characteristics. In this report, data on the continuous bench-scale operation of the system under a variety of conditions show sustained levels of oxidation in excess of 95 pct. Research done under contract J0100079 by the University of Notre Dame. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Juneau, Alaska, Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; U.S. Department of Energy, Morgantown, W. Va.; Mine Safety and Health Administration, Arlington, Va.; National Mine Health and Safety Academy, Beckley, W. Va.; and Office of Surface Mining Library and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Order ONLY from NTIS: PB 83–137810; paper copy price code A07.

OFR 186–82. Establishment of Associative Nitrogen Fixing Grasses on Metal Mine Tailings, by L. H. Wullstein. June 1982. 42 pp. 4 figs. The purposes of this study were (1) to evaluate selected grasses for nitrogen fixation attributable to microorganisms inhabiting their roots and (2) to establish nitrogen-fixing bacteria on the roots of selected

metal-tolerant grasses by inoculation trials. Nitrogenase activity (C_2H_2 reduction) was found to be associated with *Agropyron dasystachyum, Agropyron smithii, Aristida purpurea, Oryzopsis hymenoides,* and *Stipa comata.* Uptake of fixed nitrogen was also demonstrated for these grasses. Two unidentified nitrogen-fixing bacteria were isolated, one from *Stipa comata* and the other from *Aristida purpurea. Cynodon dactylon* and *Agropyron cristatum* were successfully inoculated with the unknown isolate obtained from *Stipa comata.* The inoculated plants exhibited nitrogenase activity whereas uninoculated controls gave negative results. Research done under contract J0205054 by the University of Utah. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Juneau, Alaska, Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; Office of Surface Mining Library and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C.; and Office of the Assistant Director—Minerals and Materials Research, U.S. Bureau of Mines, Washington, D.C. Order ONLY from NTIS: PB 83–137596; paper copy price code A03.

OFR 187–82. Phase Equilibrium Studies of Refractory Oxide Systems. Part I: SrO-ZrO_2-MgO and SrO-MgO-Dolomite, by Charles E. Semler. March 1982. 99 pp. 40 figs. The possible utility of selected compositions in the systems SrO-ZrO_2-MgO and SrO-ZrO_2-dolomite for commercial refractory products was confirmed in this study. Specifically, the compositions of interest are located in the subsystems $SrZrO_3$-ZrO_2-MgO and $SrZrO_3$-ZrO_2-dolomite. Both subsystems have regions that are not affected by hydration, but the subsystem $SrZrO_3$-ZrO_2-MgO has a larger candidate compositional region. Solid-state phase relations were determined for the subject systems over the temperature range 1,600° to 1,300° C, with compatibility diagrams presented for each. The systems appear to show good refractory character with no apparent low melting compositions. Because the compositions of commercial interest lie mostly in the higher ZrO_2 portion of each system, information is presented regarding the firing treatment required to develop stabilized cubic ZrO_2. A list of suggestions for further study of these systems, to further delineate the characteristics required for possible commercial utilization, is presented. Research done under contract J0100045 by Ohio State University. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Order ONLY from NTIS: PB 83–134874; paper copy price code A05.

OFR 188–82. Haulroad Berm and Guardrail Design Study and Demonstration. Volume I, by Gary L. Stecklein and John Labra. June 1981. 186 pp. 57 figs. This report presents the findings of the test programs, simulations, and analyses performed to determine the requirements for the effective application of berms and guardrails as truck restraint systems for elevated mine roadways. Included are criteria for effective vehicle restraints for guardrail applications and recommendations for berm applications based on scale model tests and computer simulations. Full-scale haulage vehicle-berm interaction field tests were performed to correlate the results of these model tests and computer simulations. Recommendations for the construction of berms were made on the basis of tests of berm-bearing strength, response of the vehicle to different berms, and predictions based on the obtained correlation. Research done under contract H0282028 by Southwest Research Institute. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Juneau, Alaska, Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; Mine Safety and Health Administration, Arlington, Va.; National Mine Health and Safety Academy, Beckley, W. Va.; and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Order ONLY from NTIS: PB 83–137091; paper copy price code A09.

OFR 189–82. Haulroad Sign Design Study and Demonstration. Volume II, by King K. Mak. June 1981. 131 pp. 44 figs. A literature search was conducted to detemine the state of the art for signing applicable to surface mine haulage roads, along with a survey of existing Mine Safety and Health Administration (MSHA) regulations and a review of MSHA accident records. Nine mines were visited to gather information on current signing practices. Preliminary signing guidelines were then developed based on the data. Field demonstrations of the preliminary signing guidelines were conducted in which signing programs were implemented in two mines. Signing requirements were first assessed at each of the two participating mines, and the necessary signs were designed, purchased, and installed. Evaluation of the signing program as to its adequacy, appropriateness, and effectiveness was solicited from mine management and operations personnel. Experiences gained from field evaluations were then incorporated into the final signing guidelines and are presented in this report. Research done under contract H0282028 by Southwest Research Institute. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Juneau, Alaska, Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; and at the National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Order ONLY from NTIS: PB 83–137109; paper copy price code A06.

OFR 190–82. Dynamic Study of the Impact of Government Regulations on Small Surface Coal Operator, by Anil B. Jambekar and Patrick A. Kinek. December 1981. 205 pp. 83 figs. A system dynamic model was constructed as a framework to study the long-term consequences of Government regulations, and the delays inherent in these regulations, on the functional areas of small surface coal operators. The system structure is composed of four interacting sectors: a small coal operator sector, a Government sector, a market sector, and a financial-banking sector. The small coal operator is further subdivided into five interacting subsystems; land management, production management, capacity planning, finance and accounting control, and a pricing mechanism. Several policies to alleviate the financial burdens of small coal operators are tested. Research done under grant G5105031 by the Michigan Technological University. Available for reference at the Office of the Assistant Director, Mining Research and Mineral Data Analysis, Bureau of Mines, Washington, D.C.; Bureau of Mines facilities in Denver, Colo., and Twin Cities, Minn.; and Office of Surface Mining Library and National Library of Natural Resources, U.S. Department of the Interior, Wash-

ington, D.C. Copies of this report will not be available for purchase.

OFR 191–82. Inventory and Hazards Monitoring of Mined Lands Using Automated Processing of Satellite Imagery and Collateral Data, by Charles E. Glass, Robert A. Schowengerdt, and James R. Carr. December 1980. 156 pp. 70 figs. The purpose of this report is to demonstrate the flexibility of remote sensing techniques to provide data that will implement mined-lands reclamation in an efficient and cost-effective manner. An operation program is presented to use satellite remote sensing data, collateral data, and automated image analysis. The program will provide (1) an inventory of coal and copper mines and mine waste in Arizona, (2) techniques to periodically monitor mining areas using multitemporal classification and image prediction techniques, and (3) the delineation of high-priority areas for future reclamation and current land-use planning of Arizona mining areas based on environmental hazards indices computed using classified scenes and collateral data. Research done under grant G5195005 by the University of Arizona. Available for reference at the National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Copies of this report will not be available for purchase.

OFR 192–82. An Analysis of the Productivity Trends in the Strategic and Critical Minerals Industries: The Case of Copper, by James J. Doyle. October 1982. 335 pp. 1 fig. The objectives of this study are (1) to determine which productivity measures would serve as the best indicators of the financial health and efficiency of the strategic and critical minerals industries, and (2) to develop and estimate a model that identifies the major determinants of productivity, using copper as a test case. Based on an analysis of conceptual and empirical strengths and weaknesses and on a multivariate correlation model of productivity and financial measures, seven productivity measures were selected for subsequent analysis: output per production worker hour (QPM), QPM in copper smelting, QPM in copper refining, output per unit of capital (QPK), QPK in smelting and refining, multifactor productivity in mining, and total factor productivity in copper smelting and refining. An econometric model was developed and estimated that identifies the major determinants in each of the following categories: resource base and institutional characteristics, general economic factors, and technological factors. A long (1911–79) and a short (1948–79) version of the model was attempted. The results are as follows: (1) In general, the various productivity measures are affected by ore grade, capital-labor ratios, real gross national product (GNP), cost of energy, Government regulations, strikes, injury rates, and technology. (2) Technology appears to have played a more important role for labor and capital productivity in mining than any of the other productivity measures. (3) Labor productivity appears to be procyclical; that is, positively associated with the GNP while other productivity measures tend to behave countercyclically. (4) The negative impact of Government-mandated pollution control expenditures on labor productivity in copper refining is four times as great as the impact on the mining segment and three times as great as the smelting segment. Research done under contract J0113084 by JACA Corp. Available for reference at Bureau of Mines facilities in Juneau, Alaska, Denver, Colo., Pittsburgh, Pa., and Spokane, Wash.; and Office of Surface Mining Library and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Copies of this report will not be available for purchase.

OFR 193–82. Resource Evaluation of Lower Pennsylvanian (Pottsville) Depositional Systems of the Western Warrior Coal Field, Alabama and Mississippi, by Arthur W. Cleaves III. November 1981. 125 pp. 43 figs. This report presents a coal exploration and resource evaluation for the western two-thirds of the Warrior Coalfield of northwest Alabama and extreme northeastern Mississippi. The report evaluates the stratigraphy, facies characteristics, and depositional history of post "Millerella" carboniferous rock units within an 18-county area on the northern rim of the Black Warrior Basin. Generation of data for coal exploration, such as the geographic distribution, thickness, and stratigraphic position of economically exploitable coal seams, represents an important aspect of this research. The principal goals of the study involve (1) formulation of a coal exploration model based on facies analysis that will aid in the search for undiscovered coal reserves, (2) construction of a workable surface and subsurface stratigraphic framework in which to map the terrigenous clastic and coal facies elements, and (3) estimation of the total shallow subsurface and deep basin coal reserves within the study area. Research done under grant G5195024 by the University of Mississippi. Available for reference at the Office of Surface Mining Library and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Copies of this report will not be available for purchase.

OFR 194–82. The Use of a Baffled Rotating Drum Mixer in the Flocculation Dewatering of Florida Phosphatic Clay Wastes, by James L. Hendrix. October 1982. 24 pp. 6 figs. The applicability of a rotating drum with an attached trommel as a flocculation dewatering device of Florida phosphatic clay wastes was studied. Several experiments were conducted to determine the important fabrication and operating parameters. Results from the experiments indicated that the dosage of polyethylene oxide required to form a satisfactory product cake could be reduced by using the rotary drum, which introduces less shear stress into the fluid than a constant stirred tank mixer. Research done under contract J0113008 by the University of Nevada, Reno. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Juneau, Alaska, Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; Office of Surface Mining Library and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C.; and Office of the Assistant Director of Mining Research, U.S. Bureau of Mines, Washington, D.C. Copies of this report will not be available for purchase.

OFR 195–82. The Microbiological Flocculation of Phosphate and Potash Slimes, by Corale L. Brierley and Guy R. Lanza. February 1982. 131 pp. 24 figs. Beneficiation of phosphate in the Southeastern United States generates a slurry of finely divided clay wastes that are impounded to allow the particulates to settle. The aggregation of phosphatic clay slime wastes and slimes produced from potash beneficiation by microbial processes was studied using several bacterial species known to produce polymeric substances. Experiments included flocculation activity of whole cells in the presence of phosphatic clays, observation of clay flocculation rates by polymers derived from these organisms,

and clarity of polymer-flocculated clay suspensions. The polymer-producing organisms exhibited little capacity for flocculating phosphate and potash clay slimes. Fungal spores of *Cladosporium cladosporioides* (isolated from a phosphate clay waste impoundment), when agitated with clay slime for several days, caused the clay to form pellets. Separation of the clay-fungal pellets from the process water might be possible using a screening technique. Studies with *C. cladosporioides* included the determination of suitable energy substrates and supplements for growth, absorption studies of a pigment produced by the organism, determination of the time required for bioflocculant production by the organism, and an elucidation of the conditions required for the pelletization of clay slimes by the fungus. Research done under contract J0199150 by the New Mexico Institute of Mining and Technology. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Juneau, Alaska, Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; U.S. Department of Energy, Pittsburgh, Pa.; Office of Surface Mining Library and National Library of National Resources, U.S. Department of the Interior, Washington, D.C.; and Office of the Assistant Director—Minerals and Materials Research, U.S. Bureau of Mines, Washington, D.C. Order ONLY from NTIS: PB 83–137315; paper copy price code A07.

OFR 196(1)–82. Procedures for Hoist and Shaft Inspection & Maintenance. Volume I. Systems Description, by J. Cseff, W. J. Forbes, A. W. Mills III, L. Albert, and F. A. Penning. October 1981. 310 pp. 190 figs. There is a variety of shaft and hoist equipment in the United States. Nearly all of the hoist systems are electrically driven. Machine elements that comprise the hoists and ancillary equipment include bearings, shafting, drums, gear reducers, couplings, brakes, clutches, sheaves, and electrical motors. This report describes the various components encountered in most mine hoist and shaft installations along with brief descriptions of the functions and construction; hoist and balance ropes are specifically excluded. Associated with the hoisting systems are the headgear, shaft and equipment, loading-dumping facilities, and the actual conveyances and their rope attachments. Research done under contract J0100035 by V. B. Cook Co., Inc. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; U.S. Department of Energy, Pittsburgh, Pa.; Mine Safety and Health Administration, Arlington, Va.; National Mine Health and Safety Academy, Beckley, W. Va.; and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Order ONLY from NTIS: PB 83–148049; paper copy price code A14.

OFR 196(2)–82. Procedures for Hoist and Shaft Inspection & Maintenance. Volume II. Inspection & Maintenance Procedures, by J. Cseff, W. J. Forbes, A. W. Mills III, L. Albert, and F. A. Penning. October 1981. 140 pp. 25 figs. This report discusses in general terms scheduled inspection and preventative maintenance of the hoists and ancillary equipment described in volume I. Preventative scheduled inspection and maintenance procedures assist in the smooth operation of mine hoisting systems by the prevention of unscheduled or catastrophic equipment failure and its attendant downtime. Schedules and overall maintenance planning are required at the management level. Inspection, maintenance, and unusual operations or incidents must be recorded in records and equipment logs. A cross reference between MSHA regulations and various equipment components is included as part of the report. A discussion of the various nondestructive testing methods that may be applied to hoisting equipment is also included. Research done under contract J0100035 by V. B. Cook, Inc. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Denver, Colo., Avondale, Md., Twin Cities, Minn.. Rolla. Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; Mine Safety and Health Administration, Arlington, Va.; National Mine Health and Safety Academy, Beckley, W. Va.; and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Order ONLY from NTIS: PB 83–148056; paper copy price code A07.

OFR 197–82. Assessment of Critical Metals in Waste Catalysts, by Francis J. Hennion and Josef Farkas. September 1982. 170 pp. 37 figs. A survey was conducted of the U.S. catalyst industry for the purpose of defining critical metals usage and disposition. This report encompasses the petroleum, chemical, and environmental (industrial and automotive emission control) industries. Metals used for catalysts in these industries include nickel, cobalt, molybdenum, vanadium, tungsten, chromium, iron, copper, zinc, and precious metals—platinum, palladium, rhodium, rhenium, silver, and gold. In recent years, about 27 million pounds of non-noble metals have been consumed for catalysts annually. Over half of this, primarily metals of lower value or concentration, is currently not recycled. However, the more valuable nickel, cobalt, molybdenum, and tungsten are extensively recycled. About 1 million troy ounces of platinum-group metals are consumed annually for catalyst applications. The automotive industry uses over 60 percent of these metals, and only a negligible amount is currently being recycled, although the technology for recovery has been demonstrated. Of the precious metal catalysts consumed by the chemical and petroleum industries, about 15 percent is lost. The balance is recycled, primarily by toll refining. Research done under contract J0215042 by Inco Research & Development Center, Inc. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Juneau, Alaska, Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; the National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C.; and Office of the Assistant Director—Minerals and Materials Research, U.S. Bureau of Mines, Washington, D.C. Order ONLY from NTIS: PB 83–144832; paper copy price code A08.

OFR 198–82. In-Mine Measurement of Reactive Diesel Exhaust Contaminants, by K. T. Menzies, K. J. Beltis, P. L. Levins, L. H. Sadowski, and B. A. Workman. Sept. 3, 1980. 151 pp. 23 figs. This report documents laboratory and in-mine analyses of diesel exhaust pollutants carried out to assess the fate of potentially reactive species in a mine environment. Specifically, the concentration of stable compounds including carbon monoxide and carbon dioxide, and potentially reactive compounds including nitric oxide, nitrogen dioxide, sulfur dioxide, aldehydes, formaldehyde, acrolein, formic acid, odorants, particulates, soluble sulfates, and polynuclear aromatic hydrocarbons was determined. The concentration and mass emission rates of these compounds were measured in the laboratory under

three engine speed and load conditions and with three exhaust control conditions; that is, none, catalyst, and water conditioner. Once calibrated, the engine was installed in the Bureau of Mines Safety Research Coal Mine, and the concentration of exhaust pollutants was measured at several distances downstream inby the engine. Laboratory results confirm the relatively small effect of exhaust control devices on most pollutants under engine conditions of low speed and load. At higher engine speed and load, the catalyst is more effective in controlling many pollutants. The in-mine data indicate that during residence times, which are typical for miner-exhaust contact, most diesel exhaust pollutants do not decrease in concentration. The obvious exceptions are nitrogen dioxide, sulfur dioxide, and formaldehyde. The concentration of these pollutants is reduced up to 75 percent in 5 minutes. The lack of increase in levels of obvious reaction products indicates that surface loss may be a major sink for these pollutants.. Research done under contract J0188061 by Arthur D. Little, Inc. Available for reference at Bureau of Mines facilities at Tuscaloosa, Ala., Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; Mine Safety and Health Administration, Arlington, Va.; National Mine Health and Safety Academy, Beckley, W. Va.; and Office of Surface Mining Library and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Order ONLY from NTIS: PB 83-146241; paper copy price code A08.

OFR 199–82. Interactive Computer Programs for Manipulating Detailed Leontief Type Input-Output Models, by Everard M. Lofting and A. David Johnson. May 1982. 89 pp. A series of interactive FORTRAN computer programs for manipulating Leontief-type input-output models are presented with documentation and a descriptive users manual. Sample program outputs are annotated and described. Research done under contract J0113107 by Engineering-Economics Associates, Inc. Available for reference at Bureau of Mines facilities in Juneau, Alaska, Denver, Colo., Pittsburgh, Pa., and Spokane, Wash.; and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Order ONLY from NTIS: PB 83-149526; paper copy price code E05.

OFR 200–82. Impact of Proposed Lignite Mining in West Tennessee, by Richard G. Stearns, John M. Wilson, and Arthur L. Reesman. October 1981. 217 pp. 68 figs. Extensive thick lignite apparently lies within 250 feet of the land surface in Dyer, Lake, Lauderdale, Obion, and Tipton Counties, Tenn. Information on geology, land use, soils, ground water, and instability is compiled along with a bibliography. A test and monitoring site was investigated at Fort Pillow Prison in Lauderdale County. Analyses were made of lignite, overburden, associated water, and leachate. A year or more of data are presented on rainfull, water levels, and chemistry of surface water, ground water, leachate, and water from test pits. The main potential environmental problems are quality of surface water and possibly shallow ground water. The main aquifer of the region will likely be unaffected by mining. Low transmissibility of shallow aquifers will minimize lowering water levels of wells. Soil reclamation and conservation should be readily accomplished. Dangerous earthquakes have a low probability and mines are not significantly more hazardous than steep bluffs. Research done under contract J0100024 by Vanderbilt University. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Juneau, Alaska, Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; and Office of Surface Mining Library and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Order ONLY from NTIS: PB 83-146274; paper copy price code A10.

OFR 201–82. Stronger Mine Ventilation Tubing, by T. A. Raczek. Mar. 7, 1980. 70 pp. 22 figs. Materials for stronger ventilation tubing for underground use in hardrock mines were developed. The new material composites were evaluated in characteristics and compared with presently used materials on tear, tensile, puncture, and flammability properties. Based on cost versus performance data, a polyester film bonded to a polyester fabric was selected for field testing. Ventilation tubing fabricated from the selected material was field tested in two underground uranium mines for 4-month periods. The tests indicated that the new composite showed an increase in useful life in the majority of applications. However, the cost performance ratio was not sufficiently improved to warrant commercialization of the product. When connected directly to some blowers, the material in close proximity to the blower deteriorated. However, material that was punctured or torn by mechanical means did not have propagation of the tear. The high tear strength of the material prevented further damage. Improved methods of repairing inflated ventilation tubing were investigated and developed. All repair kit methods had to be portable and self-contained. Repair kits based on adhesives, pressure-sensitive tapes, and mechanical means were evaluated. Plier staplers and patch systems based on pressure-sensitive adhesive proved to be functional. Research done under contract H0188048 by Sheldahl, Inc. Available for reference at Bureau of Mines facilities at Tuscaloosa, Ala., Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; U.S. Department of Energy, Pittsburgh, Pa.; Mine Safety and Health Administration, Arlington, Va.; National Mine Health and Safety Academy, Beckley, W. Va.; and Office of Surface Mining Library and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Order ONLY from NTIS: PB 83-145060; paper copy price code A04.

