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The world is never any wider than the mind of man.
Bonanza Project: One Year Later

By Nancy J. Knepper

The Bonanza Project, was conceived to test and develop theproved the CSM proposal to establish a remote sensor testfor the National Aeronautics and Space Administration project at the Bonanza Test Site in south-central Colorado. The NASA-funded grant, which we called the Bonanza Project, was conceived to test and develop the applications of remote sensing to geological analysis and to further education in remote sensing. At present, Professors R. G. Reeves (Principal Investigator) and Keenan Lee (Associate Principal Investigator) are charged with directing the progress of the project and supervising the research, as well as providing logistical support in remote sensing courses.

The area chosen for the Bonanza Test Site is in south-central Colorado (Figure 1). This is a compact region with a limited extent. Recent fault activity is extensive in this area. Older fault systems, in combination with volcanic-tectonic collapse zones, have controlled the geological evolution of the area. The Bonanza area is traversed by the northern terminus of one of the most extensive Recent fault zones in the U.S.—the Rio Grande rift zone—which extends northward from Mexico into Colorado. This and other structures have a direct relation to, if not major control over, the occurrence and movement of ground water in the area. Older fault systems, in combination with volcanic-tectonic collapse zones, have controlled the geological evolution of the area.

In the Bonanza area, the following rocks are present: metamorphic basement terrain of Precambrian age; sedimentary strata consisting of conglomerates, sandstones, shales, and limestones, which together aggregate more than 10,000 feet; shallow intrusive and extrusive volcanic rocks and tuffs; granitic plutons; and thick alluvial basin deposits.

The geology of the Bonanza Area

The well-exposed rocks in the area include: metamorphic basement terrain of Precambrian age; sedimentary strata consisting of conglomerates, sandstones, shales, and limestones, which together aggregate more than 10,000 feet; shallow intrusive and extrusive volcanic rocks and tuffs; granitic plutons; and thick alluvial basin deposits.

The Bonanza area is traversed by the northern terminus of one of the most extensive Recent fault zones in the U.S.—the Rio Grande rift zone—which extends northward from Mexico into Colorado. This and other structures have a direct relation to, if not major control over, the occurrence and movement of ground water in the area. Older fault systems, in combination with volcanic-tectonic collapse zones, have controlled the geological evolution of the area.

Part of the geologic field work during the past year has been concentrated on determining the detailed geology of three specific areas. These three areas chosen for detailed study — the Rio Grande rift zone, the Bonanza mining district, and the Sargent area—are critical to an understanding of Bonanza regional geology, and they are the main areas which will be correlated with remote sensor data obtained from NASA flights 101 and 105, to be discussed later.

Work is currently in progress to compile a comprehensive geologic mapping done in the Bonanza area. The entire area has been mapped to a resolution scale of at least 1:20,000 in detail and 1:32,000 or larger. Detailed mapping has been concentrated in areas of economic importance, such as the Leadville and Bonanza mining districts, and areas where Phanerozoic sedimentary rocks crop out. Only a small portion of the Precambrian terrain has been mapped in detail. Much of the Sangre de Cristo Range has been mapped in detail because of the combination of interesting structure, Pennsylvanian-Pennsylvanian stratigraphic problems, and excellent exposures. The foothills region along the eastern flank of the Wet Mountains and the Wet Mountains, including the Canon City region, has also been mapped in detail.

ACQUISITION OF REMOTE SENSOR DATA

Problems have arisen in getting sensor data from the works, in particular in obtaining data from the various remote sensor systems. Some of the problems of the past year have been concentrated on determining the detailed geology of three specific areas. These three areas chosen for detailed study — the Rio Grande rift zone, the Bonanza mining district, and the Sargent area—are critical to an understanding of Bonanza regional geology, and they are the main areas which will be correlated with remote sensor data obtained from NASA flights 101 and 105, to be discussed later.

Work is currently in progress to compile a comprehensive geologic mapping along the Rio Grande rift zone. The entire area has been mapped to a resolution scale of at least 1:20,000 in detail and 1:32,000 or larger. Detailed mapping has been concentrated in areas of economic importance, such as the Leadville and Bonanza mining districts, and areas where Phanerozoic sedimentary rocks crop out. Only a small portion of the Precambrian terrain has been mapped in detail. Much of the Sangre de Cristo Range has been mapped in detail because of the combination of interesting structure, Pennsylvanian-Pennsylvanian stratigraphic problems, and excellent exposures. The foothills region along the eastern flank of the Wet Mountains and the Wet Mountains, including the Canon City region, has also been mapped in detail.

Preliminary Data Analysis

The resolution of Venus Fly-by radar system is very coarse and generalizes the terrain to such an extent that most features of the area are virtually indistinguishable. The most consistent data available from the imagery are generally curved or straight linear features, or those features which occupy a definite area, such as small groups of trees or areas of barren vegetation covering a forested region. Major drainage lines in mountainous areas are generally detectable.

