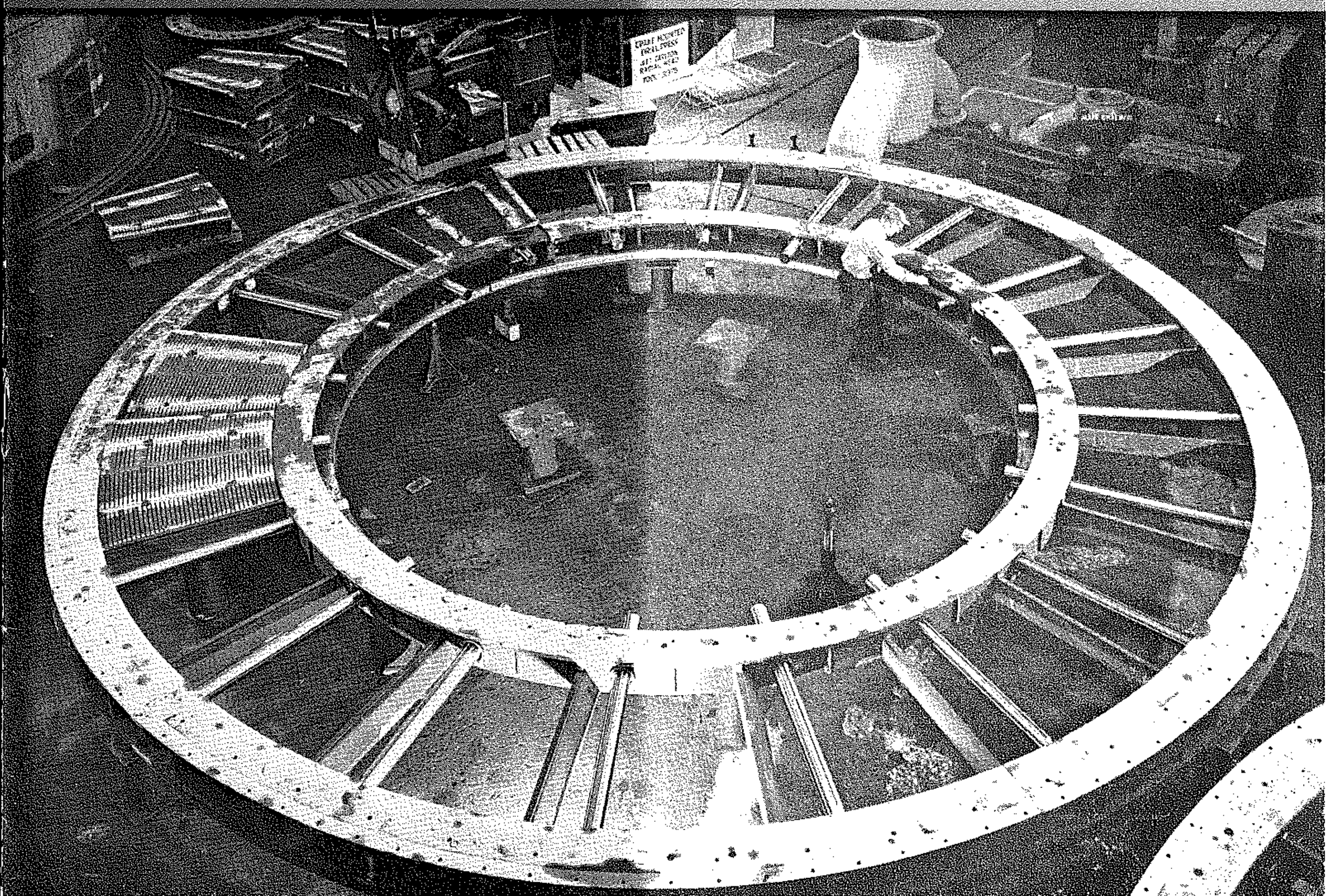
THE MINES MAGAZINE

FEBRUARY 1960

- Improved Ore Milling Practice
- Operation Mohole
- Geology in Development of Mining
- Nation's 'Mines-Above-Ground'
- Research Man and His Environment
- 'Spring Water,' Ceramics, Aluminum Cans



CLASS NOTES

When advising us of change of address, please confirm your position or title and company affiliation.

1882-1930

Frank E. Lewis, '01, writes that for the next few months he will be receiving mail at 303 W. 6th, Pittsburg, Kans.

Alfred R. Flinn, '13, gives his mailing address as 45 Hickory Trail, Lake Mohawk, Box 57, Sparta, N. J.

Ernesto C. Bengzon, '21, has moved from Manila to 12 Esteban Abada, Loyola Heights, Q.C. Philippines.

Louis C. Fopeano, '21, manager of Peter Lumber Co., lives at 459 S. 5th Ave., Royersford, Pa.

Joseph A. Haskin, '22, formerly with Hudson Bay Mining and Smelting Co. at Flin Flon, Manitoba, has retired and is now living at 57 Comares Ave, Saint Augustine, Fla.

Fitzhugh B. Jones, '23, chemist for the Food and Drug Administration, gives his address as 284 Park Ave., Freeport, N. Y.

Francisco G. Joaquin, '26, may be addressed at Casa Franca 4, Loakan Rd., Baguio, Mt. Province, Philippines.

Harold F. Browne, '28, supervising safety engineer for the U. S. Bureau of Mines, receives mail at 4100 Hampshire Blvd., Fort Worth 3, Texas.

Gordon C. MacDonald, '28, has moved from Oklahoma City to 7611 E. 81st St., RR2, Tulsa, Okla.

Robert L. Boeke, x-'29, chief assayer, receives mail c/o A.S.&R. Co., El Paso Lab., 1112 Mills Bldg., El Paso, Texas.

S. W. McNeil, '29, safety director for Northspan Uranium Mines Ltd., lives at 298 Mississauga Ave., Elliott Lake, Ontario.

Harry J. Wolf, '03, consulting engineer to Lajo Mines Ltd., operating silver-mining properties in British Columbia, and to Surinam Development Corp., developing extensive gold and platinum placer deposits in Surinam, South America, recently has been elected a director of Standard Beryllium Corp. of New York, with mineral interests in Brazil.

1931-'40

John R. Aho, '31, district industrial engineer for Oliver Iron Mining Division, has moved from Eveleth, Minn., to 707 13th St. So., Virginia, Minn.

Capt. R. C. Jensen, '32, staff, commander U. S. Naval Reserve Training Command, has been transferred from Port Hueneme, Calif., to 30th and Fort St., Omaha 11, Nebr.

Robert C. Berggren, '33, is a partner in the M. R. Crossman Industrial Advertising Co. of Burbank, Calif. He lives at 546 N. Hollywood Way.

Dr. Bruno O. Winkler, '33, has been transferred from Sumatra, Indonesia, to the London Office of the Standard-Vacuum Oil Co. His new address is Dr. Bruno O. Winkler, General Representative, Standard-Vacuum Oil Co., Africa House, 5th Floor, Kingsway, London, W.C.2, England.

David M. Evans, '36, is an independent consulting geologist with offices at 722 Patterson Bldg., Denver 2, Colo.

Morgan Leonard, '36, receives mail c/o Baritina de Venezuela, Apartado 9117, Caracas, Venezuela, S. A.

D. L. Risley, x-'37, project engineer for Humphrey Design Co., lives at 12937 Cedar Rd., Cleveland Heights 18, Ohio.

Castle O. Reiser, '38, professor of engineering at Arizona State University, lives at 518 Concorda Dr., Tempe, Ariz.

Jones Ruiz Castro, '38, has moved from Pampangas to 141 Cordillera St., Quezon City, Philippines.

Lt. Col. Louis E. Bremkamp, '38, deputy chief of staff for logistics, U. S. Army (Pentagon), is living at 5812 Danforth St., McLean, Va.

Allen S. Crowley, '39, independent contractor, has moved from Joplin, Mo., to Goreville, Ill., where he receives mail c/o General Delivery.

J. M. Baggs, '39, assistant sales manager for The R. J. Brown Co., has moved from Chicago to 404 N. Warson Rd., St. Louis 24, Mo.

Sebastian Moll, Jr., '39, has changed his mailing address from Tigoan, Camarines, Philippines, to San Luis Terrace Bldg., Manila, Philippines.

Jose C. Quema, '39, receives mail at 1115 R. Hidalgo, Manila, Philippines.

David Sycip, '39, may be addressed c/o Northern Motors, Inc., Isaac Peral, Manila, Philippines.

Marciano E. Natividad, '40, lives at 1015 Craig St., Sampaloc, Manila, Philippines.

Manuel C. Javellana, '40, has moved from Iloilo City, Panay, Philippines, to Baguio City, Philippines, where he may be addressed c/o Philex Mining Co.

Jesus L. Jalandoni, '40, receives mail c/o Commercial Credit Corp., Natividad Bldg., Manila, Philippines.

Rolando J. Gamboa, '40, is addressed at 405 Quisumbing Bldg., Manila, Philippines.

Ananias T. Crisostomo, '40, receives mail c/o COR Minerals, Inc., Ayala Bldg., Manila, Philippines.

John R. Wagner, '40, is receiving mail c/o Pacific Merchandising Corp., 303 Dasmarinas St., Manila, Philippines.

Edward F. Porter, '40, manager of the central industrial division of Dorr-Oliver, Inc., has been transferred from Dallas to Chicago. His new address is c/o Dorr-Oliver Inc., 813 Merchandise Mart, Chicago 54, Ill.

1941-'45

Serviliano Aquino, '41, lives at 64 M. Clara, Quezon City, Philippines.

Anselmo D. Claudio, Jr., '41, picks up his mail c/o G. M. Cansipit, Inc., 205 Wilson Bldg., Manila, Philippines.

Rolando L. Espinos, '41, has moved from La Castellana, Philippines to Bacolod, Occ. Negros, Philippines.

Estanislao Y. Feria, '41, lives at 333 Icasa St., Manila, Philippines.

John R. Kuykendall, Jr., '41, may be addressed c/o Northern Motors, Inc., Isaac Peral, Manila, Philippines.

Jack L. Mataya, '41, is employed by Pan American Petroleum Corp., 444 7th Ave. S.W., Calgary, Alberta, Canada.

Philip A. Gerow, '41, who has been living in Modesto, Calif., now makes his home at 532 E. Poplar St., Stockton, Calif.

James D. Buhler, '42, is production superintendent for Kaiser Aluminum and Chemical Corp., Mead, Wash. His address is 10724 Elma Dr., Spokane 53, Wash.

Carlos A. Schwarck, '42, may be addressed at Avenida Turpial 55, Urb. Valle Arriba, Caracas, Venezuela, S. A.

Richard F. Miller, '43, is employed by Caltex Pacific Oil Co. at Pakanbaru, Sumatra, Indonesia.

Melvin M. Tongish, '43, has requested us to change his mailing address from Quiriquire, Venezuela, to Esso Standard (Libya) Inc., P.O. Box 281, Benghazi, Libya, North Africa.

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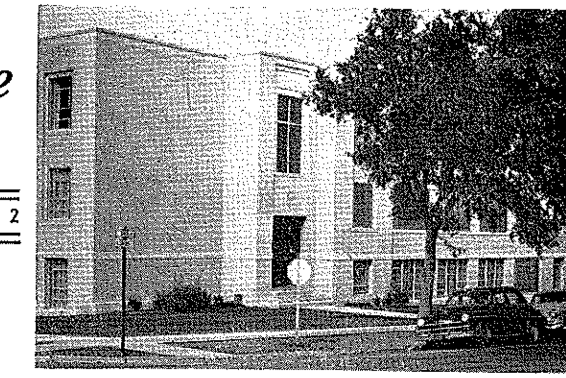

CONTENTS—

DEPARTMENTS—

FRONT COVER—

A highly maneuverable crane-mounted radial press at Allis-Chalmers West Allis (Wis.) Works drills holes in one of two 25-ft. diameter annular coolers being furnished Humboldt Mining Co. The coolers will be used in conjunction with first full-scale operation of the grate-kiln system in an iron ore agglomeration process. The cooler grate sections, some of which are shown in place, tip separately at one point in the machine's cycle to discharge completely cooled pellets. (See story in Plant News, page 37.)

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NEWS of the MINERAL INDUSTRIES

Clear Creek Mining Co. Allotted $84,500 by OME For Mineral Exploration

Clear Creek Mining Co. of Denver, Colo. and Idaho Springs has been authorized to spend $84,500 for mineral exploration by the Office of Minerals Exploration, Department of the Interior.

The government will loan the company $42,250 on a matching fund basis.

The joint program is part of a larger exploration program on the two strong vein systems intersecting and forming a flat X north of Idaho Springs. Near the intersection the veins are cut by the Central or Big Five Tunnel 1700 feet below the surface and 8500 feet north of Idaho Springs.

Twelve hundred to 1600 feet of virgin ground vertically and 12,000 feet of virgin ground along the strike of the veins comprises the over-all target of the exploration work. Gold, silver, copper, lead and zinc are the important metals sought.

The project was started in 1956 by Contract Engineering Co. In 1958 Clear Creek Mining Co. was formed to operate the mine.

Contract Engineering Co. is owned and operated by Alfred G. Hoyl, '40, and Paul L. Goddard, '47. The mining project is managed by Contract Engineering Co. George R. Kyler, '54, is mine superintendent.

Bureau Accomplishments Described in 1959 Report

Bureau of Mines achievements in coal, petroleum, and other minerals research, helium production, and health and safety were cited by Secretary of the Interior Fred A. Seaton in his annual report to the President for the 1959 fiscal year.

Highlighting the Government's programs for metals, nonmetallics, and mineral fuels during a period that saw increasing supplies of essential materials, the Secretary's report notes the following outstanding accomplishments:

Coal: The Bureau began an ambitious study to determine whether hydraulic methods can be employed successfully in the United States to mine bituminous coal. Another new project seeks techniques for removing explosive methane gas from coal seams in advance of mining. Anthracite research included an experiment in mining a thick, moderately pitching vein of coal mechanically, and continuation of a full-scale longwall mining test.

Coal-preparation studies emphasized improvement of methods for cleaning bituminous coal. Nuclear radiation also was used to gain more knowledge of the fundamental properties of both bituminous coal and anthracite.

Petroleum and Natural Gas: The Bureau participated in long-range cooperative studies to estimate future requirements of these fuels and outline ways of assuring supplies. Oil and gas technology moved ahead with Bureau development of new production methods, improved instrumentation, and more accurate techniques for determining basic characteristics of hydrocarbons.

Health and Safety: A Bureau-devised, portable mining shield was made available commercially, and a pocket-sized methane detector was developed.

Production of safety-education films for mineral-industry workers was intensified, and approximately 10,000 persons completed the Bureau's various accident-prevention courses. The Bureau's 246 Federal inspectors made nearly 12,000 inspections of the Nation's coal mines.

Helium: A fifth Government helium plant, designed to produce 290 million cubic feet of helium annually, neared completion at Keyes, Okla., promising an adequate supply of the lightweight gas, at least temporarily. Simultaneously, the Department of the Interior renewed its request for legislation that would encourage private industry to build and maintain up to 12 new plants to recover huge quantities of helium now lost when it goes to fuel markets as a constituent of natural gas.

Metallurgy: Pioneering experiments by the Bureau of Mines created shaped molybdenum castings that are expected to speed space exploration and missiles development. High-purity tungsten and yttrium metals were ob-

(Continued on page 34)

TECHNICAL SOCIETIES and ASSOCIATIONS

FLASH

The National Western Mining Conference, co-sponsored by the Colorado Mining Association and the Denver Chamber of Commerce, has been postponed to April 21-23 because of a delay in completing Denver's new Hilton Hotel, where the conference will be held.

Mining Education to be Discussed By Leaders at AIME Convention

Just where is mining education going? Is it "Phoenix or Dodo"?

Educators, engineers, scientists and company executives in fields that are vitally concerned with the answer have definite opinions. The opinions vary and often are controversial. Some of the nation's prominent spokesmen in these categories of interest will express their views on the afternoon and evening of Feb. 14, on the opening day of the national convention of the American Institute of Mining, Metallurgical, and Petroleum Engineers, in New York.

Its own afternoon meeting on education has been scheduled by each of the three constituent organizations of AIME, the Society of Mining Engineers, The Metallurgical Society and the Society of Petroleum Engineers, sponsored by their respective Committees of Education.

In the evening all will unite in a dinner meeting of the AIME Council of Education at which Elmer W. Pehrson, lecturer on mineral economics, Columbia University will speak on "U.S.A. in Minerals—Eagle or Ostrich."

For the session of the Society of Mining Engineers' Committee of Education, Professors Stefan Boshkov and Malcolm Wane, of the Columbia University School of Mines, co-chairmen of the meeting, have announced that the program will include discussions by Prof. H. Ralph Rice, head of the Department of Mining Engineering, University of Toronto; J. D. Reilly, of the Hanna Coal Co., Cadiz, Ohio; Alvin W. Knoerr, editor of Engineering and Mining Journal; Stanley D. Michaelson, of Salt Lake City, chief engineer of the Western Mining Division, Kennecott Copper Corp., and former president of the Society of Mining Engineers, and C. M. Brinckerhoff, of New York, president of the Anaconda Co.

The Metallurgical Society education program, the same afternoon, will have as its theme "The Terminal B. S. Program in Metallurgical Engineering, Its Importance, Problems, and Future."

Honorary Membership In AIME Awarded to Five Men

The highest distinction, Honorary Membership, within the gift of the American Institute of Mining, Metallurgical, and Petroleum Engineers, has been awarded to five men of outstanding achievement in fields of interest represented by the 89-year-old, 35,000-member organization.

This signal and significant accolade will be bestowed formally the evening of Feb. 17, 1960, during AIME's Annual Banquet, in the Statler-Hilton Hotel, New York, on:

Andrew Fletcher, of New York, president of St. Joseph Lead Co.; John Meston Lovejoy, of New York, consultant on oil investments; Henry DeWitt Smith, of New York, former vice president of Newmont Mining Corp.; Wilfred Sykes, of San Francisco, former president of Inland Steel Co.; and William Embry Wrather, of Washington, D. C., former director of the United States Geological Survey and 1947 recipient of an honorary Doctor of Engineering degree from the Colorado School of Mines.

All five new Honorary Members have received professional and academic honors. Messrs. Fletcher, Lovejoy, Smith and Wrather have been presidents of AIME. Mr. Sykes has been an AIME vice president.

Special Forum Major Feature Of AIME Meeting, Feb. 14-18

A special forum on Navy Materials problems, constituting a new concept of communication between military and civilian scientists and presenting high defense officials as spokesmen, has been announced by The Metallurgical Society of AIME as a major feature of the Annual Meeting of the American Institute of Mining, Metallurgical, and Petroleum Engineers, being held Feb. 14 to 18 in New York.

In planning a series of forums, of which this will be the first, The Metallurgical Society of AIME notes that they will provide assembled scientists at the meetings opportunity for comment on and discussion of certain Government programs and goals. The next forum, to be devoted to Army situations, will be held during the Fall Meeting of The Metallurgical Society of AIME in Philadelphia at the Sheraton Hotel, Oct. 17-21, 1960.

(Continued on page 14)

PROFESSIONAL DIRECTORY

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PROFESSIONAL DIRECTORY

E. L. Anders, Jr., M.S., '50
Consulting Petroleum Engineer
327 First National Bank Building
Abilene Texas

BALL ASSOCIATES
Douglas Ball, '43
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Richard Fulton, '50
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Oil and Gas Consultants
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Eugene E. Dawson, '38
American Independent Oil Co.
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Department of Geology
The University of Texas
Austin 12, Texas

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Paul M. Hopkins
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Land Surveyor
Mining Geologist and Engineer
2222 Arapahoe Street P. O. Box 403
Crestview 9-2313 Golden, Colorado

Howard E. Itten, '41
President
Empire Geophysical Inc.
6000 Camp Bowie Blvd. Ft. Worth, Texas

William Crowe Kellogg, '43
Kellogg Exploration Company
Geologists—Geophysicists
3301 N. Marengo Altadena, California
Sycamore 4-1973

George A. Kiersch, '42
Engineering Geology
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1010 Grosvenor Place Oakland, Calif.

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1201 Sinclair Building
Ft. Worth, Texas

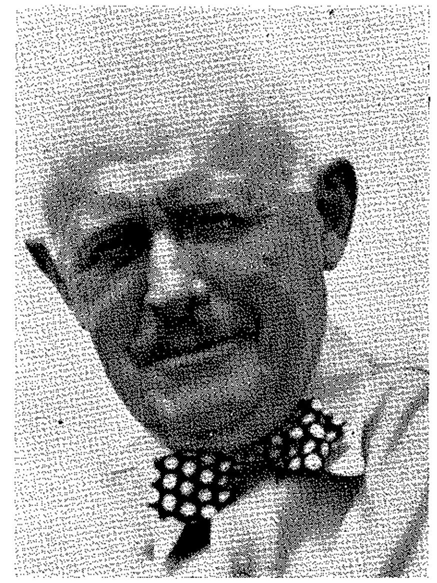
Harry J. Wolf, '03
Mining and Consulting Engineer
3 Glenwood Street Little Neck 63, N. Y.

Ben F. Zwick, '29
Manager, Oil and Gas Dept.
CHEMICAL BANK NEW YORK TRUST CO.
165 Broadway New York, N. Y.

Improved Ore Milling Practice Increases Value of Colorado's Idaho Springs-Central City Ores

By

S. POWER WARREN, '13



S. POWER WARREN

Purpose, Remarks and Conclusions

The purpose of this report is to show that the gold-silver-copper-pyrite ores in the Idaho Springs-Central City District of Colorado have never had the advantage of the present "state of the art" of milling. Such processes as highly selective flotation separation of copper and lead minerals from iron-bearing minerals have never been used, nor has the cyanidation, in a mine site mill, of gold-silver values in a pyrite concentrate, been used.

Improved technical and economic developments, which cause marginal mineral deposits to become ore deposits do not alone, necessarily, indicate the presence of appreciable ore bodies. However, when such developments are combined with a past history of good production, up-to-date geological information and the true causes for the discontinuance of mining, these combined data certainly present a situation worthy of serious consideration.

The efficient use of the processes referred to above in a well designed and built treatment plant (not a Poor Boy Plant), when handling a Russell Gulch ore, used as an example, and assaying Au 0.5 oz.; Ag 5.0 oz.; Cu 2.0%; Fe 20.0%; will raise the return per ton of ore, to the miner, with which he pays mining and milling, from $0.77 to $28.

Miners Must Help Themselves

Reports from most old mining camps continue to be pessimistic. Very few small mines are operating. Business men in the East claim they do not need gold and that a price increase will benefit only the few persons interested in gold mining. Base metals—lead-zinc-copper—produced in the U. S. are being replaced quite extensively by aluminum, stainless steel and plastics. Prices for base metals are low, because of foreign imports from mines operated with cheap labor. Politicians promise various kinds of help but are ineffective, because there are comparatively few miners to help; consequently the political help, being in proportion to the number of miners' votes, is small—very small.