OFR 202–82. Soil-Depth Requirements To Reclaim Surface-Mined Areas in the Northern Great Plains, by Richard C. Barth and Brooks K. Martin. April 1982. 191 pp. 24 figs. The objective of this research was to (1) determine existing reclamation practices and measure reclamation success for surface coal mines in the Northern Great Plains, (2) determine the optimum soil-depth requirements for grass production following surface mining, and (3) determine plant uptake of nutrients and trace elements in reclamation situations. Fourteen field plots were established at active coal mines. A wedge was cut into spoil and back-filled with soil; soil depth ranged from zero to 152 cm over a linear distance of 15 m. Perennial grasses were planted in each plot and production was measured from 1978 to 1981. Based on spoil traits and biomass response patterns, plots were grouped into four types. Spoil for type I was near neutral, slightly saline, nonsodic, and clay loam in texture. Perennial grasses reached maximum production with approximately 50 cm of soil depth. Spoil for type II plots

was characterized as sodic and fine textured; soil-depth requirements averaged 83 cm for maximum production. Spoil for type III plots was characterized as strongly acid, and production increased throughout the range tested. Spoil for type IV plots was similar to soil in chemical and physical traits; there was no production response to soil depth. Soil-depth requirements were also dependent upon precipitation and species. In general, soil-depth requirements decreased in dry years and with use of introduced species. An appendix contains data evaluations on an individual plot basis. Research done under contract J0265025 by Colorado School of Mines Research Institute. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Like City, Utah, and Spokane, Wash.; and the Office of Surface Mining Library and the National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Order ONLY from NTIS: PB 83–148221; paper copy price code A09.

OFR 203–82. An Application of the Dedicated Wire Technique To Improve Coal Mine Trolley Carrier Phone Communications, by Robert L. Lagace and Richard H. Spencer. December 1981. 78 pp. 25 figs. A whole-mine experiment to assess the practical feasibility and utility of the dedicated-wire technique to overcome poor trolley carrier phone system performance at a large underground coal mine was designed, performed, and evaluated. The technique involves the use of a single, low-loss, properly terminated, and branched auxiliary wire placed in the rail haulageway. This auxiliary dedicated wire allows signals to electromagnetically couple to the trolley wire-rail transmission line and thereby significantly decreases the overall signal attenuation rate on the trolley wire-rail line. The in-mine dedicated-wire demonstration program and its results, conclusions, and recommendations are described. Research done under contract J0308036 by Arthur D. Little, Inc. Available for reference at Bureau of Mines facilities in Tuscaloosa, Ala., Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; Mine Safety and Health Administration, Arlington, Va.; National Mine Health and Safety Academy, Beckley, W. Va.; and Office of Surface Mining Library and National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C. Order ONLY from NTIS: PB 83–149070; paper copy price code A05.

MINERAL LAND ASSESSMENTS

The following reports, part of a continuing series of Mineral Land Assessment reports, are available for consultation at the Bureau of Mines, Field Assessment and Evaluation Program Staff, Washington, D C , and at the National Library of Natural Resources, U.S. Department of the Interior, Washington, D C. Specific reports are also available at the field office indicated following their titles.

MLA 1–82. Mineral Resources of the Lost Cove and Harper Creek RARE II Further Planning Areas; Avery and Caldwell Counties, North Carolina, by Robert B. Ross, Jr., and Thomas M. Crandall. 1981. 61 pp. 7 figs. Eastern Field Operations Center, Pittsburgh, Pa.

MLA 2–82. Mineral Resources of the Mt. Henry RARE II Area (No. 1–666), Lincoln County, Montana, by Martin D. Conyac. 1981. 7 pp. 1 fig. Western Field Operations Center, Spokane, Wash.

MLA 3–82. Mineral Resources of the Los Machos Hills RARE II Area (No. 5111), San Luis Obispo County, California, by David K. Denton, Jr. 1981. 8 pp. 1 fig. Western Field Operations Center, Spokane, Wash.

MLA 4–82. Mineral Resources of the Raymond Peak RARE II Area (No. 4985), Alpine County, California, by Francis E. Federspiel, Douglas F. Scott, and Eric E. Cather. 1981. 18 pp. 1 fig. Western Field Operations Center, Spokane, Wash.

MLA 5–82. Mineral Resources of the Kings River (B5–198) and Rancheria (C5–198) RARE II Areas, Fresno County, California, by Warren D. Longwill. 1981. 25 pp. 1 fig. Western Field Operations Center, Spokane, Wash.

MLA 6–82. Mineral Resource Investigation Lusk Creek RARE II Further Planning Area; Pope County, Illinois, by Robert M. Thompson. 1981. 28 pp. 7 figs. Eastern Field Operations Center, Pittsburgh, Pa.

MLA 7–82. Mineral Resources of the Log Cabin Saddlebag (5052), Hall Natural Area (5051), Horse Meadow (5049), Tioga Lake (5050), RARE II Study Areas Mono County, California, by Francis E. Federspiel, Douglas F. Scott, Eric E. Cather, Nicholas T. Zilka, and Andrew M. Leszcykowski. 1981. 16 pp. 1 fig. Western Field Operations Center, Spokane, Wash.

MLA 8–82. Mineral Resources of the Garcia Mountain RARE II Area (No. 5107), San Luis Obispo County, California, by David A. Lipton. 1981. 9 pp. 1 fig. Western Field Operations Center, Spokane, Wash.

MLA 9–82. Mineral Resources of the La Brea RARE II Area (No. 5117), Santa Barbara County, California, by John R. Benham and Robin B. McCulloch. 1981. 9 pp. 1 fig. Western Field Operations Center, Spokane, Wash.

MLA 10–82. Mineral Resources of the Trail Lake RARE II Area (No. B5–095), Lassen and Plumas Counties, California, by Joseph L. Ritchey and Eric E. Cather. 1981. 7 pp. 1 fig. Western Field Operations Center, Spokane, Wash.

MLA 11–82. Mineral Resources of the Reservoir-North RARE II Area (No. H1–485), Teton County, Montana, by Lawrence Y. Marks. 1981. 6 pp. 1 fig. Western Field Operations Center, Spokane, Wash.

MLA 12–82. Mineral Resources of the Long Swamp RARE II Area (No. A6024), Okanogan County, Washington, by John R. Benham. 1981. 6 pp. 1 fig. Western Field Operations Center, Spokane, Wash.

MLA 13–82. Mineral-Resource Potential of the Lower San Francisco RARE II Further Planning and Wilderness Recommendation Areas, Greenlee County, Arizona, Grant and Catron Counties, New Mexico, by Michael E. Lane. 1981. 7 pp. 1 fig. Intermountain Field Operations Center, Spokane, Wash.

MLA 14–82. Mineral Resources of the Oat Mountain RARE II Area (No. 5197), Fresno County, California, by James M. Spear. 1981. 9 pp. 1 fig. Western Field Operations Center, Spokane, Wash.

MLA 15–82. Mineral Resources of the Lake Eleanor RARE II Area (No. 5807), Trinity County, California, by Eric E. Cather and Joseph L. Ritchey. 1981. 10 pp. 1 fig. Western Field Operations Center, Spokane, Wash.

MLA 16–82. Mineral Resources of the Santa Lucia Wilderness, San Luis Obispo County, California, by Charles Sabine and Leon E. Esparza. 1981. 6 pp. 1 fig. Western Field Operations Center, Spokane, Wash.

MLA 17–82. Mineral Resources of the Welcome Creek Wilderness, Granite County, Montana, by Terry J. Close. 1981. 15 pp. 1 fig. Western Field Operations Center, Spokane, Wash.

MLA 18–82. Mineral Resources of the Big Snowies Wilderness Study Area (RARE II 1–739) Fergus and Golden Valley Counties, Montana, by Francis E. Federspiel and James D. Huffsmith. 1981. 8 pp. 1 fig. Western Field Operations Center, Spokane, Wash.

MLA 19–82. Mineral Resources of the Agnew RARE II Area (No. 5199), Fresno County, California, by James M. Spear. 1982. 9 pp. 1 fig. Western Field Operations Center, Spokane, Wash.

MLA 20–82. Mineral Resources of the North Fork American River (5–262) RARE II Study Area, Placer County, California, by Francis E. Federspiel, Andrew M. Leszcykowski, and Frederick A. Spicker. 1981. 17 pp. 1 fig. Western Field Operations Center, Spokane, Wash.

MLA 21–82. Mineral Resources of the Black Mountain RARE II Area (No. 5108), San Luis Obispo County, California, by Peter N. Gabby. 1981. 12 pp. 1 fig. Western Field Operations Center, Spokane, Wash.

MLA 22–82. Mineral Resources of the Three Sisters Wilderness, Deschutes, Lane, and Linn Counties, Oregon, by J. Douglas Causey and Spencee L. Willett. 1981. 12 pp. 1 fig. Western Field Operations Center, Spokane, Wash.

MLA 23–82. Mineral Resources of the Diamond Peak Wilderness and Proposed Addition, Lane and Klamath Counties, Oregon, by Philip R. Moyle and Clayton M. Rumsey. 1981. 10 pp. 1 fig. Western Field Operations Center, Spokane, Wash.

MLA 24–82. Mineral Resources of the Anaconda Pintlar Wilderness, Beaverhead, Deer Lodge, Granite and Ravalli Counties, Montana, by Terry J. Close, Francis E. Federspiel, J. Douglas Causey, Spencee L. Willett, Richard W. Morris, and James R. Huffsmith. 1982. 23 pp. 1 fig. Western Field Operations Center, Spokane, Wash.

MLA 25–82. Mineral Resources of the Additions to the Ventana Wilderness, Monterey County, California, by Leon E. Esparza and Charles Sabine. 1982. 9 pp. 1 fig. Western Field Operations Center, Spokane, Wash.

MLA 26–82. Mineral Resources of Beaver Creek Wilderness; McCreary County, Kentucky, by Richard W. Hammack and Robert B. Ross, Jr. 1982. 40 pp. 12 figs. Eastern Field Operations Center, Pittsburgh, Pa.

MLA 27–82. Mineral Resources of Jobildunk RARE II Further Planning Area; Grafton County, New Hampshire, by Robert A. Welsh, Jr., and Lyle E. Harris. 1982. 17 pp. 3 figs. Eastern Field Operations Center, Pittsburgh, Pa.

MLA 28–82. Mineral Resource Investigation of Allegheny Front and Hickory Creek RARE II Further Planning Areas; Warren County, Pennsylvania, by Vaughn P. Girol. 1982. 26 pp. 5 figs. Eastern Field Operations Center, Pittsburgh, Pa.

MLA 29–82. Mineral Resources of the Whipple Mountains Wilderness Study Area, San Bernardino County, California, by James Ridenour, Phillip R. Moyle, and Spencee L. Willett. 1982. 34 pp. 1 fig. Western Field Operations Center, Spokane, Wash.

MLA 30–82. Mineral Resources of the Emmet Wash Wilderness Study Area, Coconino County, Arizona, by Michael E. Lane. 1982. 5 pp. 2 figs. Intermountain Field Operations Center, Denver, Colo.

MLA 31–82. Mineral Resources of Overflow Further Planning Area, Rabun County, Georgia, and Macon County, North Carolina, by Michael P. Davis. 1982. 16 pp. 3 figs. Eastern Field Operations Center, Pittsburgh, Pa.

MLA 32–82. Mineral Resources Investigation of Rainbow Lake Wilderness Area and Flynn Lake Wilderness Study Area, Bayfield County, Wisconsin, by Maynard L. Dunn, Jr., Gertrude C. Gazdik, and James J. Hill. 1982. 29 pp. 8 figs. Eastern Field Operations Center, Pittsburgh, Pa.

MLA 33–82. Mineral Resources of the Gearhart Mountain Wilderness and RARE II Area 6225, Klamath and Lake Counties, Oregon, by James Ridenour. 1982. 6 pp. 1 fig. Western Field Operations Center, Spokane, Wash.

MLA 34–82. Mineral Resources of Devils Den RARE II Further Planning Area, Rutland and Windsor Counties, Vermont, by Andrew E. Sabin and Jay G. Jones. 1982. 16 pp. 3 figs. Western Field Operations Center, Spokane, Wash.

MLA 35–82. Mineral Resource Potential of the Dragoon Mountains RARE II Further Planning Area, Cochise County, Arizona, by Terry J. Kreidler. 1982. 9 pp. 3 figs. Intermountain Field Operations Center, Denver, Colo.

MLA 36–82. Mineral Resources of the Domeland Wilderness, Kern and Tulare Counties, California, by Andrew Leszcykowski, Clayton Morlock, and Spencee Willett. 1982. 5 pp. 1 fig. Western Field Operations Center, Spokane, Wash.

MLA 37–82. Mineral Resources of the Mount Hood Wilderness, Clackamas and Hood River Counties, Oregon, by J. Douglas Causey. 1982. 13 pp. 1 fig. Western Field Operations Center, Spokane, Wash.

MLA 38–82. Mineral Resources of the Mount Washington Wilderness, Deschutes, Lane, and Linn Counties, Oregon, by J. Douglas Causey. 1982. 6 pp. 1 fig. Western Field Operations Center, Spokane, Wash.

MLA 39–82. Mineral Resource Investigation of Cornplanter RARE II Further Planning Area; Warren County, Pennsylvania, by Robert A. Welsh, Jr., and Roy H. Grau III. 1982. 24 pp. 4 figs. Eastern Field Operations Center, Pittsburgh, Pa.

MLA 40–82. Mineral Resources of Upper Buffalo Wilderness Area and Buffalo Addition RARE II Wilderness Area; Newton County, Arkansas, by Michelle K. Armstrong and Maynard L. Dunn, Jr. 1982. 19 pp. 5 figs. Eastern Field Operations Center, Pittsburgh, Pa.

MLA 41–82. Mineral Resources of the Hells Canyon Study Area, Adams, Idaho, and Nez Perce Counties, Idaho, and Wallowa County, Oregon, by Terry J. Close, Francis E. Federspiel, and Andrew Leszcykowski. 1982. 32 pp. 1 fig. Western Field Operations Center, Spokane, Wash.

MLA 42–82. Mineral Resources of Snowbird RARE II Further Planning Area; Graham County, North Carolina, by Mark L. Chatman. 1982. 18 pp. 3 figs. Eastern Field Operations Center, Pittsburgh, Pa.

MLA 43–82. Mineral Resources of Shinbone Creek and Adams Gap RARE II Further Planning Area; Clay County, Alabama, by Donald K. Harrison and Michelle K. Armstrong. 1982. 19 pp. 5 figs. Eastern Field Operations Center, Pittsburgh, Pa.

MLA 44–82. Mineral Resources of the Freel Peak RARE II Area (No. 5271), El Dorado County, California, by Thomas J. Peters and Francis E. Federspiel. 1982. 11 pp. 1 fig. Western Field Operations Center, Spokane, Wash.

MLA 45–82. Mineral Resources of the Square Butte Instant Wilderness Study Area, Chouteau County, Montana, by Charles E. Larson. 1982. 7 pp. 1 fig. Western Field Operations Center, Spokane, Wash.

MLA 46–82. Mineral Resources of Farles Prairie and Buck Lake RARE II Further Planning Areas; Marion County, Florida, by Thomas M. Crandall. 1982. 20 pp. 4 figs. Eastern Field Operations Center, Pittsburgh, Pa.

MLA 47–82. Mineral Resources of Cohutta Wilderness Area, Big Frog Wilderness Study Area, and Hemp Top and Big Frog Additions RARE II Areas, North-Central Georgia and Southeastern Tennessee, by Gertrude C. Gazdik and Maynard L. Dunn, Jr. 1982. 31 pp. 4 figs. Eastern Field Operations Center, Pittsburgh, Pa.

MLA 48–82. Mineral Resources of Sandy Creek RARE II Further Planning Area, Adams County, Mississippi, by Richard F. Bitar and Thomas M. Crandall. 1982. 18 pp. 5 figs. Eastern Field Operations Center, Pittsburgh, Pa.

MLA 49–82. Mineral Resources of the Hoover Wilderness and Proposed RARE II Additions 4–662, 5–662, 4–664, 4–666, Mono and Toulumne Counties, California, by Nicholas T. Zilka and Andrew M. Leszcykowski. 1982. 13 pp. 1 fig. Western Field Operations Center, Spokane, Wash.

MLA 50–82. Mineral Resources of Big Sandy and West Elliotts Creek RARE II Further Planning Areas and Reed Brake RARE II Wilderness Area, Tuscaloosa, Hale, and Bibb Counties, Alabama, by Michelle K. Armstrong and Peter C. Mory. 1982. 23 pp. 7 figs. Eastern Field Operations Center, Pittsburgh, Pa.

MLA 51–82. Mineral Resources of the Sawmill-Badlands RARE II Area (No. 5134), Ventura and Kern Counties, California, by Warren D. Longwill. 1982. 18 pp. 1 fig. Western Field Operations Center, Spokane, Wash.

MLA 52–82. Mineral Resources of the Golden Trout Wilderness, Tulare and Inyo Counties, California, by Nicholas T. Zilka. 1982. 9 pp. 2 figs. Western Field Operations Center, Spokane, Wash.

MLA 53–82. Mineral Resources of the Little Pine RARE II Area (No. 5278), Santa Barbara County, California, by Donald O. Capstick and Paul C. Hyndman. 1982. 7 pp. 1 fig. Western Field Operations Center, Spokane, Wash.

MLA 54–82. Mineral Resources of the Rubicon RARE II Area (No. 5026), El Dorado and Placer Counties, California, by Eric E. Cather and Douglas F. Scott. 1982. 9 pp. 1 fig. Western Field Operations Center, Spokane, Wash.

MLA 55–82. Mineral Resources of the Diablo RARE II Area (No. 5127), Santa Barbara County, California, by Donald O. Capstick and Paul C. Hyndman. 1982. 7 pp. 1 fig. Western Field Operations Center, Spokane, Wash.

MLA 56–82. Mineral-Resource Potential of the Mazatzal Wilderness and Contiguous RARE II Further Planning Area, Gila, Maricopa, and Yavapai Counties, Arizona, by Clarence E. Ellis. 1982. 12 pp. 4 figs. Intermountain Field Operations Center, Denver, Colo.

MLA 57–82. Mineral Resources of the Kaiser Wilderness Study Area, Fresno County, California, by Andrew Leszcykowski, Clayton Morlock, and Spencee Willett. 1982. 9 pp. 1 fig. Western Field Operations Center, Spokane, Wash.

MLA 58–82. Mineral Resources of Kinsman Mountain RARE II Further Planning Area, Grafton County, New Hampshire, by Richard W. Hammack and Vaughn P. Girol. 1982. 15 pp. 3 figs. Eastern Field Operations Center, Pittsburgh, Pa.

MLA 59–82. Mineral Resources of the Rice Valley Wilderness Study Area, Riverside County, California, by Gary J. Cwick, Edward L. McHugh, J. Douglas Causey, and Richard S. Gaps. 1982. 10 pp. 1 fig. Western Field Operations Center, Spokane, Wash.

MLA 60–82. Mineral Resources of the Bear Mountain RARE II Area (No. 5103), Monterey County, California, by James M. Spear. 1982. 10 pp. 1 fig. Western Field Operations Center, Spokane, Wash.

MLA 61–82. Mineral Resources of Dolly Anne RARE II Further Planning Area, Alleghany County, Virginia, by Jay G. Jones, Mark E. Piros, and Richard W. Hammack. 1982. 37 pp. 10 figs. Eastern Field Operations Center. Pittsburgh, Pa.

MLA 62–82. Placer Sampling and Related Bureau of Mines Activities in the Sound Study Area of the Chugach National Forest, Alaska, by Steven A. Fechner and Mark P. Meyer. 1982. 25 pp. 3 figs. Alaska Field Operations Center, Juneau, Alaska.