Although greatly generalized, major topographic features (major ridges, peaks, and valleys) can be readily detected on the imagery. More subtle features of topography such as secondary stream banks, small ridges and small scarps (less than 15 feet high) are not easily found; however, the selection of vegetation does allow some subtle features to be located.

Many prominent mountain drainages are just on the imagery where they debouch into the adjacent lowlands. Venus Fly-by radar imagery cannot be used to map topographic features, or changes in lithology. The excellent resolution of the system allows the interpreter to distinguish objects as small as single trees and small dirt roads. Topographic patterns are especially emphasized by vigorous vegetation along water courses and the low reflectivity of water in the infrared region, which appears dark on the photos. Cultivated fields are readily distinguishable from pasture or forests by pattern and color.

Geologic structures in the San Luis Valley show well on both the color and color infrared photography. Faults in Pleistocene and/or Holocene valley fill of the San Luis Valley were detected and mapped where previously none had been delineated, either on USGS air photos or by field mapping.

Color infrared photography of the San Luis Valley west of the Sangre de Cristo Mountains shows gently curving features which are the surface expression of faults believed related to the formation of the San Luis Valley. The pattern of these features is not evident in the field, and only became apparent when viewed from above. The color infrared photography aids in locating and identifying the faults, owing to the enhanced contrast afforded by this color infrared system. The scale and resolution of the Mission 106 photography (b) on right, closely shows an anticlinal structure truncated by a northwest-trending fault.

Figure 1. Index map of Bonanza Area in South-Central Colorado.

Figure 2. An example of Remote Sensing (infrared imagery) compared with aerial photography. This illustrates how data from different wavelength regions of the electromagnetic spectrum yield new geological information. The conventional photography (a) shown at left, shows little of geologic interest, while the infrared imagery (b) on right, closely shows an anticlinal structure.
MICROPALEONTOLOGISTS and stratigraphers are overwhelmed by the vast accumulation of literature dealing with taxonomy and occurrence of Foraminifera. At present it is estimated that approximately 30,000 species of Foraminifera have been recognized and described in the literature, and that the present publication rate is about one thousand articles per year. Consequently, it is difficult for workers to keep abreast of the literature. Furthermore, workers must have a consistent taxonomic and nomenclatural framework to enable them to make valid observations and communicate their findings.

As micropalentologists become more sophisticated, not only is information added, but criteria for recognition and delineation of species are changed. Each worker must painstakingly sift the literature to be certain he has accurately traced the history of a species name and considered all possible synonyms. Then, a search must be made to determine geologic and geographic occurrence of species and all supposed synonyms. In summary, micropalentologists and stratigraphers are faced with the problems of voluminous and expanding accumulations of information coupled with changing concepts, nomenclature, terminologies and objectives. These problems led to the formation of the Western Interior Foraminifera Data Project.

Work was begun in July, 1966, and should soon be available for public use. This project was initially financed by the Colorado School of Mines Foundation, Inc. and was later funded by National Science Foundation Project GP-785. Dr. Harry C. Kent is the principal investigator. Foraminifera data was collected from the systematic paleontology sections of papers pertaining to Cretaceous strata within the States of Alaska, Arizona, Colorado, Idaho, Kansas, Minnesota, Montana, Nebraska, New Mexico, North Dakota, Oklahoma, South Dakota, Texas, Utah, and Wyoming, as well as the Canadian provinces of Alberta, British Columbia, Manitoba, and Saskatchewan.

The data abstracted from the available papers include:

1. A general bibliography file of 794 references noted in the western interior sphere, and a sub-file of 175 western interior articles of which 132 contained a systematic paleontology section; this file includes papers published up to 1968.
2. Primary species information as noted by the individual author. This includes plates, figures, page numbers, type specimen and repository.
3. Synonyms of the species as noted in each article, as well as the corresponding reference.
4. The stratigraphic and geographic locations as noted in each article. There are over 30,000 items in this file alone.

The collected information is filed on magnetic tape for computer storage and retrieval. From the stored information it is possible to obtain details related to geographic location, the previous work done in the area, species described, locations, and stratigraphic range. Computer programs can be written to obtain the desired information.

The information bank is intended to serve as a basic for more extensive systems of paleontologic information storage and retrieval. It is to be hoped that extensive information systems will serve the paleontologist and geologist in study and research within the near future. The job of abstracting data will be tremendous, but the advantages will be even greater.

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Bell's River, Florida. Vertical tubes in lower part of section represent fossilized burrows of the decapod crustacean Callionassa Say.

The interpretation of environment of deposition and distribution forms an important base for the interpretation of ancient sediments. A detailed study of modern conditions will provide a firmer foundation for the interpretation of ancient sediments. Students participating in the program provide their own living expenses.

PREPARATION of lateral pool of sedimentary structures on foreshore of beach at Galveston Island, Texas. Student: Cooper Land.