The writer, whose political influence is nil and whose capital for investments is still smaller, believes that in all Colorado mining camps, present methods of ore treatment and value recovery can be materially improved. The Idaho Springs-Central City District of Colorado can be taken as an example.

THE AUTHOR

S. Power Warren (better known as "Pi" to his many friends) received an E.M. degree in 1913 from the Colorado School of Mines and an M.Sc. degree in 1930 from Queen's University, Kingston, Ontario.

A recognized authority in the field of metallurgy, Mr. Warren has spent a lifetime working directly with the problems of the metal mining industry. For a period of 12 years (1923-35), he taught at the Colorado School of Mines as associate professor of metallurgy.

For four years beginning in 1919 he was employed by American Metal Co. in various metallurgical consulting capacities in the U. S., Cuba and Mexico—including that of mill superintendent at its Climax molybdenum property.

After leaving the Colorado School of Mines faculty, he was general superintendent and metallurgist at mining properties throughout the U. S. and Canada. From August 1941 to December 1942 he was plant superintendent and metallurgist for U. S. Vanadium Corp., Uravan, Colo., and for the next two and a half years was principal metallurgical engineer for Metal Reserve Co. of Washington, D. C. From April 1945 to January 1947, he served in governmental agencies dealing with the minerals industries.

Since leaving the government service, Mr. Warren has been engaged in private consulting practice for such companies and government agencies as Golden Cycle Corp., Kerr-McGee Oil Industries, Wah Chang Trading Corp., Singmaster and Breyer, Ball Associates, Colorado School of Mines Research Foundation, U. S. Mint, War Assets Administration, and Atomic Energy Commission.

A registered mining engineer in the state of Colorado, Mr. Warren is a member of both the American Institute of Mining and Metallurgical Engineers and the Canadian Institute of Mining and Metallurgical Engineers.

Production of End Products Ultimate Goal

The procedure for such a review will be the comparison of present practice with new technology to show the resulting economies of plants built at or near mine

site, and combining concentration with extraction. The treatment scheme in these plants will eventually produce metal and/or metal products with the help of chemical processing. These metals and/or products will eventually be available for direct sales to consumer.

Specific Ore Used as Example

The type of plant and the process to be used will depend upon the ore prevalent in the district tributary to the plant site. For a definite consideration at this time, a gold-silver-copper-pyrite ore, of the type prevalent in many mines in the Idaho Springs-Central City District will be used. It will assay as follows:

Au. 0.5 oz.; Ag. 5.0 oz.; Cu. 2.0%; Fe 20.0%. The plan can be enlarged at any time to take in ores containing lead and zinc if and when they are present.

In the ore being used as a typical example, only a small portion of the gold is free, most of the balance follows the pyrite. Many assays of some of the pyrite show no gold, while others show gold associations. The rich and poor pyrite cannot always be recognized nor is there an effective method of separating, physically, the gold-bearing from the barren pyrite. The silver and copper are present mostly as gray copper; Tetrahedrite and/or Tennentite. Some chalcopyrite can be seen under the microscope.

Problem of Barren Pyrite Known for 100 Years

This ore with its high iron content (20% Fe approximately, 44% pyrite) presents a problem in the recovery of gold that was first encountered in this district 100 years ago, about 1860, when the following episode took place, as reported by Hollister in his book "The Mines Of Colorado" printed in 1867.

> During the Spring 1860 the Gold Dirt Lode had been struck and very rich it was. By the end of the year six quartz mills were running from it. One sluice took out, in seventeen days, $2,227. Hurlbut & Co's six-stamp mill started October 1st, and up to January 5th, 1861, had taken out $11,526.94 and had been idle four weeks of the time. Between June and November two men realized from the lode, over and above expenses, $35,000. Hollister & Co. struck pyrite on the lode seventy feet from the surface. Before that, they had been working sixty hands, and their weekly yield of gold was from $1,500 to $2,000. Upon striking the pyrite, a run of eighteen hours gave but one dollar and forty cents. They commenced experimenting. A pan of "tailings" was boiled in quicksilver. The amalgam therefrom yielded $9.70. The same material was exposed to the frost two nights, and boiled again in quicksilver, yielding this time $4.80. The process was repeated with the following results: $3.67, $6.34, $2.73, $1.04, $1.06, $0.33, making a total of $29.67 from the pan of tailings.

It is easy to visualize why a gold recovery process, involving boiling mercury was not a success, but at the same time it points to a method of unlocking the gold in pyrite. Mercury boils at about 357° C. Pyrite at such a temperature, will ignite in the presence of air, break down the pyrite crystal and expose the gold to amalgamation; hence, the results as shown.

Smelting Used to Recover Gold from Pyrite

Many years were spent—1860 to 1900—trying to free the gold from the pyrite. As smelter processing improved, the mills gradually installed concentrating machines to recover the pyrite and other minerals containing the gold, after the ore had passed through stamps or arastas and over the amalgamation plates. Jigs, Gilpin County bumpers, Wilfley tables, Card tables and Vanners produced a bulk mineral concentrate, mostly pyrite, and sent it to the smelter.

This pyrite-copper ore and concentrate was smelted at first in a smelter in Black Hawk which started in 1867. It was called the Argo Smelter and was moved to Argo near Denver in 1878. It was shut down in 1909. The ore and concentrate treated in this plant averaged as high as 15% copper when the operation first started, but reduced in grade to as low as 2% copper when the shutdown came in 1909.

The stamp mills pulverized the ore, to free the gold from the pyrite, so as to catch as much as possible on the amalgamation plates and consequently produced excessive quantities of slime minerals—gray copper, galena, pyrite. This fine mineral could not be recovered with gravity concentration machines or any other process then known.

Cyanidation Recommended for Gold Recovery

In the period of 1909 to 1912, several metallurgical experimenters, notably Marshall Draper and Percy Alsdorf, treated these slimes mineral tailings, containing values in gold, by cyanide process. In 1912 the Hudson Mill, at the junction of Chicago Creek and Clear Creek in Idaho Springs, installed a cyanide plant in a ten-stamp mill. The next year, 1913, based upon the success of the cyanidation in the Husdon Mill, it was decided to build a 300-ton mill at the mouth of the Argo Tunnel. The first 100-ton unit of this Argo Mill was built in 1913 and operated as a cyanide plant until some time in 1917 when cyanidation was replaced by the flotation process. One of the first successful flotation plants was installed by the writer in the Spring of 1915 in the Hudson Mill.

Flotation Process Replaces Cyanidation

The discontinuance of cyanidation was not caused by any failure of the process to recover gold, but to the low recovery of copper and lead (which were increasing in amount in the ores) that a custom mill was forced to purchase because of competition with the smelter. Gravity concentration machines would not recover all the base metal values from the slime, whereas, the flotation process would; hence a process that would make a good gold recovery plus a good base metal recovery was considered desirable, even though the gold and silver was sold to the smelter, instead of the U. S. Mint.

During the period 1912-1917, other mills used the cyanide process to recover the gold, but by 1919 all had installed flotation to recover the gold value in the slime plus the values in copper and lead.

Flotation Returns Barren Pyrite Problem

The flotation process not only increased the recovery of lead and copper minerals, but also the recovery of the undesirable barren pyrite, which had been thrown away during the cyanide period. From that time to the present the barren pyrite, associated with the gold-silver-copper-lead values has been, for the most part, concentrated with these values and sent to the smelter. Here, thousands of tons of sulfur have been burned off and thrown away and other thousands of tons of silicious flux and coke have been mixed with the iron from the pyrite so it could be liquefied, separated from the gold and thrown away, with all the zinc, if it happened to be present in the ore or concentrate.

Selective Flotation Isolates Barren Pyrite

This barren pyrite, called "troublesome pyrite" by many operators during the years, can be separated from the valuable, precious and base metals, by selective flotation. This will thereby reduce the transportation and the smelter costs on the Au-Ag-Cu values, by avoiding the payments for freight and smelter treatment on the barren pyrite. After selective flotation, the barren pyrite can be recovered, the gold and silver recovered by cyanidation and pyrite sold to sulfuric acid manufacturers and for pig iron.

Monetary Return Values Compared

Because the function of this report is to make comparisons (not to resolve shipper-smelter settlement sheet differences), all calculations are made on a slide rule.

The Russell Gulch District ore, assays of which are given above, if shipped direct to a smelter, will return to the miner per ton of ore $0.77 after deducting transportation and smelting costs. If this ore is bulk concentrated, the return to the miner per ton of ore will be $9.77 after payments are made for transportation, smelter treatment and a milling charge of $5. If a selective flotation-cyanide plant makes a high grade copper concentrate for shipment to the smelter and a barren pyrite concentrate for cyanidation and shipment of the pyrite to an acid manufacturer, the return to the miner per ton of ore will be $23 after payments for transportation, smelter, milling and pyrite treatment are made.

It tabulates like this:

Return to Miner per Ton of Ore	
Shipment of ore direct to smelter	$ 0.77
Bulk Concentrate direct to smelter	$ 9.77
Selective Flotation-Cyanidation-Acid	$23.00

This means, that depending upon how the ore is treated and sold, the miner will have $0.77, $9.77 or $23 per ton from the same ore, with which to pay the costs of mining and delivering the ore to the truck at the mine, ready for shipment to smelter or mill.

General Comparisons

This result, on an actual ore, prompted the study of similar ores with varying amounts of pyrite. Consequently, a series of calculations were made, using hypothetical ores having the same gold-silver-copper contents, but with the iron assay ranging from 5% to 30%.

Barren Pyrite Treatment Costs

In these calculations, the same transportation costs and smelter treatment schedule of costs are used on all products. The cost of cyanidation in a unit of concentrator plant at mine site of the pyrite flotation concentrate is estimated to be $2.50 per ton of concentrate, and the transportation cost from Idaho Springs to Denver is $2.50 per ton. A value of $6 per ton delivered to the acid plant is used. The over-all result of barren pyrite treatment is that it pays its own transportation, the cost of cyanidation and $1 per ton profit. This means the gold and silver extracted from the pyrite is shipped to the mint, with all costs of production paid by the pyrite.

In order to simplify the comparison of the results on these ores, three charts have been prepared.

Bulk Concentrate Production and Handling

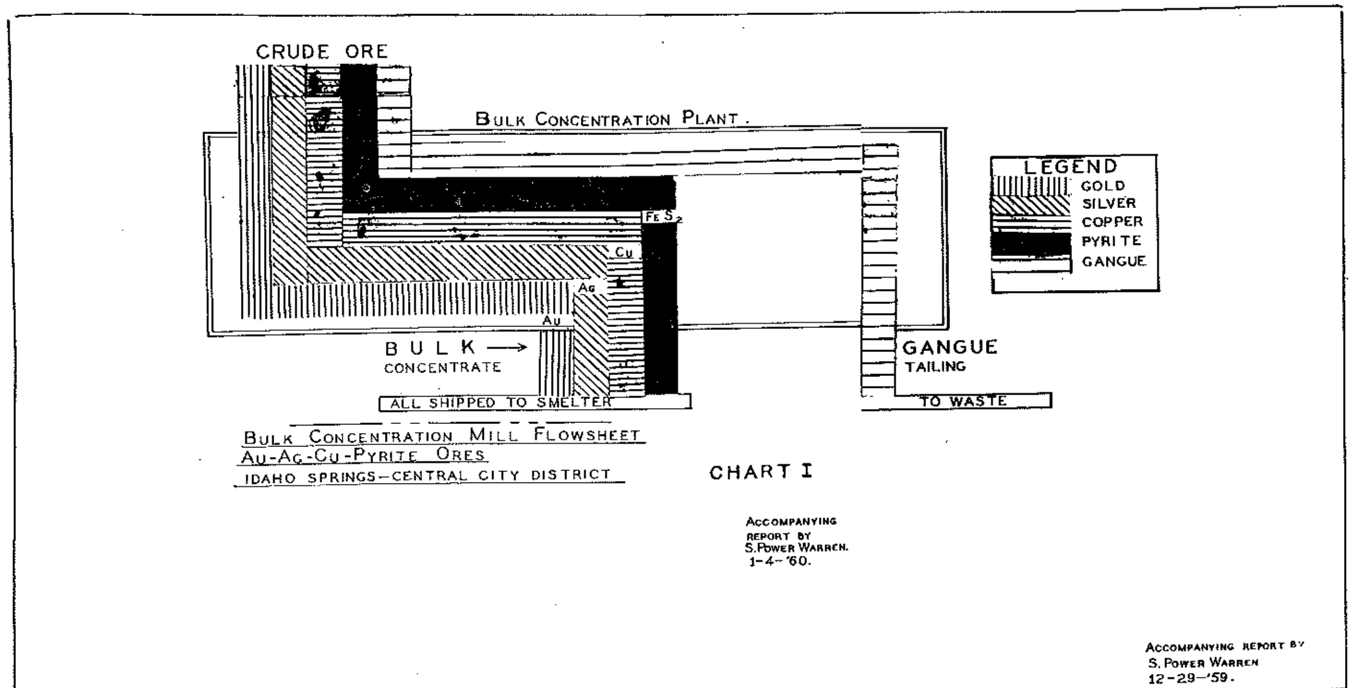
Chart I shows a flowsheet for bulk concentration, whereby all mineral is put into one concentrate and sent to the smelter. The gangue is simply sent to waste. This method of concentration gives good over-all recoveries in a simple, not-too-costly mill.

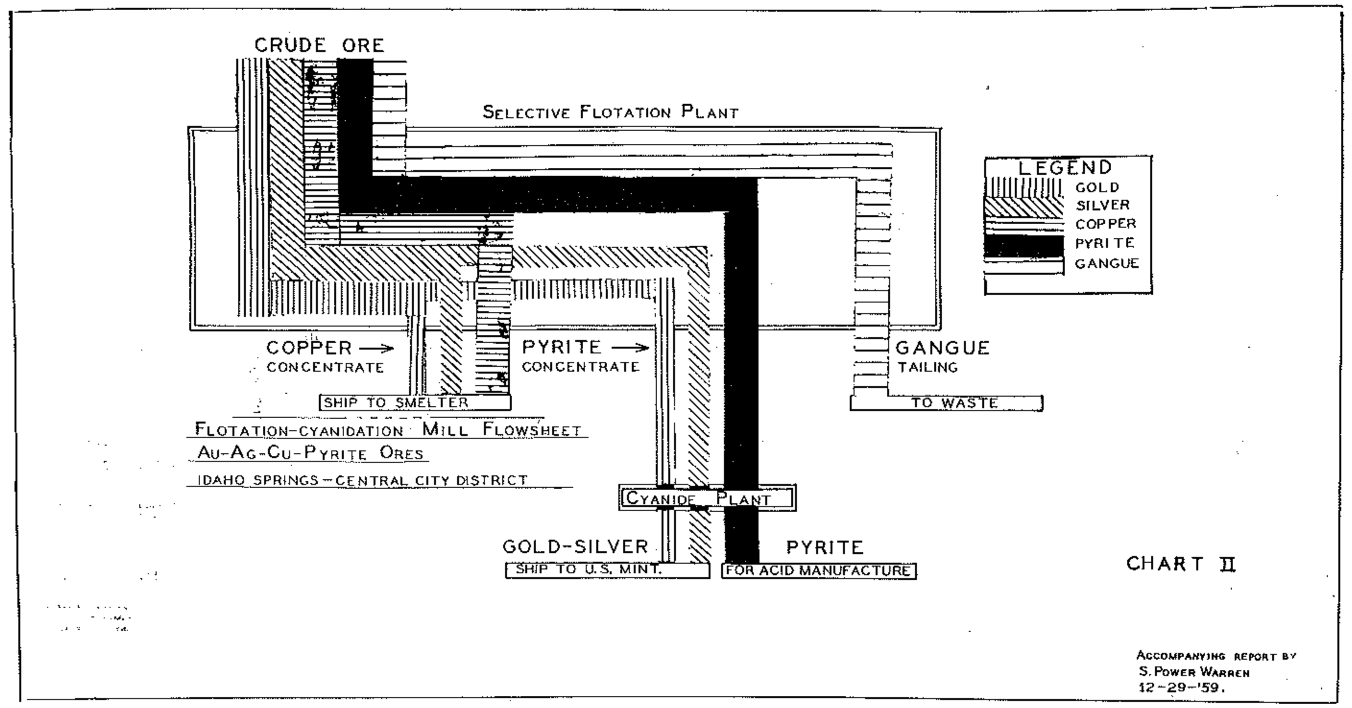
Because all minerals are placed in one concentrate, a greater burden of separating the metals is placed on the smelter, which has a high cost of operation. Smelting processes differ, in accordance with the metal to be treated, making it necessary for the smelting company first to treat the bulk concentrate for the extraction of the predominant base metal, with some of the precious metals, and, then treat smelter-produced intermediate products containing other base metals, with precious metals, in other parts of their own plant or ship these intermediate products to another smelter specializing in another base metal.

Selective Flotation-Cyanidation-Acid

Chart II shows flowsheet for selective flotation, straight flotation, cyanidation and acid manufacture.

This milling scheme, which is much less costly than smelting, produces (1) a small amount of a high grade base metal concentrate for shipment to the smelter where it is easier to treat with its high cost operation than a bulk concentrate, and (2) a second concentrate which is harder for the smelter to treat, but which can be treated by cyanidation, to recover gold and silver, without leaving the mill at mine site. The second concentrate, when barren of gold or silver, is then shipped for acid manufacture.





The first objective of this selective flotation is to make a very good recovery of the base metal—lead or copper—with as good a grade as possible. The better the grade the fewer the tons to be shipped to the smelter, but grade is secondary to base metal recovery, because the milling operation to follow provides for no recovery of the lead or copper.

The recovery of gold and silver in this first high grade base metal concentrate is of minor importance, because (1) the smelter allows a good payment and recovery for gold and silver, (2) the base metal value pays the cost of smelting, and (3) the second mill concentrate will make a good gold and silver recovery.

This selective flotation cyanidation plant will produce:

1. A high grade base metal concentrate for shipment to a smelter.
2. A precious metal bullion for shipment to the U. S. Mint.
3. A barren pyrite concentrate for use in sulfuric acid manufacture and iron.
4. A waste gangue tailing.

Flowsheet Easily Expanded for Other Metals

This flowsheet, designed to treat simple gold-silver-copper-pyrite ore, can be expanded to include lead and zinc ores without too much trouble. In the case of a lead concentrate a good smelter market exists, but for a zinc concentrate the market is poor.

That there are ores available to be treated in a simple mill makes it logical to consider these ores as the first step to a more complex plant capable of handling any of the ores in the district, which is the reason why this report is confining itself to the first step.

Treatment Schemes Compared Economically

Chart III is a graphic presentation of the monetary return to a miner per ton of ore when it is shipped direct; the monetary return per ton of ore when the ore has a varying iron content and is bulk concentrated; the monetary return from one ton of ore when the ore has a varying iron content and is treated by selective flotation, straight flotation, cyanidation and acid manufacture.

Chart Description

The first thing to note on *Chart III* is the horizontal base line, above which are shown the payments from the smelter, and below which are shown the transportation and smelter costs. The horizontal lines above and below the base line indicate dollars per ton of crude ore. The large cross-hatching, across 12 columns above the base line, represents a cost of $10 to mine and $5 to mill one ton of ore. The area on each column above the cross-hatched area indicates the monetary return to the miner for each set of conditions, after all operating costs are paid.

All columns represent value in dollars, per ton of crude ore. To obtain a comparison between the values of gold-silver-copper-pyrite, columns are shown with various styles of cross-hatching. Note how the columns for gold (vertical cross-hatching) show the greatest value. The gold and silver (diagonal cross-hatching) values were placed at the top of the column, so it could be seen graphically, when the copper (horizontal cross-hatching) was concentrated sufficiently to pay all the costs of smelting and transportation.

The pyrite is shown in full dark, to insure it a prominent place on the graph, because of its importance to this report. Note the small value in the monetary columns.

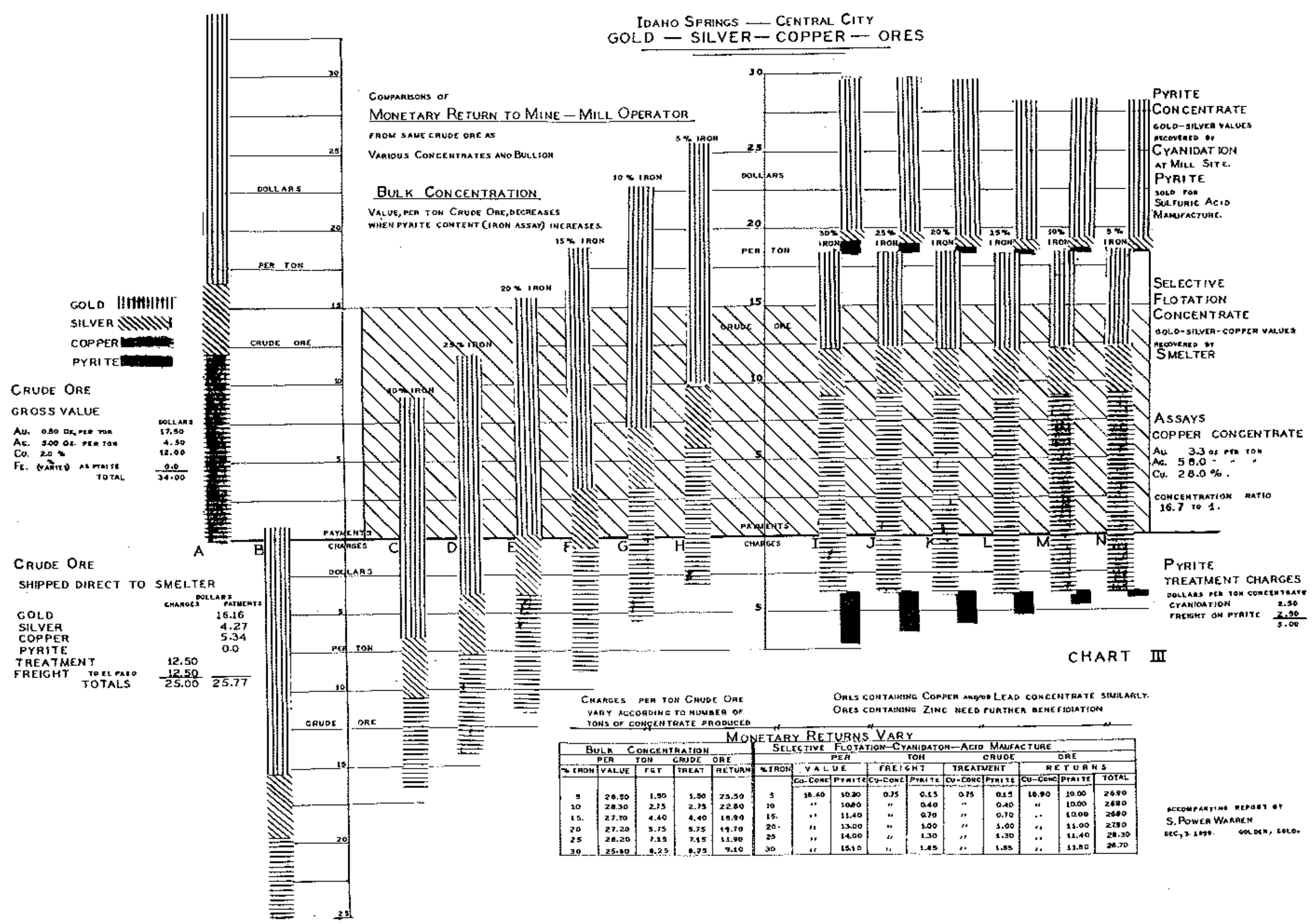
Three Treatment Schemes Compared Graphically

The three possible methods of handling this ore, i.e., direct shipment, bulk concentration and selective flotation-cyanidation-acid manufacture are shown on the chart as follows:

System	Column
Direct Shipment	A and B
Bulk Concentration	C-D-E-F-G-H
Selective Flotation-Cyanidation-Acid	I-J-K-L-M-N

Direct Shipment

In *Column A* is depicted the gross value of the valuable metals gold-silver-copper, as shown in the tabulation on its left. It is shown above the base line simply



MONETARY RETURNS VARY

Bulk Concentration per ton crude ore: % Iron	Value	Fgt	Treat	Return
5	28.50	1.50	1.50	25.50
10	28.30	2.75	2.75	22.80
15	27.70	4.40	4.40	18.90
20	27.20	5.75	5.75	14.70
25	26.20	7.15	7.15	11.90
30	25.60	8.25	8.75	9.10

Selective Flotation—Cyanidation—Acid Manufacture per ton crude ore: % Iron	Value: Cu-Conc	Value: Pyrite	Freight: Cu-Conc	Freight: Pyrite	Treatment: Cu-Conc	Treatment: Pyrite	Returns: Cu-Conc	Returns: Pyrite	Returns: Total
5	16.40	10.20	0.75	0.15	0.75	0.15	16.90	10.00	26.90
10	"	10.80	"	0.40	"	0.40	"	10.00	26.90
15	"	11.40	"	0.70	"	0.70	"	10.00	26.90
20	"	13.00	"	1.00	"	1.00	"	11.00	27.90
25	"	14.00	"	1.30	"	1.30	"	11.40	28.30
30	"	15.10	"	1.45	"	1.55	"	11.80	28.70

as a means of comparing returns from other operations with the theoretical. *Column B* depicts the tabulation on its left. This tabulation shows not only the reduction in payments from the theoretical, but also the cost of transportation and smelting. The top of the column is less than $1 above the base line, consequently this scheme is out from a miner's point of view.