MLA 63–82. Mineral-Resource Potential of the Paria Plateau Wilderness Study Area, Coconino County, Arizona, by Michael E. Lane. 1982. 8 pp. 2 figs. Intermountain Field Operations Center, Denver, Colo.

MLA 64–82. Mineral Resources of the Matilija RARE II Area (No. 5129), Ventura and Santa Barbara Counties, California, by Robert H. Lambeth. 1982. 13 pp. 1 fig. Western Field Operations Center, Spokane, Wash.

MLA 65–82. Mineral Resources of Bread Loaf RARE II Further Planning Area, Addison and Washington Counties, Vermont, by Richard F. Bitar and Michelle K. Armstrong. 1982. 15 pp. 4 figs. Eastern Field Operations Center, Pittsburgh, Pa.

MLA 66–82. Mineral Investigation of the Pleasant View RARE II Area (No. 5008), Los Angeles County, California, by David A. Lipton. 1982. 8 pp. 1 fig. Western Field Operations Center, Spokane, Wash.

MLA 67-82. Mineral Investigation of the Orleans Mountain RARE II Area (No B5079), Humboldt and Siskiyou Counties, California, by J. Mitchell Linne and Donald J. Barnes. 1982. 18 pp. 1 fig. Western Field Operations Center, Spokane, Wash.

MLA 68–82. Mineral Investigation of the Quatal RARE II Area (No. 5268), Ventura County, California, by William W. White III. 1982. 15 pp. 1 fig. Western Field Operations Center, Spokane, Wash.

MLA 69–82. Mineral Investigation of the Pyramid RARE II Area (No. 5023), El Dorado County, California, by Douglas F. Scott. 1982. 7 pp. 1 fig. Western Field Operations Center, Spokane, Wash.

MLA 70–82. Mineral Resource Investigation of Carr Mountain RARE II Further Planning Area, Grafton County, New Hampshire, by Gertrude C. Gazdik. 1982. 18 pp. 3 figs. Eastern Field Operations Center, Pittsburgh, Pa.

MLA 71–82. Mineral Investigation of the Antimony RARE II Area (No. 5136), Kern County, California, by Lucia Kuizon. 1982. 14 pp. 1 fig. Western Field Operations Center, Spokane, Wash.

MLA 72–82 Mineral Resources Investigation of the Huston Park RARE II Further Planning Area, Carbon County, Wyoming, by Michael E. Lane. 1982. 3 pp. 1 fig. Intermountain Field Operations Center, Denver, Colo.

MLA 73–82. Mineral Investigation of the Southern Massanutten RARE II Further Planning Area, Page and Rockingham Counties, Virginia, by Thomas J. Wawro, Mark L. Chatman, and Paul T. Behum. 1982. 26 pp. 7 figs. Eastern Field Operations Center, Pittsburgh, Pa.

MLA 74–82. Mineral Resources Investigation of Graham Creek RARE II Further Planning Area, Angelina

and Jasper Counties, Texas, by George S. Ryan. 1982. 5 pp. 1 fig. Intermountain Field Operation Center, Denver, Colo.

MLA 75–82. Mineral Resources Investigation of the Savage Run Wilderness, Albany and Carbon Counties, Wyoming, by Steven E. Kluender. 1982. 8 pp. 2 figs. Intermountain Field Operations Center, Denver, Colo.

MLA 76–82. Mineral Resources Investigation of the Chambers Ferry RARE II Further Planning Area, Sabine County, Texas, by George S. Ryan. 1982. 5 pp. 1 fig. Intermountain Field Operations Center, Denver, Colo.

MLA 77–82. Mineral Resources Investigation of the Four Notch RARE II Further Planning Area, Walker County, Texas, by George S. Ryan. 1982. 5 pp. 1 fig. Intermountain Field Operations Center, Denver, Colo.

MLA 78–82. Mineral Resources Investigation of the Ryan Hill RARE II Further Planning Area, Socorro County, New Mexico, by Clarence E. Ellis and David C. Scott. 1982. 8 pp. 2 figs. Intermountain Field Operations Center, Denver, Colo.

MLA 79–82. Mineral Investigation of the San Joaquin RARE II Area (No. F5047), Madera County, California, by Donald O. Capstick. 1982. 9 pp. 1 fig. Western Field Operations Center, Spokane, Wash.

MLA 80–82. Mineral Investigation of the Table Mountain RARE II Area (No. 5035), Inyo County, California, by Donald O. Capstick and Andrew L. Stump. 10 pp. 1 fig. Western Field Operations Center, Spokane, Wash.

MLA 81–82. Mineral Investigations of the Madison RARE II Areas (No. 1549, Parts E, J, N, R, and S), Madison and Gallatin Counties, Montana, by Robert H. Lambeth, Steven W. Schmauch, Ronald T. Mayerle, and Michael M. Hamilton. 1982. 31 pp. 2 figs. Western Field Operations Center, Spokane, Wash.

MLA 82–82. Mineral Investigation of the Dardanelles RARE II Areas (Nos. 4982 and 5982), Alpine and El Dorado Counties, California, by Douglas F. Scott, Francis E. Federspiel, Eric E. Cather, and Harry W. Campbell. 1982. 12 pp. 1 fig. Western Field Operations Center, Spokane, Wash.

MLA 83–82. Mineral Investigation of the Benton Range RARE II Area (No. 5056), Mono County, California, by Richard L. Rains, Donald J. Barnes, Harry W. Campbell, David K. Denton, Jr., Stephen R. Iverson, Rodney E. Jeske, and Scott A. Stebbins. 1982. 15 pp. 1 fig. Western Field Operations Center, Spokane, Wash.

MLA 84–82. Mineral Investigation of the Dry Lakes RARE II Area (No. 5131), Ventura County, California, by William W. White III. 1982. 17 pp. 1 fig. Western Field Operations Center, Spokane, Wash.

MLA 85–82. Mineral Investigation of the Clarion River RARE II Further Planning Area, Elk County, Pennsylvania, by Robert A. Welsh, Jr., and Paul T. Behum. 1982. 32 pp. 6 figs. Eastern Field Operations Center, Pittsburgh, Pa.

MLA 86–82. Mineral Investigations of the Savannah RARE II Further Planning Area, Liberty County, Florida, by Thomas M. Crandall. 1982. 22 pp. 4 figs. Eastern Field Operations Center, Pittsburgh, Pa.

MLA 87–82. Mineral Investigations of Unaka Mountain RARE II Further Planning Area, Unicoi County, Tennessee, by Mark L. Chatman. 1982. 16 pp. 5 figs. Eastern Field Operations Center, Pittsburgh, Pa.

MLA 88–82. Mineral Investigations of Mount Wolf-Gordon Pond RARE II Further Planning Area, Grafton County, New Hampshire, by Clay M. Martin and Thomas J. Wawro. 1982. 16 pp. 3 figs. Eastern Field Operations Center, Pittsburgh, Pa.

MLA 89–82. Mineral Investigation of the Glacier Peak Wilderness and Adjacent Areas, Chelan, Skagit, and Snohomish Counties, Washington, by R. B. Stotelmeyer, F. L. Johnson, E. L. McHugh, F. E. Federspiel, D. K. Denton, Jr., and S. A. Stebbins. 1982. 36 pp. 1 fig. Western Field Operations Center, Spokane, Wash.

MLA 90–82. Mineral Investigations of Dartmouth Range RARE II Further Planning Area, Coos County, New Hampshire, by Frederick W. Miller. 1982. 18 pp. 5 figs. Eastern Field Operations Center, Pittsburgh, Pa.

MLA 91–82. Mineral Investigation of Presidential Range-Dry River Wilderness, Coos and Carroll Counties, New Hampshire, by Lyle E. Harris. 1982. 18 pp. 3 figs. Eastern Field Operations Center, Pittsburgh, Pa.

MLA 92–82. Mineral Investigations of the Middle Fork Judith RARE II Area (No. 1734) and the Included Middle Fork Judith Wilderness Study Area, Judith Basin and Meagher Counties, Montana, by Michael M. Hamilton and Ronald T. Mayerle. 1982. 18 pp. 1 fig. Western Field Operations Center, Spokane, Wash.

MLA 93–82. Mineral Investigation of the Lincoln Creek RARE II Area (No. 5983), Douglas County, Nevada, by Scott A. Stebbins. 1982. 9 pp. 1 fig. Western Field Operations Center, Spokane, Wash.

MLA 94–82. Mineral Investigation of the Coxcomb Mountains Wilderness Study Area (BLM), Riverside and San Bernardino Counties, California, by Andrew M. Leszcykowski and J. Douglas Causey. 1982. 11 pp. 1 fig. Western Field Operations Center, Spokane, Wash.

MLA 95–82. Mineral Investigation of Pemigewasset RARE II Further Planning Area, Grafton and Carroll Counties, New Hampshire, by Andrew E. Sabin, Clay M. Martin, and Robert M. Thompson. 1982. 16 pp. 3 figs. Eastern Field Operations Center, Pittsburgh, Pa.

MLA 96–82. Mineral Resources Investigation of the Richland Creek Addition RARE II Further Planning Area, Newton and Searcy Counties, Arkansas, by Robert H. Wood II. 1982. 7 pp. 2 figs. Intermountain Field Operations Center, Denver, Colo.

MLA 97–82. Mineral Land Assessment of Yakobi Island and Adjacent Parts of Chichagof Island, Southeastern Alaska, by Arthur L. Kimball. 1982. 199 pp. 31 figs. Alaska Field Operations Center, Juneau, Alaska.

MLA 98–82. Mineral Investigation of Wild River RARE II Further Planning Area; Coos County, New Hampshire, by Robert A. Welsh, Jr., Gertrude C. Gazdik, Richard F. Bitar, and Ronald W. Mikolajczyk. 1982. 17 pp. 3 figs. Eastern Field Operations Center, Pittsburgh, Pa.

MLA 99–82. Mineral Investigations of Flint Mill Gap RARE II Further Planning Area, Carter and Johnson Counties, Tennessee, by Jay G. Jones. 1982. 24 pp. 6 figs. Eastern Field Operations Center, Pittsburgh, Pa.

MLA 100–82. Mineral Investigation of the Caribou Wilderness, Lassen and Plumas Counties, California, by Edward L. McHugh and Clayton M. Rumsey. 1982. 7 pp. 1 fig. Western Field Operations Center, Spokane, Wash.

MLA 101–82. Mineral Investigation of the Pine Creek RARE II Area (No. 6248), Harney County, Oregon, by David K. Denton, Jr. 1982. 7 pp. 1 fig. Western Field Operations Center, Spokane, Wash.

MLA 102–82. Mineral Investigation of the Selway-Bitterroot Wilderness (FS), Idaho County, Idaho and Missoula and Ravalli Counties, Montana, by Nicholas T. Zilka and Michael M. Hamilton. 1982. 14 pp. 2 figs. Western Field Operations Center, Spokane, Wash.

MLA 103–82. Mineral Investigation of the Yolly Bolly-Middle Eel Wilderness (FS), Tehama and Trinity Counties, California, by Andrew M. Leszcykowski and Michael Gobla. 1982. 9 pp. 1 fig. Western Field Operations Center, Spokane, Wash.

MLA 104–82. Mineral Investigation of the Arroyo Seco RARE II Area (No. 5012), Los Angeles County, California, by Peter N. Gabby. 1982. 9 pp. 1 fig. Western Field Operations Center, Spokane, Wash.

MLA 105–82. Mineral Investigation of the Wonder Mountain RARE II Area (No. 6086), Mason County, Washington, by Stephen R. Iverson. 1982. 11 pp. 1 fig. Western Field Operations Center, Spokane, Wash.

MLA 106–82. Mineral Investigation of the Caliente RARE II Area (No. 5017), San Diego County, California, by Ronald T. Mayerle. 1982. 11 pp. 1 fig. Western Field Operations Center, Spokane, Wash.

MLA 107–82. Mineral Investigation of the Bighorn Mountains Wilderness Study Area, San Bernardino County, California, by Charles Sabine and Gary J. Cwick. 21 pp. 2 figs. Western Field Operations Center, Spokane, Wash.

MLA 108–82. Mineral Resources Investigation of the Chama River Canyon Wilderness and Contiguous RARE II Further Planning Area, Rio Arriba County, New Mexico, by Thomas D. Light. 1982. 13 pp. 3 figs. Intermountain Field Operations Center, Denver, Colo.

MLA 109–82. Cobalt Content in Samples From the Omar Copper Prospect, Baird Mountains, Alaska, by Uldis Jansons. 1982. 16 pp. 3 figs. Alaska Field Operations Center, Anchorage, Alaska.

MLA 110–82. Mineral Investigation of the Sheep Hole/Cadiz Wilderness Study Area (BLM), San Bernardino County, California, by Phillip R. Moyle and Clayton M. Rumsey. 1982. 36 pp. 2 figs. Western Field Operations Center, Spokane, Wash.

MLA 111–82. Mineral Resources Investigation of West Slope Tetons (South) RARE II Further Planning Area, Teton County, Wyoming, by Steven E. Kluender. 1982. 7 pp. 2 figs. Intermountain Field Operations Center, Denver, Colo.

MLA 112–82. Mineral Investigation of the Muddy Mountains Wilderness Study Area (BLM), Clarke County, Nevada, by Andrew M. Leszcykowski, Leon E. Esparza, and Clayton M. Rumsey. 1982. 16 pp. 1 fig. Western Field Operations Center, Spokane, Wash.

MLA 113–82. Mineral Investigation of Cheat Mountain Further Planning Area, Randolph County, West Virginia, by Paul T. Behum and Richard W. Hammack. 1982. 63 pp. 16 figs. Eastern Field Operations Center, Pittsburgh, Pa.

MLA 114–82. Mineral Investigation of the Thousand Lakes (FS) Wilderness, Shasta County, California, by Edward L. McHugh and Clayton M. Rumsey. 1982. 8 pp. 1 fig. Western Field Operations Center, Spokane, Wash.

MLA 115–82. Mineral Investigation of Great Gulf Wilderness Area, Coos County, New Hampshire, by Vaughn P. Girol and Thomas M. Crandall. 1982. 15 pp. 3 figs. Eastern Field Operations Center, Pittsburgh, Pa.

MLA 116–82. Mineral Resources Investigation of the Manzano Mountain Wilderness, Torrance and Valencia Counties, New Mexico, by Thomas D. Light. 1982. 6 pp. 3 figs. Intermountain Field Operations Center, Denver, Colo.

MLA 117–82. Mineral Resources Investigation of the Little Blakely RARE II Further Planning Area, Garland County, Arkansas, by Robert H. Wood II. 1982. 9 pp. 3 figs. Intermountain Field Operations Center, Denver, Colo.

MLA 118–82. Mineral Resources Investigation of the Pusch Ridge Wilderness, Pima County, Arizona, by George S. Ryan. 1982. 19 pp. 4 figs. Intermountain Field Operations Center, Denver, Colo.

MLA 119–82. Mineral Resources Investigation of the Sandia Mountain Wilderness, Bernalillo and Sandoval Counties, New Mexico, by Richard F. Kness. 1982. 44 pp. 4 figs. Intermountain Field Operations Center, Denver, Colo.

MLA 120–82. Mineral Investigation of the Lick Creek RARE II Area (No. 6285), Wallowa and Baker Counties, Oregon, by Ronald T. Mayerle. 1982. 11 pp. 1 fig. Western Field Operations Center, Spokane, Wash.

MLA 121–82. Zinc-Lead Occurrences in and Near the National Petroleum Reserve in Alaska, by Uldis Jansons. 1982. 55 pp. 12 figs. Alaska Field Operations Center, Juneau, Alaska.

MLA 122–82. Mineral Investigations of Hell Hole Bay, Little Wambaw Swamp, Wambaw Creek, and Wambaw Swamp Wilderness Areas, Berkeley and Charleston Counties, South Carolina, by Clay M. Martin and Gertrude C. Gazdik. 1982. 19 pp. 2 figs. Eastern Field Operations Center, Pittsburgh, Pa.

MLA 123–82. Mineral Resources Investigation of the Service Creek Roadless Area, Routt County, Colorado, by Steven E. Kluender. 1982. 6 pp. 2 figs. Intermountain Field Operations Center, Denver, Colo.

MLA 124–82. A Manganese Occurrence on Chenega Island, Prince William Sound, Alaska, by Joseph M. Kurtak. 1982. 9 pp. 3 figs. Alaska Field Operations Center, Anchorage, Alaska.

MLA 125–82. Mineral Investigation of the Bridger Wilderness and Green-Sweetwater RARE II Wilderness Recommendation Area, Sublette and Fremont Counties, Wyoming, by George S. Ryan. 1982. 12 pp. 3 figs.

Intermountain Field Operations Center, Denver, Colo.

MLA 126–82. Mineral Investigation of the Mount Naomi RARE II Further Planning Area, Cache County, Utah, and Franklin County, Idaho, by Philip R. Bigsby. 1982. 12 pp. 2 figs. Intermountain Field Operations Center, Denver, Colo.

MLA 127–82. Mineral Investigation of the Wheeler Peak Wilderness, Taos County, New Mexico, by S. Don Brown. 1982. 32 pp. 6 figs. Intermountain Field Operations Center, Denver, Colo.

MLA 128–82. Mineral Investigation of the Fox Mountain RARE II Area (No. 5120), Santa Barbara County, California, by Robin B. McCulloch and Terry R. Neumann. 1982. 9 pp. 1 fig. Western Field Operations Center, Spokane, Wash.

MLA 129–82. Mineral Investigation of the Whetstone Roadless Area, Cochise and Pima Counties, Arizona, by Robert A. McColly and David C. Scott. 1982. 22 pp. 7 figs. Intermountain Field Operations Center, Denver, Colo.

MLA 130–82. Mineral Investigation of the Goat Rocks Wilderness Study Area (FS), Lewis and Yakima Counties, Washington, by Terry C. Close. 1982. 12 pp. 1 fig. Western Field Operations Center, Spokane, Wash.

MLA 131–82. Mineral Investigation of Parts of the Rock Creek, Little Goose, and Cloud Peak Contiguous Roadless Areas, Big Horn, Johnson, and Sheridan Counties, Wyoming, by S. Don Brown. 1982. 11 pp. 3 figs. Intermountain Field Operations Center, Denver, Colo.

MLA 132–82. Mineral Investigation of the Fiddler Butte Wilderness Study Area, Garfield County, Utah, by John P. Briggs. 1982. 19 pp. 6 figs. Intermountain Field Operations Center, Denver, Colo.

MLA 133–82. Mineral Investigation of the Rattlesnake Roadless Area, Coconino and Yavapai Counties, Arizona, by Robert A. McColly. 1982. 5 pp. 1 fig. Intermountain Field Operations Center, Denver, Colo.

MLA 134–82. Mineral Investigation of the Wet Beaver Creek RARE II Further Planning Area, Coconino and Yavapai Counties, Arizona, by Alan M. Bielski. 1982. 5 pp. 1 fig. Intermountain Field Operations Center, Denver, Colo.

MLA 135–82. Mineral Investigation of the Kisatchie Hills Wilderness, Natchitoches Parish, Louisiana, by George S. Ryan. 1982. 4 pp. 1 fig. Intermountain Field Operations Center, Denver, Colo.

MLA 136–82. Mineral Investigation of the Superstition Wilderness and Contiguous RARE II Further Planning Areas, Gila, Maricopa, and Pinal Counties, Arizona, by Jimmie E. Jinks. 1982. 25 pp. 4 figs. Intermountain Field Operations Center, Denver, Colo.

MLA 137–82. Mineral Investigation of the Hells Hole Roadless Area, Greenlee County, Arizona, and Grant County, New Mexico, by John P. Briggs. 1982. 22 pp. 7 figs. Intermountain Field Operations Center, Denver, Colo.

MLA 138–82. Mineral Investigation of the Elk Creek RARE II Area (No. 5140), Lake and Mendocino Counties, California, by James M. Spear. 1982. 9 pp. 1 fig. Western Field Operations Center, Spokane, Wash.

MLA 139–82. Mineral Investigation of the Hells Gate Roadless Area, Gila County, Arizona, by Robert A. McColly. 1982. 13 pp. 2 figs. Intermountain Field Operations Center, Denver, Colo.

MLA 140–82. Mineral Investigation of Chattahoochee River RARE II Further Planning Area, Towns, Union, and White Counties, Georgia, by Robert A. Welsh, Jr., and Ronald W. Mikolajczyk. 1982. 25 pp. 5 figs. Eastern Field Operations Center, Pittsburgh, Pa.