STUDENTS James Cronobie and Harnicka Taramgro take a box core in the backshore area of the beach at Galveston Island, Texas.
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MAY, 1970 - THE MINES MAGAZINE

Geology Summer Field Course

By Rudy C. Epis

SINCE 1900, the geology summer field course has involved a mobile program throughout central and western Colorado. Prior to that time, semi-permanent facilities were used during the entire six weeks of the course, and relatively short trips away from the central location provided some degree of variety in geologic settings and problems. Best known among these facilities is the camp at Wildhorse, south of Pueblo, where many hundreds of CSM alumni received their first professional training in field geology.

Because of the significant advances in highways and highway vehicles, a mobile camp is more feasible now than in earlier decades. It seems only logical, therefore, that the department would eventually take advantage of the spectacular examples of fundamental geological field relations so wonderfully exposed throughout the Colorado portion of the Southern Rocky Mountains.

The philosophy behind the field course is to provide students with training, experience, and competence in a variety of geological situations. This philosophy is actually the basis for establishing the mobile aspect of the course; specific areas have been selected to illustrate principles, processes and problems relating to stratigraphy and sedimentation, structural and tectonic geology, plutonic igneous and metamorphic geology, volcanology, geomorphology, and the application of the above to the fields of petroleum, mining and engineering geology. Field trips between areas and lectures in camp emphasize the regional relations of local areas in an effort to bring together a comprehensive understanding and appreciation for the geologic history of a large portion of the Rocky Mountains.

During the past decade, the staff has researched numerous localities and has used them on various occasions for one-week problems. Examples include the eastern Uinta Mountains, Colorado National Monument (Utah), Oversey-Silverton district, north-eastern San Juan volcanic field, Bozeman district, Cripple Creek district, South Park, Canyon City emplacement, Sangre de Cristo Mountains, Moab (Professor of Geology, Colorado School of Mines).
A NEW technology will be important to the future petroleum industry by improving methods of exploration, transportation, and refining efficiency and therefore results in reserves additions and reducing costs of finding and exploiting petroleum resources. Technological improvements have been made throughout the history of the petroleum industry and undoubtedly will continue to be made—these have increased production and exploration using surface waters and stream sediment samples in Uncompahgre River drainage basin.

Several recent studies by the National Petroleum Council and the U.S. Department of Interior's Office of Oil and Gas have reviewed various aspects of new technology in oil and gas exploration, drilling and recovery, productive capacity, transportation, and refining efficiency. Important aspects of technological advances that affect the petroleum industry are summarized below.

EXPLOITATION

No major breakthrough in improvement of exploration methods has been made in recent years and none is anticipated; gradual improvements are being made constantly. Improved geophysical methods have made possible the location of a few salt water traps, but there has been little improvement in the ability to find stratigraphic traps in sandstones by the use of geophysics. A trend toward deeper drilling has developed in recent years and will continue.

Knowledge of depositional environments and geochronology of modern sediments has increased markedly and this knowledge has been used in interpreting ancient environments and in evaluating oil and gas potential. With subsurface information, it is possible to reconstruct geographic features as they existed in the geologic past. There is continuing improvement in these techniques and they offer for the most promising methods for future exploration. An increase in drilling activity will increase the rate at which subsurface geologic techniques may be applied. Methods of computer processing, analysis and simulation are increasing the efficiency of data usage.

Increased study of pressure, temperature, and fluid movements in reservoir rocks also should lead to a modest increase in exploration efficiency. New tools and well logging methods, and improvements in present methods, should increase the ability to interpret subsurface conditions.

Development of a direct above-ground oil-finding technique does not seem to be a reasonable expectation. Most exploration is the result of the controlled imagination of the geologist or geophysicist—his education and training and working conditions are as important as new developments in exploration technology. In the future exploration. An increase in drilling and recovery, productive capacity, transportation, and refining efficiency is possible.

DRILLING AND RECOVERY

A major part of exploration and development expenses is allocated to drilling and completing wells. Changes in drilling—rig design and drilling methods have reduced time and cost of drilling some holes. Costs of drilling deep wells have been reduced in many areas, but costs of intermediate-depth wells have remained relatively constant.

Reductions in expense have been attained through drilling smaller-diameter holes, water injection and development wells, and completions in multi-phase producing zones. Additional cost reductions will continue to be made, but these will be offset by increased labor and materials costs. A new drilling method that would revolutionize exploration and development is a recurrent dream, but it will not be based on a new technology. Much basic and applied research has been devoted to the problem of recovering as much oil as possible from the reservoir rock after a field has been discovered. Of the estimated 14 billion barrels of oil discovered in the United States, one estimated four billion barrels (29 percent), including enhanced recovery, is recoverable under existing economic conditions and by present recovery techniques. These are probably conservative estimates, as additional billion barrels may be economically recoverable by fluid injection. An estimated additional two to three billion barrels may be physically recoverable by fluid injection and by other means if costs could be reduced sufficiently. Most injection projects use water and/or gas, but much progress is being made in the use of solvents (miscible-agent technique), which promises to be an important step in the development of new techniques.