Bulk Concentration

Columns C and *H* inclusive, depict what return will come to the miner in a bulk concentrate containing the same quantity of gold-silver and copper from one ton of ore, when the iron assay (pyrite content) varies from 30% in *Column C* to 5% in *Column H.* Obviously the large quantities of pyrite appreciably reduce the return to the miner for the same quantity of gold, silver and copper, in one ton of ore.

This series of columns show a miner must analyze his ore for iron as well as for valuable metals when simple bulk concentration is contemplated. It is quite natural for a miner to let his hope get the better of common sense and take a chance that his ore is low iron.

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Columns I to *N* inclusive depict the return to the miner by the more carefully planned milling scheme that makes a copper concentrate for sale to a smelter, a second concentrate for cyanidation, and a pyrite tailing for acid manufacture.

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TECHNICAL SOCIETIES

(Continued from page 8)

Coal Section of AIME Organized in Utah

The 35,000-member American Institute of Mining, Metallurgical and Petroleum Engineers has announced the establishment of the Utah Coal Section of AIME. Its members, for the most part, are located in Carbon and Emery counties. The new AIME Utah Coal Section will be the only AIME Section in the West having as its main interest the underground and open pit mining of coal and the preparation of coal for market.

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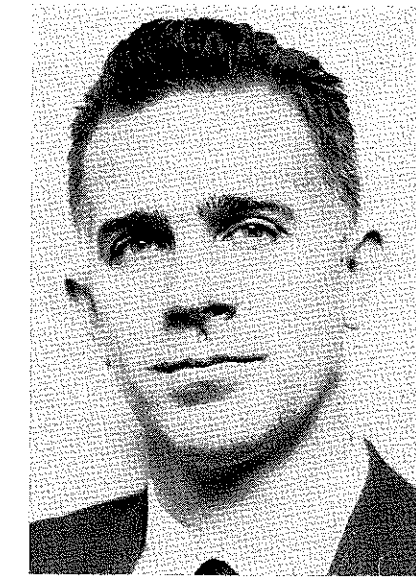
Operation Mohole*

By

WILLARD BASCOM, x-'42



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A project is now being planned to drill a hole completely through the oceanic crust to obtain samples of the mantle—probably to a depth of 30,000 ft. The mammoth undertaking is sponsored by the AMSOC committee of the U. S. National Academy of Sciences. Current plans suggest that the project will be a two-phase program. The first phase would test deep-drilling techniques and sampling upper layers.

The undertaking is called the Mohole project, named for the prime objective of the hole—the Moho, the indefinite and little-known boundary between the earth's crust and mantle. The word Moho comes from Professor A. Mohorovicic of Yugoslavia, who first described the seismic discontinuity at that point.

Where will the Mohole be drilled? How deep will it be? How much will it cost? Who will pay for it? When can it be drilled?

These are questions that are now being solved. Although it was first suggested that the hole be drilled from an oceanic island to a depth of 33,000 to 50,000 ft., it is now believed possible to probe the Moho more easily from a floating drilling platform anchored in open ocean, where the earth's crust is the thinnest. At certain locations where the water depth is from 10,000 to 18,000 ft., the Mohorovicic discontinuity may be penetrated at 28,000 to 35,000 ft. below the ocean surface. This means only 13,000 to 18,000 ft. of actual drilling. How hard the drilling will be is anyone's guess.

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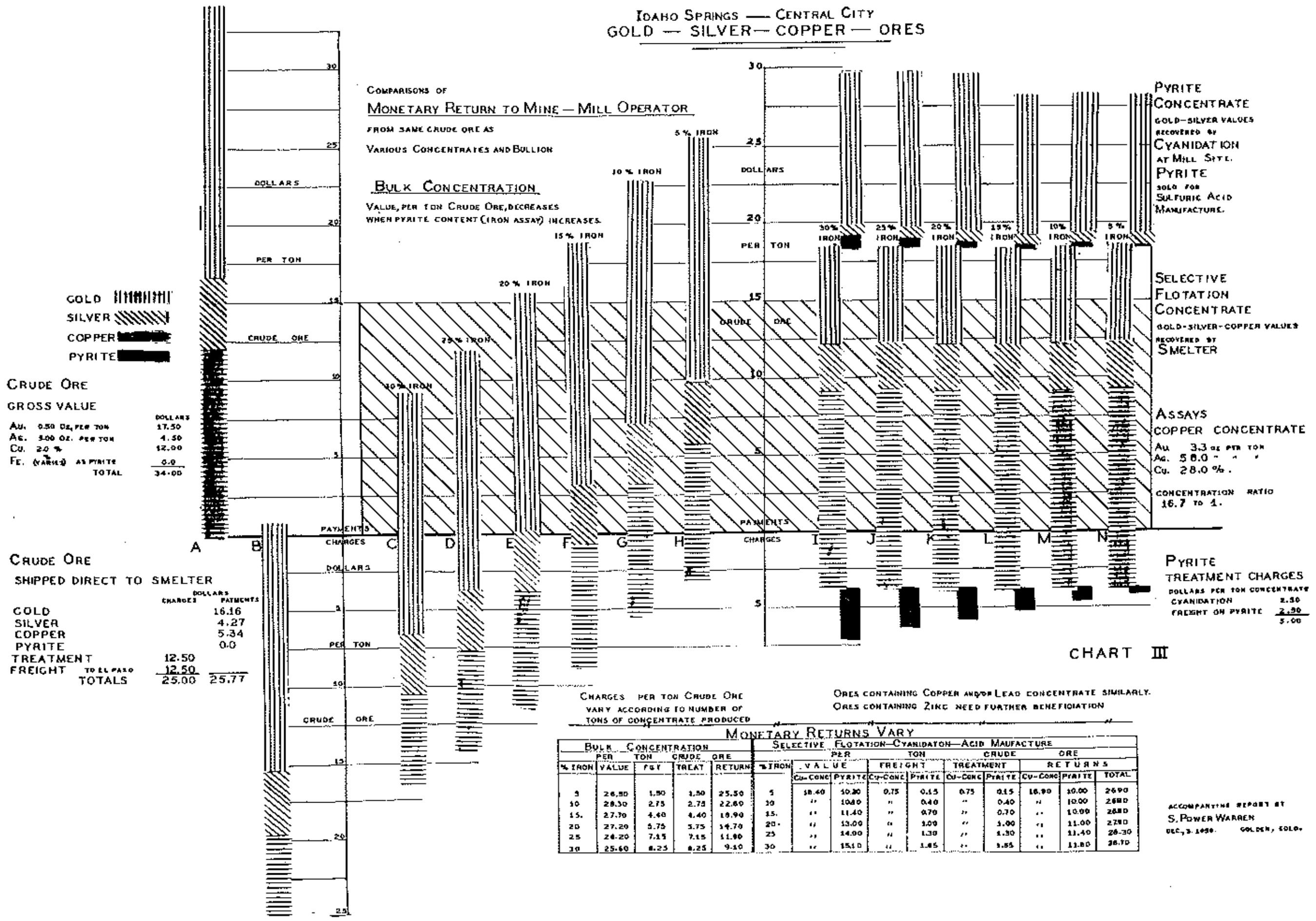

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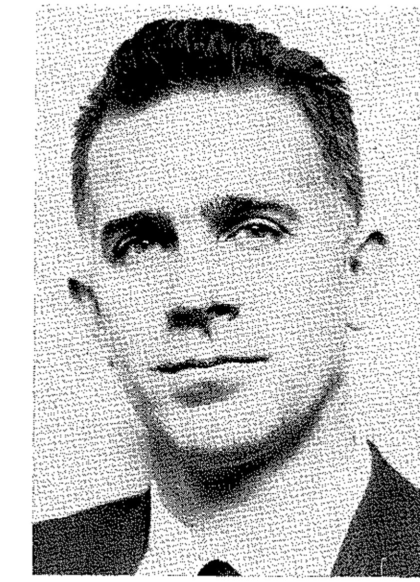

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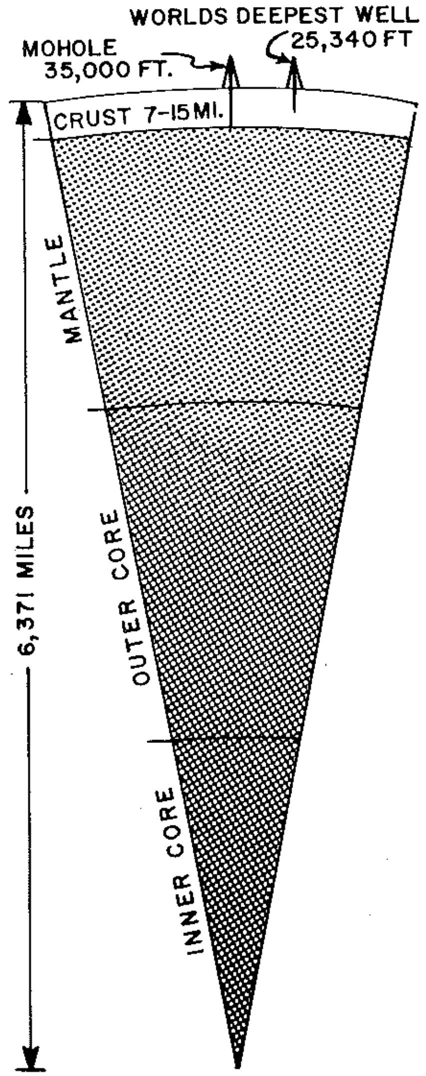


A cross section of the earth from the surface of its outer crust to its inner core. The objective of the Mohole is to penetrate the first inner zone called the "Mantle."

▾ Figure 1.

What materials must be drilled through? What is expected to be found?

Structure Theory

The structure and material of the earth's interior is a puzzle which has long challenged the mind of man. In all major aspects the most acceptable present hypothesis holds together very well. This is remarkable, for it requires that there be reasonable agreement between at least eight sub-sciences, all of which make indirect measurements. Studies of astronomy, meteorites, volcanoes, geologic structure, gravity, seismic waves, the magnetic field, and heat flow each contribute to the total knowledge.

If one assumes that meteorites are the wreckage of a planet similar to earth and that the rocks spewed out by volcanoes (whose seismic precursors begin well below the Moho) contain samples of mantle material, then we already have samples of the deep rocks. Dr. Harry Hess, Department of Geology, Princeton University, believes that mantle rock actually outcrops (at St. Paul's Rocks in the mid-Atlantic, in Japan and in California). Astronomical observations give the total mass, the average density and the moment of inertia of the earth.

Evidence about the structure of the earth has come primarily from earthquake waves. Seismologists have worked out characteristics of the planet which keep within the limits set by other evidence.

Mantle

The hypothesis of inner and outer cores surrounded by a thick mantle and capped with a thin crust has stood the tests of many years; now the problem is to refine the information and to obtain evidence which cannot come from further advances in seismology. Composition of the mantle which represents about 85 per cent of the volume of the earth is the principal problem of geophysics today, for although a lot is known about it, uncertainties remain.

Exact mineralogical and rock composition, density, strength, temperature, amount of radioactivity, thermal and electrical conductivity—all of these will contribute immeasurably to the understanding of the earth and its origin. Moreover they will serve to enhance the value of the indirect geophysical measurements. Finally, some new and entirely unexpected piece of evidence may be unearthed that will cause science to revise substantially its concept of the earth.

Floating Crust?

The crust is closer and easier to study than the interior—but also more controversial. Generally it is agreed that continents represent relatively thick blocks of andesitic rocks and that ocean basins are composed of much thinner basaltic rocks—the average thicknesses being about 30 Km and 10 Km respectively. The crust seems to act as though it is floating on viscous plastic mantle material; however, the response time is long and certain anomalous areas not in isostatic equilibrium complicate the problem.

The Moho, which defines the boundary between crust and mantle, is recognized by an abrupt increase in the velocity of seismic waves—from around 7.0 Km per sec. to 8.2 Km per sec.

As the earth developed, the water which reached its surface naturally ran downhill and covered the lower, thinner basaltic material forming an ocean.

Composition of the oceanic crust is studied by seagoing seismologists who use pairs of ships—one setting off explosions, the other listening. In this way it has been discovered that beneath much of the ocean there are three main layers of material: (1) The soft sediments, (2) the "second layer," and (3) the "crust." (*Fig. 2.*)

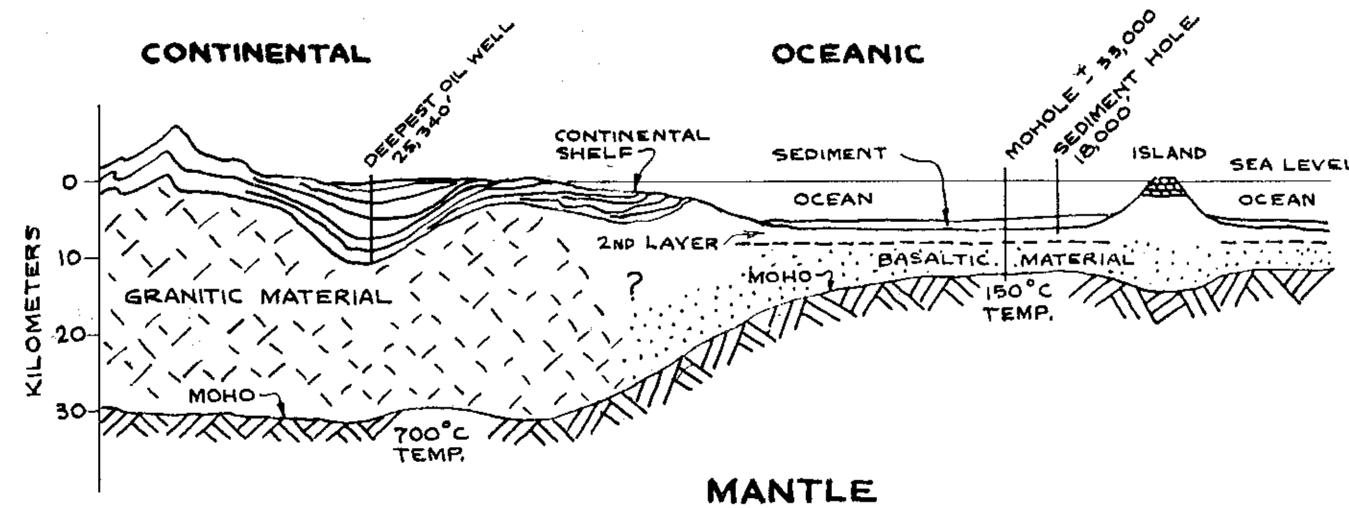
Soft Sediments

The soft sediments of the deep sea floor (red clays and calcareous oozes) have been repeatedly sampled with cores which have penetrated as much as 20 meters into the bottom and reached as far back as Cretaceous time.

The seismic evidence suggests that they are remarkably uniform in thickness, averaging about four-tenths of a kilometer. Unfortunately, this is far too thin to agree with the figure one gets by multiplying present sedimentation rates by the supposed age of the oceans. So one very large question to be answered is, "What happened to the rest of the sediments?" Moreover, it seems possible that the record of early evolution, missing on land, could be preserved in the lowest sediments.

Second Layer

There are at least four theories about the composition of the "second layer"—all of which begin with the knowl-



This schematic cross section of the earth's crust and upper mantle shows why it will be much easier to reach the Moho at a deep water ocean location. A continental location might require a well depth of 100,000 feet; and oceanic island location perhaps 50,000 feet; but possibly only 30 to 35,000 feet at a selected deep water ocean location.

▾ Figure 2.

edge that it conducts seismic waves at 4.5 to 5.5 Km per sec. It may be compacted sediments, basalt, dolomite or more soft sediments screened by a layer of basalt; usually it is one to two kilometers thick.

Crust

The third layer or "crust" has a seismic velocity of about 6.5 Km per sec.; it is commonly called basalt but as Hess points out this is more a matter of 150 years of tradition than of evidence. In fact, some scientists doubt that there are as many as three layers; others think there are more.

What Is Moho?

One of the interfaces (possibly the Moho) may represent the primordial surface of the earth. It may have a surface something like the face of the moon today; it may be covered by a layer of meteoritic material or perhaps a conglomerate. It may give evidence of our earthly atmosphere and ocean, or it may have been altered beyond recognition. These speculations have served to make the proposed exploratory holes even more exciting.

Many of these suggestions have been discussed and debated in the literature. Harry Hess believes that the Moho represents a frozen isotherm; J. F. Lovering thinks it represents a temperature pressure relationship which has caused a phase change from an ecologite mantle to a basalt crust. Tuzo Wilson believes that continental andesitic material must be rising from the mantle—from greater depths than the basalts. He notes that K. Sapper's figure of 0.8 Km^3 per year over geologic time would account for the volume of the continents and that a slightly higher rate of volcanism in the early stages would allow for the emission of an oceanic crust as well. Harold Jeffreys believes that the ocean crust is too rigid to permit sidewise motion of the continents but recently there has been renewed interest in Wegener's continental drift theory. There are points of disagreement on the distribution of radioactivity, on the interpretations of seismic velocities, and on the causes of oceanic trenches.

The very fact that there is not agreement is a good reason to do some direct exploration (if there were no controversy there might be even greater suspicion that something was wrong).

Coring

Some of these questions will be resolved if a continuous core of the various layers beneath the sea floor can be brought into the laboratory for study and analysis. In addition, in the hole from which the core is taken, measurements can be made of temperature, heat-flow, the magnetic field, plastic deformation and seismic velocity.

It is therefore the objective of the AMSOC Committee to see that a continuous, oriented core to the mantle is obtained and that the hole(s) are thoroughly instrumented. Some of the instruments already exist; others will have to be developed or miniaturized to fit in the hole (which will be about 4-in. in diameter at the bottom).

No geologist or geophysicist doubts the value of such data; the question is, "How can it be done, and for how much money?"

In *Nature* of Sept. 13, 1958, Dr. Gaskell examined some of the technical problems of deep-hole drilling. However as AMSOC's feasibility study progresses, new objectives have been developed and new drilling technology has been uncovered so that now Gaskell's thoughts need to be updated. For example, the idea of drilling from an oceanic island has been abandoned because recent studies indicate that the mantle is as deep as 17 Km under the islands that have been studied.

Developments in floating drilling platforms make it appear that deep-water drilling is feasible in any case; besides, we need the sedimentary data.

Temperature No Problem

A review of the temperature situation suggests that temperatures in the mantle immediately beneath the ocean crust will be less than 200 C. At several sites where seismic work has been done, the total reach of the drillstem from the water surface to the mantle will need to be only

30,000 ft. Thus as the project develops, the objectives seem more attainable with less difficulty and expense.

TABLE 1.

Reach of Drill Required to Achieve Various Objectives

	PHASE	PACIFIC						ATLANTIC	
		Clipperton Island area 10°—53′N 105°—09′W		Guadalupe Island area 28°—45′N 117°—31′W		Due South of San Diego, Cal. 5°—47′N 123°—59′W		North of Puerto Rico 20°—40′N 66°—30′W	
		Km.	Feet	Km.	Feet	Km.	Feet	Km.	Feet
Depth of water	I	3.1	10,100	3.5	10,700	4.3	14,000	5.5	18,000
Depth to bottom of sediment	I	3.3	10,400	3.6	10,900	4.8	15,700	6.0	19,600
Depth to bottom of 2nd layer	I	4.2	13,800	5.2	17,000	5.5	18,000	8.0	26,200
Depth to Moho	II	8.6	28,100	10.8	35,500	9.7	31,800	9.6	31,500

Note: Geophysicists think in kilometers but drillers work with feet. Pacific data from R. W. Raitt, Scripps Institution of Oceanography. Atlantic data from J. Worzel, G. Sutton, et al, Lamont Geological Observatory.

Table 1 shows the length of drill pipe required to reach the surface of various layers beneath the sea floor at four sites which are under consideration.

Two-Phase Program

Inspection of these figures shows that a drill reaching to 6 Km. (20,000 ft.) will return data on the upper three layers. Beneath that it is another 3 to 5 Km. to the Moho. For this reason the project will be divided into two phases. The first of these involves the modification of existing equipment for drilling holes in the upper layers.

The second phase—which will take us on to the Moho—will probably require a completely new engineering design for the total length of the drill pipe must be well over a mile beyond that used in the deepest oil well to date (25,340 ft. hole by Phillips Petroleum Company in West Texas).

Testing

It is generally assumed that no one site or hole will satisfy all the requirements of Mohole.

The final hole to the mantle must be drilled where the geologic situation is uncomplicated and where the Moho is closest to the surface. To locate that place, seismic, gravity and heat flow surveys must be conducted.