MLA 141–82. Mineral Investigation of Rich Mountain RARE II Further Planning Area, Gilmer and Fannin Counties, Georgia, by Robert M. Thompson and Vaughn P. Girol. 1982. 12 pp. 4 figs. Eastern Field Operations Center, Pittsburgh, Pa.

MLA 142–82. Mineral Investigation of the Big Maria Mountains Wilderness Study Area (BLM) CDCA-321, Riverside County, California, by Edward L. McHugh, J. Douglas Causey, Richard S. Gaps, and Gary J. Cwick. 1982. 26 pp. 2 figs. Western Field Operations Center, Spokane, Wash.

MLA 143–82. Mineral Investigation of the Columbine-Hondo Roadless Area, Taos County, New Mexico, by John P. Briggs. 1982. 21 pp. 9 figs. Intermountain Field Operations Center, Denver, Colo.

MLA 144–82. Mineral Investigation of the Black Butte RARE II Area (No. 5269), Glenn and Mendocino Counties, California, by James M. Spear. 1982. 8 pp. 1 fig. Western Field Operations Center, Spokane, Wash.

MLA 145–82. Mineral Investigation of Tray Mountain RARE II Further Planning Area, Rabun, Habersham, Towns, and White Counties, Georgia, by Mark L. Chatman. 1982. 39 pp. 8 figs. Eastern Field Operations Center, Pittsburgh, Pa.

COOPERATIVE PUBLICATIONS

WITH THE U.S. ENVIRONMENTAL PROTECTION AGENCY

EPA 1–82. Environmental Considerations for Emerging Copper-Winning Processes, by H. Dolezal, M. Hayashi, G. Potter, and J. O. Burckle. 1982. 6 pp EPA–600/S2–82–058.

WITH THE GEOLOGICAL SURVEY U.S. DEPARTMENT OF THE INTERIOR

The Wilderness Act (Public Law 88–577, September 3, 1964) and the Conference Report on Senate Bill 4, 88th Congress, direct the Geological Survey and the Bureau of Mines to make mineral surveys of wilderness and primitive areas. Areas officially designated as "wilderness," "wild," or "canoe" when the act was passed were incorporated into the National Wilderness Preservation System. Areas classifield as "primitive" were not included in the Wilderness System, but the act provided that each area should be studied for incorporation into the Wilderness System. The act also directs the Secretary of the Interior to review roadless areas of 5,000 contiguous acres or more and every roadless island within the national wildlife refuges and game ranges under the Secretary's jurisdiction, and to report the suitability or nonsuitability of each area or island for preservation as a wilderness. The mineral surveys of the primitive areas, wildlife refuges, and game ranges are one aspect of the suitability studies.

The following publications can be obtained from—

U.S. Geological Survey
604 South Pickett St.
Alexandria, VA 22304–4658

GS 1–82. Mineral Resources of the Boulder-Pioneer Wilderness Study Area, Blaine and Custer Counties, Idaho, by the U.S. Geological Survey and U.S. Bureau of Mines. With sections on geology, by J. H. Dover; aeromagnetic studies, by D. R. Mabey; geological and geochemical evaluation, by F. S. Simons; and economic appraisal, by E. T. Tuchek and James Ridenour. 1981. 303 pp. 66 figs. 5 pl. Geol. Surv. Bull. 1497. $15.

GS 2–82. Mineral Resources of the Sheep Mountain Wilderness Study Area and the Cucamonga Wilderness and Additions, Los Angeles and San Bernardino Counties, California, by the U.S. Geological Survey and U.S. Bureau of Mines. With sections on geology and geologic and geochemical evaluation, by J. G. Evans; aeromagnetic studies, by Leroy Pankratz; economic appraisal of Sheep Mountain Wilderness Study Area, by James Ridenour, S. W. Schmauch, and N. T. Zilka; and economic appraisal of Cucamonga Wilderness and additions, by N. T. Zilka and S. W. Schmauch. 1982. 92 pp. 2 pl. Geol. Surv. Bull. 1506–A–E. $5.50.

GS 3–82. Mineral Resources of Proposed Additions to the Salmon-Trinity Alps Primitive Area, California, by Preston E. Hotz, Robert C. Greene, Terry J. Close, and Robert K. Evans. 1982. 54 pp. 21 figs. 1 pl. Geol. Surv. Bull. 1514. $4.25.

GS 4–82. Mineral Resources of the Craggy Mountain Wilderness Study Area and Extension, Buncombe County, North Carolina, by F. G. Lesure, A. E. Grosz, B. B. Williams, and G. C. Gazdik. 1982. 27 pp. 6 figs. 1 pl. Geol. Surv. Bull. 1515. $4.

GS 5–82. Mineral Resources of the Minarets Wilderness and Adjacent Areas, Madera and Mono Counties, California, by the U.S. Geological Survey and U.S. Bureau of Mines. With sections on regional setting, geology, and geochemical studies, by N. King Huber; geophysical studies, by Howard W. Oliver; geothermal-resource evaluation, by Roy A. Bailey; and economic-mineral appraisal, by Horace K. Thurber, Michael S. Miller, C. Thomas Hillman, David S. Lindsey, and Richard W. Morris. 1982. 159 pp. 55 figs. 3 pl. Geol. Surv. Bull. 1516–A–D. $7.50.

GS 6–82. Mineral Resources of the Big Frog Wilderness Study Area and Additions, Polk County, Tennessee, and Fannin County, Georgia, by John F. Slack, Gertrude C. Gazdik, and Maynard L. Dunn, Jr. 1982. 25 pp. 8 figs. Geol. Surv. Bull. 1531. $2.50.

WITH THE STATE OF NORTH CAROLINA NORTH CAROLINA GEOLOGICAL SURVEY

NCGS 1–82. Clays and Shales of the North Carolina Piedmont, by Eldon P. Allen and Kenneth J. Liles. 1982. 266 pp. NC Geol. Surv. OFR 80–4. $58.

REPORTS AVAILABLE FROM THE NATIONAL TECHNICAL INFORMATION SERVICE

Bureau of Mines publications and open file reports are available from the National Technical Information Service (NTIS) in two forms: paper cover copies and microfiche. Price codes are listed for paper copies of each publication. Contact NTIS for a copy of the current price schedule for domestic orders (any order going to Canada, the United States, or Mexico) or the current schedule for foreign orders (any orders going to a country other than Canada, the United States, or Mexico). Microfiche copies of most of the publications are available on request (price code A01 unless otherwise indicated). Purchases may be made by check or money order payable to the National Technical Information Service, charged to a deposit account at NTIS, or charged on a VISA, MasterCard, or American Express credit card. Address requests to—

National Technical Information Service
U.S. Department of Commerce
Springfield, VA 22161

or call 703–487–4650.

BUREAU OF MINES INDEX

This index primarily lists all 1982 Bureau of Mines publications placed with the National Technical Information Service. A description of each publication can be found in the individual publication listings. Other indexes, by Bureau series and number, can be found in the 5-year lists of Bureau of Mines publications and articles for the calendar years 1965–69, 1970–74, 1975–79, and in the annual lists for the calendar years 1980 and 1981.

Bureau series and number	NTIS accession number	Paper copy price code
B 672	PB 83–174052	A22
B 673	PB 83–119479	A03

* For microfiche price for this publication, please contact NTIS.

Bureau series and number	NTIS accession number	Paper copy price code
IC 8862	PB 82–195512	A03
IC 8863	PB 83–125302	A04
IC 8864	PB 83–125294	A02
IC 8868	PB 82–195694	A02
IC 8870	PB 82–196593	A99
IC 8871	PB 82–195553	A02
IC 8872	PB 82–201302	A04
IC 8873	PB 82–221250	A03
IC 8874	PB 82–202250	A02
IC 8875	PB 82–221359	A02
IC 8876	PB 82–220401	A02
IC 8877	PB 82–235524	A04
IC 8878	PB 82–232505	A03
IC 8879	PB 82–233669	A03
IC 8880	PB 82–221276	A02
IC 8881	PB 82–235516	A14
IC 8882	PB 82–235532	A02
IC 8883	PB 82–257544	A02
IC 8884	PB 82–266180	A05
IC 8885	PB 83–122655	A02
IC 8886	PB 83–116434	A15
IC 8887	PB 83–140624	A04
IC 8888	PB 83–112557	A03
IC 8889	PB 83–103176	A02
IC 8890	PB 83–119511	A05
IC 8891	PB 83–119404	A06
IC 8892	PB 83–143149	A02
IC 8893	PB 83–119487	A05
IC 8894	PB 83–119412	A02
IC 8895	PB 83–145508	A02
IC 8896	PB 83–172189	A03
IC 8897	PB 83–156869	A02
IC 8898	PB 83–157685	A03
IC 8899	PB 83–156794	A02
IC 8900	PB 83–197616	A03
IC 8901	PB 83–178830	A06
IC 8902	PB 83–156802	A02
IC 8903	PB 83–171934	A02
IC 8904	PB 83–156810	A02
IC 8905	PB 83–140616	A03
IC 8906	PB 83–197079	A04
IC 8907	PB 83–156026	A05
IC 8908	PB 83–162420	A03
IC 8910	PB 83–156398	A04
MY 1980, v. 1	PB 82–180027	A99*
MY 1980, v. 2	PB 82–255829	A25
MY 1980, v. 3	PB 82–220906	A99*
MY 1981, v. 1	PB 83–177568	A99*
MY 1981, v. 2	PB 83–213975	A24
MY 1981, v. 3	PB 83–213983	A99*
OFR 1–82	PB 82–146325	A07

REPORTS AVAILABLE FROM THE NATIONAL TECHNICAL INFORMATION SERVICE

Bureau series and number	NTIS accession number	Paper copy price code
OFR 2–82	PB 82–147471	A07
OFR 3–82	PB 82–148388	A10
OFR 4–82	PB 82–146275	A09
OFR 5–82	PB 82–146267	A04
OFR 6–82	PB 82–149352	A09
OFR 8(1)–82	PB 82–152125	A08
OFR 8(2)–82	PB 82–152133	A12
OFR 9–82	PB 82–163940	A05
OFR 10–82	PB 82–161936	A04
OFR 11(1)–82	PB 82–168048	A04
OFR 11(2)–82	PB 82–168055	A11
OFR 12–82	PB 82–163395	A07
OFR 13–82	PB 82–163965	A13
OFR 14–82	PB 82–164526	A11
OFR 15(1)–82	PB 82–166471	A13
OFR 15(2)–82	PB 82–166489	A19
OFR 16–82	PB 82–172727	A06
OFR 17–82	PB 82–172719	A08
OFR 19–82	PB 82–180993	A18
OFR 22–82	PB 82–183104	A12
OFR 23–82	PB 82–183369	A07
OFR 24–82	PB 82–183112	A07
OFR 25–82	PB 82–183351	A06
OFR 26–82	PB 82–183401	A07
OFR 27–82	PB 82–190547	A03
OFR 29(1)–82	PB 82–187964	A07
OFR 29(2)–82	PB 82–187949	A04
OFR 30–82	PB 82–183344	A09
OFR 31–82	PB 82–196270	A15
OFR 33–82	PB 82–187139	A15
OFR 34–82	PB 82–185471	A08
OFR 35–82	PB 82–184714	A10
OFR 36–82	PB 82–188707	A20
OFR 37–82	PB 82–194184	A11
OFR 38–82	PB 82–192022	A13
OFR 39(1)—(7)–82 set	PB 82–218132	E99**
OFR 39(1)–82	PB 82–218207	A05
OFR 39(2)–82	PB 82–218140	A03
OFR 39(3)–82	PB 82–218157	A03
OFR 39(4)–82	PB 82–218165	A03
OFR 39(5)–82	PB 82–218173	A03
OFR 39(6)–82	PB 82–218181	A03
OFR 39(7)–82	PB 82–218199	A03
OFR 40(1)–82	PB 82–195736	A03
OFR 41(1)–82	PB 82–199985	A08
OFR 41(2)–82	PB 82–199993	A04
OFR 42–82	PB 82–198557	A05
OFR 45–82	PB 82–197492	A04
OFR 46–82	PB 82–202706	A06
OFR 47–82	PB 82–201385	A08
OFR 49–82	PB 82–201815	A05
OFR 50–82	PB 82–201864	A10
OFR 52–82	PB 82–209719	A07
OFR 53–82	PB 82–209727	A04
OFR 54–82	PB 82–205691	A08
OFR 55–82	PB 82–205725	A06
OFR 56–82	PB 82–209768	A06
OFR 57–82	PB 82–200486	A05
OFR 58–82	PB 82–200494	A04
OFR 59–82	PB 82–202748	A04
OFR 62–82	PB 82–203241	A08
OFR 63–82	PB 82–202656	A05
OFR 64–82	PB 82–202649	A03
OFR 65–82	PB 82–202664	A02
OFR 66–82	PB 82–204868	A04
OFR 67–82	PB 82–204876	A03
OFR 68–82	PB 82–245945	A08
OFR 71–82	PB 82–213927	A03
OFR 72–82	PB 82–218041	A11
OFR 73–82	PB 82–215765	A04
OFR 74–82	PB 82–208422	A07
OFR 75–82	PB 82–213901	A06
OFR 76–82	PB 82–214099	A17
OFR 77–82	PB 83–175562	A08
OFR 78–82	PB 82–218660	A06
OFR 79–82	PB 82–218652	A04
OFR 80–82	PB 82–235979	A09
OFR 81–82	PB 82–235987	A04
OFR 83–82	PB 82–243940	A02
OFR 84–82	PB 82–243932	A10
OFR 85–82	PB 82–243957	A05
OFR 86–82	PB 82–244724	A11
OFR 87–82	PB 82–243973	A08
OFR 88–82	PB 82–246042	A04
OFR 89–82	PB 82–246034	A07
OFR 90–82	PB 82–246018	A14
OFR 91–82	PB 82–244740	A11
OFR 92–82	PB 82–244252	A11
OFR 93–82	PB 82–244245	A03
OFR 94–82	PB 82–244237	A06
OFR 95–82	PB 82–244260	A05
OFR 96–82	PB 82–245937	A03
OFR 97–82	PB 82–243965	A15
OFR 98–82	PB 82–244708	A09
OFR 99–82	PB 82–244732	A13
OFR 100(1)–82	PB 82–244286	A07
OFR 100(2)–82	PB 82–244294	A11
OFR 100(3)–82	PB 82–244302	A11
OFR 106–82	PB 82–244229	A06
OFR 107–82	PB 82–257205	A07
OFR 108–82	PB 82–250598	A07
OFR 109–82	PB 82–250580	A03
OFR 110–82	PB 82–249939	A12
OFR 111–82	PB 82–251562	A04
OFR 112(1)–82	PB 82–249699	A17
OFR 112(2)–82	PB 82–249657	A08
OFR 114–82	PB 82–253030	A22
OFR 115–82	PB 82–254525	A06
OFR 118–82	PB 82–251984	A05
OFR 119–82	PB 82–251943	A15
OFR 120–82	PB 82–251919	A04
OFR 121(1)–82	PB 82–251950	A10
OFR 121(2)–82	PB 82–251968	A04
OFR 122–82	PB 82–251935	A03
OFR 123–82	PB 82–251976	A03
OFR 124–82	PB 82–252016	A03
OFR 125–82	PB 82–255480	A07
OFR 126–82	PB 82–255464	A07
OFR 127–82	PB 82–251927	A06
OFR 128–82	PB 82–251992	A06
OFR 133–82	PB 83–134866	A99

** Not available in microfiche.

Bureau series and number	NTIS accession number	Paper copy price code
OFR 135–82	PB 82–262460	A07
OFR 136(1)–82	PB 83–100545	A09
OFR 136(2)–82	PB 83–101030	A06
OFR 137–82	PB 82–256223	A04
OFR 138–82	PB 82–257841	A10
OFR 139(1)–82	PB 82–259219	A07
OFR 139(2)–82	PB 82–259227	A11
OFR 139(3)–82	PB 83–110965	A03
OFR 145–82	PB 83–109207	A10
OFR 146(1)–82	PB 83–120261	A04
OFR 146(2)–82	PB 83–120279	A05
OFR 147–82	PB 83–104661	E05
OFR 148–82	PB 83–104679	E04
OFR 149–82	PB 83–102681	A07
OFR 150–82	PB 83–110197	A03
OFR 151–82	PB 83–106781	A08
OFR 154–82	PB 83–107730	A04
OFR 155–82	PB 83–117887	A08
OFR 156–82	PB 83–115865	A13
OFR 157–82	PB 83–115840	A05
OFR 158–82	PB 83–115857	A11
OFR 159–82	PB 83–114876	A11
OFR 160–82	PB 83–114744	A06
OFR 161(1)–82	PB 83–122598	A11
OFR 161(4)–82	PB 83–122606	A03
OFR 164–82	PB 83–114868	A10
OFR 166(1)–82	PB 83–115873	A13
OFR 166(2)–82	PB 83–115881	A09
OFR 167–82	PB 83–114884	A10
OFR 168–82	PB 83–114173	A05
OFR 169–82	PB 83–115014	A12
OFR 170–82	PB 83–119149	A09
OFR 171–82	PB 83–119388	A06
OFR 172–82	PB 83–122762	A05
OFR 173–82	PB 83–120154	A14
OFR 174–82	PB 83–120170	A14
OFR 175–82	PB 83–122754	A05
OFR 176–82	PB 83–120147	A06
OFR 177–82	PB 83–119370	A04
OFR 178(1)–82	PB 83–120378	A24
OFR 178(2)–82	PB 83–120386	A23
OFR 179–82	PB 83–170639	A05
OFR 180–82	PB 83–147777	A09
OFR 181–82	PB 83–138859	A03
OFR 182–82	PB 83–136051	A15
OFR 183–82	PB 83–138065	A99
OFR 184–82	PB 83–136358	A10
OFR 185–82	PB 83–137810	A07
OFR 186–82	PB 83–137596	A03
OFR 187–82	PB 83–134874	A05
OFR 188–82	PB 83–137091	A09
OFR 189–82	PB 83–137109	A06
OFR 195–82	PB 83–137315	A07
OFR 196(1)–82	PB 83–148049	A14
OFR 196(2)–82	PB 83–148056	A07
OFR 197–82	PB 83–144832	A08
OFR 198–82	PB 83–146241	A08
OFR 199–82	PB 83–149526	E05
OFR 200–82	PB 83–146274	A10
OFR 201–82	PB 83–145060	A04
OFR 202–82	PB 83–148221	A09
OFR 203–82	PB 83–149070	A05

Bureau series and number	NTIS accession number	Paper copy price code
RI 8590	PB 82–177353	A03
RI 8592	PB 82–177346	A02
RI 8594	PB 82–177338	A03
RI 8595	PB 82–176215	A02
RI 8596	PB 82–177320	A02
RI 8597	PB 82–176256	A03
RI 8598	PB 82–177312	A03
RI 8601	PB 82–176579	A02
RI 8603	PB 82–177791	A02
RI 8604	PB 82–176603	A02
RI 8605	PB 82–176587	A03
RI 8606	PB 82–176595	A02
RI 8607	PB 82–193178	A03
RI 8608	PB 82–195314	A03
RI 8609	PB 82–195355	A02
RI 8610	PB 82–194895	A02
RI 8611	PB 82–195363	A02
RI 8612	PB 82–193434	A03
RI 8613	PB 82–195405	A02
RI 8614	PB 82–195348	A02
RI 8615	PB 82–194903	A02
RI 8616	PB 82–201310	A02
RI 8617	PB 82–202987	A03
RI 8618	PB 82–201328	A03
RI 8619	PB 82–203001	A02
RI 8620	PB 82–194911	A02
RI 8621	PB 82–201286	A02
RI 8622	PB 82–176959	A02
RI 8623	PB 82–195397	A02
RI 8624	PB 82–202995	A03
RI 8625	PB 82–201336	A03
RI 8626	PB 82–202979	A02
RI 8627	PB 82–201344	A02
RI 8628	PB 82–220237	A02
RI 8629	PB 82–202268	A02
RI 8630	PB 82–220294	A02
RI 8631	PB 82–220245	A02
RI 8632	PB 82–220252	A03
RI 8633	PB 82–201351	A02
RI 8634	PB 82–202342	A02
RI 8635	PB 82–221391	A02
RI 8636	PB 82–221375	A02
RI 8637	PB 82–221490	A02
RI 8638	PB 82–219924	A03
RI 8639	PB 82–221508	A02
RI 8640	PB 82–221516	A04
RI 8641	PB 82–233685	A04
RI 8642	PB 82–221318	A02
RI 8643	PB 82–220419	A02
RI 8644	PB 82–217027	A02
RI 8645	PB 82–220286	A03
RI 8646	PB 82–220278	A02
RI 8647	PB 82–220260	A02
RI 8648	PB 82–217035	A02
RI 8649	PB 82–221383	A02
RI 8650	PB 82–233750	A02
RI 8651	PB 82–220229	A02
RI 8652	PB 82–212994	A05
RI 8653	PB 82–232489	A02
RI 8654	PB 82–233768	A02
RI 8655	PB 82–233719	A02
RI 8656	PB 82–202243	A02