If these experiments are successful, it is estimated that an additional 200 billion barrels of oil may be recoverable from new fields or from existing fields having additional oil in place. The recovery of additional oil and gas from oil shale deposits by methods of surface mining and in-situ techniques may be important to the future of the petroleum industry.

U.S.G.S. Geologic References

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*Professor of Geology, Colorado School of Mines.

**Benefits of new technology have been increased in interpretation of ancient environments and in evaluating oil and gas potential. With subsurface information, it is possible to reconstruct geographic features as they existed in the geologic past. There is continuing improvement in these techniques and they offer for the most promising methods for future exploration. An increase in drilling activity will increase the rate at which subsurface geologic techniques may be applied. Methods of computer processing, analysis and simulation are increasing the efficiency of data usage.

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MEASUREMENTS OF SOIL AND ROCK BEHAVIOR
Donald R. Stewart ’61 — W. H. Thornley, Jr.

Impact of New Technology On the Petroleum Industry
By John D. Haun°

The geology summer field course for the coming season (June 7—July 28) is typical of those of the past 15 years. It is outlined below.

First Week: Field trip—Gold Hill in Colorado National Monument near Grand Junction; five days field work in the Monument including section measurement, analysis of primary sedimentary structures, mapping of folded and faulted sedimentary formations on aerial photographs and topographic maps; field trip—Colorado National Monument to Gunnison, including important stops at the Black Canyon of the Gunnison River and dam sites of the Morrow Point and Blue Mesa dams of the Grandstaff Project, with personal visit to the Bureau of Reclamation.

Second Week: Cochetopa Creek area southeast of Gunnison; five days mapping on aerial photographs and topographic maps of Peralumin granitic pluton and associated meta- gneiss and metagabbro intruded into metamorphic and metasedimentary rocks of the Uneom- tasedimentary rocks. Field trip—San Juan Mountains; short report. Field trip—Silverton to Durango; five days plan view mapping on narrow gauge railroad along Animas Creek; short report.

Third Week: Jacks Creek area west of Crested Butte; five days mapping on foliated metasedimentary rocks; emphasis on structural petrology and diorite and metagabbro intruded into granitic pluton and associated meta-
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**CASE OF POSTAL**

**15**
Some extracted text not provided.
Depression and lacustrine deposition prevailed. Consequently the characteristic lithologies of the Green River Formation are well laminated, lacustrine mudstone, shale, marlstone, and dolomite. The Green River Formation can be subdivided on the basis of condition content and presence or absence of substantial quantities of kerogen into threeappable members (from oldest to youngest): Douglas Creek, Anvil Points, Garden Gulch, Parachute Creek, and Evacuation Creek (Donnell, 1961). See Figure 3.

The Douglas Creek and Anvil Points Members are dominated by brown to buff, cross-bedded, rippled sandstone, algal and oolitic limestone, and gray shale, which is barren of kerogen. These beds accumulated at or near the shore of the newly formed lake in the high-energy environments of the delta, shoreline, and alluvial plain. The Douglas Creek and Anvil Points Members show that the greater thickness of organic lacustrine mud was accumulating near the shore than in the center of the lake during the same time. The Parachute Creek Member contains the gibbsite, dawsonite, nahcolite, halite and the thickest and richest kerogen-bearing beds in the Green River Formation. The Member is composed almost entirely of dolomite and marlstones, most of which yield oil when distilled. The thickness and oil yield grade of the kerogen-rich dolomite increases greatly toward the center of the basin from all sides, as shown on Figures 4, 4, and 5 (Shattuck, 1905, p. 39). The coincidence of the present structural low of the basin and the thickest area of rich “oil shale” shows that chemical stratification of the lake must have controlled the preservation of the organic material on the lake bottom. Thus, the relatively clear and fresh surface water supported a prolific flora, while the bottom conditions beyond a critical depth were reducing and saline, favorable for the preservation of the organic debris. Figures 3 and 4 show that the basal 400 feet of kerogen-bearing dolomite accumulated in the center of the basin while kerogen-rich marlstones were deposited nearer the edges of the lake. The gibbsite, dawsonite, nahcolite and halites are concentrated in this same interval.

The Member. The principal difference between the Garden Gulch Member and the overlying Parachute Creek Member is the relative lack of kerogen and carbonate in the Garden Gulch. Locally in the center of the basin, the Garden Gulch Member contains significant concentrations of kerogen. Figures 3 and 4 display the facies relationships of the Garden Gulch with the overlying Parachute Creek and underlying Anvil Points and Douglas Creek. The shoreward divergence of the bedding planes and time lines within the Garden Gulch Member shows that a greater thickness of algalic lacustrine mud was accumulating near the shore than in the center of the lake during the same time.