One possible location is on the abyssal plain some 200 miles north of Puerto Rico, where the water is 18,000 ft. deep and the Moho is about 14,000 ft. below the ocean floor. Even more promising locations are located in the Pacific Ocean, as indicated in *Table 1*.

Initial test sites, designed to test equipment, are also expected to yield important information about sedimentation.

The ideal site would be the lowest spot on the original earth surface into which the earliest waters drained and brought sediment. Here continuous layers of sediment would represent the entire history of the earth. Paleontologists have fond hopes of recovering cores of fossil-bearing formations older than the Cambrian.

In addition to geological location problems, weather, accessibility to supply points, strong currents and rough seas must also be considered.

Objectives of phase one would be to obtain the best possible samples of the upper layers while testing out deep-water drilling methods. For example, no one is sure how closely a ship must be held in position in deep water while it drills but several schemes have been proposed which would probably keep it within a circle the diameter of which is less than three per cent of the depth (12,000 or so feet of water). Forces due to the drag of ocean currents on the drill pipe and casing are as yet unknown because of the lack of reliable deep-current data. Questions of how often casing will have to be run and how it will be supported; of how well the soft sediments can be cored and if sea water is a satisfactory drilling fluid will be answered by the first test holes.

There are four floating platforms which mount intermediate-depth oil rigs drilling in shallow water off the coast of the United States.

Many of the problems of ocean drilling have been ingeniously solved by these operators so that only minor modifications of standard drilling techniques are needed. Several ways have been found for re-entering the hole and recirculating drilling muds; these require that a riser pipe, conductor or casing reach to the surface. It is even possible to temporarily abandon a hole and recover it again.

Equipment Available

In depths of 35 to 360 ft., holes have been drilled to nearly 12,000 ft. CUSS I for example, now drilling for oil off the California Coast, is a well designed vessel that would make an excellent deep-drilling experimental platform if it were equipped with a heavier draw-works (such as are available) and a deep mooring system.

Holding a ship in position in water two and a half miles deep might be accomplished by (1) anchors which are explosion-jetted into the bottom and connected to the ship by neutrally buoyant hawser lines of synthetic material; (2) a dynamic anchoring system in which a group of outboard propulsion units (which can exert propulsive force in any direction) are centrally controlled by an operator who holds his position by watching taut-line buoys and/or listening to a vertical beam of underwater sound rising from a transducer fixed to the bottom.

Thus, the mooring, drilling, setting of casing and riser pipe, coring and instrumentation all appear to be well within the bounds of our technology. Engineering design work has started; so has agitation for funds.

Drilling Cost

As the feasibility study progresses, the original cost estimates have shrunk and it now appears that the entire project might be carried out for about $15 million. This is not an inconsiderable sum but it is far less than that of a rocket propelled "moon probe," whose ostensible objective is to learn about the nature and origin of the solar system. It seems a little foolish to go off to look at the moon when we don't know what lies a few kilometers beneath us on the home planet.

The first phase could be accomplished for about $2.5 million; the second for about $7.5 million. It is hoped that the project will be funded jointly by private interests and by the U. S. National Science Foundation. Certain related aspects of oceanography and of doing heavy work at sea might be supported by the U. S. Navy although there is foreseen no direct military application.

Spudding Date

When drilling will start is uncertain, depending on the length of time to complete preliminary work and to obtain funds. The scientific planning of objectives, locations and instruments; the collection of needed data and the resurvey of the most promising area is already under way.

Then by trial and error, test drilling can begin. It must then be found out how to set up and drill in open ocean without getting pipe and lines in a hopeless snarl. The proper drilling fluid must be found, as well as the proper drilling bits to penetrate the basalt or whatever hard structure lies beneath sediments on the ocean floor. Coring and sampling techniques must be worked out, first in drilling them, then getting them safely to the surface, finally in preserving them.

After these problems are solved, then modifications for the Mohole itself can be made. It is expected that as much as 1600 ft. of soft sediments must be drilled—then the hard-rock road to Moho can begin. This hole to the mantle will be very difficult; no one has illusions about this. It is not even known that the Moho can be recognized when it is reached!

Whatever is found, much will be contributed to the knowledge of this planet. AMSOC believes that Operation Mohole is likely to produce the greatest advances in man's knowledge of the earth in our time.

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What Is AMSOC?

The American Miscellaneous Society, or AMSOC, was founded in 1952 as a whimsical spoof of scientific societies which are sometimes too specific for their own good. Its cable address, AMSOC, is well known in the alphabetical world of Washington. Because it has no formal members, officers, by-laws or publications it is, of course, a very efficient group. It has close ties with the Committee for Informing Animals of their Taxonomic Position and the Committee for Cooperation with Visitors from Outer Space.

On the subject of drilling through the crust of the earth however, the AMSOC group is quite serious and has been formally organized so that it can receive funds from the U. S. National Science Foundation. Its original members were: Gordon Lill (chairman); Prof. Maurice Ewing; Dr. William Heroy; Prof. Harry Hess; Dr. Harry Ladd; Dr. Arthur Maxwell; Prof. Walter Munk; Prof. Roger Revelle; Dr. William Rubey; Dr. Joshua Tracey, and Willard Bascom (technical director).

The Mohole project, in more or less its present form, was born at a breakfast at Professor Munk's house at the Scripps Institute of Oceanography in California at which he and Professor Hess led the conversation in the need for a geophysical analog for the space exploration program. AMSOC proposed a deep drilling project.

It is significant that in the following September, at the meeting of the I.U.G.G. in Toronto, a resolution was passed "urging the nations of the world—to study the feasibility and cost of an attempt to drill to the Mohorovicic discontinuity at a place where it approaches the surface." A hole 10 to 15 Km. deep on an oceanic island was suggested. The sponsors were Harry Hess, Roger Revelle and T. F. Gaskell.

TECHNICAL SOCIETIES

(Continued from page 14)

Aug. 17 Earthquake Discussed At 10th AAPG Convention

A panel discussion of the Hebgen Lake, Mont., earthquake of Aug. 17, 1959 by people vitally connected with the disaster was a highlight of the 10th Annual Convention of the Rocky Mountain Section of the American Association of Petroleum Geologists held in Billings Feb. 7-10.

Six participants presented slides and first hand accounts of the quake, according to Herb Hadley and John Fanshawe, co-chairmen of the program planning committee. Among those who were present for the occasion were Dr. I. J. Witkind, geologist for the U. S. Geological Survey, Denver, Colorado who was in the area at the time of the quake doing geological mapping; F. L. Woodard, photo engineer of Billings, who took photographs of the path of the fault after the quake; Robert Burley from Billings who was camped in the area at the time as was Frank Swenson, a hydro-geologist with the U. S. Geological Survey in Billings; R. R. Rend, power superintendent, Montana Power Co., Butte, who is in charge of repairs necessitated by damage to the Hebgen Dam, and Dr. J. P. Wehrenberg, geology department, University of Montana, Missoula, who with Dr. C. F. Richter noted seismologist of the California Institute of Technology, visited the area after the quake and interpreted the seismograph reports recorded at the institute.

Moderator of the panel was William W. Mallory with the U. S. Geological Survey in Denver, who was also in the area at the time of the quake.

AIChE National Meeting Feb. 21-24 in Atlanta, Ga.

Seventy-one technical papers on a wide variety of subjects will be presented during the four-day 42nd National Meeting of the American Institute of Chemical Engineers (A. I. Ch. E.) at the Atlanta-Biltmore Hotel in Atlanta, Ga., Feb. 21-24.

A feature of the meeting will be a banquet address by Dr. E. C. Harrison, president of Georgia Institute of Technology. J. W. Mason, of Georgia Tech, is the general chairman.

Technical sessions will be on nuclear feed materials processing, high temperature pressure technology, the textile industry, mass transfer applications in waste treatment, filtration, mineral engineering, missiles and rockets, engineering education, petroleum solvents, management, pesticides and kinetics.

Student program is being arranged by H. C. Lewis of the School of Engineering, Georgia Tech.

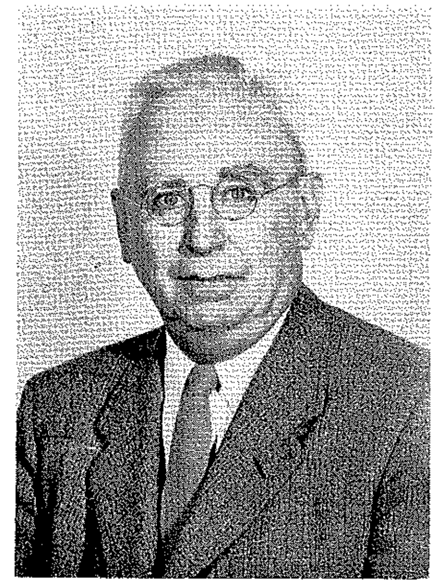
56th Annual ACI Meeting March 14-17 in New York

The 56th Annual Convention of the American Concrete Institute will be held March 14-17 at the Commodore Hotel, New York City.

The technical program, of interest to designers, builders, research men, and others in related fields in the concrete industry, will get underway Tuesday afternoon, March 15. Approximately 30 papers will be presented at eight sessions.

Monday, March 14, and Tuesday morning, March 15, will be devoted to meetings of ACI technical committees to review current work and aims.

The Place of Geology In the Development Of the Mining Industry*



DR. THOMAS B. NOLAN

By
DR. THOMAS B. NOLAN

Certain factors that affect the well-being of the mineral industry are certain to become increasingly advantageous with passing time. Demand for the products of the industry will continue to increase as a result of population growth, increasing consumption per capita, and an expanding technology. Competition from other parts of the world, now one of the troubles besetting the industry, is likely to decrease as the ever-growing demand consumes foreign deposits just as it has our own, and also as other parts of the world begin to industrialize and consume their own mineral raw materials.

These are only long-term advantages, however. They lead to a prediction that we will have a mineral industry far into the future, but they are not an answer to the immediate problem. Our problem is what can be done now or in the immediate future to bridge the gap until that day—not so far away—when no part of the world will enjoy a competitive advantage. Maintenance of supplies of mineral raw materials will then be a world problem rather than a domestic one.

But for the present, many of our mines are closed through inability to compete successfully in world markets. A number of our higher grade ore deposits are depleted or are approaching depletion and the rate of discovery of new ones appears at times to be discouragingly low.

The problem of maintaining our competitive position is serious, but it is not hopeless, and I believe it can be solved. It will require the use of all of our accumulated knowledge and experience, and of the results of intensive research that is designed to improve our understanding of the processes of ore formation and our capacity to utilize that understanding. It will require the discovery of new deposits and new districts, which means improvements in our methods of prospecting, exploration, and appraisal. It will require new techniques in the methods of mining and treating ores. In short, it means that we must use intelligence rather than depend on good fortune and be prepared to develop and apply new ideas and new methods.

* Material in this paper presented by Dr. Nolan at the 62nd National Western Mining Conference in Denver, Colo.

THE AUTHOR

A native of Greenfield, Mass., Dr. Thomas B. Nolan attended Yale University, receiving a Ph.D. in 1924. Following his appointment to the Geological Survey in the same year, he mapped several districts in the western United States.

During World War II, he was in charge of the Survey's work on tungsten deposits. Dr. Nolan served as the Survey's assistant director from December 1944 until appointed director in January 1956 to succeed Dr. William E. Wrather.

Dr. Nolan is a past president of the Society of Economic Geologists and a member of many other professional organizations, including the National Academy of Sciences, the Mining and Metallurgical Society of America, the American Philosophical Society, the American Institute of Mining and Metallurgical Engineers, and the Geological Society of America. He was the recipient of the Spendiaroff Award of the XVI International Geological Congress in 1933 and the K. C. Li Gold Medal and Prize in 1954.

Aid to Mining in Transition Period

I believe that the Geological Survey can and will play an important role in this transition, not as a participant in the actual prospecting or development, but in assisting the mining industry to do these things more effectively and economically. The Survey does many things of interest to the mineral industry. One of its activities, as you probably know, is to make topographic maps, which are essential to many activities in the mineral industry, not the least of which is to provide a base on which to plot geologic data.

In the field of geology, it produces geologic maps which serve a number of purposes. Properly prepared and used, they make it possible to determine the distribution and nature of the rocks that contain, or constitute, our mineral resources and to discover the combination of geologic factors that have controlled the concentration of any valuable substance, be it metal, oil, water, or coal, so that we can learn to select and reject with confidence the evidence visible on the surface or provided by drill

holes or geophysics. In addition, of course, such maps have many applications to construction, engineering, soil conservation, and agriculture.

Scope of USGS Outlined

The USGS is also concerned with mineral resources in the broadest sense—the Organic Act that established the Survey directed it to appraise the "products of the national domain." This is a comprehensive responsibility, for it extends, in one dimension, through the whole range of chemical elements and mineral products; and in another, through the whole range of concentrations from workable ores down through marginal and submarginal ores to simple geochemical anomalies. The USGS must cover the entire range of mineral products because modern technology has brought with it requirements for a whole new group of materials, and the demand for new substances with unique or specialized properties can confidently be predicted to continue in constantly increasing degree. It must be concerned with the entire range of concentrations for at least two major reasons: First, the marginal ore of today and even the sub-ore will not uncommonly become the ore of tomorrow; and secondly, we must learn all we can of the geochemical concentrations, environments, and habits of the elements before we can hope to understand the chemical and physical principles that control their transportation and deposition to form ore deposits.

The formulation and understanding of principles must be one of the Survey's major objectives, whether or not it applies them to mineral substances such as water, oil, and coal or to metals or non-metals. In a negative sort of way this is not only an objective but a legal requirement, since the Organic Act, to quote from it again, prohibits any of us in the USGS from undertaking "surveys or examinations for private parties or corporations." We are justified in studying or mapping individual mines or prospects, or local water supplies, only to the extent that the results are beneficial to the nation, rather than to the individual or company.

Basically this means that our results, maps, and reports, should be generally applicable and presented in the form of principles or conclusions that are valid for many areas or many situations. We couldn't pretend to deal with the problems and desires of individuals throughout the country and throughout the industry, even if the law permitted it, but we can help all collectively by furthering the knowledge of ore deposits and the principles that control them. It will be increasingly true in the future that the more we know of these principles, the more successful we are going to be in finding new or different ore concentrations and in becoming more efficient in mining and utilizing them.

Survey Does Research of Many Kinds

In pursuit of this search for principles—or "ground rules" if you like—the Survey does research of many kinds, some of it of direct application to the mineral industry, and all of it at least of indirect benefit. A few products of the research that have been important to the industry include such things as: the development of many sensitive chemical tests now widely used in geochemical exploration and the technique of their application in the field; the development of, or contributions to, many geophysical methods now widely used in exploration, such as the flying magnetometer, and airborne radiation detectors; the application of isotope methods to problems of geology and mineral deposits, as, for example, the use of oxygen isotopes to detect former heat patterns that may be correlated with ore deposition; a large part in

the unraveling of the complex mineralogy of uranium, which is important both to the geology of uranium and to the beneficiation plants. A recent example is the discovery by a Survey paleontologist that certain bacteria concentrate deuterium, or "heavy hydrogen," illustrating once again that important discoveries may come from unexpected quarters and as by-products of research motivated by quite another end.

The basic function of the Geological Survey is thus to gather all information possible in the broad fields of geology and mineral resources and to make it available for the use of the public. Such information is essential to the mineral industry, but it alone will not find ore deposits. The actual prospecting and exploration should be done by private enterprise, but it must have the benefit of the most ingenious techniques we can devise, if we are to be successful in finding and exploiting the deposits that will permit us to compete in a world market.

Possibilities for Ore Deposits

That such deposits exist seems to me to be a certainty. Several years ago, I called attention to the fact that the numerous mining districts of the Great Basin are all located within the comparatively small areas of the exposed mountain ranges, and that many more should exist beneath the large areas covered by alluvium and young volcanic rocks. A start has been made on testing the validity of this idea by geophysical methods. It now appears possible to apply some of the new geochemical techniques to the problem, and the Survey plans to investigate this possibility in the field.

I believe there are areas in Colorado in which major ore deposits may occur that have not yet been adequately studied or explored. We do not know yet whether the Leadville ore bodies end beneath the town or extend westward beneath the four-mile-wide covered area that lies between Leadville and the mining districts at the foot of the mountains to the west. We have not determined whether major ore deposits lie in or under the sedimentary rocks that adjoin the great Climax deposit and are separated from it by the Mosquito fault.

In the San Juans, in district after district, Survey geologists have found that the major known ore deposits are related directly to a late and rather brief stage in the volcanic activity that built up this great mountain mass. Is it not possible that major ore deposits lie buried by lavas that cover mineralized throats of older volcanoes that contributed to the development of the mountains?

At Gilman, surface manifestations of the largest single base-metal sulfide body known in Colorado are so weak that the deposit might still lie undetected, had not the Eagle River cut a canyon through it. Might not other deposits lie in the large area of geologically similar terrane that has no such deep canyon cut through it?

Some of our geologists now recognize a poorly defined line or belt of young faults that extend across Colorado from New Mexico into Wyoming. The faults are inconspicuous because they lie principally in valleys and basins. They are known, however, to provide a locus for the occurrence of fluorspar deposits in a number of places. Unexplored portions of the belt should therefore be promising places to look for new fluorspar deposits, and also for concentrations of other minerals that have a similar geological environment. Other examples in Colorado could be cited, and a similar list could be compiled for any of the other Western States.

Geologic Work Necessary

Careful and time-consuming geologic work is necessary to evaluate possibilities such as these, and, indeed, in many cases, even to recognize them. Such geologic work, supported by geophysical and geochemical work, and followed by wisely directed exploration should the situation warrant it, probably offers the most promising approach to the discovery of new deposits and districts. I firmly believe that it will be successful, especially if the industry actively seeks and utilizes both the new or improved techniques of exploration and mining that we can confidently expect to be developed, and the opportunities presented by demands for new materials brought about by new technology.

Many of our present great producing deposits were known for many years before they became producers, but were unworkable because of their low grade or complex mineralogy. An outstanding example is the taconites of the Iron Ranges, on which large new enterprises are being planned, but for a hundred years distinctly a marginal or submarginal ore. An example in Colorado is the Climax deposit of 40 years ago.

Marginal Deposits May Be Utilized

As time goes on, we may expect to utilize more and more deposits that by present standards are too low in grade, too refractory, or too costly to work. Where shall we find them? I expect that many will be found as a by-product of the continuing search for high-grade deposits. I suspect that such marginal deposits will be discovered in the same proportion to high-grade ores, as has been true in the past. And, of course, we know of many at the present time, deposits that have been discovered, but found to be unworkable, during the past 100 years.

These below-grade deposits are of two types. One is uniformly low in grade and has never progressed in its exploitation beyond the prospecting stage. Deposits of this type have in some instances extremely large tonnage and may contain more than one substance of value. Once the inevitable advances in mining and beneficiation are made, they will be worked.

Potential Major Resources

The second kind of marginal deposit is represented by the material left behind as unprofitable during the mining of higher grade ores; the rock on the other side of the "assay wall." Such material, I believe, is a potential major resource that awaits only technologic advances to be productive.

Colorado, and all of the West, is peppered with mining districts that have enjoyed little or no activity for decades, or at best, only spasmodic operation on a scale far below that of their heyday, 50 or 100 years ago. Many of these districts still contain large volumes of mineralized rock. More metal than has been mined from the high-grade deposits in the past may well remain in the old districts stored in walls of old stopes. The material occurs in many forms: as masses of rock containing disseminations or veinlets of valuable minerals that are abundant enough to constitute low-grade ore; small, hidden ore bodies or extensions of known ores that were missed or abandoned during previous periods of activity; bodies of mixed or refractory ores that were not amenable to treatment by then-known methods; concentrations of such materials as pyrite and pyrrhotite that were left behind because of their low gold or copper content; and in some places, large tonnages in dumps, stope fillings, tailings piles, or low-grade placer accumulations.

I am convinced that deposits of this type will eventually be utilized, perhaps sooner than we anticipate. Historically there has been a consistent trend in the direction of lower and lower grade ores, as a result of improved methods and techniques. Certainly we have every reason to believe that the rate of improvement will, if any change occurs, speed up rather than slow down and thus bring into the range of economic feasibility material we now regard as waste. Actually, we have begun to enter this stage already. An outstanding example of the direction in which we are moving is provided by Butte, where, after stoping selectively along veins for 75 years, a large volume of the mineralized country rock in which the old stopes lie is being mined by open-pit and block-caving.

New Mining and Milling Methods

Butte also illustrates a development that should be the subject of another talk, for the future of the mining industry involves not only a new and improved geology, but also new mining methods, and, in many cases, new metallurgy, as well. As a geologist, I'm clearly not competent to discuss and appraise this type of development, but I cannot help being impressed by the interdependence between the nature and grade of the ore deposit, and the factors involved in mining and beneficiating it. Leaching has long been practiced on copper deposits, for example; it is now being used with success on the ores of some other elements also. With the development of new reagents such as the ion-exchange resins, of new methods of large-scale fragmentation, and of a greater capability to handle the hydraulic problems, it may not be unreasonable to expect that some deposits will soon be worked merely by pumping reagents into the ground and extracting metals from the effluent. And, of course, we are all aware of the possibilities inherent in the use of controlled underground nuclear reactions as new mining tools. By finding new ore deposits, and by developing new techniques for finding and treating ores that have been marginal or submarginal in the past but which have been made workable through the results of research, I believe the mining industry can be assured of a place in our economy for some time to come.

Recovery of Metals as By-Products

In the still more distant future, we already know of great volumes of rock that contain abnormal concentrations of various metals, although by that time, we may be recovering many elements as by-products. When the petroleum industry has turned to oil shale and tar sands, for example, we may expect mineral by-products, for even though these may be in extremely low concentration, the raw material will have to be processed, energy will have been applied to it or transformed within it, and an opportunity to skim off mineral by-products at a negligible cost should arise. Ultimately, the petroleum industry may turn to coals—the low-grade coals of the West, or perhaps the left-over coal lost in conventional mining operations in other areas. Here again, we can expect an appreciable mineral by-product, for coals contain a wide assortment of elements, some in very appreciable concentrations.

Industry Must Adjust to Change

It seems to me a certainty that demand for mineral products will not only continue but must increase appreciably; and that it is equally likely that Colorado and its neighboring states contain within their borders the resources to contribute importantly toward fulfilling this demand. I am also confident that geologists and engineers in the profession can be depended upon to develop the new ideas and to devise and perfect the new methods that will make it possible to find and exploit the new sources not only of the mineral raw materials we have produced in the past but the new materials demanded by

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Nation's 'Mines-Above-Ground' Afford Vast Aluminum Reserves

By
ALUMINUM SMELTERS RESEARCH INSTITUTE

With U. S. manufacturers finding new uses for aluminum almost daily, the prospects for future supply might well be of some concern. However, within 30 years, recovery from scrap alone will yield tonnages exceeding the nation's total 1959 production of the metal. The reason for this is simple, but often overlooked. Every product manufactured today from aluminum goes to provide a vast national metal reserve which, through obsolescence and scrap recovery, will make available a ready supply of re-usable aluminum in future decades. By 1990, those untapped reserves may total almost 100 million tons. In that same year, scrap recovery would yield an estimated 2,175,000 tons.