Bureau series and number	NTIS accession number	Paper copy price code
RI 8657	PB 82-232463	A03
RI 8658	PB 82-233727	A02
RI 8659	PB 82-232471	A02
RI 8660	PB 82-233735	A02
RI 8661	PB 82-232497	A02
RI 8662	PB 82-233743	A03
RI 8663	PB 82-232125	A02
RI 8664	PB 82-232109	A02
RI 8665	PB 82-232091	A03
RI 8666	PB 82-232133	A03
RI 8667	PB 82-232083	A02
RI 8668	PB 82-234055	A02
RI 8669	PB 82-234063	A02
RI 8670	PB 82-232117	A03
RI 8671	PB 82-260464	A05
RI 8672	PB 82-257148	A03
RI 8673	PB 82-256959	A02
RI 8674	PB 82-262767	A03
RI 8675	PB 82-255704	A02
RI 8676	PB 82-262759	A03
RI 8677	PB 82-262791	A02
RI 8678	PB 82-263435	A02
RI 8679	PB 82-262775	A02
RI 8680	PB 82-260985	A02
RI 8681	PB 82-260977	A02
RI 8682	PB 82-260803	A02
RI 8683	PB 82-257171	A02
RI 8684	PB 82-257163	A02
RI 8685	PB 82-262783	A02
RI 8686	PB 82-263492	A02
RI 8687	PB 83-111286	A02
RI 8688	PB 82-255894	A02
RI 8689	PB 83-111278	A02
RI 8690	PB 83-111260	A02
RI 8691	PB 83-111252	A04
RI 8692	PB 83-111245	A03
RI 8693	PB 83-111237	A02
RI 8694	PB 83-111229	A02
RI 8695	PB 83-149443	A02
RI 8696	PB 83-112839	A04
RI 8697	PB 83-122721	A02
RI 8698	PB 83-149161	A03
RI 8699	PB 83-119461	A02
RI 8700	PB 83-122648	A02
RI 8701	PB 83-111450	A02
RI 8702	PB 83-148064	A03
RI 8703	PB 83-148023	A02
RI 8704	PB 83-111294	A02
RI 8705	PB 83-144618	A03
RI 8706	PB 83-111443	A02
RI 8707	PB 83-149146	A02
RI 8708	PB 83-178723	A03
RI 8709	PB 83-124578 129510	A02
RI 8710	PB 83-149153	A02
RI 8711	PB 83-144600	A03
RI 8712	PB 83-146928	A03
RI 8713	PB 83-144592	A02
RI 8714	PB 83-149435	A03
RI 8715	PB 83-157818	A03
RI 8716	PB 83-144584	A02
RI 8717	PB 83-149393	A02
RI 8718	PB 83-149138	A02
RI 8719	PB 83-148031	A02
RI 8720	PB 83-157719	A02
RI 8722	PB 83-157636	A03
RI 8723	PB 83-157834	A03
RI 8724	PB 83-157701	A02
RI 8725	PB 83-157867	A02
RI 8726	PB 83-171801	A03
RI 8727	PB 83-171900	A02
RI 8728	PB 83-156893	A02
RI 8729	PB 83-143974	A03
RI 8730	PB 83-143982	A03
RI 8731	PB 83-171918	A02
RI 8732	PB 83-157875	A02
RI 8733	PB 83-157651	A02
RI 8734	PB 83-171926	A02
RI 8735	PB 83-171819	A02
RI 8736	PB 83-178731	A03
RI 8737	PB 83-175877	A03
RI 8738	PB 83-179820	A02
RI 8739	PB 83-179762	A02
RI 8745	PB 83-172197	A02
SP 2-82	PB 82-257502	A07
SP 3-82	PB 83-171827	A07
SP 4-82	PB 83-190918	A03
SP 5-82	PB 83-178293	A08
TPR 115	PB 82-195876	A02
TPR 116	PB 82-194853	A02
TPR 117	PB 82-221326	A03
TPR 118	PB 82-220732	A02
TPR 119	PB 83-171793	A02

ARTICLES IN OUTSIDE PUBLICATIONS

The following articles have appeared in the outside press. Copies of these articles are NOT available from the Bureau of Mines.

OP 1–82. Methane Control on Longwall—European and U.S. Practices, by Joseph Cervik. Pres. at Soc. Min. Eng., AIME, Ann. Meeting, New Orleans, La., Feb. 18–22, 1979; ch. 9 in Longwall-Shortwall Mining, State of the Art, 1981, pp. 75–80. Common methods of controlling gob gas in U.S. mines are by means of ventilation of gob areas and gas drainage through surface boreholes. Costs of drilling surface gob holes increase as deeper coalbeds are mined. Where gob holes cannot be drilled because of topography, ventilation is the only means of control. Even then, sufficient air may not be available to dilute methane in the bleeder entries to acceptable levels. Thus, new methods of gob gas control need to be developed that are independent of surface topography, and of the mine ventilation system, less costly than present systems. Except for slight variations in procedures and equipment, Great Britain, the Federal Republic of Germany, France, Belgium, Poland, and Czechoslovakia use a common methane control method that is different from the systems generally used in the United States. This Bureau of Mines paper reviews European mining methods, mining conditions, and methane control technology and discusses their applicability to U.S. mines.

OP 2–82. Recovery of Gold and Other Heavy Minerals From Alluvial Deposits: Equipment and Practices, by J. M. Gomes and G. M. Martinez. Proc. Internat. Gold/Silver Conf., Reno, Nev., May 21–23, 1981, 12 pp. The potential for recovering gold and other heavy mineral byproducts from sand and gravel operations is discussed. The Bureau of Mines recently completed a study to determine heavy minerals present in the west coast sand and gravel deposits. Methods and equipment used for the recovery of gold and other heavy minerals in the deposits are discussed. Flowsheets for the recovery of gold and for the possible recovery of other heavy mineral byproducts are shown.

OP 3–82. Comparative Anatomy of a Pottsville Lithic Arenite and Quartz Arenite of the Pocahontas Basin, Southern West Virginia: Petrogenetic, Depositional, and Stratigraphic Implications, by David W. Houseknecht. J. Sediment. Petrol., v. 50, March 1980, pp. 3–20. Appalachian carboniferous stratigraphy remains controversial partly because of unclear petrogenetic, depositional, and stratigraphic relationships displayed by Pottsville sandstones, which have been interpreted as being of either alluvial or barrier-beach origin. Two associated sandstones of the New River Formation of southern West Virginia provide the setting for a detailed examination of this problem. The Lower Raleigh lithic arenite consists of elongate and lobate, dip-oriented bodies that display erosional bases, interfinger laterally with shales, fine upward at the top, and are unidirectionally trough cross-bedded basinward. The Upper Raleigh quartz arenite consists of elongate, dip-oriented bodies updip in the basin and elongate and lobate, strike-oriented bodies downdip. The quartz arenites display erosional bases, interfinger laterally with shales, fine upward at the top, and are unidirectionally planar cross-bedded basinward. Evidence suggests that Lower Raleigh detritus was derived from a southeasterly metamorphic-sedimentary source terrane and deposited in high-constructive lobate deltas. Upper Raleigh quartzose detritus may have been derived from coarse-grained alluvial facies equivalents of Lower Raleigh deltaic facies and deposited in deltas whose margins were modified by marine processes. It appears that the Lower and Upper Raleigh sandstones are not deltaic and barrier-tidal facies equivalents, thus negating gross regional stratigraphic relationships implied by the barrier model. Additionally, these conclusions suggest that use of quartz arenite as a unique lithogenetic rock type for predictive purposes is prone to error.

OP 4–82. Anticipating Coal Mining Problems in Hartshorne Formation, East-Central Oklahoma, Using Sedimentary Facies Analysis, by David W. Houseknecht and Anthony T. Iannacchione. Am. Assoc. Pet. Geol. Bull., v. 64, May 1980, p. 724; Okla. Geol. Notes, v. 40, No. 5, October 1980, p. 209. This study of sedimentary facies associated with the Hartshorne coalbeds of east-central Oklahoma provides an opportunity for preventive planning to minimize mining problems

OP 5–82. Methane Production Potential From Hartshorne Coal Beds in Deep Parts of Pittsburg, Coal, and Hughes Counties, Oklahoma, by Anthony T. Iannacchione and David W. Houseknecht. Am. Assoc. Pet. Geol. Bull., v. 65, No. 8, August 1981, pp. 1499–1500. This paper discusses the methane production potential investigation performed by the Bureau of Mines of the Hartshorne coalbeds in the Arkoma Basin, Okla.

OP 6–82. Predicting Zones of Potentially Unstable Coal Mine Roof Based on Consideration of Sedimentary Facies: A Case Study, by Anthony T. Iannacchione, James P. Ulery, Frank E. Chase, David M. Hyman, and Donald G. Puglio. Pres. at 1980 Ann. Meeting, Geol. Soc. of America, Atlanta, Ga., Nov. 17–20, 1980, abs. with Programs, v. 12, No. 7, p. 453. This study demonstrates the use of geological data in prediction of slickensided transition zones and will aid in projecting main entries under the most competent roof and in planning an effective roof support system for advancing sections of a coal mine.

OP 7–82. Mineral Industries, by Thomas G. Langton and Phillip N. Yasnowsky. The Encyclopedia of Mineralogy, Encyclopedia of Earth Sciences, ed. by K. Frye. Hutchinson Ross Publishing Co., Stroudsburg, Pa., v. 4B, 1981, pp. 258–270. This encyclopedia article gives a brief and general discussion of the development of the mineral industry to its present state and its role in the national economy. Selected mineral data, with an accompanying textual discussion on reserves, production, import reliance, and consumption are provided.

OP 8–82. New Closure Rate Instruments for Retreat Mining Operations, by James R. McVey and Wayne L. Howie. Min. Eng., v. 33, No. 12, December 1981,

pp. 1699–1700. The Bureau of Mines Spokane Research Center has constructed an intrinsically safe closure-rate instrument that provides the mine operator a means for predicting an imminent roof fall during pillar robbing. This improves operator and machine safety and prevents delays in digging out equipment. The instrument system consists of two rugged retrievable extensometers connected by long electrical cables to a digital readout unit for reading closure and closure rate. Once a predesignated closure rate is reached, the extensometer is retrieved by pulling it from the imminent roof fall area by the electrical cable. The equipment and mine personnel are also pulled back to await the fall, which usually occurs within minutes after the designated rate is reached. Although the unit is primarily designed for retreat mining operations, it can be used for any activity requiring measurement of displacement or rate of displacement with a measurement range of zero to 6 inches with 0.1 percent accuracy for openings 4½ to 12 feet.

OP 9–82. Stop #21. Steeply Dipping Upper Freeport Coal, by D. G. Puglio and A. T. Iannacchione. Proc. 9th Internat, Cong. of Carboniferous Stratigraphy and Geology, Urbana, Ill., May 10–June 2, 1979; pub. in Geology of the Northern Appalachian Coal Field, Guidebook, Field Trip No. 2, ed. by J. Donahue and H. B. Rollins, pp. 27–28. Coalbeds that dip nearly vertically have not previously been seen in Pennsylvania west of the Allegheny Front. This paper discusses some steeply inclined coalbeds that were observed during a field trip west of West Bolivar, Westmoreland County, Pa.

OP 10–82. High-Constructive, Tidally Influenced Deltaic Sedimentation in Arkoma Basin: Desmoinesian Hartshorne Sandstone, by D. W. Houseknecht, Mark A. Kuhn, Albert P. Matteo, Jr., David J. Steyaert, John F. Zaengle, and Anthony T. Iannacchione. Am. Assoc. Pet. Geol. Bull., v. 65, No. 8, August 1981, p. 1499. This paper describes the probable origin of the Hartshorne Sandstone and associated fine-grained facies of the Arkoma basin located in Arkansas and Oklahoma. Understanding the genesis of these delta plain facies reportedly will enhance petroleum and coal exploitation efforts within the Hartshorne of the Arkoma basin.

OP 11–82. Occurrence and Recovery of Rutile From Western Copper Mill Tailings, by G. V. Sullivan and T. O. Llewellyn. Pres. at SME-AIME Fall Meeting and Exhibit, Denver, Colo., Nov. 18–20, 1981, SME Preprint 81–333, 7 pp. The Federal Bureau of Mines examined tailings samples from 13 western copper operations to determine the potential for recovering rutile. Results showed that six of the samples contained sufficient liberated titania to be considered potential sources. One sample contained 0.75 percent TiO_2 or 0.40 percent liberated rutile. Batch flotation studies developed a procedure that recovered 70 percent of the liberated rutile at a grade of 34.7 percent TiO_2. Sulfuric acid leaching studies on 12 of the samples dissolved 100 to 2,200 grams Cu per ton of tailings; leaching of the slimes showed slightly more copper was dissolved, 1,800 to 3,300 grams Cu per ton of minus 10-micrometer material. Bulk sulfide flotation of nine of the samples resulted in concentrates that contained 0.38 to 2.0 percent Cu and 0.7 to 2.1 and 6.9 to 42.9 grams per ton Au and Ag, respectively.

OP 12–82. Improved Optical Probe for Monitoring Dust Explosions, by R. S. Conti, K. L. Cashdollar, and I. Liebman. Rev. Sci. Instr., v. 53, No. 3, 1982, pp. 311–313. An improved optical probe was developed to monitor dust-cloud concentration in explosions even in the presence of dust flame radiation. Principal features of the probe include a pulsed light-emitting diode and a photodetector with optical interference filter to reduce flame radiation. The probe has a U-shaped configuration and air jets to keep the windows dust free. Experimental data are presented for a coal dust explosion.

OP 13–82. Retractable Core Bit Drilling System, by W. C. Larson, W. W. Svendsen, J. F. Hoffmeister, and R. E. Cozad. Pres. at SME–AIME Ann. Meeting, Las Vegas, Nev., Feb. 24–28, 1980, SME Preprint 80–116, 16 pp.; Min. Eng., v. 34, No. 2, February 1982, pp. 163–170. This paper presents the background, history, and current development of a retractable core bit for a wireline drilling system. Design criteria, concept development, and system of the retractable bit system are discussed, including laboratory test results.

OP 14–82. Computer Simulation of Zirconium-Hafnium Separation by Countercurrent Extraction, by D. J. MacDonald. Sep. Sci. Technol., v. 16, No. 10, 1981, pp. 1355–1371. In carrying out research and development on an improved method for production of reactor-grade zirconium oxide, the Bureau of Mines has prepared a computer program capable of accurately predicting the stage-by-stage performance of a multistage countercurrent solvent extraction system for separation of zirconium from hafnium using a tertiary amine extractant. The results were used to plan laboratory experiments using a multistage countercurrent mixer-settler unit. The number of extractor stages, number of scrubber stages, feed solution concentrations, scrubber solution concentration, feed flow, scrubber flow, and organic-phase flow are the significant variables. The computer simulation indicates the effects of changes in the pertinent variables and makes it possible to locate the best combination of variables without a prohibitively large number of time-consuming experiments.

OP 15–82. Development of an In-Line Water Spray Cooler, by J. F. McCoy, A. Whillier, K. S. Heller, and E. D. Thimons. J. Mine Vent. Soc. S. Afr., v. 35, No. 1, January 1982, pp. 1–6. This paper describes an experimental program financed by the Bureau of Mines for the development of an in-line cooler using direct water-to-air contact heat exchange. The direct water-to-air contact design eliminates problems of dust buildup on cooling surfaces, a frequent problem of fin-coil coolers in mines. While direct-contact coolers such as spray chambers are relatively tolerant to dust loading, their thermal performance, in practice, has not been viewed in the United States as competitive with counter-flow, fin-coil-type exchangers. This is believed to be due to the negligible experience with the direct water-to-air coolers in North American mines. The purpose of this paper is to describe a successful experience with a water spray-type cooler. The program consisted of resolving initial specifications, design, development of the cooler including laboratory testing, and in-mine testing at the Homestake Gold Mine in South Dakota.

OP 16–82. Insoluble Crosslinked Starch Xanthate as a Selective Flocculant for Sulfide Minerals, by S. C. Termes, R. L. Wilfong, and P. E. Richardson. Pres. at AIME Ann. Meeting, Dallas, Tex., Feb. 14–18, 1982, Reprint 82–171, 8 pp. This paper discusses recent Federal Bureau of Mines research on the selective flocculation of various minerals with insoluble crosslinked starch xanthate (ISX). ISX is

insoluble, has a shelf life of over a year when kept cold, and has a higher molecular weight due to crosslinking than the soluble noncrosslinked starch xanthate used in previous flocculation studies on nonsulfide minerals. ISX readily flocculates a number of sulfide mineral fines but not silicious gangue. Floc formation, floc size, and settling rate are strongly dependent on pH, with the pH dependence differing for each mineral. Bornite has been selectively flocculated from bornite-quartz mixtures, and the bornite containing flocs were separated from the unflocculated quartz using decantation and washing procedures.

OP 17–82. Engineering Properties of Coal Measure Rocks, by Richard E. Thill and James A. Jessop. Pres. at 111th SME-AIME Ann. Meeting, Dallas, Tex., Feb. 14–18, 1982, SME Preprint 82–146, 26 pp. Engineering properties of rock are essential in most phases of mining from site reconnaissance through mineral processing. Review of the literature indicates, however, that property data is scarce for most coal measure rocks in the United States. The Bureau of Mines has undertaken a wide-ranging testing program to provide more complete property data for coal strata in the U.S. coal basins. The property data are expected to have applications in geophysical exploration, development of premining and hazard detection probes and instrumentation, mine design, engineering and rock mass classification, subsidence engineering, and ground control. This paper describes the comprehensive program encompassing in situ geological, geophysical, and geotechnical properties and laboratory determinations of acoustic, electromagnetic, physical, mechanical, and index properties and discusses results for 500 feet of coal measures at a mine site in the northern Appalachian, eastern coal province.

OP 18–82. A Review of Potential Domestic Raw Materials as Substitutes for Refractory-Grade Bauxite, by Dale E. Wittmer. Proc. 111th AIME Ann. Meeting, Dallas, Tex., Feb. 14–18, 1982; pub. in Light Met., 1982, pp. 23–35. The Bureau of Mines characterized foreign and domestic bauxites and domestic high-alumina grogs with respect to chemical and mineralogical analyses and refractory properties. Domestic raw materials such as ferruginous bauxites, saprolites, and zunyite were evaluated as substitutes for imported refractory-grade bauxite (RGB). Available data on ferruginous bauxite reserves are insufficient to evaluate the potential of upgraded ferruginous bauxite as a RGB substitute. Saprolite deposits of the southeast were evaluated as a source of gibbsite, but results indicate that simple beneficiation procedures would not produce a suitable RGB substitute. Initial evaluation of a synthetic magnesium aluminate spinel produced from aluminum dross as a RGB substitute was encouraging.

OP 19–82. Microbial Processes for Removal of Suspended Clays From Selected Industrial Wastewaters, by Carole L. Brierley, Guy R. Lanza, and Bernard Scheiner. Biotechnology and Bioengineering Symp. John Wiley & Sons, Inc., New York, No. 11, 1981, pp. 507–520. Finely divided clays, generated by beneficiating phosphate, are impounded for up to several decades to effect dewatering. Under contract to the Bureau of Mines, several microbiological processes were tested for aggregating suspended clays. Polymers, isolated from *Leuconostoc mesenteroides*, *Xanthomonas sp.*, and *Beijerinckia indica*, flocculated dilute phosphatic clay-slime at a rate comparable to polyethylene oxide; however, biopolymer-flocculated clays produced turbid supernatants. *Cladosporium cladosporioides*, enriched from phosphatic clay-slimes, produced a bioflocculant, and agitated incubation of *C. cladosporioides* spores, sugar, and yeast extract with phosphatic clay-slimes induced clay-fungus pelletization. Microbiologically mediated clay removal may have application in industrial wastewater clarification.