The Parachute Creek Member contains the gibbsite, dawsonite, nahcolite, halite, and the thickest and richest kerogen-bearing beds in the Green River Formation. The Member is composed almost entirely of dolomite and marlstones, most of which yield oil when distilled. The thickness and oil yield grade of the kerogen-rich dolomite increases greatly toward the center of the basin from all sides, as shown on Figures 4, 4, and 5 (Shattuck, 1905, p. 39). The coincidence of the present structural low of the basin and the thickest area of rich “oil shale” shows that chemical stratification of the lake must have controlled the preservation of the organic material on the lake bottom. Thus, the relatively clear and fresh surface water supported a prolific flora, while the bottom conditions beyond a critical depth were reducing and saline, favorable for the preservation of the organic debris. Figures 3 and 4 show that the basal 400 feet of kerogen-bearing dolomite accumulated in the center of the basin while kerogen-rich marlstones were deposited nearer the edges of the lake. The gibbsite, dawsonite, nahcolite and halite are concentrated in this same interval.

The gibbsite and dawsonite are concentrated in a stratigraphic interval between 400 and 1400 feet below the A-groove marker bed. Figures 3 and 4 show that the greater concentration of organic debris was probably a factor contributing to the formation of the gibbsite, dawsonite, and nahcolite. The conditions which allowed the preservation of the organic debris became more widespread with the passage of time, permitting the accumulation of the basinwide kerogen-rich NaHCO₃ zone (“a Mahogany Ledge”) near the top of the Parachute Creek Member.

The A-groove marker bed is a widespread, thick, relatively kerogen-rich tuffaceous dolomite bed which can be used effectively as an electric-log marker for correlation purposes.

Hence, the stratigraphic sections (Figures 4 and 9) are hung on this marker. The upper 1000 feet of the Parachute Creek Member contains dawsonite, gibbsite, and nahcolite in significant quantities, although it is much more irreguarly distributed than in the lower portion.

The Evacuation Creek Member is composed of buff to brown, lutitic sandstones, siltstones, kerogen-rich marlstones, and shales, which accumulated in the waning stages of the lacustrine deposition. Thus, the Member included interbedded facies resulting from varying depositional environments: lacustrine (laminated marlstones and shales), shoreline, deltaic, and alluvial (sandstones, siltstones, and nonlaminated shales). The gradual restriction of the lake caused the contact between the Parachute Creek and the overlying Evacuation Creek Members to be gradational and a facies relationship. Hence, kerogen-bearing marlstone deposition persisted in the much-restricted lake in the basin center long after non-lacustrine conditions overtook the rest of the basin.

Dawsonite and Gibbsite—The distribution of significant concentration of quantities of kerogen-rich dolomite to accumulate in the waning stages of the lacustrine deposition. Thus, the Member included interbedded facies resulting from varying depositional environments: lacustrine (laminated marlstones and shales), shoreline, deltaic, and alluvial (sandstones, siltstones, and nonlaminated shales). The gradual restriction of the lake caused the contact between the Parachute Creek and the overlying Evacuation Creek Members to be gradational and a facies relationship. Hence, kerogen-bearing marlstone deposition persisted in the much-restricted lake in the basin center long after non-lacustrine conditions overtook the rest of the basin.

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of dawsonite and gibbsite is summarized on Figures 3, 4, 5, and 6. A 200-foot-thick continuous interval averaging greater than 1.5 per cent aluminum (and an average of 20-35 gal/ton) extends over approximately 200 square miles, being confined essentially to a northwest-southeast-trending area which conforms roughly to the present basin axis. A significant thickness of the 1.5 per cent aluminum zone extends to the outcrop in the northeastern corner of the basin.

In the Green River Formation is difficult to recognize macroscopically because the crystals are so small. The original discovery of the dawsonite in the Green River Formation by Milton and Eugster (1959, p. 170) and the later more detailed observations performed by Smith (1960, p. 811), and Smith and Milton (1966, p. 1014-1015), were made with X-ray diffraction techniques. Smith and Milton have also used indices of refraction measurements in their dawsonite determinations.

In the quest for rapid, inexpensive, quantitative analytical tools for dawsonite, various chemical techniques were tried. It was found that by maintaining careful control of pH and leaching time, a 30 per cent hydrochloric acid solution would dissolve dawsonite and gibbsite and would not appreciably attack the aluminum silicate, i.e., various zeolites, clay minerals, and other forms of aluminum in a sample was then determined by quantitative methods. This inexpensive quantita-

Figure 6. Total Thickness of Intervals Averaging 3.5 per cent aluminum (Dawsonite & Gibbsite), Green River Basin, Colorado.

Figure 7. Typical Differential Thermal Analysis Curve for Dawsonite and Gibbsite. (Note: endothermic peak at 100°C indicates gibbsite, and another at 540-580°C, (4) is not detectable by X-ray diffraction, and (2) as a result of the alteration of feldspar and clay minerals to dawsonite, gibbsite, and sodium-montmorillonite.