Waste into National Resources

The job of turning this growing array of aluminum waste into a wealthy national resource will fall largely to the aluminum smelting industry, which has been performing this task for the past half century. Currently, this $200 million industry recovers about 375,000 tons per year and converts the material into alloys that total approximately one fifth of U. S. aluminum production.

Pioneered around 1904, the aluminum smelting art matured into a science just 30 years ago, when eight growing companies formed the Aluminum Smelters Research Institute and embarked upon a continued program for the improvement of casting alloys and the advancement of the young industry. Since that turning point, almost one out of every four pounds of aluminum alloy produced in the U. S. has come from reborn scrap—a total of more than 11 billion pounds transformed into ingot from old vacuum cleaners, etc., factory metal shavings and a host of other items.

Metal's Widest Application

The bulk of smelter production goes to the nation's foundries for castings—the metal's widest application. Since pure aluminum is seldom used for castings, due to its low strength, the smelter adds other elements to improve its properties. This is the point at which the *melting* of scrap is elevated to the science of *smelting* aluminum alloy.

To increase the uses of his product, the smelter seeks newer and more versatile blends. During the past 30 years, he has developed more than 50 new alloys and more than 400 variations to meet individual customer needs. The continuous research job has cost individual smelters more than $1 million, and several are spending up to $100,000 on specific current programs.

The multi-million dollar research efforts have paid off handsomely—for both smelter and customer. Self-aging alloys have been developed whereby submicroscopic processes slowly draw certain of the alloy's elements out of solid solution at room temperature, providing high-strength alloys without costly heat treating.

Alloys Allow New Uses

Other new alloys allow fabrication processes, such as drilling, tapping, milling, turning and facing, to be done at much higher speeds, some as high as 5,000 feet per minute. This has helped boost fabricator profits, through lower machining costs and cutting tool wear.

These and other developments have opened the door to uses of aluminum not formerly possible. Some 14 different castings of smelters' aluminum went up with the Jupitor C missile that recently placed a U. S. satellite in orbit; these same high shock-resistant alloys have also been useful in making bazooka rocket launchers and torpedos.

Another recent development sparked the interest of furniture men. One of them stated this year: "Cast aluminum permits advanced new design concepts not previously possible with other metals, wood or plastics. It does this by permitting continuous, thin, graceful furniture parts free of unsightly welds and joints." He went on to prove the point by using castings to make several hundred classroom chairs for the Air Force Academy; plans to use similar designs for hospitals, theaters, and sports arenas.

Through advancements in heat dissipation qualities of alloys, the metal is being used in nuclear plants. At Oak Ridge, a 3,500-pound casting houses a giant reactor; another unit, weighing 780 pounds, encases a rotary compressor. Both of the castings were made from smelters' aluminum.

Many metallurgical applications cannot be proved overnight. For example, it has taken several years for a cast aluminum architectural statue to prove its weather-defying qualities. But the 6,500-pound smelters' alloy casting of Ceres, goddess of grain, has withstood the elements successfully since 1931 atop Chicago's Board of Trade Building.

Still later improvements, such as better ductility, dimensional stability, and ease of casting, have helped to make these alloys commonplace for use in business machines, photo equipment, portable power tools, outboard motors, lawn mowers, radar units, bomb sights, golf clubs, and carts and even tees. It is even lightening the load for the tap dancer: the taps on his shoes are cast from smelters' aluminum.

Foundry Aluminum Supplied

As important as are the smelters' alloy developments, their role as supplier of about 65 per cent of the nation's foundry aluminum is of even greater concern to the economy. This role is twofold. First, they must accurately transform scrap material into finished ingot of exact, specified alloy. The task is far more difficult than to take the virgin metals and only blend the right amounts of raw material, all properly labeled and measured. They must take scrap of often unknown mixture and determine its exact content before adding the needed elements to the blend.

And yet, the smelter's alloy is as metallurgically exact as that produced from original ingredients. This incredible transformation truly requires a magic wand, and the smelter has found several. The techniques he has developed have become so precise that he can take a carload of scrap and, within minutes, determine its composition of up to 15 different elements.

Quality Control Maintained

To analyze his scrap and maintain rigid quality control over his finished ingot, the smelter's science today uses three primary tools:

(1) Quantometer Testing—a direct reading spectograph which electronically analyzes scrap and ingot samples to determine proportion of elements involved.
(2) Physical Testing—which include mechanical properties test, tensile strength, yield strength and elongation, are regularly used to check the "built-in" strength of alloys. Impact and hardness tests are also applied.
(3) X-Ray Defraction—ensuring freedom from non-metallic matter. The test identifies the defect and traces the cause.

Customer Service Supplied

Their second role as a supplier is customer service. Because their plant locations span the country's industrial areas, and because their individual sizes span the full scale of business enterprise, the smelters are able to service their customers with a speed and attention rarely found in the metals field.

They normally ship by truck on an overnight basis. But they can act much faster if necessary. Not long ago, a smelter was called by a foundry 25 miles away. The customer had inadvertently run out of ingot, due to a flurry of orders. Within six hours, five tons of ingot were at the foundry—delivered by private autos.

Recently, a pattern casting firm needed a special alloy for immediate use. Although 400 miles from the smelter's plant, the firm had its ingot five hours later —by air express.

Because of this kind of comfort to his supply worries, the average foundryman today must maintain only a minimum inventory. In fact, there's at least one foundry that maintains no inventory at all. It depends on its smelter for shipments each Monday and Wednesday.

Many times, the smelter doubles as a metallurgical missionary: he helps the foundryman sell the idea of aluminum castings to the end user. A few months ago, one smelter accompanied a foundryman to call upon a fabricator of industrial truck transmissions. He illustrated the merits of aluminum over the metal then being used, and closed the sale. The transmission maker saved 15 per cent in costs—and everybody profited.

During the past 30 years, aluminum has sprouted up to become the second most used metal in the world. In the U. S., largest user of the metal, the salvage and return to production of more than 11 billion pounds in that period has been a national resource conservation of immense scale.

Cost to U.S. Without Salvage

Without the return of this salvaged aluminum during the past three decades, the duplication of this metal reserve would have cost the U. S.:

- 41 billion pounds of raw bauxite (more than the annual world production) and more than one billion pounds of other alloying metals.
- 2,000 ship voyages to carry the raw materials to the U. S. (at 10,000 tons per vessel)
- two years of U. S. primary production at full current capacity
- enough electric energy to power the entire U. S. for eight weeks (more than 102 billion kilowatt hours).

In another sense, the 11 billion pounds of salvaged scrap would be equivalent aluminum to build three million six-room aluminum homes, and 57 B-52 bombers besides.

During World War II, the smelters rescued 1608.9 million pounds of waste aluminum, which was equivalent to have built more than 45,000 B-29 bombers.

In 1952, the President's Materials Policy Commission estimated that by 1975 the annual U. S. consumption of aluminum would reach nine billion pounds. But this year, U. S. industry will gobble up more than four billion pounds, and the statisticians have already begun revising their projected figures. Some of the reasons:

- three out of four metal working plants plan to expand their aluminum needs within five years
- one in three plans a totally new use for aluminum
- 38 per cent of the plants are switching from another material to aluminum.

Application to Automotive Field

One of the biggest factors is the metal's new applications in the automotive field. Detroit says that aluminum can shave 500 pounds from a standard car of 3,600 pounds test weight. Example: an aluminum oil pump weighs .8 pounds as compared with six pounds for standard pumps. Auto men used an average of 25 pounds per car in 1954; 47 in 1958; 57 in 1959. More aluminum parts are soon to come: air suspension parts in 18 cars; carburetor bodies in 19; oil pump bodies in 10; oil filter bodies in 5; fuel pump bodies in 19; engine pistons in 19; distributor housings in 5.

To meet the nation's estimated demand for nine billion pounds by 1975, would require: 36 billion pounds of bauxite annually (current mining rate: 16 billion pounds); 90 billion kilowatt hours to extract the alumina (14 per cent of the total current U. S. power production); and more than double the current U. S. production capacity. Instead, experts predict a greater reliance on raw materials already within our grasp: the ever-mounting reserve of aluminum in the form of factory wastes and obsolescent products.

The rapid growth of recovered aluminum during the next 30 years will be largely due to the increased availability of old (obsolete products) scrap rather than new

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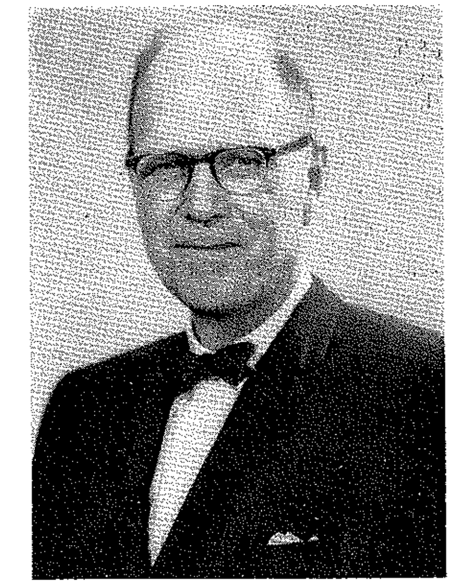
The Research Man And His Environment*

By
E. V. MURPHREE



E. V. MURPHREE

THE AUTHOR

Eger V. Murphree is president of Esso Research and Engineering Co., the Jersey Standard affiliate whose chief function is to provide the science and technology required by operating affiliates to maintain and improve their positions in the world's markets.

Born in Bayonne, N. J., in 1898, Mr. Murphree attended the University of Kentucky, where he received a B.S. degree in chemistry and an M.S. in 1921. He joined the Esso organization at Baton Rouge, La., in 1930, and transferred to Esso Research and Engineering Co. in 1934. After assignments as manager of development and research, and vice president, he became president in 1947.

The author or co-author of 45 papers and the holder of 32 U. S. patents, he is perhaps best known among oil and chemical scientists for his contributions in the field of fluid catalytic cracking.

Active in a variety of government, petroleum industry and university projects, Mr. Murphree is a member of the General Advisory Committee and of the Ad Hoc Advisory Committee on the Reactor Policies and Programs of the Atomic Energy Commission; a member of the Advisory Board of the Institute of Mathematical Sciences of New York University; director of the Kentucky Research Foundation; and a member of the American Chemical Society, American Institute of Chemical Engineers, American Physical Society, Society of Chemical Industry, and the National Academy of Sciences. He served as president of the Fifth World Petroleum Congress held in New York in June 1959.

When I think of the tremendous scientific tasks that are at hand and of the wondrous opportunities for research that the more distant future holds, I like—assuming a world truly at peace—to envision mankind free of disease, poverty and hunger. We would have control of the weather. Unlimited supplies of cheap energy would be ours from sources as yet untapped.

Travel in space would be commonplace. Communications, transportation, housing would be so vastly improved as to bear little resemblance to what we know today. And with all this, man would have unprecedented leisure in which to pursue his happiness.

But, obviously, to achieve much of that rosy future is going to require a tremendous increase in our storehouse of scientific knowledge. And most of this increase must be in basic, fundamental knowledge, because our supply of this priceless commodity is running low.

If we are to acquire this knowledge, then I do believe we who are engaged in the search for it must reappraise our organizations, our methods, our procedures. Above all, we must take a careful look at the practicing research man himself, for he is the primary source of the knowledge we must have.

Careers of Scientists Examined

What kind of individual should tomorrow's research man be? Perhaps the careers of men who have made major contributions to our present fund of knowledge may offer clues as to certain characteristics that the research men of the future should share.

There was Antoine Lavoisier, eighteenth century scientist, who devoted all of his relatively brief lifetime to research work. His first major contributions were made when he was 32 years old, and he continued to produce until his death at 51. One of his major works, a classic treatise on 30 chemical elements, was published when Lavoisier was 46.

Michael Faraday was the nineteenth century chemist whose work in another field has been immortalized by the use of his name for a unit of electrical measurement. Faraday discovered the chlorides of carbon when he was 29, seven years after he began studies under Sir Humphry Davy. Then he went on to make major contributions in both chemistry and electricity until his death at the age of 76.

Emil Fischer, the German biochemist who won the Davy medal when he was 38 years old and the Nobel prize when he was 50, gave 45 years of his life to his field. He made his first major contribution at the age of 23, and his last two just before he died at the age of 67. Fischer's creed is worth re-emphasizing today: He believed in the sound training of chemists and in the practice of investigation for its own sake.

Thomas Midgley was an American physical chemist who won many honors for the work he accomplished in a

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relatively short life before his death in 1944 at the age of 55. Schooled as a mechanical engineer, he made major contributions in such diverse fields as tetraethyl lead, fluorine for refrigerants, the recovery of bromine from sea water, the chemistry of vulcanization, and synthetic rubber. Midgley was once aptly described as a man who possessed the most important characteristics of the research engineer—versatility and action.

Irving Langmuir, who died less than two years ago when he was 76, devoted a lifetime to the uncovering of new knowledge, and published more than 150 scientific papers. He won the Nobel prize when he was 51 for his work in surface chemistry. Possessed of an insatiable curiosity, Langmuir produced important work in other diverse fields: high vacuum tungsten filaments; catalysis of surfaces; weather phenomena; and the flight of birds.

Vladimir Ipatieff, the pioneer in the investigation of catalysis at high temperatures and pressures, developed the high pressure autoclave when he was 36. Then he continued to contribute in the area of catalysis and high pressure reactions up to his death seven years ago, when he was 85.

I could cite many contemporaries who have been prolific contributors of scientific knowledge throughout their lives. To name but two: There is J. Farrington Daniels, now in his seventies, long active in studies in chemical kinetics, photosynthesis, atomic power and solar energy. He has published about two dozen important papers in just the past few years. There is Peter Debye, now 75, a Nobel prize winner at 52 and a creative scholar in physics, physical chemistry and molecular structures.

Qualities in "Ideal" Research Man

From what I know of the careers of men like these and from what I know of their characters and personalities, I have listed eight qualities that I see as possibly significant factors in the make-up of an "ideal" research man.

1. Each of these men made a lifetime career of research. While we know all too little of their formative youthful years, I would strongly suspect that they began asking the simple question "Why?" almost as soon as they knew how to talk. And they kept right on asking "Why?" all their lives.

2. These men all possessed a high level of initiative. They never lacked for something to do; in fact, it would have been very difficult for anyone to hold them back and make them stop working. To them, research was not "work" in the popular sense; it was a way of life.

3. A third quality of these men was dedication. By this I mean, first, dedication to a problem at hand—sticking to the job until an answer is found. I mean, also, dedication to research itself and to the unfolding of scientific knowledge, for these men were very broad in their thinking; they sought ideas and information in all facets of their field of activity.

4. These scientists were creative. They originated ideas. Their thinking processes led them constantly to the development of new theories. Their powers of synthesis were great; yet their powers of analysis were equally great. They were able to take the ideas they originated and sort them out, analyze them, discard the useless and the nonessential thoughts and perhaps find different and better ways of looking at ideas of seemingly little value. Even early in their careers these men needed little guidance or direction from others, particularly in the sense of supervision. They did, however, seek out and constantly use ideas and theories that other scientists had developed.

5. After a period of years, when these men had become deeply immersed in their careers of scientific research, they became what we call today "authorities." They gained deserved recognition for their mastery of their fields. Yet they never stopped learning, nor did they stop creating; they remained scholars in the classical sense.

6. In general, these men were active among their professional colleagues and in their scientific societies. They were intensely interested in promoting the over-all advance of science.

7. A seventh quality of the great scientists was the desire to make their contributions available to others, and they were sufficiently articulate to be able to communicate their ideas. The best ideas in the world are completely worthless if they remain locked up inside their creators' brains.

8. Their major interest in life was making contributions to science through their own research efforts, rather than managing or supervising others. Yet these men possessed talent for scientific leadership. They were able to teach and to inspire others. They worked well on their own; many also worked well with a group or team of researchers. Even those not engaged in university teaching possessed the kind of professorial spark that could stimulate others.

The eight qualities I have outlined represent the ideals we must seek in the research man, the scientist we must have to meet tomorrow's needs. We are going to need the giants—the Lavoisiers, the Faradays, the Langmuirs, and men of their caliber. And the striving for such giants will bring to us numbers of top-flight scientists and engineers of only slightly lesser stature, and also badly needed.

Proper Environment Provided

Assuming we can find such men—and I am completely confident that we can—what must the industrial research organization provide in the way of proper environment for them?

First is a clear definition of the scientist's responsibilities. Research management should tell the research man what the organization's problems are, what goals it is working toward and what specific needs it faces. Then the management should ask him to propose a method of solving those problems with which he is concerned. In other words the research organization wants a man who determines what should be done, not a man who asks what he must do. The management must do everything possible to encourage him to take responsibility for developing scientific information in the specific area in which his interests lie. Doing these things will go a long way toward helping the research man develop his initiative, exercise his curiosity and be truly creative.

The second environmental need is simple, direct lines of communication. Research management has an executive responsibility to review continually the progress of the research effort. But to maintain the effectiveness of this review, the organization pattern must be kept simple. The lines of communication must be open and rapid. The aim is to increase the research man's expertness in his chosen field. This means reducing or eliminating the nontechnical, routine details from his duties, yet keeping him responsible for the proper technical direction and guidance of those working with him.

The third goal in creating an ideal research environment is ample opportunity for expansion of knowledge. By this I mean the growth of the individual's knowledge with the growth in science itself. This can be accomplished partly by providing adequate library and technical information facilities and partly by such activities as seminars, forums, formal courses of advanced study, and conferences with consultants and outside authorities. Management should search constantly for consultants who can provide valuable scientific advice as well as stimulation and inspiration.

It is in this area of environment that the research man can develop another important quality—mastery of his field. The more expert a man becomes, the more easily does he solve the current problems, and the more time he has for creatively probing the unknown.

For example, in Esso Research and Engineering Co., for about twelve years we've conducted a program we call the Esso Research forums. In 1958 this plan brought to our research center in Linden about 20 authorities in various fields of chemistry and engineering. Primarily from university and research institute laboratories, these men came from this country and from abroad—from Canada, England, Germany, Belgium and the Netherlands. Speaking before groups of our own people numbering as many as 100 or more, these men discussed chemical and engineering subjects related to our work. We have been highly pleased with this program.

The research forum is just one phase of our advanced learning activities. We are now planning a formal advanced study program.

The fourth element of the proper research environment is time and opportunity for the research man to exchange ideas and information with colleagues. In many ways expansion of knowledge is attained by such an interchange. Research management must encourage this fruitful kind of cross-fertilization by creating an atmosphere conducive to free informal discussions in the laboratories and by holding internal forums and seminars where creative minds can communicate.

This can be done in a number of ways. For example, periodic technical meetings can be held, where technical papers are presented and then discussed by the men at both formal and informal sessions. Such meetings are intellectually stimulating and give the research man a chance to develop the ability to communicate and to think on his feet.

A fifth need is broad recognition of the scientist's technical achievements. He should be encouraged to participate in technical and professional societies and to prepare technical and scientific papers. It is most important to provide an atmosphere favorable to writing for publication. Perhaps it is wise, when needed, to provide assistance in the preparation of the finished scientific paper. It should be made clear to the research man that he has a responsibility for contributing to the fund of scientific knowledge.

In providing this phase of the ideal environment, management again emphasizes its recognition that a career in research is important, and that it is essential for the research man to become an authority in his field.

Sixth, and finally, research management must adequately reward accomplishment. It must recognize that if outstanding men are to make careers of industrial research, there must be compensation in keeping with the scientists' contributions.

The establishment of a technical ladder of progression is one example of how this can work in practice. This is a system whereby a technical man moves up a ladder with salary ranges and job titles—depending upon his accomplishments—that are equivalent to the more conventional management progression ladder in prestige and stature.

When the organization includes this kind of a system as part of the environment, it becomes profitable for the research man to stay in research, to make it a lifetime career and to become an authority in his field. At the same time, the system in no way neglects the organization's need for good managers. Should the research man show an interest and ability in management, the conventional system of management progression is open to him. Such progression, however, is not necessary for adequate rewards.

The future of our country depends heavily on accelerated expansion of good research by good research men. The men can be found and developed if research management provides the kind of environment in which their talents can flourish.

PLACE OF GEOLOGY IN MINING

(Continued from page 22)

our advancing technology. Because of these convictions, I think there is no doubt that the industry will be able to provide the final requirement: the capacity to adjust quickly to change—change in methods, in requirements, and above all in ideas; the ability, in other words, to look ahead with confidence rather than look back with regret. If this is done, I am confident that the domestic mining industry will be in business, far, far into the future; and I assure you that we as geologists, and especially those of us in the Geological Survey, look forward to the opportunity of assisting the minerals industry in achieving this end.

NATION'S 'MINES-ABOVE-GROUND'

(Continued from page 24)

(scrap generated by fabrication). Whereas today less than one quarter of total scrap aluminum is recovered from obsolete products, and more than three-quarters from scrap generated by industrial fabrication, the ratio will relatively soon begin a grand scale reversal. As aluminum is used in more and more products with each passing year, the growth of obsolescent scrap will rise at a rate unparalleled by new scrap.

Aluminum Scrap Forecast

Within just the next six years, total recovery may reach 668,000 tons, with old scrap rising to 30 per cent of the total. By 1970, industry can expect a recovery of 880,000 tons—35 per cent coming from old scrap.

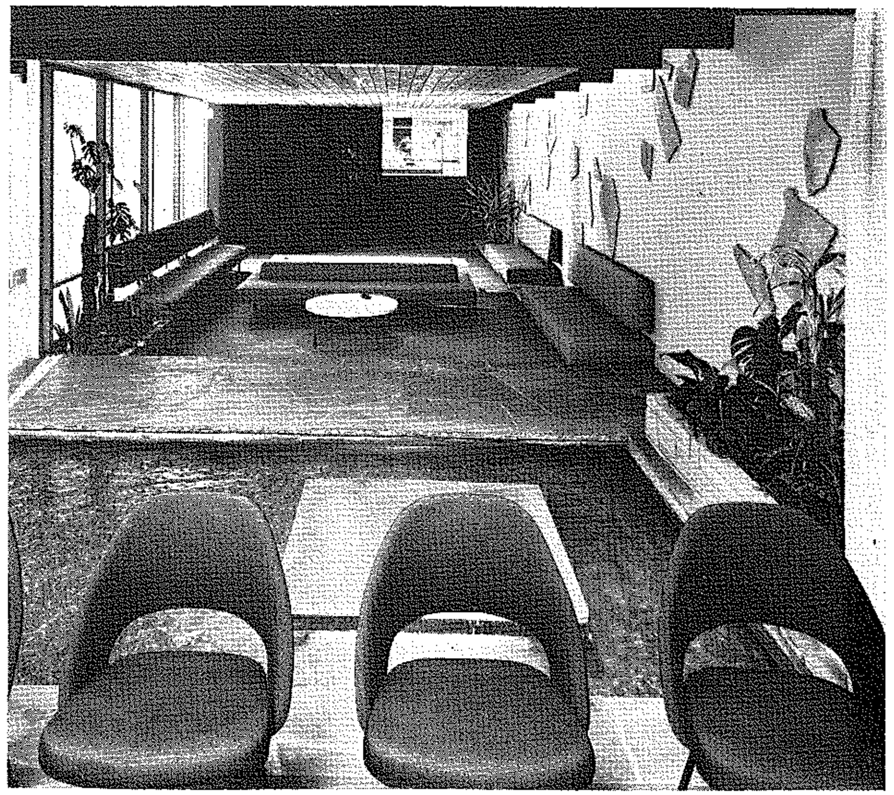
The forecast for 1980 shows a total of 1,465,000 tons recovered, with 44.5 per cent from old scrap.