OP 20–82. An Industrial Application of Sulfur Concrete, by R. H. Funke, Jr., and W. C. McBee. Ch. 12 in Sulfur: New Sources and Uses, ed. by M. E. D. Raymont. ACS Symp. Series 183, 1982, pp. 195–208. In cooperation with the U.S. Department of the Interior, Bureau of Mines, and the Sulphur Institute, ASARCO Incorporated tested components of sulfur concrete, both precast and poured in place, in corrosive environments of sulfuric acid. Favorable endurance of these samples led to a full-scale cooperative demonstration project, which was the rehabilitation of an electrolytic zinc cellhouse basement floor of approximately 21,000 square feet. Sulfur concrete utilizing an aggregate gradation of minus 3/8-inch and minus 1/8-inch materials was produced in a portable asphalt patch mix plant. Mixing and placing operations were conducted without problems. Economics of sulfur concrete versus portland cement concrete are highly variable. Total costs were approximately 15 pct higher than for portland cement. Potential uses are electrolytic cells, holding tanks and vats, and floor and basin areas exposed to acidic environments.

OP 21–82. A Simulation Model for Predicting the Performance of Vibrating Screens, by Douglas C. Grant, Kevin Hennings, Thomas Bobick, and Roy Bartholomae. National Limestone Inst. Operations Day Program Booklet, 1982, pp. 57–72. Replacing a woven wire deck on a vibratory screen with one of another type raises questions as to how screening performance may be expected to vary. This paper describes the development of a digital computer model capable of predicting screen performance and the testing done to provide a data base for correlation and verification. Within the range of operating conditions tested, the simulation model in its present state is generally capable of predicting separation efficiency to within ±2 percentage points. Also, predicted sieve analyses of the underproduct and overproduct are in good agreement with those measured.

OP 22–82. Demonstration of Technology To Recycle Chromic Acid Etchants at Gould, Inc., by Glenn L. Horter and L. C. George. Proc. 4th Recycling World Cong. and Exposition, New Orleans, La., Apr. 5–7, 1982, pp. M/3/5/1—M/3/5/13. The process research unit for the regeneration and recycling of chronic acid-sulfuric acid etching solutions developed by the Bureau of Mines was demonstrated in cooperation with Gould, Inc., in Niles, Ill. The process research unit continuously regenerated and recycled etching solution from a brass etching circuit during normal production throughput for 17 days. Evaluation of the data obtained during the demonstration shows that the etching solution was maintained at an acceptable level of performance, consumption of sodium dichromate was reduced by 68 pct, generation of waste was reduced by 76 pct, and the cost of the operation was reduced by 70 pct.

OP 23–82. Canister Concept Provides Early Fire Warning in Mines, by Mervin D. Marshall, Edward D. Thimons, David W. Kneebone, and Stanley Gross. Min. Cong. J., v. 68, No. 4, April 1982, pp. 64–69.

Presently, many metal-nonmetal mines have fire-warning systems that make use of a stench gas, which is released from the surface into the compressed-air lines and/or ventilation air. Usually the stench gas is the volatile liquid ethyl mercaptan, mixed with either Freon 11 or Freon 22 to render it inert. Time delays for the stench gas to reach underground mine personnel and the uncertainty of effectively distributing the gas throughout the mine are disadvantages of these surface-release stench systems. To avoid these problems, MSA Research Corp. and the Bureau of Mines have developed a stench gas canister with a heat-fusible release for use in mine locations susceptible to fire. In the event of a fire near the canister, the heat-fusible alloy melts, releasing the gas into the ventilation air and warning all miners downstream of the fire. With appropriate detectors on the mine exhaust, the tracer gas can provide warning of a fire during off-duty shifts or when no mine personnel are downstream of the release.

OP 24–82. Conservation of Chromium in the Tanning Industry, by Jean J. Tancous and Lawrence C. George. Proc. 4th Recycling World Cong. and Exposition, New Orleans, La., Apr. 5–7, 1982, pp. M/3/2/1—M/3/2/17. The tanning industry uses trivalent chromium in the form of water soluble chromium sulfate for the tanning of hides and skins that are byproducts of the meat industry. The U.S. total demand for dichromate in 1976 was 161,00 tons and the tanning industry used 17% or one-sixth of this amount. The waste generated was 9% or one-eleventh of the U.S. total demand. Because of the concern about chromium usage and waste, the Bureau of Mines and Tanners Council of America Inc. made a study of conservation of chromium in the tanning industry. The chromium wasted is present in leather trimmings and shavings, in the effluents from process procedures, and in sludge generated. Ways to recycle the effluent chromium and to recover the chromium from solid waste will be discussed including the possibility of using the chromium-bearing shavings and trimmings with pelletized stainless steel waste in the steel mill. From bench-scale experiments conducted, it was determined that the most economically feasible way to recover chromium from solid waste is by incineration.

OP 25–82. Characterization — Characterization of Bulk Samples, by U.S. Bureau of Mines. Paper in Characterization, Recovery and Recycling of Electric Arc Furnace Dusts, Lehigh University, Bethlehem, Pa., sec. III, February 1982, pp. III.B–1—III.B–4. Bulk chemical analyses including the EP Toxicity Test were undertaken by the Avondale Research Center. As expected, the alloying elements chromium, nickel, and molybdenum show up prominently in the stainless steel and specialty alloy dusts The amounts of these elements are sufficient to make recovery a viable activity. Carbon steel dusts are richer in zinc (up to 28 wt-pct) and lead (up to 3.8 wt-pct) because of the greater use of galvanized and other coated products in the melt.

OP 26–82. Chemical and Physical Separation—Bulk Specimens—Task B—Chemical Extraction, by U.S. Bureau of Mines. Paper in Characterization, Recovery and Recycling of Electric Arc Furnace Dusts, Lehigh University, Bethlehem, Pa., sec. IV, February 1982, pp. IV.A–1—IV.A–24. One large representative sample of carbon steel dust and one large representative sample of stainless steel dust were given a series of chemical dissolution or leaching tests by the Rolla Research Center. From the results, it would appear that because of the relatively high unit value of the Cr, Ni, Mo, etc., arc furnace dusts from stainless and specialty steelmaking can best be treated pyrometallurgically for recycle by techniques such as in-plant greenballing and recycling to the furnace, or centralized processing to produce master alloy for recycle.

OP 27–82. Chemical and Physical Separation—Bulk Specimens—Task B—Physical Separation, by U.S. Bureau of Mines. Paper in Characterization, Recovery and Recycling of Electric Arc Furnace Dusts, Lehigh University, Bethlehem, Pa., sec. IV, February 1982, pp. IV.C–1—IV.C–13. One large sample of carbon steel dust and one large sample of stainless steel dust were given physical separation tests by the Twin Cities Research Center. The tests showed that physical separation was of no value in treating high-chromium dust from stainless steelmaking. However, physical separation using wet processing has potential value for treating high-zinc dust from carbon steelmaking. Because of the very small particle size and high specific surface area, separation methods requiring adsorption of chemical reagents are not economically feasible with the present technology and the particle size is too small for specific gravity-based techniques. Low-intensity wet magnetic separation is the most practical method of physical separation. Separation with a typical ceramic permanent magnet wet drum separator yields a low-zinc ferromagnetic product and a zinc-enriched product.

OP 28–82. Reconnaissance of Rare-Metal Occurrences Associated With the Old Crow Batholith, Eastern Alaska-Northwestern Canada, by James C. Barker. Short Notes on Alaskan Geology, 1981. Alaska State Department of Natural Resources, College, Alaska, Geol. Rept. 73, 1982, pp. 43–49. Evidence suggests that the emplacement, tectonics, and chemical composition of the Old Crow batholith, located in eastern Alaska and western Yukon Territory, Canada, are favorable for the occurrence of tin, tungsten, uranium, tantalum, niobium, and other rare metals. This evidence is reinforced by findings of uranium, tin, rare-earth oxides, and base metals during the 1976–80 field seasons.

OP 29–82. Alkaline Igneous Rocks in the Eastern Alaska Range, by Jeffrey Y. Foley. Short Notes on Alaskan Geology, 1981. Alaska State Department of Natural Resources, College, Alaska, Geol. Rept. 73, 1982, pp. 1–5. Previously unreported, alkaline igneous rocks occur in the eastern Alaska Range as two dike swarms, one near the West Fork of the Robertson River and another to the east near the Tok River. These rocks intrude the underlying Precambrian and possibly younger, crystalline metamorphic terrane and are believed to be the youngest igneous rocks in the area. A single potassium-argon age date (69.2 ± 1.5 million years) on biotite indicates that a local, Late Cretaceous thermal event was associated with a stage of alkaline magmatism.

OP 30–82. Method for Automatically Rounding Data on the Wang 2200 in Basic Computer Language, by Scott F. Sibley. Geophys. Res. Ltrs., v. 9, No. 2, February 1982, pp. 120–123. The method described permits any set of numbers within an allowable range to be rounded to any number of significant figures. This is accomplished by generation of an array (rounding position) data bank, which is unique for each combination of the following vari-

ables: (1) Chosen decimal position, (2) number range of the number to be rounded, and (3) number of significant figures to which this number is to be rounded. It is especially useful as a subroutine in programs that generate large quantities of figures (such as reserve or resource tonnages) that require rounding.

OP 31–82. Consideration of Overburden Lithology for Subsidence Prediction, by Sathit Tandanand and Larry R. Powell. Proc. Workshop on Surface Subsidence Due to Underground Mining, Morgantown, W. Va., Nov. 30–Dec. 2, 1981, pp. 17–33. Geological differences among various coalfields restrain the applicability of subsidence prediction using existing European methods. To modify these methods for domestic conditions, the Bureau of Mines developed a method of assessment to evaluate the lithological effects on subsidence in the northern Appalachian basin by examining data collected from 16 longwall panels in the coalfield. The assessment is partially completed, and the results to date show that the ratio of maximum subsidence to the extraction thickness, known as the subsidence factor, can be expressed in terms of the width-to-depth ratio by a simple exponential equation that has a coefficient tentatively considered as the subsidence index. This index varies with the lithology of a particular site and can be expressed in terms of the percent distribution of weak and strong rocks in the overburden.

OP 32–82. Thermal Energy Recovery for Deep Mines, by Edward D. Thimons and Robert N. Torbin. Pres. at 1st Mine Ventilation Symp., University of Alabama, Tuscaloosa, Ala., Mar. 29–31, 1982; Eng. and Min. J., v. 183, No. 5, May 1982, pp. 98–99. High temperatures and humidities in deep mines make a comfortable working environment difficult and expensive to maintain. Large quantities of refrigeration water must be carried down long, vertical pipelines. The electrical costs of this refrigeration are rising owing to increased demand and rising kilowatt-hour costs. Converting the energy of falling water into useful work is a well-developed engineering concept. Much of the electric power consumed in the United States is generated this way. Water that flows down long, vertical pipelines into deep mines could be used to operate a turbine at the bottom of the pipeline.

OP 33–82. Identification and Quantification of Asbestos in Construction Materials Using Polarized Light Microscopy: The Need for Standards, by R. L. Virta, K. B. Shedd, and W. J. Campbell. Proc. NBS/EPA Asbestos Standards Workshop, Gaithersburg, Md., Oct. 1–3, 1980; NBS SP 619, March 1982, pp. 34–43. The Bureau of Mines Particulate Mineralogy Unit, in cooperation with the Environmental Protection Agency (EPA), conducted a round robin program to evaluate the reliability of analyses of asbestos-containing building materials by polarized light microscopy. This microscopic technique was selected by EPA as the principal analytical method for asbestos identification and quantification in their program to evaluate the potential health risks from exposure to airborne asbestos in public buildings. Results of the round robin show a need for monomineralic reference samples of asbestos and nonasbestos components of these materials to aid in identification training. Also necessary are bulk standards containing known amounts of asbestos to be used in verification and quality control of quantification techniques.

OP 34–82. Selective Extraction of Tungsten From Searles Lake Brines, by P. B. Altringer, P. T. Brooks, and W. A. McKinney. Sep. Sci. Technol., v. 16, No. 9, 1981, pp. 1053–1069. Tungsten was successfully extracted from the brines of Searles Lake, Calif., in a demonstration unit based on 9 years of laboratory research conducted by the U.S. Department of the Interior, Bureau of Mines. Pilot-scale operation was initiated in July 1979 at the Westend facility of the Kerr-McGee Chemical Corp. at Trona, Calif. The extractive method, based on a novel ion exchange resin, resulted from research supporting one of the Bureau's goals: helping to insure an adequate supply of minerals to meet national economic and strategic needs. The objectives met during pilot testing included proving operational viability during seasonal changes in brine properties, concentrating the tungsten to enable concluding tungsten recovery research, supplying escalation data necessary for commercialization, and confirming earlier small-scale laboratory work. The demonstration unit typically removed 92 percent of the tungsten from alkaline brine using QRF (8-hydroxyquinoline-resorcinol-formaldehyde) resin beads produced by the Bureau. A "merry-go-round" system was employed whereby two 12-inch-diameter resin beds were loaded in series while a third bed was eluted. Testing was concluded after treating over 500,000 gallons of brine. Tungsten, isolated in the primary ion exchange system, was reconcentrated in a secondary ion exchange system. Several tungsten products were produced from tungsten-rich solutions.

OP 35–82. The Effectiveness of Overpressure Ventilation: A Mathematical Study, by Robert C. Bates and John C. Edwards. Ch. 24 in Radiation Hazards in Mining: Control, Measurement, and Medical Aspects, ed. by M. Gomez. Pub. by Society of Mining Engineers of AIME, New York, 1981, pp. 149–154. Results are given of a mathematical study by Bureau of Mines personnel of overpressurization ventilation effects in underground uranium mines. The mathematics and computer codes make it possible to analyze many facets of transient and steady-state radon diffusion with Darcy flow. Rapid changes in radon flux occur after imposing a pressure differential across the model. Flux into the model mine drops to near zero and then increases to the steady-state level, while the sink flux increases rapidly and then drops slightly to the steady-state level. Magnitudes of mine flux decreases and sink flux increases are dependent upon the distance from the mine to sink, permeability, and amount of overpressure. Current work on more complex models is also described.

OP 36–82. A Plan for Modeling Uranium Radon Daughter Concentrations, by Robert C. Bates and John C. Edwards. Ch. 38 in Radiation Hazards in Mining: Control, Measurement, and Medical Aspects, ed. by M. Gomez. Pub. by Society of Mining Engineers of AIME, New York, 1981, pp. 256–259. Modeling uranium mine radiation control methods and natural environmental radon variations is an extremely complex endeavor. A number of authors have examined particular facets of the problem and have proposed models for their area of interest. Bureau of Mines personnel brought together many of these individual studies, and from them have attempted to develop a coordinated plan for modeling radon daughter concentrations in the uranium mine environment. This approach is described.

OP 37–82. Ventilation Cost Impact of Reduced Radon-Daughter Working Levels, by Robert C. Bates.

Ch. 159 in Radiation Hazards in Mining: Control, Measurement, and Medical Aspects, ed. by M. Gomez. Pub. by Society of Mining Engineers of AIME, New York, 1981, pp. 1066–1070. Published information on costs of radon-daughter control in uranium mines was analyzed to develop estimates of the cost per ton for any level of radiation exposure control. All data were converted to 1967 cost of living index to provide a common analysis base. Results of the analysis show that the cost per ton increases exponentially as the radiation level is lowered. A linear relationship with the cost of living index is assumed, and equations and graphs are provided to estimate control cost per ton for any exposure control level and cost of living index.

OP 38–82. Evaluation of Recent Developments in Radon Progeny Measurements, by T. B. Borak, E. Franco, K. J. Schiager, J. A. Johnson, and R. F. Holub. Ch. 66 in Radiation Hazards in Mining: Control, Measurement, and Medical Aspects, ed. by M. Gomez. Pub. by Society of Mining Engineers of AIME, New York, 1981, pp. 419–425. The evaluation of grab sampling methods for monitoring exposure to radon progeny is presented. Each method is examined individually according to accuracy, precision, and uncertainties attributed to human errors. An analysis of procedures that are common to all measurement methods is included.

OP 39–82. Bureau of Mines Statement of Principles, by John A. Breslin. Ch. 6 in Radiation Hazards in Mining: Control, Measurement, and Medical Aspects, ed. by M. Gomez. Pub. by Society of Mining Engineers of AIME, New York, 1981, pp. 15–16. Control of radiation hazards in mines is only one of many goals of the Bureau of Mines. Radiation research is only a small part of the Bureau's mine health and safety research program. This paper describes the mission and programs of the entire Bureau of Mines, with emphasis on the mine health and safety program of which the Bureau's radiation research is a part.

OP 40–82. Sandcasting Titanium and Zirconium, by J. M Burrus and R. K. Koch. Foundry M&T, v. 110, No. 5, May 1982, pp. 43–51. Research conducted at the Bureau of Mines Albany Research Center on alternatives to the rammed-graphite molding process currently used in industry is described. With the alternative molding processes developed in this research, the cost of titanium castings could be reduced to allow cast titanium to substitute for chromium-, nickel-, and cobalt-containing alloys in the transportation and chemical processing industries.

OP 41–82. Instrumentation for Measuring Uranium Miner Exposure to Radon Daughters, by Robert F. Droullard. Ch. 51 in Radiation Hazards in Mining: Control, Measurement, and Medical Aspects, ed. by M. Gomez. Pub. by Society of Mining Engineers of AIME, New York, 1981, pp. 332–338. The U.S. Bureau of Mines has investigated instrumentation and methods for measuring exposure to radon daughters in underground mine atmospheres. Both personal and area monitors have been studied through in-house and contract research. A field study in uranium mines identified some reliability problems that required additional work for the personal dosimeter systems. Improved versions of continuous working level detectors have been developed and tested for use as area monitors in underground mines. Test results for the personal and area monitors were satisfactory for underground mine applications.

OP 42–82. Bureau of Mines Studies Forest Appraisal Part of RARE II Program, by Steven A. Fechner and Mark P. Meyer. Alaska Miner, v. 10, No. 5, May 1982, pp. 13, 18. Part of the requirements of RARE II withdrawals for the Chugach National Forest require that a mineral assessment be done of the area. The eastern half of the forest, called the SOUND Study Area, has been examined over the past 3 years. This report presents a review of the work so far in the 4-year program.

OP 43–82. Control of Radiation Hazards in Underground Uranium Mines, by John C. Franklin. Ch. 69 in Radiation Hazards in Mining: Control, Measurement, and Medical Aspects, ed. by M. Gomez. Pub. by Society of Mining Engineers of AIME, New York, 1981, pp. 441–446. Alpha-emitting radon daughter products are a recognized health hazard contributing to the development of lung cancer in persons exposed to excessive concentrations over an extended period. The primary control technique used by the mining industry is dilution with fresh air. Because the uranium is deposited in porous sandstone in most U.S. mines, the control of this hazard with dilution requires excessive volumes of air. As the mines become larger and deeper, the cost for ventilation becomes a major expenditure for the mining industry. Most mines are maintaining levels of radon daughters lower than required by law but to maintain these present levels the mining companies are going to be drilling more vent holes or using other control techniques as the mine expands. These control techniques are being investigated by the Bureau of Mines to determine their effectiveness, cost, and safety for underground use.

OP 44–82. Airborne Radiation Warning System, by John C. Franklin and David M. Shaw. Ch. 148 in Radiation Hazards in Mining: Control, Measurement, and Medical Aspects, ed. by M. Gomez. Pub. by Society of Mining Engineers of AIME, New York, 1981., pp. 980–983. A 32-channel warning system for high working level, fan operation, and airlock-doors has been constructed. The working level monitors have a microcomputer for accumulating the pulses, converting to working level, and triggering an alarm at a variable set point and at one working level. The system can detect changes in air velocity which indicate surface fan failures or changes in the ventilation system. Using this alarm system, the ventilation engineer will be alerted prior to excessive levels of radon daughters being reached so corrective action can be taken.

OP 45–82. Multicomponent Regular Solutions, by N. A. Gokcen. Scripta Metallurgica, v. 16, 1982, pp. 723–727. Statistical thermodynamics of the binary regular solutions is now on a firm basis with a treatment based on the actual enumeration of configurations of molecules in solution. The equations resulting from the first approximation to the binary regular solutions are fairly simple but they become complicated for ternary and multicomponent solutions. Similar equations have not yet been derived for multicomponent solutions. The purpose of this paper is therefore to derive the appropriate equations for multicomponent regular solutions and to discuss briefly their significance.