Econometrics—The continuous interval averaging greater than 1.5 and 2.8 per cent aluminum have a minimum gross value in the ground of almost 11 and 22 per cent of extractable aluminum, respectively, using a value of $1 per pound of aluminum.

The gross value, in place, of the kerogen contained in this same zone (averaging 25 gallons of oil per ton) is approximately $1.75 per ton. The ultimate value of this rock could be controlled more by its value as aluminum ore than by its value as a source of oil. Every square mile of (the 200 square miles) that has a 100-foot-thick continuous interval averaging 1.5 per cent aluminum contains between 1/4 and 1 billion tons of potential ore. Final economic evaluation of the net value of this material clearly depends upon extraction and refining costs.

The dawsonite and gibbsite of the Green River Formation of the Florissant Basin represent a tremendous domestic resource as an aluminum-bearing mineral. The United States presently imports over 10 million tons of bauxite (66 per cent of its needs). This bauxite and dawsonite resource is more than adequate, if developed and when developed, make the United States more self-sufficient in aluminum.
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“We are explorers. We’re in 18 countries. Miners, researchers, market holders—we bring opportunity to underdeveloped lands, new technologies, new payrolls, new tax income. Nickel in the ground is useless. We put it to work.

INTERNATIONAL NICKEL
Ed Crabtree Retires as Director of CSM Research Institutes, Succeeded by Dr. Herman Ponder

E. H. CRABTREE, director of the Colorado School of Mines Research Institute at Golden since 1955, retired April 1 and was succeeded by Dr. Herman Ponder, former director of the Institute’s Mining Division.

The Colorado School of Mines Research Institute is a not-for-profit organization serving the scientific research needs of the mineral industries throughout the world in the metallurgical, chemical, mining, ceramic, and nuclear fields. The Joint announcement was made by Dr. Orlo E. Childs, president of the Research Institute’s Board of Trustees and president of the Colorado School of Mines.

"The Trustees of the Research Institute value Mr. Crabtree for his 48 years of service to the mineral resource industries and for his 15 years as inspiring leadership of the Institute," Dr. Childs said. "At the same time, we are pleased to announce the promotion of Dr. Ponder from within the staff of the Institute." Dr. Childs added that Mr. Crabtree has been elected to the Board of Trustees and president of the Colorado School of Mines.

Mr. Crabtree, 65, has been with the University of Missouri since 1949, serving as assistant professor of geology in 1949, associate professor in 1951, and professor in 1955. In 1959, he was named "Who’s Who in America." In 1964, he joined the University of Colorado School of Mines as professor of geology and mineralogy, and served as director of the Colorado School of Mines Research Institute until his retirement on April 1, 1970. Since his retirement, Mr. Crabtree has been an active member of the Institute’s Advisory Board and has continued to serve as a consultant to the Institute.

Mr. Crabtree was a key figure in the development and expansion of the Institute, which was founded in 1955.

Dr. Ponder is a 1955 graduate of the University of Missouri and gained his doctorate in geology at Missouri in 1969. He is a member of the American Institute of Mining, Metallurgical, and Petroleum Engineers (AIME), and is a Registered Professional Engineer in the State of Colorado.

Mr. Crabtree will continue to assist the CSM Research Institute in the development of the Table Mountain Research Center on a 70-acre site at 999 West 16th Street in Denver, Colorado.

With the Manufacturers

**Cone Crusher Rebuilder (531)**

A new automatic welding system for hard-facing and reboloming cone crusher mantles and liners has been developed by Handick Manufacturing Co., 605 S. Market Ave., Alhambra, Calif. 91801. The unit, named Radionic 60, features automatic advance of the arc up the face of the mantle or liner. It has a 0-60 rpm, 3.2 million capacity, 200 pounds, and rotated beneath a stationary welding gun. Circle 531 on Reader Service Card.

**Measuring Device (532)**

A new portable measuring device that will provide a measurement of coal dust levels is now being field tested by Research Appliance Co., Allison Park, Pa. The unit, developed by scientists at the Pennsylvania State University, provides continuous, instantaneous readout so that dangerous levels of coal dust can be determined immediately. Present methods of measuring coal dust take between 12 and 36 hours. By that time, two or three shifts of miners have been subjected to the dust and to dangers of explosion. Circle 531 on Reader Service Card.

**Bon Core Grinder (529)**

A new portable and lightweight Bon Core Grinder, which grinds core to 80 percent minus 100 mesh for chemical or mineralogical analysis, is now available. The grinder, developed by General Scientific Equipment Co., Limekiln Pike and Williams Ave., Philadelphia, Pa., 19150. Terminates minus 100 mesh for chemical or mineralogical analysis. Circle 532 on Reader Service Card.

**Drum and Barrel Cart (527)**

A new tractor-loader is now being offered by General Scientific Equipment Co., Limekiln Pike and Williams Ave., Philadelphia, Pa., 19150. Terminates minus 100 mesh for chemical or mineralogical analysis. Circle 532 on Reader Service Card.