Projecting figures to 1990, it is predicted that the total scrap aluminum supply of 2,175,000 tons will include 1,200,000 tons of obsolescent scrap recovered from products made yesterday, today and tomorrow.

To recover this metal and turn it into fresh alloys for U. S. industry, the smelters know that it is simply a waiting game. Unlike natural resource-based industries whose reserves can only be increased through costly prospecting and discovery, their reserves keep relentlessly growing more rapidly than depletion takes place.

Inevitably, as more aluminum products are replaced by even newer ones, more scrap will come rolling in. When it does, the nation's 'mines-above-the-ground' will be ready—to change more waste into wealth.

Coors Makes 'Spring Water,' Ceramics, Aluminum Cans



▼The elegant Reception Room, shown above, is available to all visitors who tour Coors brewery during daylight hours (8:30 a.m. to 4:30 p.m.). It is also used by special organized groups five nights a week. An estimated 60,000 people visited the room as guests last year.

As generations of Mines' men are quick to agree, graduating seniors leave Golden with their silver diplomas and a taste for Coors beer. Their predilection for Coors brew remains with them whether they travel to the far corners of the world or stay within Coors' 11-state marketing area in the West and Southwest. Wherever and whenever it may be obtained, Coors is a favorite beverage at Mines alumni gatherings.

Substantial Sales Gain

This preference for Coors is shared by countless numbers of the beer-drinking fraternity. Production of Coors last year was well over 1.6 million barrels—up 812,000 barrels from production just five years ago. This substantial sales gain has boosted Coors from 24th place among the nation's brewers to 14th.

Quality, a key word in the 87-year-old Coors' success story, is almost a fetish with the entire organization. In order to maintain quality, no new state has been invaded for Coors beer sales in 11 years. William Coors, president of the brewery, makes this explanation: "We have always felt it most important to keep our roots firmly in the ground. We've seen too many companies lose quality control when they get too big."

Another effective method used by Coors to maintain quality is to sell its own malt barley seed to farmers each spring and buy back just enough barley and seed for its needs in the succeeding year.

Other Quality Products

But "Pure Rocky Mountain Spring Water" is not the only quality product turned out by Coors. Its Porcelain Co. division is the world's largest producer of laboratory porcelain ware, and in addition the plant makes special ceramic products used in missiles, rockets, and atomic reactors. The company successfully entered the porcelain business during World War I when the blockade cut off German imports of porcelain crucibles, spoons, bowls and other equipment used in laboratories.

Still another Coors affiliate, Aluminum International, Inc. manufactures aluminum cans so that Coors beer may be test-marketed in the Denver area in aluminum packaged containers.

Once the third largest manufacturer of malted milk in the country (mostly for Mars, Inc., Chicago candy maker), Coors discontinued the department in 1958 in order to provide more facilities for beer production.

Management Responsibilities

Adolph Coors, Jr., son of the founder, remains active in the firm as treasurer and board member, but actual operations are carried on by his sons: Adolph III, board chairman; William K., president of the brewery, and Joseph, president of the porcelain plant. With daily luncheons together something of a ritual, the Coors brothers divide management responsibilities. Their offices are of plain cinder-block with walls painted light blue; and since they believe private secretaries are an unnecessary luxury, they call upon the company's pool of stenographers when they need secretarial help. Frugality and conservatism blended with dynamic progressiveness—these are salient characteristics of the Adolph Coors Co.

ALUMNI NEWS

Chicago area Miners are reactivating Great Lakes Section. See story in From the Local Sections, page 34.

Harris, '41, Denver Branch Manager for Ingersoll-Rand

Frank B. Harris, a 1941 mining engineering graduate of the Colorado School of Mines, has been appointed manager of the Denver Branch of Ingersoll-Rand.

Mr. Harris replaces Alfred A. Holland (a 65-year-old youngster) who has retired, after serving 27 years as manager of the Branch. The many Mines' friends of Al Holland wish him pleasurable days of golf and fishing and time to pursue his hobby of electronics.

After graduating from Mines, Mr. Harris worked a year for Ingersoll-Rand before enlisting in the U. S. Marine Corps for a four-year hitch during World War II. In March 1946 he reported back with Ingersoll-Rand in the Los Angeles office and spent the next 13 years in that area.

Mr. Harris was transferred to Denver last October, and since that time he has been busy getting reacquainted with area friends and responsibilities and getting his wife, Ruth, and their three children—Christine, Mark, and Peggy—settled in their new home at 17 Martin Lane, Englewood, Colo.

The John M. Cokes, '28, Return From Trip to Mexico City

Prof. John M. Coke, a 1928 graduate of Mines and head of the CSM engineering drawing and descriptive geometry department, returned Jan. 4 with his bride, the former Mrs. R. S. Lomax, from a wedding trip to Mexico City.

While in Mexico City, the Cokes —who were married Dec. 26 in Denver—saw quite a bit of three Mines Men: Georges Ordonez, '29; Charles W. Campbell, '47, and William R. Schiele, '41.

The couple, who resides at 12725 W. 19th Place, Denver 15, Colo., are members of Rolling Hills Country Club. Mrs. Coke is a member of the Denver Art Museum and a Republican discussion group, while Professor Coke is an active member of Sigma Alpha Epsilon, Tau Beta Pi and Sigma Gamma Epsilon fraternities.

Morrisey, '42, Advertising Manager of AAPG Bulletin

Norman S. Morrisey, a 1942 geological engineering graduate of the Colorado School of Mines, has been appointed advertising manager of The Bulletin of the American Association of Petroleum Geologists. He was elected to Tau Beta Pi while in his junior year at Mines and held a Massachusetts Scholarship.

Morrisey has been active in oil exploration since his discharge from the U. S. Navy in 1946. In addition to his degree from Mines, he holds an M.S. degree in geological engineering from the University of Tulsa. His master's thesis was on the "Madison Limestone of the Big Horn and Wind River Basins of Wyoming."

From 1947 to 1954 he was employed by Pan American Petroleum Corp., then Stanolind Oil and Gas Co. on oil exploration assignments in Casper, Amarillo, Tulsa, Shreveport and Oklahoma City. He spent several summers doing geological field work in the Rocky Mountains while with Pan American. He was district geophysical coordinator in Pan American's Oklahoma City office when he resigned to accept a position as drilling development editor of The Oil and Gas Journal.

Until recently Morrisey was a consulting geologist with offices in Tulsa, but now will devote his entire efforts to the new position of advertising manager of The Bulletin.

Active in both the A.A.P.G. and the Society of Exploration Geophysicists, Morrisey was formerly vice president of the Tulsa Geological Society. His hobbies are reading, bridge, fishing, golf, horseback riding, and hi-fi. His mailing address is 3012 S. Cincinnati, Tulsa, Okla.

Dr. Choh-Yi Ang, '43, Named Director Mallory Laboratories

Dr. Choh-Yi Ang, who received E.M., Met. E. and M.Sc. degrees (1943 and 1947) from the Colorado School of Mines and a Ph.D. degree from the University of Illinois, has been appointed director of the Materials Laboratories of P. R. Mallory & Co., Inc., in Indianapolis, according to an announcement by Dr. F. R. Hensel, Mallory's vice president for engineering.

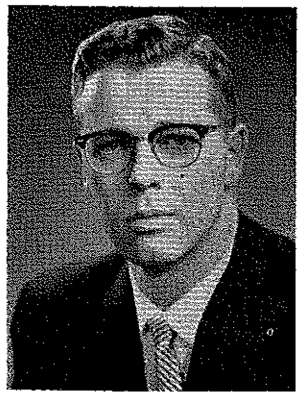
Dr. Ang will direct research and development of new structural and electronic materials and processes, heat resistant and semi-conducting inter-metallics, neutron and gamma radiation.

A member of the Mallory research and development staff since 1954, Dr. Ang has supervised investigations of tungsten alloys, copper alloys, electrical contact materials, cermets, inter-metallics, powder metallurgy and other metallurgical processes. As a research assistant at the University of Illinois from 1951 to 1954, Dr. Ang studied the anelasticity of iron, nickel, gold, tantalum and columbium.

His professional society memberships include the American Institute of Mining, Metallurgical and Petroleum Engineers, the American Society for Materials, the Society for Nondestructive Testing, and the Institute of Metals. He is also a member of Sigma Xi and Tau Beta Pi honorary fraternities.

During the 1940's Dr. Ang was associated with mines and mills in China, the Philippines and the United States.

Allen D. Gray, '52, Elected Director of Susquehanna Corp.



Allen D. Gray, a 1952 graduate and former faculty member of the Colorado School of Mines, was recently elected a director of The Susquehanna Corp., Chicago Ill. The election of Gray fills one of two vacancies created by the Board's action increasing membership from 10 to 12 directors.

Gray is president of Susquehanna-Western, Inc., Denver subsidiary of The Susquehanna Corp., which operates the company's metallurgical and chemical plants, including a uranium mill and sulphuric acid plant at Riverton, Wyo., and a uranium mill at Edgemont, S. Dak.

Gray also holds a degree from Pennsylvania State University and is a member of the American Institute of Mining and Metallurgical Engineers and the Colorado Mining Association. His home address is 14 Village Rd., Englewood, Colo.

Dobbin, '52, Gets Citation For Distinguished Service

Carroll E. Dobbin, a 1952 recipient of an honorary Doctor of Engineering degree from the Colorado School of Mines, has received a Citation for Distinguished Service from the U. S. Interior Department. Dobbin retired last May as regional geologist with the U. S. Geological Survey in Denver.

The citation reads in part:

"Dr. Dobbin began his outstanding career in the Geological Survey in 1917. During his entire service he has brilliantly served the Survey in a supervisory capacity. One of the highlights of his career was the major prominence achieved in the petroleum industry by staff members who had received their guidance and training under his supervision. As Regional Geologist, Branch of Mineral Classification, Dr. Dobbin was in charge of all mineral land classification activities in the Rocky Mountain Region during the early days of the administration of the Leasing Act . . . Recognition of his exemplary service to industry is evidenced by his election in 1947 to the Presidency of the American Association of Petroleum Geologists . . . His distinguished publication record is represented by 57 titles of wide latitude . . . In recognition of his valuable contributions in the field of petroleum geology, his outstanding professional and administrative leadership, and his devotion to the service of the public, Dr. Dobbin is granted the highest honor of the Department of the Interior, its Distinguished Service Award."

CLASS NOTES

(Continued from page 2)

Lew Adamec, '43, has returned to the United States from Medilla, Spanish Morocco. His present address is 225 Kendall Way, Covina, Calif.

Peter W. Leidich, '43, is general mine manager for Mineral Materials Co. of Lovelock, Nev. His P.O. Box number is 531.

Donald J. Marshall, x-'44, is manager of the Rocky Mountain and Mid-Continent Division of Sunset International Petroleum Corp. His address is 2425 S. Yates St., Denver, Colo.

1946-'50

Sailendra K. Chakravorty, '47, is senior staff engineer for Hudson Bay Oil & Gas Co., Ltd. He lives at 1039 78th Ave S.W., Calgary, Alberta, Canada.

Bengt G. Fagerberg, '47, is chief engineer for Loussavaara-Kiirunavaara AB. His address is Upplandsu 3, Malmberget, Sweden.

Jack E. Gaines, '47, lives at 11515 Pacific Ave., Tacoma 44, Wash.

Richard I. Kuehl, '47, is supervising engineer for Phillips Petroleum Co., with address at 935 Maplewood, Idaho Falls, Idaho.

M. H. Levy, '47, employed in the tax department of Ernst & Ernst, lives at 4201 Cathedral Ave. N.W., Washington 16, D. C.

Rulon S. Mahannah, '47, geologist for Shell Oil Co., has been transferred from Calgary to Edmonton. His present address is Box 186, Edmonton, Alberta, Canada.

Balwant S. Negi, '47, is employed by the Oil and Natural Gas Commission, 65 Rajpur Rd., Dehra Dun, Uttar Pradesh, India.

John W. Gettman, '47, project engineer for USGS, lives at 5044 Steele St., Denver, Colo.

Bruce C. Clark, '48, has moved from Dumas, Texas, to Festus, Mo. His P.O. Box number is 63.

Leo P. Mosheim, '48, consulting geologist, lives at Apartado 271, San Jose, Costa Rica, C. A.

William W. Sabin, '49, is chief technologist for Ethyl Corp., Chicago, Ill. His address is 1308 Arbor Vitae Rd., Deerfield, Ill.

Thomas O. May, '49, is supervising geophysicist for The California Co., with address at 800 California Co. Bldg., New Orleans 12, La.

W. B. Kays, Jr., '49, is petroleum engineer in the oil development department of Union Pacific Railroad Co. His address is 176 Roycroft Ave., Long Beach 3, Calif.

Clement R. Hofmann, '49, has moved from Omaha, Nebr., to 2950 Krameria St., Denver 20, Colo.

J. F. Hatch, III, '49, is mining engineer for The American Agricultural Chemical Co. of Pierce, Fla. His address is 2107 S. King Ave., Lakeland, Fla.

D. M. Coleman, '49, has moved from Healdton, Okla., to 4500 Hughes Dr., Wichita Falls, Texas.

Dr. S. N. Anana Narayan, '49, is employed by Nickel Information Bur. Ltd., United Bank of India Bldg., Phirozshah Mehta Rd., Bombay 1, India.

V. S. Balderson, '50, is division geophysicist for The Pure Oil Co., with mailing address at 239 8th Ave. S.W., Calgary, Alberta, Canada.

B. L. Bessinger, '50, field engineer for Hughes Tool Co., has completed the company's training program in Houston, Tex., and has been assigned to Birmingham 9, Ala., with address 1329 Shades Crest Rd.

Clyde W. Kerns, '50, has moved from Billings, Mont., to Casper, Wyo. His P.O. Box number in Casper is 1652.

Sol Meltzer, '50, may be addressed at 316 39th Ave. S.W., Calgary, Alberta, Canada.

1951

Robert D. Briscoe, metallurgist for Granite City Steel Co., lives at 2805 Parker Rd., Florissant, Mo.

Van D. Howbert, II, is division geologist for Honolulu Oil Corp., with address 202 E. Dormard, Midland, Texas.

George Y. King has been transferred by Mobil Oil Co. from Newark, Ohio, to Pittsburgh, Pa. His new address is c/o Mobil Oil Co., Suite 301, 250 Mt. Lebanon Blvd., Pittsburgh 34, Pa.

Robert L. Menk has been transferred by Creole Petroleum Corp. from Falcon, Venezuela to Caracas, Venezuela. His "apartado" number is 889.

Ivan B. Robinson is research engineer for Aluminum Co. of America with mailing address at 2769 Hastings Ave., New Kensington, Pa.

Bruce E. Roll has moved from Pueblo, Colo., to Pratt, Kans., where he is district production superintendent for Lion Oil Co. His P.O. Box is 580.

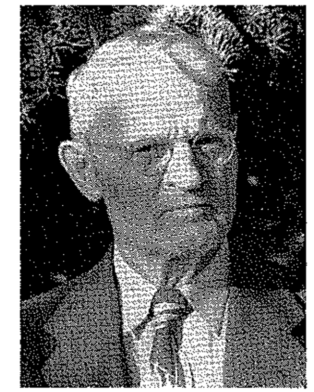
Boris S. Voukovitch, geologist for Geophoto Services, Inc., has moved from Golden, Colo., to 431 S. Marshall St., Denver 26, Colo.

Richard M. Zoerb is geologist for Conorada Petroleum Corp., with mailing address 630 Fifth Ave., Suite 3106, New York 20, N. Y.

(Continued on page 32)

IN MEMORIAM

Charles M. Rath



Charles M. Rath, who received his E.M. degree from the Colorado School of Mines in 1905, died Dec. 22, 1959 while visiting his stepson, Lloyd C. Bowman, in Casper, Wyo. Mr. Rath was president of the Colorado School of Mines Alumni Association from June 1927 to June 1929, was one of the original incorporators of the Colorado School of Mines Foundation (Sept. 20, 1928), and was a member of its Board of Directors at that time.

Born May 14, 1881 in Cheyenne, Wyo., he attended the Cheyenne public schools and for a three-year period after his graduation from Mines was employed by the Union Pacific Coal Co. of Hanna, Wyo., the Sierra Madre Mining and Development Co. of Choix, Sin., Mexico, and the Daily West Mining Co. of Park City, Utah.

His experience in the petroleum industry commenced in 1909 when he went to work for the Field Division of the U.S. General Land Office, where most of his work dealt with compliance with the U.S. Land Laws, particularly those pertaining to petroleum. He appeared in court frequently as a technical witness for the United States.

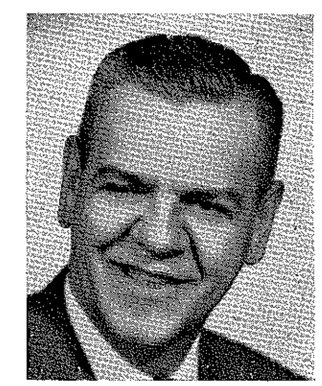
In 1917-18 he was geologist for the Western Exploration Syndicate, now the Consolidated Royalty Oil Co. in Casper, Wyo., and for 13 years (1918-31) was geologist and geophysicist for Midwest Refining Co., now Pan American Petroleum Corp.

From 1931 to the time of his death, Mr. Rath practiced his profession as a consulting geologist, performing work for many of the outstanding oil operators in the Rocky Mountain Region. He was widely known and respected in the oil industry, and his death marks the closing of another page in the pioneering work done by the dedicated men who have shown the way for the development of the great oil industry of the Rocky Mountain Region.

Mr. Rath was a member of the American Association of Petroleum Geologists, Tulsa, Okla., being the last survivor of the three incorporators of the association; a member of the Wyoming Geological Association, Casper, Wyo.; a charter member and past president of the Rocky Mountain Association of Geologists; a charter member of the Petroleum Club of Denver; a charter member of the Rocky Mountain Petroleum Pioneers; a member of the Denver Mining Club, and a 50-year member of the Masonic Lodge at Cheyenne, Wyo.

Survivors include his wife, Louise, of Denver; a daughter, Mrs. Raymond C. Johnson of Denver; two sons: Roger of Denver, and Ross of McIntosh, Fla., and seven grandchildren.

Robert Rudolph Schultz



Robert Rudolph Schultz, class of 1936, died unexpectedly of a heart attack Dec. 6, 1959. His home was at 420 N. Wall St., Joplin, Mo. He was the general manager and executive vice president of The Rogers Iron Works of Joplin.

Mr. Schultz was born in Mt. Vernon, Ind., on Oct. 27, 1909, the son of Dr. and Mrs. Rudolph Schultz. He graduated from Mt. Vernon High School and attended Evansville University and the University of Cincinnati before coming to Colorado School of Mines in 1934 to complete his education. While here he majored in metallurgical engineering and received his degree in 1936. He was a member of Sigma Alpha Epsilon and served as president of the fraternity during his senior year.

After graduation Mr. Schultz went to work as a sales engineer for the Traylor Engineering and Manufacturing Co. of Allentown, Pa. After two years he moved to Milwaukee and took a similar position with Nordberg Manufacturing Co. During World War II, he served as an officer in the U. S. Corps of Engineers. While stationed at the Army Supply Depot, Columbus, Ohio, he met and married Jen Loree Baker of New Matamoras, Ohio. They were married Nov. 21, 1943.

Mr. Schultz was discharged from the Army as a captain in Jan. 1946. He returned to the Nordberg Manufacturing Co. as sales manager and continued there until 1949. The next two years found him with Willamette Iron and Steel in Portland, Ore., as sales manager. In 1951 he moved to Washington, D. C., as a consultant to the Office of Price Administration. After a few months in Washington, he moved to Joplin, Mo., and joined the Rogers Iron Works as general manager and executive vice president.

In addition to his wife, Jennie, he is survived by his mother, Mrs. Kate Whitworth Schultz, and a host of close friends.

John Wesley Whitehurst

John Wesley Whitehurst, a 1910 mining engineering graduate of the Colorado School of Mines, died Nov. 5, 1959, at City Hospital, Ponca City, Okla. He had been in ill health since July.

Born Nov. 2, 1887 in Salida, Colo., Mr. Whitehurst attended Colorado College for a year before graduating from Mines, where he was a member of Tau Beta Pi, honorary engineering fraternity.

After a five-year period employed as superintendent of gold and silver properties in Mexico, he served in the Army for 17 months during World War I as a first lieutenant. After the war, he worked for Bruce Bement Oil Co. in Indiana, Louisiana and Arkansas. On Sept. 14, 1921, he married Miss Charlotte Linch in Ponca City, Okla., and shortly thereafter founded the Whitehurst Construction Co. and started building residences. The company was later employed by Continental Oil Co. to construct additions to its refinery and many stations throughout the mid-continent fields. His company also was engaged for many years on construction work for Great Lakes Pipeline Co. in the northwest and midwest areas, Yellowstone Pipeline Co. at Spokane, Wash., Sun Ray Oil Co., Cities Service Refinery, and many civic buildings in Ponca City.

Mr. Whitehurst was an amateur camera enthusiast and was always interested in the work of the University of Oklahoma Speech and Hearing Clinic. Organizations to which he belonged included the Associated Contractors of Oklahoma, Grace Episcopal Church, and the University of Oklahoma's Touchdown Club and Dad's Association (his four daughters having attended the University of Oklahoma).

Survivors include his wife, Mrs. Charlotte Whitehurst, Ponca City, Okla.; three daughters: Mrs. Margaret Louise Sandlin, Manhattan Beach, Calif., Mrs. Barbara Janice Rhyne, Arvada, Colo., and Mrs. Kathryn Ruth Douglas, Dallas, Texas; two sisters: Mrs. George D. Meston, Hollywood, Calif., and Mrs. George G. Griswold (whose husband is a 1914 graduate of the Colorado School of Mines), Butte, Mont.; and six grandchildren.

William B. Patrick

William B. Patrick, a 1909 mining engineering graduate from the Colorado School of Mines, died Jan. 8 at his home in Boulder, Colo.

Born Oct. 25, 1885 in Leadville, Colo., he attended grade and high schools in Denver before entering Mines. He worked for a number of years as a mining engineer in Goldfield and Rhyolite, Nev., then returned to Colorado and started farming in eastern Jefferson County.

In 1928 he became an employment counselor and continued in this activity until his retirement two years ago. He was active for many years with alumni groups from the Colorado School of Mines and Sigma Alpha Epsilon fraternity.