OP 46–82. A Resin-Loaded Paper X-Ray Fluorescence Method for Determining Uranium in Phosphate Materials, by Benjamin W. Haynes, Jerome Zabronsky, and David L. Neylan. Proc. 30th Ann. Conf. on Applications of X-Ray Analysis, Denver, Colo., Aug. 3–7, 1981, pp. 107–111. An analytical method has been developed at the Bureau of Mines Avondale

Research Center for determining uranium in phosphate rock processing and waste materials using a combination of preconcentration and X-ray spectrography. Previous work has shown the usefulness of resin-loaded papers for preconcentration in X-ray analysis on samples of varying matrices. This method allows the determination of other radionuclides in the sample while avoiding the use of alpha spectrometry for determining uranium. A roundrobin analysis of phosphate material samples involving this center and other Bureau of Mines research centers gave results that agreed with values obtained by accepted procedures. Good agreement was also obtained for the certified value of uranium in National Bureau of Standards SRM 120b phosphate rock.

OP 47–82. Factors Affecting Radon Transport and the Concentration of Radon in Mines, by R. F. Holub, P. J. Dallimore, and the Department of Physics and Geosciences, Western Australian Institute of Technology. Ch. 154 in Radiation Hazards in Mining: Control Measurement, and Medical Aspects, ed. by M. Gomez. Pub. by Society of Mining Engineers of AIME, New York, 1981, pp. 1022–1028. Basic to solving the problem of the role of radon transport on radon concentrations in mines is to establish whether it occurs primarily as diffusion in force flow through porous rock or through fissures in the rock. The laboratory experiments performed involved measurements of diffusion and emanation coefficients, porosity, and permeability of representative rock samples. Significant differences have been found when comparing the results of the laboratory permeability determinations to those of the mine determinations. Considerations of underlying principles, however, suggest that the diffusion and emanation coefficients are the same in laboratory and mine. It was also found that moisture content plays a dominant role in radon transport through rock. Using these concepts and findings, some conclusions about the radon concentrations in mines have been drawn.

OP 48–82. Assessment of Toxicity Impacts Associated With Phosphogypsum in Florida, by Alexander May and John W. Sweeney. Proc. Environmental Symp. '82, sponsored by the Fertilizer Inst., San Antonio, Tex., Mar. 8–10, 1982, pp. 97–121. A part of the Bureau of Mines Minerals Environmental Technology research program is to assess problems associated with radium in the large tonnages of phosphogypsum in Florida. Another part is to develop a data base so that, through a continuing research effort, potential environmental problems can be identified and mitigated. The Bureau's Tuscaloosa Research Center conducted research to characterize phosphogypsum to determine if it is hazardous or toxic, and if so, to investigate means of mitigating the situation so that the phosphogypsum could be used in a variety of high-volume applications.

OP 49–82. The Role of the Bureau of Mines in Radiation Hazards Research, by George E. Niewiadomski. Ch. 18 in Radiation Hazards in Mining: Control, Measurement, and Medical Aspects, ed. by M. Gomez. Pub. by Society of Mining Engineers of AIME, New York, 1981, pp. 97–104. This paper highlights the current efforts of the Bureau of Mines radiation hazards research program. It is aimed at obtaining a fundamental understanding of the behavior and transport of radon and radon daughters, developing more accurate and reliable instruments and measurement methods, and developing cost-effective control techniques. Also discussed are the most recent accomplishments and the future research plans of the program.

OP 50–82. Comparative Cavability Studies at Three Mines, by Louis A. Panek. Ch. 9 in Design and Operation of Caving and Sublevel Stoping Mines, pub. by Society of Mining Engineers of AIME, New York, 1981, pp. 91–106. This paper explains the rationale of the Bureau of Mines ongoing investigation that has the objective to develop procedures for precalculating the minimum span required for sustained caving and the size distribution of the caved ore fragments, based on rock mass strength tests and measurements of joint spacing and attitude. With the help of such quantitative design procedures the undercut-cave method can be extended to a much wider range of mineral deposit characteristics.

OP 51–82. Ground Movements Near a Caving Stope, by Louis A. Panek. Ch. 24 in Design and Operation of Caving and Sublevel Stoping Mines, pub. by Society of Mining Engineers of AIME, New York, 1981, pp. 329–354. Measurements of ground movements showed that a halo of cracking develops about a caving stope, extending to distances greater than 100 meters, the principal change of deformation being extension directed toward the cave. The development of the fracture zone of expansion has significant implications with respect to the caving, drawing, and ground support operations.

OP 52–82. Geotechnical Factors in Undercut-Cave Mining, by Louis A. Panek. Underground Mining Methods Handbook, pub. by Society of Mining Engineers of AIME, New York, 1982, pp. 1456–1465. This paper is a state-of-the-art summary that relates the underlying geotechnical factors to the mining processes and presents approaches to generating the measurement data that are needed to resolve the corresponding problems.

OP 53–82. Large-Scale Dewatering Tests of Phosphate Clay Waste: Progress Report, by B. J. Scheiner, Annie G. Smelley, and D. R. Brooks. Proc. Environmental Symp. '82, sponsored by the Fertilizer Inst., San Antonio, Tex., Mar. 8–10, 1982, pp. 57–70. Recently, the Bureau of Mines developed a dewatering technique for phosphatic clay waste. The technique consists of treating the clay waste with a flocculant such as polyethylene oxide and dewatering the resulting flocs on a mechanical device such as a rotary screen. In small-scale continuous tests at the Bureau's Tuscaloosa Research Center, clay waste was consolidated from a nominal 4 pct solids to about 20 pct solids. Based upon these encouraging results, a field test unit was operated at the Estech Corp.'s City Silver Mine, located near Bartow, Fla. The unit is now operating at the Occidental Suwannee River Mine near White Springs, Fla. This report describes the results of field tests conducted to date.

OP 54–82. U.S. Bureau of Mines Develops Portable Crusher for Underground Hardrock Mines, by Robert L. Schmidt. Eng. and Min. J., v. 183, No. 1, January 1982, pp. 72–75. The high cost of materials-handling in most underground hardrock mines prompted the Bureau of Mines to develop a portable, low-headroom crusher. This equipment can be positioned close to the face to allow the operation maximum utilization of low-cost conveyor haulage. The unit was successfully tested in a limestone quarry, and a long-term production test is planned.

OP 55–82. The Bureau of Mines Automated Minerals Information System—AMIS, by Jon P. Stone and L. Michael Kaas. Proc. 17th Internat. Symp. on computer applications in the mineral industry, Golden, Colo., Apr. 19–23, 1982; ch. 67 in Application of Computers and Operations Research in the Mineral Industry, pp. 740–753. The Automated Minerals Information System (AMIS) is an integrated data base system being developed to support the Bureau of Mines minerals information collection and analysis activities. The system facilitates cross-referencing and integration of domestic and foreign information from a variety of sources. The AMIS provides a central source of minerals information that is versatile and responsive to the needs of problem and policy analysts as well as supporting the needs of those involved in data collection and interpretation. As the AMIS becomes fully implemented, it will become an important tool in forecasting and assessing the impact of policy decisions that affect the supply and demand for minerals. This paper describes the AMIS in detail.

OP 56–82. Brushes Lessen Stopping Leaks, by Robert J. Timko, Mervin D. Marshall, and John C. King. Coal Age, v. 87, No. 4, April 1982, pp. 108–114. Most ventilation air that enters a typical coal mine never reaches the mine working sections. Because of poor stopping construction, the air short circuits to the returns instead. With power costs at the present level and expected to rise, mines are becoming aware that ventilation air is a significant cost of operation. The Bureau of Mines concentrated on practical, low-cost improvements in building concrete block stoppings that would be available to any mine operator. It was found that a strong and airtight block stopping could be built by brushing instead of trowelling on mortars. Using a brush, rather than a trowel, has several benefits. The average mine laborer is more proficient with a brush. The final sealant finish is smooth, and any unsealed holes are apparent. Airtightness is improved at the block joints and around the periphery of the stoppings, where leakage is most prevalent. Finally, in the hands of the mine laborer, this method offers a faster application with less waste.

OP 57–82. Resource and Environmental Assessment of Large-Volume Wastes: Cement Kiln Dust, Phosphate Rock Wastes, and Coal Ash, by Benjamin W. Haynes, Gary W. Kramer, Robert C. Gabler, Jr., and Robert L. Stoll. Proc. 14th Mid-Atlantic Industrial Waste Conf., June 27–29, 1982, College Park, Md., pp. 222–231. The Bureau of Mines Avondale Research Center has investigated the resource recovery potential of three large-volume wastes in response to questions raised concerning some of the potential environmental problems that could be caused by these wastes. These wastes—cement kiln dust, phosphate rock wastes, and coal ash—were chosen because of their potential for resource recovery and possible alternative uses. By determining alternative uses and/or valuable accessory minerals present, the wastes could be converted from a potentially hazardous waste to a resource, reducing adverse environmental effects. Details of these studies on large-volume waste are given including methods of analyses, compositions of the wastes, resource recovery potential, and environmental assessment.

OP 58–82. Mining Picks Up Across the State. Gold Was the 1980 Glamour Metal, by Tom Pittman. Alaska Construction & Oil, v. 22, No. 6, June 1981, pp. 28, 30–31, 34. This paper discusses the mining activity of gold and barite in Alaska during 1980. The discussion includes comparisons of production and prices between 1979 and 1980 and gives estimates for the future.

OP 59–82. How the Six Cleanest U.S. Longwalls Stay in Compliance, by Charles D. Taylor and Robert A. Jankowski. Min. Cong. J., v. 68, No. 5, May 1982, pp. 37–40. The objective of a U.S. Bureau of Mines program was to conduct dust surveys at six longwall sections having double-drum shearers, which were regularly in compliance, and to identify the dust control techniques that were the most effective. As each of the mines selected had a record of regular compliance with Federal Dust Standard, all sampling was "short-term" (often less than 30 minutes) and no attempt was made to relate the survey results to dust sampling results obtained by the companies for compliance purposes. The sampling procedures used during this survey were developed jointly by the Bureau of Mines and Foster-Miller Associates, Inc. In addition to monitoring dust levels, measurements were also taken throughout the shift to monitor airflow along the face, and water usage on the shearer. This program was a cooperative effort of the Bureau of Mines and the Mine Safety and Health Administration.

OP 60–82. Subsidence Control by Backfilling, by Alice S. Allen and James Paone. Ch. 4 in Underground Mining Methods Handbook, ed. by W. A. Hustrulid. Pub. by the Society of Mining Engineers of AIME, New York, 1982, pp. 210–226. The consequences of subsidence become more serious as increasing requirements for mineral products conflict with the needs of an expanding population for surface land area. As a means of controlling subsidence in urban undermined areas, the Bureau of Mines has developed the pumped-slurry process for backfilling underground mine workings that are inaccessible because of flooding, gas accumulation, or caving. In a mixing tank, fill materials are placed in suspension and conveyed in a closed system through a slurry pump, distribution pipeline, and injection borehole into subsurface mine voids. Materials used for fill include crushed waste rock left from mining and processing, fly ash, and sand. In many areas, the local mine pool provides adequate quantities of water. The objective of backfilling mine voids is to mitigate adverse environmental effects of underground mining. The potential for future subsidence is substantially diminished. If waste mine rock is used for fill material, unsightly waste piles are eliminated, restoring land for higher economic use. Removal of waste piles also eliminates bank fires caused by spontaneous combustion, noxious and poisonous gases, particulate matter, and sediment and acid drainage that may enter nearby streams and ponds.

OP 61–82. Bureau of Mines Research To Improve Underground Metal/Nonmetal Mining Technology, by L. L. Davis. Min. Eng., v. 33, No. 3, March 1981, pp. 305–312. Current research by the Bureau of Mines to develop technology for improving efficiency and productivity in metal/nonmetal mines is described. The research program addresses a wide variety of problems associated with each of the major categories of mining: underground mining, surface mining, in situ mining, and premining investigations. An overview of the Bureau's research activities is given with emphasis on underground mining. In particular, two innovative and promising concepts currently under development are described: a unique shaft sinking system that uses an impact hammer for rock fragmentation, and a low-profile

portable crusher for underground hard-rock applications.

OP 62–82. Utilization of Domestic Low-Grade Titaniferous Materials for Producing Titanium Tetrachloride, by G. W. Elger, J. E. Tress, and R. R. Jordan. Pres. at AIME Ann. Meeting, Dallas, Tex., Feb. 14–18, 1982; pub. in Light Met., 1982, pp. 1135–1147. The Bureau of Mines is investigating the use of low-grade domestic titaniferous materials to produce titanium-rich slags as substitutes for imported rutile used in titanium tetrachloride production. This investigation is part of the Bureau's program to develop technology for maintaining an adequate supply of minerals to meet national economic and strategic needs.

OP 63–82. Restoration of Groundwater Quality Following Pilot-Scale Acidic In-Situ Uranium Leaching at Nine-Mile Lake Site Near Casper, Wyoming, by William H. Engelmann, P. E. Phillips, Daryl R. Tweeton, Kent W. Loest, and Michael T. Nigbor. Soc. Pet. Eng. J., June 1982, pp. 382–398. The results of the first restoration effort for a pilot-scale acidic leaching of a uranium ore body in the United States are given. The project was performed under an agreement between the Bureau of Mines and a joint venture consisting of Rocky Mountain Energy, Mono Power Co., and Halliburton Co. The leaching phase is described only briefly; it was reported earlier by Tweeton. Leaching was done with H_2SO_4 (pH range of 1.6 to 3.9) and H_2O_2 (80 to 1,000 ppm) over an 11-month period. The restoration phase began in September 1978 and was completed in 11 months. Water samples were taken from observation wells located between injection and production wells while the leaching solution was decreased in strength. Ground water quality in the leaching ore zone was restored by diluting and neutralizing effects of injecting native groundwater and treated water produced from recovered solution. Recovered water was purified by a combination of chemical precipitation and reverse osmosis. In situ measurements of pH, Eh, dissolved oxygen, conductivity, and temperature were made by a downhole probe in one of the wells. Water samples were taken and analyzed for U, V, Na, K, Ca, Mg, SO_4, P, Cl, F, Fe, Mn, Si, Zn, As, and Se.

OP 64–82. Longwall Cuts Dust Build-up, by Robert A. Jankowski and Joseph Hetrick. Coal Age, v. 87, No. 6, June 1982, 4 pp. A longwall at Barnes and Tucker Coal Co.'s Lancashire No. 20 mine, near Barnesboro, Pa., is controlling respirable dust successfully with a bidirectional shearer featuring a small and a large drum and a cutting sequence that keeps face workers in a split of clean air during most of the mining cycle. The longwall unit, which cuts about 800 tons per shift in a 60-in-thick area of the Lower Kittanning seam, has a consistent record of compliance with a 2.0-mg/m^3 Federal respirable-dust standard. According to a survey the Mine Safety and Health Administration conducted in 1978, the average face worker's exposure to respirable dust at the mine ranged from 1.1 to 2.0 mg/m^3. In 1981, dust exposure was 0.6 to 1.5 mg/m^3 for designated occupations. Air along the 400- to 500-ft-wide longwall face flows into the tailgate and out through the headgate. A separate split of air from the belt entry returns into the gob entry as well. The longwall panel is supplied with 18,000 ft^3/min of air that achieves a face velocity of 200 ft/min.

OP 65–82. Recent Advances in Mine Safety Technologies in the United States of America, by Robert L. Marovelli and Chi-shing Wang. Proc. 11th World Min. Cong., Belgrade, Yugoslavia, May 31–June 3, 1982, v. B, pp. 649–674. Over the past 12 years the U.S. Bureau of Mines almost quintupled its annual expenditures on minerals health and safety research. The expanded research and development program is having significant impact on the advancement of mine safety technologies. This paper highlights some innovations that have been validated by industrial applications or by extensive field demontsrations.

OP 66–82. Recovering Accessory Minerals From Lead and Zinc Process Wastes, by V. R. Miller and D. L. Paulson. Pres. at Resource Recovery and Environmental Issues of Industrial Solid Wastes Symp., Gatlinburg, Tenn., Oct. 28–30, 1981. Pub. in Res. and Conserv., Elsevier Scientific Publishing Co., Amsterdam, the Netherlands, v. 9, August 1982, pp. 95–104. This research is part of a continuing effort to reduce environmental conflicts and occupational hazards associated with mineral processing and to recover valuable constituents in wastes. A laboratory process for lead smelter flue dust (sulfation roasting followed by water leaching) extracts over 95 pct of the Cd and Zn. Ninety-nine percent of the Cd is recovered from solution by sponging with zinc dust, and Zn is electrowon from the resulting solution after purification. The Cd and Zn leach residue consists largely of $PbSO_4$, which is converted to $PbCO_3$ and leached with H_2SiF_6 to produce $PbSiF_6$ electrolyte for lead electrolysis. Accessory minerals (such as Co and Ni) are separated into purification residues for subsequent recovery. A copper-cake residue treatment process consists of leaching with sulfuric acid to extract Cd and Zn, which are recovered as in the flue dust processing. The insoluble residue, containing Cu, As, Co, and Ni, is leached with manganese dioxide and sulfuric acid to solubilize those metals while leaving a residue of $PbSO_4$. The solubilized metals are recovered from the leach solution by caustic purification (As and Fe removal) and sequential sulfide precipitations. The products are copper sulfide and cobalt-nickel sulfide. The manganese is reclaimed from the leach liquor as manganese dioxide for recycle.

OP 67–82. Ceramic Roadway Aggregates, by A. V. Petty, Jr. Proc. ASTM Committee D–4 Symp. on Road and Paving Materials, Orlando, Fla., Dec. 10, 1980; pub. in Extending Aggregate Resources, ASTM STP 774, 1982, pp. 196–212. Through a cooperative program between the Bureau of Mines Tuscaloosa Research Center and the Federal Highway Administration, ceramic aggregates having high wear resistance and polish resistance were developed. Three hundred aggregate compositions, incorporating a variety of low-cost "waste" materials, were evaluated over a 30-month period. Aggregates are produced using conventional ceramic processing techniques and fired at temperatures ranging from 900° to 1,500° C. British Wheel and Los Angeles Abrasion tests were used for initial screening of the aggregates. These data, in addition to raw materials costs, availability, and energy requirements, were used to select nine compositions for circular track tests at Maryland and North Carolina Highway Department facilities. Economic evaluations showed that present production costs, based on a 1,000-ton-per-day operation, ranged from $10 to $120 per ton of material produced. Guyana bauxite was used as a standard, and several of the

selected compositions developed surpassed the bauxite in performance and were lower in cost.

OP 68–82. New Mining Technologies Resulting From U.S. Bureau of Mines Research, by Donald G. Rogich. Proc. 11th World Min. Cong., Belgrade, Yugoslavia, May 31–June 3, 1982, v. B, pp. 397–409. The Bureau of Mines conducts a wide variety of research to improve the technology associated with the exploitation of mineral deposits. These studies, which cover all aspects of surface and underground mining, have produced a number of innovative techniques and equipment that have significant potential benefits in minerals extraction. This paper examines a number of recent developments that have been the product of Bureau of Mines research, with emphasis on the problems to be overcome, the research approach, the resulting developments, and potential benefits. Specific items to be addressed include a retractable drill bit for exploration and development drilling; developments in borehole mining techniques for the exploitation of small, near-surface deposits; new low-headroom crusher developments for room-and-pillar mining; and large-scale crusher developments for open pit mines. These developments have application to a wide variety of minerals exploitation including uranium, limestone, copper, lead, and zinc, as well as problems in minerals exploration.

OP 69–82. Measurement of the Thickness of Amphibole Asbestos Fibers With the Scanning Electron Microscope and Transmission Electron Microscope, by A. G. Wylie, K. B. Shedd, and M. E. Taylor. Proc. 17th Ann. Conf. of the Microbeam Analysis Society, Washington, D.C., Aug. 9–13, 1982. Pub. in Microbeam Analysis—1982, ed. by K. F. J. Heinrich. San Francisco Press, Inc., San Francisco, Calif., Aug. 9, 1982, pp. 181–187. Knowledge of the cross-sectional shape of mineral fibers is important for their accurate dimensional characterization. Two techniques for the measurement of width and thickness of fibers are described and compared: one for the scanning electron microscope (SEM) and one for the transmission electron microscope (TEM). The frequency distributions of log thickness and width determined by these techniques are considerably more accurate when the TEM is used. However, the use of either technique results in essentially the identical quantitative descriptions of the relationship between thickness and width for amosite and crocidolite. A general relationship between thickness and width for amphibole asbestos is log thickness = 0.692 log width — 0.493; a rectangle is a reasonable approximation of its cross-sectional shape.