**Fork-Lift (525)**

A fork-lift attachment for their 5000 tractor/loader is now being offered by Walden, Inc., Fairview, Okla. 73737. The lift attaches to the house after easy removal of the bucket. Three pins fasten the lift which features 46-inch forks and a 1.500-pound lift capacity. Excellent for industrial uses, the Walden 5000 tractor loader features hydrostatic drive making shifting of gears unnecessary. This is particularly advantageous for maneuvering in close quarters. Circle 532 on Reader Service Card.

**Hydraulic Transmission (526)**

Output speeds are infinitely variable from 0 to 1200 RPM. This heavy-duty transmission can be driven with any 2 to 10 HP motor or engine. Designed for continuous duty, rugged industrial use, delivers smooth, constant speed with instantaneous speed selection that is easy and precise . . . and just as simple with remote control. Among its many features are neutral off position; high efficiency; extremely compact design; ball and roller bearings throughout. (Roberts Electrol Co., 415 W. Grand Ave., Chicago, Ill. 60622). Circle 532 on Reader Service Card.

**With the Manufacturers**

Drum and Barrel Cart Cab (528)

Sound-suppressing cab (up to 12:1) and high-capacity (up to 1000 GPM per hour) in a single-pass operation. Because of design simplicity the cost is low. Test results indicate the DENVER "ConTeroL" Crusher is equal to or superior to comparable jaw crushers, cone crushers and coffee-mill crushers in price, reduction ratio, capacity and ease of cleaning. Due to the high ratio of reduction, it is often possible to eliminate the necessity of crushing rolls in sample preparation. The flames of the crushed product is easily controlled by throat opening adjustment. Circle 532 on Reader Service Card.

Read More Information

Use MINES Magazine's convenient READER SERVICE CARD, circling numbers that correspond to items interested in, drop card in mail. No stamp necessary!
Atlantic Richfield Modernizes Its Refinery in Houston

Atlantic Richfield has completed a $25,000,000 modernization of its crude oil distillation facility in Cody, Wyo. The modernization includes the addition of a delayed coking unit and four other new units. The Texas Company, owners of the project, is a major factor in the progress of the company's efforts to improve the efficiency and reliability of its air pollution control equipment, particularly when the conversion of high sulphur crude oil is involved. Atlantic Richfield has also reported that lower heat, lower sulphur and petroleum by-products.

Companies Form Joint Venture To Develop Mineral Deposits

Bethlehem Steel Corp., Mine Finders, Inc., and Coosbaugh Mining Corp. have formed a joint venture to explore and develop a broad spectrum of mineral deposits and recoverable metals. Bethlehem's Edward P. Leach, vice president, mining, identified his company as the major partner in the new joint venture. The agreement, he said, provides for a long-term program involving the exploration and development of economic mineral deposits in Western Canada and Alaska.

Mine Finders is a newly formed Colorado corporate staffed with highly skilled geologists and supporting exploration personnel. Dr. E. Stewart R. Wallace, its president, is a leading geologist experienced geologist and supporting exploration personnel. Dr. E. Stewart R. Wallace, its president, is a leading geologist experienced.

To Develop Plant Near Kingman, Ariz.

Coosbaugh Mining Corp., president, mining, identified his company to obtain an immediate commitment for long-term financing but to assume its costs in annual stages, as equipment is actually in use.

A. W. Grier Named Manager Of Geodata International

Ben F. Rumfield, president of Geodata Corp. of Denver, Colo., has been named manager of Geodata International. The company to obtain an immediate commitment for long-term financing but to assume its costs in annual stages, as equipment is actually in use.

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MEETING — BOARD OF DIRECTORS
Colorado School of Mines Alumni Foundation
March 19, 1970

MEETING was called to order by President Hal Addington at 7:30 p.m. Those present were: Hal Addington, president; David Squibb, director; Dick Vincent, director; Donald Craig, director; Rob Maggio, treasurer; Neal Harr, secretary; Bill Burger, alumni staff; Jay Mayhew, chairman, Legislative Committee.

The minutes of the two previous meetings were read and approved.

The financial statement of February, 1970, was presented by Bill Burger, discussed, and approved.

OLD BUSINESS
1. Jay Mayhew has been appointed Chairman of the Legislative Committee.
2. The next meeting of the Board of Directors will be held Thursday, April 16, 1970.

NEW BUSINESS
1. A student loan of $500 was requested by Paul Brown. A motion to grant the loan was moved, seconded, and unanimously approved.
2. R. B. (Bob) Dunning, Oklahoma City, has applied for associate membership in the CSM Alumni Association. A motion in approval was made, seconded, and unanimously passed.
3. Mr. Nick Swenson was recommended by Russell Volk for honorary membership in the CSM Alumni Association. A motion to approve this recommendation was made, seconded, and unanimously passed.
4. The next meeting of the Board of Directors will be held Thursday, April 16, 1970.