Mr. Patrick is survived by his wife, Dorothy, of Boulder; two sons, Alan Patrick of Boulder, and Roger Patrick of Grants, N. M., and three granddaughters.

Robert H. McDonald

Robert H. McDonald, who attended the Colorado School of Mines for over two and a half years (withdrawing January 1956), died Jan. 16 in a Climax, Colo., hospital of injuries suffered a few hours earlier in a traffic accident on U. S. Highway 6 two miles east of Frisco, Colo.

Mr. McDonald was an engineer for Tipton and Kalmbach, Inc. Born January 27, 1930, in Steamboat Springs, Colo., he came to Denver when he was 10. He was a graduate of East Denver High School.

Survivors are his wife, Alice Winslow McDonald of Aspen, and his mother, Mrs. Margaret McDonald of Denver.

CLASS NOTES

(Continued from page 30)

1952

Behram K. Antia's present address is Block "H" Dalal Estate, Lamington Rd., Bombay 8, India.

Donald L. Brehm is senior geologist for Esso Standard (Guatemala) Inc., with mailing address Apartado 1337, Guatemala City, Guatemala, C. A.

Weldon G. Frost is staff geologist for Mobil Oil Francaise with address 54 Rue de Londres, Paris, 8eme, France.

Thomas E. Johnson has moved from Butte, Mont., to Caracas, Venezuela, where he is employed by Phillips Petroleum Corp. His "apartado" number is 1031.

B. G. Newton is district geologist for Pan American Petroleum Corp., with mailing address Box 1437, Bismarck, N. Dak.

Lawrence C. Simmons, assistant metallurgical supervisor for Bethlehem Steel Co. of Vernon, Calif., lives at 2934 Candlewood, Lakewood 11, Calif.

William L. Vorhies is a member of the technical staff of Hughes Aircraft Co., Culver City, Calif. His address is 3391 Mandeville Canyon Rd., Los Angeles 49, Calif.

Foster J. Witthauer, mill chief, New Jersey Zinc Co., Gilman, Colo., receives mail at P.O. Box 51.

Mr. and Mrs. George E. Tarbox are the parents of a son, John Edward, born Jan. 8. The Tarboxes also have two daughters—Melinda, 4, and Dorothy Lee, 2. Mr. Tarbox is with Pan American Petroleum Co. at Lubbock, Texas.

Robert D. Turley and Clement A. Lehnertz, Jr., have formed a consulting firm, Exploration Engineering, 1114 South Coast Bldg., Houston 2, Texas. They will specialize in photo-geology and surface geology.

1953

John P. Holland is senior engineer for Humble Oil & Refining Co. His address is 4529 Driftwood, Corpus Christi, Texas.

Robert G. Jacobsen has been transferred by Mobil Oil Co. from Billings, Mont., to Pittsburgh, Pa. His present address is c/o Mobil Oil Co., Suite 301, 250 Mount Lebanon Blvd., Pittsburgh 34, Pa.

C. Ted Robinson is melting division superintendent for Penberthy Inst. Co. of Seattle, Wash. His address is 16204 SE 8th, Bellvue, Wash.

1954

Howard G. Fleshman is senior mining engineer for Kaiser Refractories Co., with mailing address 3 Terrace Circle, Mexico, Mo.

Jack V. Glinkman is geophysicist for Sun Oil Co. His address is 1502 Arlington, Apt. B, Corpus Christi, Texas.

Newell H. Orr, Jr., sales engineer for Aluminum Co. of America, has been transferred from Denver, Colo., to Pittsburgh, Pa., with home address 451 Brown's Lane, Apt. 30, Pittsburgh 37, Pa.

Melvin G. Oxsen, geologist for Lion Oil Co., has been transferred from Salt Lake City to Durango, Colo. His P.O. Box number in Durango is 3132.

J. Arnie Siltanen, salesman for Construction & Mining Supply Co. of Phoenix, Ariz., lives at 512 W. Culver, Scottsdale, Ariz.

1955

1st Lt. Frank M. Akiyama's mailing address is Hq. Co. 24th Engr. Bn. (A.D.), APO 696, New York, N. Y.

Lieh-Leng Cheng may be addressed at P.O. Box 288, Manilla, Philippines.

Jack S. Diskin is mine engineer for American Gilsonite Co., with mailing address P.O. Box 64, Bonanza, Utah.

John J. Gallagher is petroleum engineer for Canadian Superior Oil Co. His address is 703 6th Ave. SW, Calgary, Alberta, Canada.

Donald H. Holland has moved from Denver, Colo. to Tucson, Ariz., where he may b eaddressed c/o B. A. Williamson, 5642 E. Copper.

Narotamdas K. Kothari is employed by Associated Cement Co. Ltd., Nowrozabad Colliery, Madhya Pradesh, India.

Eugene E. Risch's mailing address is Box 1169, Riverton, Wyo., where he is employed as an engineer by Hidden Splendor Mining Co.

Donald R. Wienecke is process engineer for Phillips Petroleum Co., with mailing address 4716 Toalson Rd., Bartlesville, Okla.

1956

Nathan Avery, petroleum engineer for Schulz and Brannan Drilling Co., lives at 4919 Lake Park Dr., Wichita Falls, Texas.

Bruce O. Barthel, petroleum engineer for Mobil Oil Co., receives mail at Box 565, Pampa, Texas.

A. Bruce MacDonald may be addressed c/o Charles R. Hetherington Co. Ltd., 708-7th Ave., S.W., Calgary, Alberta, Canada.

Jack R. Cowden, associate engineer for Continental Oil Co., has moved from Gering, Nebr., to 541½ S. Workman, Lyons, Kans.

Willard L. Goodwin, metallurgist for Kaiser Aluminum and Chemical Corp., lives at 3500 Millbrook Dr., Parkersburg, W. Va.

Herbert A. Ritschard has moved from Kremmling, Colo., to 1014 Grand Ave., Glenwood Springs, Colo.

1957

Harry M. Losee has moved from Tallulah, La., to Brewton, Ala. His P.O. Box number is 229.

Donald W. Norberg has moved from Redondo Beach, Calif., to 2220 S. Emerson St., Denver 10, Colo. Norberg, who previously worked for General Petroleum Corp., is now employed by Stearns-Roger Manufacturing Co.

(Continued on page 34)

FROM THE LOCAL SECTIONS

Minutes of Section Meetings should be in the Alumni Office by the 15th of the Month preceding Publication.

ALABAMA

Birmingham Section
Pres.: Joseph Hohl, '25
Sec.: Richard White, '42
249 Flint Dr., Fairfield

ARIZONA

Arizona Section
Pres.: Bob Thurmond, '43
V. Pres.: Gene Klein, '43
Sec.: John H. Bassarear, '50
c/o Pima Mining Co., Box 7187, Tucson
Annual meetings: First Monday in December; 3rd Sunday in May (annual picnic).

Four Corners Section
See New Mexico for officers

CALIFORNIA

Bay Cities Section
Pres.: John D. Noll, '51
V. Pres.: Ralph D. Eakin, '48
Treas.: Herbert D. Torpey, '51
Sec.: Charles G. Bynum, '26
2810 Loyola Ave., Richmond

Southern California Section
Pres.: W. C. Prigge, '42
V. Pres.: R. E. McGraw, '53
Treas.: J. R. Leonard, '42
Sec.: M. C. McKinnon, '52
9826 Corella Ave., Whittier

COLORADO

Denver Section
Pres.: Ed. Haymaker, '41
V. Pres.: M. John Bernstein, '47
Sec.-Treas.: Douglas Rogers, '48
TA 5-2307

Four Corners Section
See New Mexico for officers

Grand Junction Section
Pres.: John Emerson, '38
V. Pres.: Tony Corbetta, '48
Sec.-Treas.: Joe Hopkins, Ex-'37
1235 Ouray Ave., Grand Junction

DISTRICT OF COLUMBIA

Washington, D. C. Section
Pres.: Charles T. Baroch, '23
V. Pres.: Vincent G. Gioia, '56
Sec.-Treas.: Thomas E. Howard, '41
9511 Nowell Dr., Bethesda 14, Md.
Luncheon meetings held every 2nd Thurs. noon at Sphinx Club, 1315 K St., N. W.

ILLINOIS

Great Lakes Section (Chicago)
Inactive

KANSAS

Kansas Section
Pres.: Francis Page, '39
Sec.: James Daniels, '51, AM 5-0614
205 Brown Bldg., Wichita
Meetings: Called by Sec. Contact Sec. for date of next meeting

LOUISIANA

New Orleans Section
Pres.: George Burgess, '49
V. Pres.: Emory V. Dedman, '50
Sec.-Treas.: Thomas G. Fails, '54
Shell Oil Co., Box 193, New Orleans

MINNESOTA

Iron Range Section
Pres.: Paul Shanklin, '49
V. Pres.: Leon Keller, '43
Sec.-Treas.: James Bingel, '53
50 Garden Dr., Mt. Iron, Minn.
Exec. Com.: Wm. Gasper, '43 and Robert Shipley, '52

MISSOURI

St. Louis Section
Pres.: Earl L. H. Sackett, '33
Sec.-Treas.: E. W. Markwardt, X-'32
621 Union Ave., Belleville, Ill.

MONTANA

Montana Section
Pres.: John Suttie, '42
V. Pres.: John Bolles, '49
Sec.-Treas.: Wm. Catrow, '41
821 W. Silver St., Butte

NEW MEXICO

Four Corners Section
Pres.: Dick Banks, '53
V. Pres.: Tony King, '57
Sec. Treas.: Tom Allen, '41
2104 E. 12th St., Farmington

NEW YORK

New York Section
Pres. & Treas.: Ben F. Zwick, '29
Sec.: H. D. Thornton, '40
Union Carbide Corp.
30 E. 42nd St., New York City

OHIO

Central Ohio Section
Pres.: Roland Fischer, '42
Sec.-Treas.: Frank Stephens, Jr., '42
Battelle Mem. Inst., Columbus

Cleveland Section
Pres.: Charles Irish, '50
Treas.: Theodore Salim, '53

Pennsylvania-Ohio Section
See Pennsylvania for officers

OKLAHOMA

Bartlesville Section
Pres.: R. C. Loring, '37 and '39
V. Pres.: C. T. Brandt, '43
Sec.-Treas.: W. K. Shack, '51
4726 Amherst Dr., Bartlesville

Oklahoma City Section
Pres.: Lynn Ervin, '40
V. Pres.: Clayton Kerr, '30
Meetings the 1st and 3rd Tuesday of each month at the Oklahoma Club

Tulsa Section
Pres.: Parke Huntington, '26
V. Pres.: Jerry Diver, '52
Sec.-Treas.: Jim Newell, '52

PENNSYLVANIA

Eastern Pennsylvania Section
Pres.: Samuel Hochberger, '48
V. Pres., Sec-Treas.: Arthur Most, Jr., '38
91 7th St., Fullerton

Pennslvania-Ohio Section
Pres.: L. M. Hovart, '50
Sec.-Treas.: George Schenck, '52
7130 Thomas Blvd., Pittsburgh
Meetings upon call of the secretary

TEXAS

Houston Section
Pres.: Jack Earl, '53
V. Pres.: John C. Capshaw, '54
Sec.-Treas.: Nick Shiftar, '40
5132 Mimosa St.,
Bellaire, Texas

North Central Section
V. Pres.: Howard Itten, '41
Sec.-Treas.: Harley Holliday, '42
4505 Arcady Ave., Dallas 5
Sec.-Treas.: S Geffen, Ex-'42, Ft. Worth
Sec.-Treas.: John Thornton, '50
609-B Scott St., Wichita Falls

Permian Basin Section
Pres.: Van Howbert, '51
V. Pres.: Hal Ballew, '51
Sec.-Treas.: Tom McLaren, '52
P. O. Box 1600, Midland
Luncheon meetings held first Friday of each month at Midland Elk's Club.

South Texas Section
Pres.: James Wilkerson, '31
V. Pres.: Edward Warren, '50
Sec.-Treas.: Richard Storm, '53
1007 Milam Bldg., San Antonio

UTAH

Four Corners Section
See New Mexico for officers

Salt Lake City Section
V. Pres.: Joe Rosenbaum, '34
Sec.-Treas.: Kenneth Matheson, Jr., '48
614 13th Ave., Salt Lake City

WASHINGTON

Pacific Northwest Section
Pres.: Wm. Douglass, '11
Sec.: C. Ted Robinson, '53
16204 S.E. 8th, Belleview

WYOMING

Central Wyoming Section
Pres.: John Newhouser, '50
Sec.: Adolph Frisch, '53
2805 O'Dell Ave., Casper

LOCAL SECTIONS OUTSIDE U. S. A.

CANADA

Calgary Section
Pres.: R. F. Zimmerly, '47
V. Pres.: J. S. Irwin, Jr., '54
Sec.-Treas.: G. L. Gray, '50
1304 4th St. S.W., Calgary
Luncheon meetings held 3rd Monday of each month in Calgary Petroleum Club; visiting alumni welcome.

PERU

Lima Section
Pres.: Richard Spencer, '34
V. Pres.: Hernando LaBarthe, '42
Sec.-Treas.: Norman Zehr, '52
Casilla 2261, Lima
Meetings first Friday of each month, 12:30 p.m., Hotel Crillon (April through December), or on call.

PHILIPPINES

Baguio Section

Pres.: Francisco Joaquin, '26
V. Pres.: Claude Fertig, x-'27
Sec.: P. Avelino Suarez
Balatoc Mining Co., Zambales

Manila Section

Pres.: Servilano Aquino, '41
V. Pres.: Gus Neumann, '21
Sec.-Treas.: J. Kuykendall, '41

TURKEY

Ankara Section

Alumni visiting Turkey contact either: F. Ward O'Malley, '42, Explr. Mgr., Tidewater Oil Co., Kumrular Sokakb, Yenisehir Ankara; Tel. No. 21328.

Ferhan Sanlav, '49, Turkiye Petrolleri A. O. Sakarya Caddesi 24, Ankara; Tel. No. 23144.

VENEZUELA

Caracas Section

Pres.: William A. Austin, Jr., '27
V. Pres.: G. V. Atkinson, '48
Sec.-Treas.: T. E. Johnson, '52
c/o Phillips Petr. Co.
Aptdo 1031
Asst. Sec.-Treas.: R. L. Menk, '51
c/o Creole Petr. Corp.
Aptdo 889

Great Lakes Section

A group of Miners whose work brings them close to Chicago's Loop at lunch time was contacted by Charles R. Fitch and Raymond E. Watson. An informal luncheon meeting was held Dec. 9 at Johnny's Steak House, 501 S. Wabash Ave. In attendance were:

R. E. Pierson, '41; F. L. Stewart and R. E. Watson, '43; F. D. Squire, x-'44; J. J. Seerley and M. G. Zangara, '48; C. R. Fitch, H. B. Parfet and W. W. Sabin, '49; G L. Miller, '50.

The problems connected with reactivating the Great Lakes Section were discussed and those present felt it preferable to have another similar luncheon meeting in the spring. Meanwhile, plans are under way to contact all alumni in the area to advise them of the existence of this nucleus who object to seeing the current listing on the page carrying news From the Local Sections.

During the interim, the Great Lakes Section will operate on a purely social basis. We will advise of the next luncheon date so it may be announced in The Mines Magazine.

Anyone in the area wishing additional information or having suggestions regarding the revival of the Great Lakes Section should contact:

Mr. Charles R. Fitch
c/o Charles Ringer Co.
7915 S. Exchange Ave.
Chicago 17, Ill.
Phone: SO-8-0444

CLASS NOTES

(Continued from page 32)

Richard K. O'Neil is now assigned as a production engineer to the Wind River District of the production department of Conoco Oil Co., with both home and office located at Circle Ridge, Wyo., about 55 miles west of Riverton. His mailing address is P.O. Box 953, Riverton, Wyo.

Warawit N. Paiboon may be addressed c/o College of Engineering, Chalalongkorn University, Bangkok, Thailand.

James W. Speck's new mailing address is P.O. Box 494, Rock Springs, Wyo. Speck is now working for the U. S. Geological Survey as a petroleum regulatory engineer under the Branch of Oil and Gas Operations. He was transferred from Casper to Rock Springs on Nov. 1.

James Sundquist has moved from Rock Springs, Wyo., to Moab, Utah, with mailing address P.O. Box 545.

John E. Van Dell, project engineer for Concrete Conduit Co. (a division of American-Marietta Co.), has moved from Redlands, Calif., to 825 Holly St., Rialto, Calif.

Donald K. Walker, formerly of Arlington, Va., now lives at 8231 W. 16th Pl., Lakewood, Colo.

1958

William C. Bagby's new address is 33 Aberdeen Ave., Cambridge 38, Mass.

Paul W. Bonham, Jr., is an ensign in the U. S. Navy, Civil Engineer Corps. His mailing address is Ens. P. W. Bonham, Jr., Code 406, Pearl Harbor Naval Shipyard, Navy No. 128, c/o FPO San Francisco, Calif.

Peter F. Bowen, junior engineer for Utah Construction Co., has moved from Ft. Lauderdale, Fla., to 1106 E. Main, Riverton, Wyo.

Charles Robert Cavanaugh is engineer trainee with Kennecott Copper Corp., with mailing address c/o General Delivery, Hayden, Ariz.

James V. Luxner has moved from East Bank, W. Va., to 341 N. Avenue A, Canton, Ill.

Charles E. Ramsey, Jr., is petroleum engineer for Tennessee Gas and Oil Co., with mailing address 511 N.W. 47th, Oklahoma City, Okla.

Stanley G. Young, ensign in the U. S. Navy, may be addressed at Material Laboratory (900c), N. Y. Naval Shipyard, Brooklyn 1, N. Y.

1959

Edward A. Fernau, junior engineer (soils) for NYSDPW-Bureau of Soils, has moved from Cohoes, N. Y. to 68 Waller Ave., White Plains, N. Y.

Keith George is now project engineer for Western Construction Corp., with mailing address Rt. 1, Box 298-J, Titusville, Fla.

Duane I. Graham, second lieutenant U. S. Army, lives at 1008 Potomac Ave., Apt. B-1, Alexandria, Va.

David R. Hiatt, engineer trainee with Allis Chalmers Manufacturing Co., may be addressed Rt. 1, Box 455, Golden, Colo.

Phillip D. Irwin is engineer trainee with Socony Mobil Oil Co., with mailing address 3212 F. Road, Clifton, Colo.

Robert A. Lame, civil engineering assistant with Los Angeles County Flood Control District, lives at Apt. 19, 1143 E. Garvey Blvd., West Covina, Calif.

George A. Lawrence is employed by Colorado Fuel & Iron Corp. His address is 30½ Carlile Pl., Pueblo, Colo.

Roderick W. MacDonald, now serving a hitch in the U. S. Army, will soon be transferred from West Palm Beach, Fla., to Ft. Carson, Colo. His mailing address is 2905 Olive St., Denver 7, Colo.

J. R. McKee, engineer for Perforaciones A Chorro, gives his new address as Apartado 4168, Puerto La Cruz, Venezuela.

Lt. Charles H. McKinnis, U. S. Army Chemical Corps may be addressed USA Chemical Corps Arsenal, Pine Bluff Arsenal, Ark.

Robert E. Miller is nuclear logging engineer for Pan Geo Atlas Corp., with mailing address 5207 Willow Glen, Houston, Texas.

Joe L. Thompson is engineer for United Producing Co., Inc., with address 110 W. 11th, Liberal, Kans.

Rawley L. Young's address is 4907 W. 1st St., Winston-Salem, N. C.

MINERAL INDUSTRIES

(Continued from page 6)

tained by Bureau metallurgists on a laboratory scale, new economies were attained in hafnium production, and the Bureau began a commercial evaluation of its electrolytic process for recovering high-purity titanium from scrap and other materials.

Other Bureau attainments in this field were successful experiments in which both coal and natural gas were used as iron blast-furnace fuels, and production of low-nickel austenitic stainless steel from offgrade ores. Research on nonmetallics advanced with studies of super refractories, elemental boron, and asbestos.

Mining: New knowledge was gained in studies of blasting techniques and rock breakage, and progress was made in research to find ways of utilizing submarginal phosphate-rock deposits.

Foreign Activities: Bureau specialists gave technological aid in mineral development to 15 friendly countries, and 25 foreign scientists and engineers trained at Bureau establishments during the year.

Uranium Stretch Out Plan Agreed to by U.S. and Canada

The U. S. Atomic Energy Commission will not be in a position to exercise its options to purchase additional Canadian uranium concentrate in the post-1962 period but has agreed to a stretch-out arrangement with Canada during the period of March 31, 1962, through Dec. 31, 1966.

Under the stretch-out agreement, the Commissions' total Canadian uranium commitment remains unchanged with respect to the pounds to be delivered and the prices to be paid under existing contracts. Both countries believe that this arrangement will be mutually advantageous.

CAMPUS HEADLINES

CSM Grows Steadily During Presidency of Dr. John W Vanderwilt

The Colorado School of Mines has undergone continual expansion under the direction of Dr. John W Vanderwilt, president since 1950.

When Dr. Vanderwilt took office, the School maintained nine major buildings and had an enrollment of 950 students. Today there are 16 major buildings and a total enrollment of 1100. During the past 10 years, seven major buildings have been constructed at a cost of $5,000,000. Included are two dormitories, a metallurgical engineering building, a petroleum building and unit operations wing, a library and gymnasium in addition to the chemistry facility. Renovation of other buildings brings the total construction figure close to $6,000,000 during the past decade.

Academic Changes

Even more notable have been the academic changes during Dr. Vanderwilt's presidency. These include closer integration of course material; a common first two-year curriculum for all students; a graduate school faculty and dean; a post-graduate department; more rigid entrance requirements; a strengthening of basic science and humanity requirements, and a greatly expanded faculty research program.

Dr. Vanderwilt does not favor a five-year education plan for Mines students, despite such plans at a few other engineering colleges. His major reasons are that such a plan would increase annual costs by at least 25 per cent, and he considers it a serious matter to use an extra year of a young man's productive life. He believes the college course at Mines can be kept within the four-year framework by concentrating subjects and course material and by integrating classes more closely.

New subjects are continually being introduced, however. One example is geochemical engineering which has become a strong course area in chemistry and geology. The introduction of courses in ceramic engineering is now being considered.

CSM Foundation, Inc.

Although a state-supported institution, Mines has taken the initiative in providing for itself. A private foundation was incorporated in 1951 for the purpose of raising supplemental funds for the School. The Foundation is now worth nearly $800,000 and income from private sources last year exceeded $300,000.

Based on its anticipated state and private support, the School has framed a "Horizon Plan" to be accomplished by 1974, the School centennial year. In 1956 a timetable was established calling for five new major buildings by 1966. A metallurgy building, dormitory and gymnasium are now in use. A new science building, to be used predominantly by the physics department, is on the drawing boards and construction is expected to begin in 1961. The fifth building—a college union—remains to be financed but temporary facilities will be achieved in the near future when remodeling of the School's old gym is completed.