OP 70–82. Extraction of Leachable Metals and Recovery of Alumina From Utility Coal Ash, by R. C. Gabler, Jr., and R. L. Stoll. Pres. at Resource Recovery and Environmental Issues of Industrial Solid Wastes Symp., Gatlinburg, Tenn., Oct. 28–30, 1981; pub. in Res. and Conserv., Elsevier Scientific Publishing Co., Amsterdam, the Netherlands, v. 9, 1982, pp. 131–142. The extraction of metals from coal ash was investigated as part of a Bureau of Mines program to convert waste materials from a disposal problem to potential secondary resources. The objectives of this study were to produce a more environmentally acceptable waste and offset waste disposal costs with recovered metal values. The research was conducted in two steps: determination of parameters affecting extraction of aluminum from coal ash, and development of extraction-recovery procedures.

OP 71–82. Heteronuclear Compounds of Arsenic and Antimony, by James E. Mauser. Met. Trans. v. 13B, No. 3, September 1982, pp. 511–513. During the roasting of copper ores when both arsenic and antimony sulfides are present, the evolution of arsenic is retarded and the volatilization of antimony increased primarily because of the formation of heteronuclear compounds. These heteronuclear compounds exhibit vapor pressure different from those of their individual parent compounds. Because the arsenic and antimony content in copper ores and concentrates is generally 1 percent or less, the anomalous vaporization behavior of mixed arsenic and antimony oxides and sulfides may be of small magnitude. However, because the phenomenon of preferential antimony volatilization was noted in roasting studies of concentrates and because high-arsenic flue dusts and antimony speiss are sometimes roasted together, the formation of heteronuclear compounds of arsenic and antimony is a factor that should be considered.

OP 72–82. Preparing Rare Earth Silicon Iron Alloys, by E. Morrice and M. M. Wong. Proc. 15th Rare Earth Research Conf., Rolla, Mo., June 15–18, 1981; pub. in The Rare Earths in Modern Science and Technology, ed. by G. J. McCarthy, H. B. Silber, and J. J. Rhyne, v. 3, Aug. 30, 1982, pp. 557–560. As part of its mission to assure the maximum recovery and use of the Nation's mineral resources, the Bureau of Mines investigated an improved procedure for producing rare earth-silicon alloys. For example, a charge consisting of 681 grams of mixed rare-earth oxides, 309 grams of ferrosilicon (75 wt-pct Si), and 182 grams of aluminum metal along with a flux consisting of 681 grams of CaO and 45 grams of MgO was reacted at 1,500° C in an induction furnace. Good slag-metal separation was achieved. The alloy product contained, in weight-percent, 53 rare earth (RE), 28 Si, 11 Fe, and 4 Al with a rare earth recovery of 80 pct. In current industrial practice, rare earth recoveries are usually about 60 pct in alloy products that contain approximately 30 wt-pct each of rare earths and silicon. Metallurgical evaluations showed that the alloys prepared in this investigation to be as effective in controlling the detrimental effect of sulfur in steel and cast iron as the commercial rare earth-silicon-iron alloys presently used in the steel industry.

OP 73–82. Use of Low-Btu Gas in Iron Ore Pelletizing, by John C. Nigro. Min. Cong. J., v. 68, No. 8, August 1982, pp. 50–58. The iron ore pelletizing industry has a current energy demand approaching the equivalent of about 4 million tons per year of western coal. In the past, a favorable combination of fuel price and supply led to the use of premium natural gas and No. 2 fuel oil as the major heat sources for the pelletizing process. A shift in premium fuel supplies and price relationships in recent years has forced the industry to seek ways to utilize coal as an alternate source of energy either in direct combustion or through conversion to gaseous or liquid fuels. In 1978, a research program to demonstrate the technical feasibility and practicality of using a hot, raw, low-Btu coal gas as a fuel for high-temperature induration of iron ore pellets was initiated by the Bureau of Mines Twin Cities Research Center. Cooperators in the program include the U.S. Department of Energy and 20 U.S. firms with interests in iron ore, coal, gas, and industrial engineering. Coal gas used in the pelletizing program was derived from gasifying bituminous, subbituminous, and lignite coals. This report summarizes the performance characteristics of a

30-day, around-the-clock gasification-pelletizing test conducted in October and November 1980 with North Dakota Indianhead lignite. Gasification was conducted in a commercial-size, 6.5-foot-diameter, Wellman-Galusha single-stage, fixed-bed, atmospheric producer with a rated capacity of about 30 million Btu per hour. Iron oxide pellets made from a commercial hematite concentrate were fired with the low-Btu gas in a 2.8-foot-diameter by 35-foot-long pilot plant rotary kiln at a rate of 900 pounds of pellets per hour. Gassifier operations at fuel rates up to 3 tons of lignite per hour and hematite pellet induration with raw lignite gas of 160 Btu per standard cubic foot are described.

OP 74–82. Infrared Temperature Measurements of Gas and Dust Explosions, by K. L. Cashdollar and M. Hertzberg. Pres. at 6th Symp. on Temperature, Washington, D.C., Mar. 14–18, 1982, Pub. in Temperature. Its Measurement and Control in Science and Industry, ed. by J. F. Schooley. American Institute of Physics, New York, v. 5, 1982, pp. 453–463. This paper presents temperature measurements of gas and dust explosions. Instrumentation used includes a commercial rapid-scan spectrometer and two multiwavelength infrared pyrometers developed at the Bureau of Mines. The rapid-scan spectrometer has a wavelength range of 1.7 to 4.8 μm and a maximum rate of 800 scans per second. One of the pyrometers is a three-wavelength, near-infrared instrument with a time response of about 20 μsec, and it measures continuum radiation from particles in the flame at wavelengths of 0.8, 0.9, and 1.0 μm. The second infrared pyrometer measures continuum radiation from hot particles at four wavelengths (1.6, 2.3, 3.8, and 5.0 μm) and band emission from carbon dioxide gas at 4.4 and 4.6 μm. It has a time response of about 25 μsec. Temperatures for small- and large-scale methane-air explosions were measured with the rapid-scane spectrometer, based on the absolute radiance and on emission-absorption measurements using a blackbody source. Measurements of both gas and dust temperatures for small-scale dust explosions were made with the rapid-scan spectrometer and the two pyrometers. The two pyrometers have also been used to make temperature measurements within full-scale mine coal dust explosions.

OP 75–82. Refractory Dolomite Raw Materials, by T. A. Clancy and D. J. Benson. Proc. Raw Materials for Refractories Conf., University of Alabama, Tuscaloosa, Feb. 8–9, 1982, v. 1, No. 1, pp. 220–253. As one of its goals to reduce the Nation's dependence on imported strategic and critical materials, the U.S. Bureau of Mines is conducting research to encourage the use of plentiful domestic dolomitic resources. Greater use of our dolomite materials in a variety of refractory processes could reduce our dependence on imported chromite and more expensive seawater periclase. A review of the literature on dolomite refractories has indicated that the United States has traditionally used less dolomite refractories than European countries. Characterization studies of 14 domestic dolomite ores, which included chemical and mineralogical analyses, density and hydration determinations, and microstructure and thermal decomposition evaluations, have shown that there were noticeable differences in the hydration, microstructure, and thermal behavior of the various ores.

OP 76–82. Rock Mechanics Instrumentation and Monitoring for Ground Control Around Longwall Panels, by Paul H. Lu. Proc. Internat. Symp. on State-of-the-Art of Ground Control in Longwall Mining and Subsidence, Honolulu, Hawaii, Sept. 4–5, 1982, pp. 159–166. This report by the Bureau of Mines presents several practical and inexpensive types of rock mechanics instrumentation for ground control around longwall panels. Application of these critical parameters, determined by this instrumentation, to the design and modification of rational longwall-mining systems is also discussed. In order to design or select an optimum mine structure or system, realistic and precise values of the design parameters must be determined in operating mines by (1) measuring ground stresses, (2) mining induced load transfer, and (3) strata movements as well as deformation moduli and rock strengths. Based on these parameters, rational and realistic criteria for mine design can be established by conducting case studies. It was found that several basic design parameters can be easily measured or determined in situ with simple, inexpensive, and practical instruments such as hydraulic borehole pressure cells, automatic recording convergence meters, automatic recording multiple-anchor-point extensometers, and hydraulic pressure recorders.

OP 77–82. Recovery of Metals and Minerals From Selected Processing Wastes, by H. V. Makar, D. M. Soboroff, and F. J. Palumbo. Res. and Conserv., Elsevier Scientific Publishing Co., Amsterdam, the Netherlands, v. 9, 1982, pp. 179–190. To improve metal and mineral recycling technology while minimizing undesirable environmental effects, the Bureau of Mines is devising and evaluating recovery methods for scrap materials that cannot now be processed using conventional techniques. Characterization and leaching tests with chromite tailings, tin recovery from detinning sludges, and conversion of flue dusts generated by the secondary copper and brass industry to zinc oxide are described. Procedures tested include leaching, mineral beneficiation, and roasting. Resource potential and environmental considerations are discussed.

OP 78–82. The Mechanization of Mining, by Robert L. Marovelli and John M. Karhnak. Sci. Am., v. 247, No. 3, September 1982, pp. 90–102. Today more than 80 percent of the mineral needs of the U.S. economy are met by only 1 percent of the labor force. This paper examines the mechanization of mining in terms of its effect on the mining of coal.

OP 79–82. Dewatering High-Clay Content Preparation Plant Tailings, by Bernard J. Scheiner. Min. Cong. J., v. 68, No. 9, September 1982, pp. 233–234. The U.S. Bureau of Mines, as part of its mission to eliminate health and safety hazards at the mine site, is developing alternate treatment and disposal methods for coal-clay waste. In the preparation of coal to produce low-ash material, a waste product containing fine coal and clay is generated. This waste product, generally minus 28 mesh in size, with the major portion being minus 325 mesh, is difficult to handle owing to the low settling of the fine clay particles. The material is usually processed in a thickener to produce a slurry containing about 30 percent (by weight) solids that is generally impounded behind earthen dams. It has been estimated that about 16 million tons of these waste solids are generated annually. Disposition of the slurries behind dams poses a potential health and safety hazard because of possible dam failure and because months and sometimes years are required for the slurry to settle and thicken naturally.

OP 80–82. Recycled Materials for Refractories, by D. E. Wittmer and A. V. Petty, Jr. Proc.

Raw Materials for Refractories Conf., the University of Alabama, Tuscaloosa, Feb. 8–9, 1982, v. 1, pp. 309–328. A major goal of the Bureau of Mines is to investigate technology that can reduce the Nation's dependence on strategic and critical imported raw materials. To this end, the Tuscaloosa Research Center has been involved in a program to investigate the potential of utilizing waste materials to produce refractories containing chromite and alumina. Magnesite-chrome brick have been produced by recycling steel plant waste refractories using conventional beneficiation techniques. In addition, preliminary evaluation of a synthetic high-alumina dross appears promising. Currently, some high-alumina refractory waste materials are being used in commercial refractories and demand is increasing for recycled refractories.

OP 81–82. Heat Capacity From 5 to 300 K of α- and β-TiO, Relative Enthalpy to 1200 K, Enthalpy of Transition, and Thermodynamic Properties to 1265 K, by R. P. Beyer, R. R. Brown, K. O. Bennington, and M. J. Ferrante. J. Chem. Thermodyn., v. 14, 1982, pp. 957–965. The heat capacities of TiO(α) and TiO(β) were measured from 5 to 305 K by adiabatic calorimetry. High-temperature enthalpies up to 1,192 K for TiO(α) were determined by copper-block drop calorimetry. The enthalpy of transition for TiO(α) to TiO(β) was determined by hydrofluoric acid solution calorimetry and by differential scanning calorimetry. The values at 298.15 K of C_p^o, $[S^o(T) - S^\circ(O)]$, and $-[G^\circ(T) - H^\circ(O)]/T$ are 39.89, 34.26, and 13.75 $J \cdot K^{-1} \cdot mol^{-1}$ for TiO(α), 40.40, 35.75, and 14.65 $J \cdot K^{-1} \cdot mol^{-1}$ for TiO(β). These thermodynamic functions are also calculated from 5 to 1,265 K for TiO(α), and from 5 to 300 K for TiO(β). The enthalpy of transition from α to β at 298.15 K is 4.7 $kJ \cdot mol^{-1}$ and at 1,265 K is 5.4 $kj \cdot mol^{-1}$.

OP 82–82. Large Rock Conveying Systems and Their Application in Open-Pit Mines, by T. W. Martin, J. M. Goris, and T. J. Crocker. Min. Eng., v. 34, No. 10, October 1982, pp. 1481–1485. The current technology of large rock conveyors is reviewed. Based on this investigation, two large rock conveyor concepts have been developed and a test facility investigation designed and fabricated. The Bureau of Mines will test these concepts along with loading and transfer points for handling mine run rock material up to 1.5 m (4.9 ft) in size. An evaluation of open pit mining systems using large rock conveyors documents substantial cost savings when compared with truck haulage.

OP 83–82. Electrochemical Determination of the Thermodynamic Properties of Sphalerite, ZnS(β), by S. C. Schaefer and N. A. Gokcen. High Temp. Sci., v. 15, 1982, pp. 225–237. As part of the Bureau of Mines effort to provide thermodynamic data for the advancement of minerals technology, thermodynamic properties of sphalerite ZnS(β) were investigated with a high-temperature galvanic cell employing stabilized zirconia as the electrolyte. In the temperature range 948 to 1,210 K, potential measurements were obtained for the cell.

OP 84–82. Pneumatic Beneficiation of Mica, by G. V. Sullivan and M. H. Stanczyk. Proc. 14th Internat. Miner. Processing Cong. on Worldwide Industrial Application of Mineral Processing Technology, Toronto, Ontario, Canada, Oct. 17–23, 1982, v. 1, No. 1, pp. V6.1–V6.19. The Bureau of Mines has conducted research into the pneumatic recovery of coarse mica pursuant to its objective of devising technology that will help maintain an adequate supply of minerals and metals to meet national economic and strategic needs. The pneumatic beneficiation technique may be advantageous in areas where water resources are limited. Researchers used a Bureau-designed system of crushers, screens, and zigzag air classifiers to concentrate coarse liberated mica particles from mica-bearing materials. A hammer mill, modified by removing 70 of its 80 free-swinging hammers and the crushing screen, proved effective for crushing and delaminating the mica without overgrinding. This pneumatic system was used to concentrate mica ores from Arizona, North Carolina, and South Dakota and waste tailings from Alabama, Georgia, and South Dakota. Using these samples, it was demonstrated that plus 0.21-millimeter-size mica can be effectively recovered by the pneumatic method. Mica concentrates containing more than 90 percent mica were produced with attendant recoveries of up to 78 percent.

OP 85–82. Determination of Sulfonamides in Animal Tissues and Feeds, by Michael H. Thomas and Karen E. Soroka. Ch. 33 in Advances in Thin Layer Chromatography. Clinical and Environmental Applications, ed. by J. C. Touchstone. John Wiley & Sons, Inc., New York, 1982, pp. 425–437. Sulfonamide drugs have proven to be effective antibacterial agents in many food-producing animals. The U.S. Food and Drug Administration has set the tolerance level for the resultant residues in uncooked edible tissues at 0.1 ppm. A rapid screening method to detect these drugs was developed to prevent gas chromatography-mass spectrometry (GC-MS) confirmation analysis of an excessive number of false positive and false negative samples. The method provides the ability to monitor multiple sulfonamides simultaneously at the tolerance level with a degree of accuracy and precision. The two most significant factors responsible for these characteristics are the internal standard and the preadsorbent spotting zone. For laboratories without access to a GC-MS instrument or a need for confirmatory information, the technique is sufficiently accurate and sensitive to function as the determination procedure. Since 18 to 24 samples can be analyzed completely per day, the procedure offers the added benefit of high sample throughput.

OP 86–82. Gold, by W. C. Butterman and J. M. Lucas. Ch. in On Gold, ed. by H. A. Lipscomb and D. R. Libey. The Waterleaf Press, DeKalb, Ill., 1982, pp. 47–89. This paper was written as part of the approach to gold as an investment in the future, based on the performance of gold in the past. A brief history on gold is presented and the process of investing in gold in a future market is examined in much the same manner as any commodity would be examined in a future market. Only a certain amount of gold is available, and the supply and demand relationships are covered.

OP 87–82. Deep Cutting: Key to Dust-Free Longwalling, by Jonathan Ludlow and Richard J. Wilson. Coal Min. and Proc., v. 19, No. 8, August 1982, pp. 40–43. The correlation between depth of cut and dust generation has been established in laboratory and test fields that have been conducted in the United States and abroad for a number of years. This article describes a recent testing program that has proved the benefits associated with deep and slow cutting on a U.S. longwall face. The tests showed that respirable dust from longwall mining can be significantly reduced without adversely affecting production by simply increasing the depth of cut of the shearer.

OP 88–82. Testing of Fire-Resistant Conveyor Belting, by Frank J. Perzak, Ellsworth R. Spencer, and Michael J. Sapko. Can. Min. Met. Bull., v. 75, No. 884, August 1982, pp. 110-115; reprinted in Fire Prev. in Min. Ind., 1982, pp. 1–5. The fire resistance of several mine conveyor belts is evaluated using a new belt-flammability apparatus developed by the U.S. Bureau of Mines. The test, experimental details, and a calculated flammability index (FI) are described. The FI values are useful for ranking the fire resistance of mine conveyor belts. Values are determined using parameters readily measured with thermocouples, high-temperature flow probes, and a methane-oxygen torch, all of which are components of the Bureau's new test apparatus. The FI varies directly with the flame-spread rate and the rate of heat release during burning and varies inversely with the critical (minimum) ignitor energy output. The fire-resistance ranking of nine different belt types using this moderately scaled apparatus is compared with available full-scale data on belt fires. This comparison shows that the ranking based on the FI is consistent with the full-scale data.

OP 89–82. Vibration and Noise From Blasting, by David E. Siskind. Inter-Noise 82, v. 1, May 17, 1982, pp. 281–284. Adverse environmental effects from blasting continue to be a major problem for the mining industry, the public living near mining operations, and the governmental agencies responsible for setting environmental standards. The Bureau of Mines has established a comprehensive blasting research program dealing with the many technical aspects of generation and propagation of ground vibrations and airblast, structure response and damage, and proper instrumentation. This paper describes the Bureau's programs and lists agencies and industries that are utilizing the results of the Bureau's research.

INDEX OF BUREAU OF MINES PUBLICATIONS

ABBREVIATIONS

B	Bulletin
EPA*	Environmental Protection Agency
GS*	Geological Survey
IC	Information Circular
MLA	Mineral Land Assessment
NCGS*	North Carolina Geological Survey
MY†	Minerals Yearbook
OFR	Open File Report
OP	Outside Publication
P	Patent
RI	Report of Investigations
SP	Special Publication
TPR	Technical Progress Report

SUBJECT INDEX

A

* Listed in the "Cooperative Publications" section.

† MY 1981 (v. 1)—Minerals Yearbook, Metals and Minerals, Volume I, 1981; MY 1981 (v. 2)—Minerals Yearbook, Area Reports: Domestic, Volume II, 1981; MY 1981 (v. 3)—Minerals Yearbook, Area Reports: International, Volume III, 1981.

B

C

D

E

F

G

H

I

J

K

L

M

N

O

P

Q

R

S

T

U

V

W

X

Y

Z

AUTHOR INDEX

In the following index, a comma following the name of the first author in an entry indicates that the first author is the senior author; all of the other authors in the entry are junior authors.

A semicolon following the name of the first author in an entry indicates that the first author is a junior author; the name of the senior author immediately follows.

* Author(s) of chapter.

* Author(s) of chapter.
† Compiler(s) and/or editor(s).

C

* Author(s) of chapter.

D

E

* Author(s) of chapter.
† Compiler(s) and/or editor(s).

F

G

* Author(s) of chapter.

H

* Author(s) of chapter.

I

J

K

* Author(s) of chapter.

L

* Author(s) of chapter.

M

* Author(s) of chapter.
† Compiler(s) and/or editor(s).

N

* Author(s) of chapter.
† Compiler(s) and/or editor(s).

O

P

* Author(s) of chapter.
† Compiler(s) and/or editor(s).

Q

R

S

* Author(s) of chapter.
† Compiler(s) and/or editor(s).

* Author(s) of chapter.

T

* Author(s) of chapter.
† Compiler(s) and/or editor(s).

U

V

W

* Author(s) of chapter.

Y

Z

*Author(s) of chapter.
†Compiler(s) and/or editor(s).