In addition to its support of the long-range building program, CSM Foundation funds are being used for (1) continual improvement of the faculty, (2) support of faculty research projects, and (3) student aid in the form of scholarships and fellowships.

CSM Research Foundation

Dr. Vanderwilt also serves as president of the Board of Trustees of the Colorado School of Mines Research Foundation, unique research wing of the School which performs nearly a million dollars worth of sponsored research annually. The CSM Research Foundation is a non-profit corporation that is fully self-supporting, and any surplus that develops from research projects is used to improve and expand the facilities.

Nearly a quarter of the Horizon Plan has been accomplished under the guidance of Dr. Vanderwilt, who is quick to acknowledge that credit for these accomplishments goes to many people including the staff, faculty, alumni and friends, and members of the Board of Trustee.

American Metal Climax Donates $10,000 to Mines

An unrestricted grant of $10,000 has been made to the Colorado School of Mines Foundation, Inc., by the American Metal Climax Foundation, Inc., of New York City.

Announcement of the contribution was made by Dr. John W Vanderwilt, Mines president, who stated the money would be used in the continuing faculty improvement program which is sponsored by the CSM Foundation.

The American Metal Climax Foundation is supported by American Metal Climax, Inc., a firm evolved from the Dec. 30, 1957, merger of American Metal Co. and Climax Molybdenum.

The grant is the second such gift to the School and, prior to their merger, both American Metal and Climax had been consistent donors to the research and academic activities at Mines.

The Climax Division operates a molybdenum mine and plant at Climax, Colo.; uranium mines and mills on the Colorado plateau; and other subsidiary mining projects in western United States.

CSM Still Ranks as Largest Mining Engineering School

The Colorado School of Mines continues to rank as the nation's largest mining engineering school, according to recent figures released by the U. S. Office of Education.

Mines with an enrollment of 168 students in 1958, is nearly twice the size of the second largest school—Missouri School of Mines, with an enrollment of 98.

The statistics, which compare 1957-58 figures with those of 1958-59, show only three schools with growing enrollments in mining. They are Colorado Mines (which increased from 157 to 168), Pennsylvania State University (which went from 32 to 37), and Lehigh University (up from 17 to 19).

There are 28 mining engineering schools in the nation, and of these 23 are accredited by the Engineers' Council for Professional Development.

Across the nation a decrease of 16.6 per cent took place in mining enrollments in 1958. Some schools which sustained heavy enrollment decreases were Arizona (down from 80 to 60), Minnesota (decreasing from 63 to 43), Missouri Mines (from 137 to 98) and Wisconsin (from 56 to 42).

Mines has shown a steady growth in mining enrollments the past six years, from 106 in the fall of 1953 to 172 this fall.

Despite the drop in enrollments, job opportunity prospects appear to be quite sound. Firms interviewing at Mines have indicated no tightening of employment opportunities.

John C. Thomas Named Laboratory Assistant

John C. Thomas, 29, has been named a laboratory assistant in the Colorado School of Mines petroleum

(Continued on page 36)

OREDIGGER SPORTS

Mines Wins Rifle Match Against Colorado College

The Mines Varsity Rifle Team, firing on the home range, won its first shoulder-to-shoulder rifle match of the season, Dec. 5, against Colorado College with a score of 1355 to 1283. Scores fired were of a possible 1500 points. High man in the three position match was Gerald Fitzgerald of Mines with a 277 of a possible 300. Dyson of Colorado College took second place with a 276.

Other members of the rifle squad representing Mines were: John Rudin with a 272; Michael Dunn, 271; John Chase, 269; Dennis Pollock, 266; Robert Johnson, 261; Don Wakefield, 261; Charles Freese, 257; and Tim Johnson, 238.

This match was the first in a scheduled series in the Colorado-Wyoming Small Bore Rifle Conference which includes Colorado College, Colorado University, Colorado State University, and the University of Wyoming in addition to Mines. Competition in the conference this year is open to all undergraduate Mines students.

In addition to these conference matches this year, Mines will fire in shoulder-to-shoulder competition with the United States Air Force Academy as well as in numerous postal matches with other college and university teams throughout the country.

The ten men selected to represent Mines in each match are the squad members with the highest average as of that date. When the ten selected cannot make a match due to academic or other conflicts — alternates are picked from other squad members.

CSM Wrestlers Outpointed By RMFAC Champion CSC

Final examinations for two weeks in January gave the Colorado School of Mines wrestlers a rest from intercollegiate action. The Orediggers were 18 to 8 victims of perennial RMFAC champion Colorado State College on Jan. 15.

Tom Tisone, at 123 pounds, won his fifth straight match and sixth of the season Jan. 15. His only loss this year has been to Ted Pierce, of Oklahoma State. Pierce was fourth in the 1958 NCAA national tournament at 130 pounds.

Glen Hasse pinned his CSC opponent in 5:58 to take the other Miner victory. Hasse, last year's leading point-maker, now has a four and three season's record. Both 147 pounder Ken Hecht and heavyweight Marv Kay dropped one point decisions to CSC wrestlers in what amounted to the closest dual meet between Mines and CSC since 1956.

Mines Wrestling Statistics—for six dual meets—University of Oklahoma 29, Mines 3; Oklahoma State University 30, Mines 0; Adams State College 6, Mines 22; University of Nebraska 2, CSM 27; University of Omaha 12, Mines 12; University of Wyoming 20, CSM 6.

Collegiate Boxing Begins

A familiar sight in the Mines Fieldhouse Jan. 15—collegiate boxing. The Miners, in their first home meet in four years, dropped a 4 to 2 dual meet decision to a class "B" amateur team representing the Denver Elks Club.

Coach Klugman Optimistic About Oredigger Swimmers

Although he has lost several swimmers since the Christmas holidays, Coach Dr. Mike Klugman of Mines was fairly optimistic about his team's chances at the triple dual meet Jan. 22 between Mines, D. U. and C.S.C.

In action for the Miners will be the season's top pointmakers. They are free stylist Dave Chasis, 19¾ points and two new CSM records; one-legged backstroke artist Bill Henry, 11¾ points and one new School record; and breast stroker George Downs, 6¾ points and one new CSM record.

Mines has defeated the University of New Mexico, 60 to 31, and lost to the Air Force Academy, 63 to 32.

Magazine Honors Tesone and Mines

Vince Tesone and the Colorado School of Mines were honored in the January issue of *Coach and Athlete Magazine*.

Tesone was named player of the year for the Rocky Mountain Region in the 1959 football season. He was named with eight other All-Americans, including Gerhard Schwedes, Syracuse; Mike McGee, Duke; Billy Cannon, LSU; Bill Burrell, Illinois; Jack Spikes, TCU; Mike Magac, Missouri; Jim Walden, Wyoming, and Bob Schloredt, Washington.

The School of Mines was featured in the magazine in a four-page article describing the academics and athletics of the college.

CAMPUS HEADLINES

(Continued from page 35)

refining department. His appointment, effective Jan. 17, was announced by Dr. Truman H. Kuhn, dean of faculty.

A chemical engineering graduate of Texas A & M, Thomas has been an instrument development engineer for the Phillips Petroleum Co. the past six years. He had previously been a chemical engineer for the same oil firm.

A U. S. Air Force veteran, Thomas is a member of the Instrument Society of America and is a registered professional engineer. He presently has four measuring and cleaning inventions pending patents.

Dr. Dumke Elected Chairman Of Colorado Section of ACS

Dr. Walter H. Dumke, chairman of the chemistry department at the Colorado School of Mines, has been elected chairman-elect of the Colorado Section of the American Chemical Society.

Dr. Dumke will serve as program chairman during 1960 and succeeds to the office of general chairman in 1961.

Nearly 600 chemists—representing education government and industry—are members of the state organization. The national ACS has a membership of more than 85,000.

Dr. Dumke, who served as section chairman of the national ACS building fund drive in 1958-1959, holds chemistry degrees from the State University of Iowa, the University of Minnesota, and Mines. Author of numerous chemistry publications, he is listed among *American Men in Science* and *Who's Who in American Education*.

ASCE Student Chapter Chartered on Campus

The Colorado School of Mines Student Chapter of the American Society of Civil Engineers was presented with its charter at a banquet held Dec. 13.

Attending the charter presentation banquet were about 25 student members—including Dave Sapik, student chapter president—Professors Thomas A. Kelly, James G. Johnstone, and Henry A. Babcock (all of the CSM civil engineering department); Mark Davidson, president of the Colorado Section of ASCE, and Leo C. Novak, outgoing president of the Colorado Section of ASCE and professor of civil engineering at the University of Colorado.

The group, newest of the CSM professional societies, was originally founded as the Mines Society of Engineering Geologists.

PLANT NEWS

Humboldt Mining Company Features Grate-Kiln System Developed by Allis-Chalmers

Humboldt Mining Co., owned jointly by Cleveland-Cliffs Iron Co. and the Ford Motor Co., will expand their iron ore mining and concentrating operations near Ishpeming, Mich., by installing two parallel lines of Allis-Chalmers grate-kiln systems.

The combination of enclosed, traveling chain-type grate and short rotary kiln has already been applied commercially for other processes, such as cement manufacture, and is noted for characteristic cleanliness and fuel economy. However, the installation at Ishpeming will be the first full-scale operation of the system to carry out an iron ore agglomeration process. It is the culmination of approximately one year of laboratory and pilot plant work at the manufacturer's Carrollville (Wis.) test facility, which indicated the practicability of the grate-kiln system for heat treatment of hematite flotation concentrates.

Irving A. Duffy, Ford vice-president, recently indicated the vast potential of the project by pointing out that "successful development of Humboldt could lead to the future use of the same operating techniques in developing similar low-grade ore deposits owned by Ford and others in the area."

Production of specular hematite from Humboldt's open pit mine and concentrator is presently 1000 long tons per day (ltpd) of concentrates. This rate will be doubled to meet the needs of each new 1000 ltpd line of grate-kiln equipment. The facility is scheduled to begin producing iron ore pellets around mid-1960.

Beneficiation at the Ishpeming operations employs a flotation technique, since specular hematite is a non-magnetic iron ore and cannot be separated magnetically from impurities.

Following concentration to more than 60 per cent total iron content, the hematite concentrates will be prepared for processing in each of the enclosed grate-kiln systems by being balled in two 9 foot diameter by 30 foot long balling drums. Balls will then pass over specially designed, four-bearing vibrating screens, which will return all undersize balls back to the feeders and permit only properly sized balls (approx. ⅜ to ⅝-in.) to enter the traveling grate section for heat processing.

The traveling chain-type grate will be 9-ft. 4-in. wide on 71-ft. centers, enclosed by refractory and housing for cleanliness and fuel economy. Preheated and partially processed balls will discharge from the traveling grate directly into a relatively short rotary kiln, 10-ft. diameter and 120-ft. in length. Processing of the balls is completed in the kiln and they are cooled in a 25-ft. diameter annular cooler.

Fuel economy of A-C process equipment is a result of efficient reuse of exhaust gases from one stage of the system to support reactions in others. By having the entire system connected and enclosed, hot kiln exit gases are caused to make two separate passes through the continuous bed of incoming balls and transfer the heat required to harden the balls sufficiently for entry into the rotary kiln. At the same time, any dust and fines which may be airborne in the kiln are carried along with the kiln exit gases and efficiently filtered out as the gasses pass through these small balls. Operating efficiency is also aided by using the hot air obtained in cooling the processed pellets as secondary combustion air in the rotary kiln.

Susquehanna Will Build Uranium Processing Plant

Plans for a proposed new uranium ore processing plant to be constructed near Falls City, Texas, at an estimated cost of $2.5 million were announced recently by Allen D. Gray, president of Susquehanna-Western, Inc., a subsidiary of The Susquehanna Corporation of Chicago. (See story about Gray in Alumni News.)

The plant, first uranium mill to be constructed in Texas and 26th in nation, will utilize a complex metallurgical recovery system to treat uranium-bearing ores chemically and produce the uranium concentrate known as "yellow cake" for sale to the U. S. Atomic Energy Commission.

It will be the third uranium plant to be operated by Susquehanna, which, together with its affiliated companies, already operates uranium processing mills at Edgemont, S. Dak., and Riverton, Wyo.

Designed to process between 200 and 250 tons of ore each day on a 24-hour basis, the new mill will expand Susquehanna's annual uranium sales by $2.5 million. The company's current annual sales of uranium products approximate $13 million annually.

Gray reported that Susquehanna-Western has secured mining leases on certain Karnes County deposits in South Texas and is conducting final negotiations with the A.E.C. for a contract covering the sale of concentrates. He estimated that the mill can be built in 10 months, and said he is hopeful that it will go into operation by October of this year.

The company's geological examination in Karnes and Duval Counties in South Texas established the existence of enough ore to justify the mill. The Karnes deposits are shallow and can be mined by open pit methods; the Duval deposits are deep and must be mined by more expensive underground methods.

Susquehanna entered the uranium business in 1956. Its Edgemont plant processes 400 tons of uranium ore per day, and has proved to be one of the world's most efficient uranium mills. The company's Riverton mill, completed in November, 1958, has a 550-ton per day capacity and features two parallel uranium recovery circuits. Susquehanna-Western also is engaged in the manufacture of chemical products, and owns and operates a large sulfuric acid plant in Wyoming.

Expansion of the company's uranium producing facilities is justified, Gray related, by continuing technological progress in the development of atomic power plants. World requirements for higher living standards and for greater electrical power capacities within the next few decades, combined with the U. S. uranium industry's ability to outproduce all competition for the foreseeable future, Gray believes, supports considerable confidence for future uranium sales.

He pointed out that U. S. uranium production is continuing to expand. Domestic producers in fiscal 1959 doubled their output of only two years ago to ship a total of 15,162 tons of uranium oxide, and by the end of 1960, production is scheduled to rise to 20,000 tons.

Dorr Heads New Firm Of Consulting Engineers

A new firm of consulting engineers, Dorr Consultants, has been formed to provide engineering, financial, and management services to the chemical process, textile, and metallurgical industries.

The five founding partners are: John Van Nostrand Dorr, Arthur K.

Doolittle, Donald F. Othmer, W. George Parks, and William E. Rudolph. Headquarters of the new organization are at 99 Park Ave., New York.

Dr. Dorr is a chemist and metallurgist, inventor of Dorr metallurgical and sewage treatment equipment and founder of the Dorr Company.

He is also honorary chairman of the Board, Dorr-Oliver, Inc.

Crucible Steel Co. Installs First Degassing Unit in U.S.

Crucible Steel Co. of America has purchased a Dortmund Horder Huttenunion degassing unit, the first to be installed in the United States, Joel Hunter, Crucible's president announced recently. This purchase includes the complete technical and operational know-how. The equipment, which will be used to improve special purpose steels, will be erected at the Company's Midland (Pa.) Works early in 1960, on a pilot production basis. It is expected that this process will result in attaining new quality levels through effective carbon deoxidation of molten steel.

Operation is based on forcing successive portions of liquid steel into an evacuated vessel by atmospheric pressure. After degassing, each portion of steel leaves the vessel with considerable kinetic energy, producing complete mixing. Towards the end of the treatment, when very little oxygen remains in the steel, alloying additions can be made from bins mounted on the top of the vessel.

The heat losses that would normally result from such an arrangement are eliminated by pre-heating the vessel to the temperature of the liquid steel. Pre-heat is accomplished by means of a graphite resistance rod mounted inside the vessel.

The equipment will be capable of degassing alloy steel heats up to 200 tons at a rate approaching one million tons per year. Many of the electric furnace alloy steels and open hearth grades now being produced by conventional methods can be treated by this process and it is anticipated that new quality levels may be established.

Units of this type have processed more than 80,000 tons of steel to date. Generally, more than half the oxide inclusions are removed, hydrogen flaking is eliminated and nitrogen is significantly reduced.

Steel users report that the improved cleanliness and reduced gas content of the treated steel lead to an increase in product yield, improved hardenability response, improved drawing characteristics, greatly improved machineability and improved mechanical properties, particularly transverse ductility.

Hardinge to Invest $300,000 In Foundry Expansion Program

Harlowe Hardinge, president of Hardinge Co., Inc., has announced that the Hardinge Manufacturing Co. (a Hardinge subsidiary) will spend $300,000 to expand and modernize its foundry facilities, to offer its customers better service on castings and "jobbing" work. The enlarged foundry will embrace approximately 32,000 sq. ft. of floor area, and will include the latest in core ovens, sand mixing apparatus, cranes, and other materials-handling equipment.

The Hardinge foundry at present has two cupolas and is capable of pouring single castings up to 30,000 pounds. It is one of the few foundries in the area which specializes in "pit-molding," and the only "Meehanite" licensed foundry in central Pennsylvania. It also pours "Ni-Hard" wear-resistant castings.

The first unit of the Hardinge Foundry was erected about 1895 by Broomell, Schmidt and Co., Ltd., predecessor of Hardinge Manufacturing Co., to produce sugar-making machinery and industrial heating equipment. The first foundry addition was made about 1915 and the present expansion program climaxes a series of improvements in the 65-year-old foundry. Hardinge has been pouring Ni-Hard castings under licensing arrangement with International Nickel Co. for some years, and in 1951 was licensed by Meehanite Metal Corp., to pour "Meehanite" metal (a semi-steel).

First Petroleum Survey Of Argentina Completed

Fairchild Aerial Surveys, Inc., a wholly-owned subsidiary of Fairchild Camera and Instrument Corp. of Syosset, N. Y., recently completed a combination aerial magnetometer and photographic survey of Argentina for the Union Oil Co. of California.

Working under severe weather conditions, Fairchild completed over 13,000 line miles of aerial magnetic surveys, believed to be the first such survey for petroleum exploration ever performed in Argentina.

In addition, the survey also provided the oil company with accurate planimetric maps of the area surveyed showing roads and other cultural features prepared from the up-to-date aerial photomaps obtained from the survey.

Le Roi Division Operations Consolidated at Sidney, Ohio

The Westinghouse Air Brake Company has announced that its Le Roi Division operations in West Allis, Wisconsin; Greenwich, Ohio, and certain functions of its Cleveland, Ohio, plant will be consolidated into one operating unit which will be established at Sidney, Ohio. The new, consolidated unit will begin operations in the early spring of this year.

"Integration of our manufacturing will result in operating economies and substantial reduction or elimination of certain fixed costs," F. J. Zielsdorf, general manager of the Le Roi Division, explained. "The plant at Sidney is laid out in such a manner as to allow a functional, integrated manufacturing operation and is large enough to permit expansion when warranted."

The consolidation move will result in a change in the functions of Le Roi's Cleveland plant. Fabrication, assembly, and other related work will be transferred to Sidney but West Allis and Greenwich plant machining will be transferred to the Cleveland plant. It is expected to terminate all Greenwich plant activity by late fall of this year.

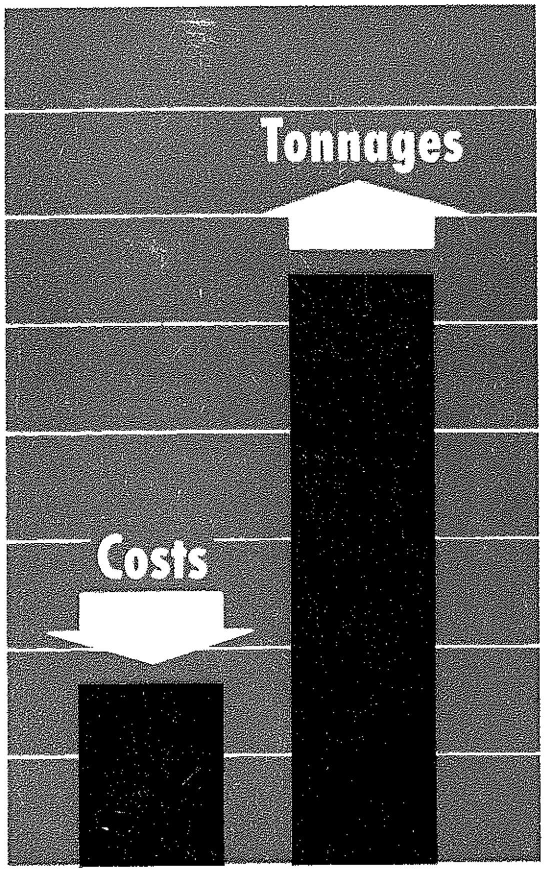
Le Roi products include portable, self-propelled and stationary air compressors, manufactured at West Allis; rock drills and one-use drill bits, produced at Cleveland; and small stationary air compressors, manufactured at Greenwich. Home office of the division has been at Milwaukee.

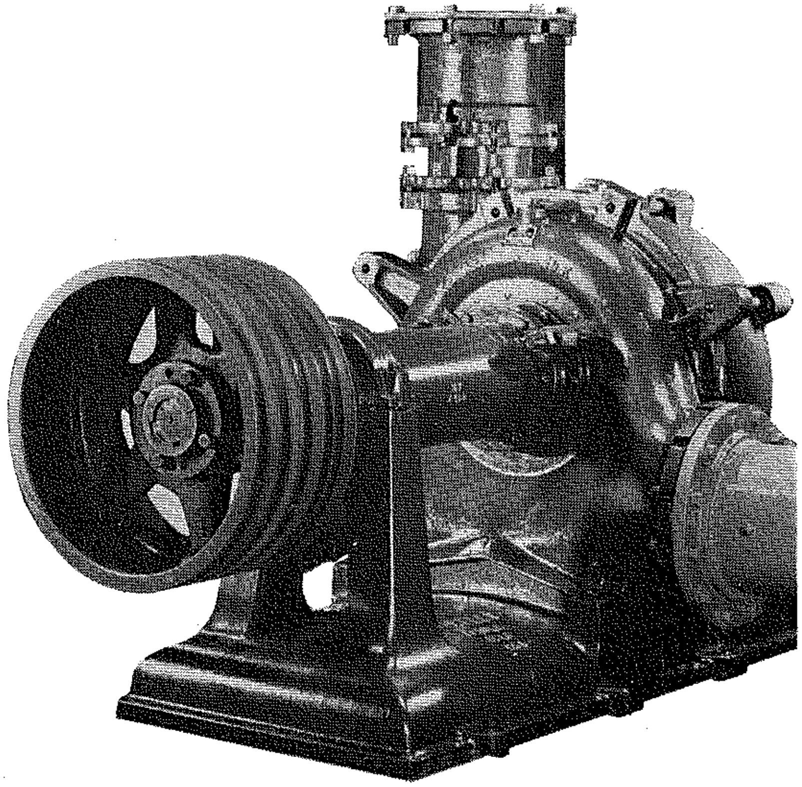
Lake Shore, Inc., Appointed Bucyrus-Erie Distributor

Lake Shore, Inc., Service & Supply Div., Iron Mountain, Mich., has been appointed an excavator-crane, Hydrocrane, bucket and parts distributor by Bucyrus-Erie Co., South Milwaukee, Wis. Lake Shore's territory includes the Upper Peninsula of Michigan and the northern Wisconsin counties of Ashland, Iron, Vilas, Forest, Florence and Marinette.

Lake Shore, Inc., maintains equipment parts and servicing facilities at its Iron Mountain plant.

ADVERTISERS' LISTINGS





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