MEETING was adjourned at 8:45 p.m.

Executive Secretary

For the past month Colonel Fortig has been recuperating from a heart operation. He expects to be back on the job soon.

Be sure to send in your reservations for the Annual Alumni Banquet to be held May 20 at the Denver Athletic Club!

Edward J. Johnson, '49
Petroleum Geology
Room 300
3835 N.W. 58th Street

Edward P. Jucovic, '60
Consulting Mining and Metallurgical Engineer
Mining Investment Evaluation
Mineral Exploration—Mill Design
F. O. Box 6977, University Station
Boise, Idaho 83707
720-322-7765

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EXECUTIVE SECRETARY

THE COLORADO SCHOOL OF MINES ALUMNI PLACEMENT SERVICE functions as a clearing house for alumni and former students who wish to receive current information about employment opportunities for which they may qualify. It also serves the oil, gas, construction and related industries and many government agencies by maintaining current listings of openings they have for qualified engineers, technical and management personnel.

Companies needing qualified men with degrees in Geological Engineering, Geophysical Engineering, Metallurgical Engineering, Mining Engineering, Petroleum Refining Engineering, Engineering Physics, Engineering Mathematics, and Chemistry are invited to list their openings with the CSM Alumni Placement Service, Guggenheim Hall, Golden, Colorado.

Listed below are coded references to the graduates of the Colorado School of Mines who were available for employment at the time this issue of The MINES MAGAZINE went to press.

Client's Code Number Degree Age Race Sex Marital Status Height, Weigt, Hair Color Preferred Fields of Work Location Preferred Languages Spoken

MEET YOUR PLACEMENT SERVICE ADVISER

Edward J. Johnson, '49
Petroleum Geology
Room 300
3835 N.W. 58th Street

THE MINES MAGAZINE • MAY, 1970
Class Notes

Robert N. Haskell, P.E., M.P. 1930, retired on Feb. 1, 1970, after many years with Pan-American. The Holders have moved to Longmont, Colo. 80501, where they have an office and plan to do more consulting. Bob says, "I am returning to Colorado early and this will satisfy a long-standing desire on both of us. I am also looking forward to the recreational aspects of Idaho." 

John P. Dempsey, M.P., M.E., 1940, wrote: "I would have been in Colombia until the end of May. Thereafter, I am moving to Yugoslavia as construction superintendent and expect to be there two years. Please continue to send my Mines Magazine through our San Francisco office."

Lee L. (Luke) Fournier, Geol. Ed., 1950, formerly area geologist with Sinclair International Oil Co. in Peru, is now associated with Roy H. Huffman, Inc., as an geologist in southeast Burma. Until Luke gets new address, he will receive his mail at P.O. Box 268, Mineola, N.Y. 11504.

E. L. Colthurst, P.E., R. 2, 1952, wrote to say that he is associated with Joe W. Hunter, chief surveyor, Oil Tool Div., P.O. Box 2539, Houston, Tex. 77002.

Bruce M. Miller, M.P., M.Eng., 1936, of Calgary, Alberta, Canada, has formed a new exploration company and known as Heritage Resources Corp. He has become the oil industry as a petroleum engineer and in 1955 joined the oil and gas department of a Canadian bank. His offices are located at Suite 284, Pacific Plaza, 700 W. Third Street, Calgary, Alberta, Canada.

Osoud S. Sara, P.E., M.P., 1959, who was recently on a business trip to the U.S. came to Davis, Idaho, and toured Idaho, Oregon and Washington with some other friends in the community. He is in the engineering firm of "C. K. & M." Consulting Engineering Firm in Ankara, Turkey. Any minors who happen to be interested, please give him a call. He will be happy to take you for some days in Ankara and the vicinity. His address and telephone numbers are given to his office at K& M Consulting Engineering Firm, Ankara, Turkey. Telephone: 18500 or 18501.

Sincerely yours,
SIDNEY W. FRENCH
Sidney W. French, Met. Ed., 1939

Robert D. Carmus, E.M., 1934, has recently completed his tour of duty in the Corps of Engineers. He has accepted a position with the Alaska Railroad in Anchorage, Alaska and will be moving to our 66th home this spring. Until his new address to give us, any correspondence may be addressed to him in care of his parents at 1059 Minnesota Ave., Anchorage, Ala. 99502.
Blakeslee Manages Halliburton Operations in West Germany

F. M. BLAKESLEE, P.E. 1925, who was formerly assistant manager of Halliburton operations in Germany, Holland and Denmark, is now head-quartered in West Germany.

Van L. Clay Commissioned Lieutenant in U. S. Air Force

VAN L. CLAY, M.F., 1949, son of Mr. and Mrs. August B. Clay, Snyder, Colo., has been commissioned a second lieutenant in the U. S. Air Force upon graduation from Officer Training School (OTS) at Lackland AFB, Tex. Lieutenant Clay, selected for OTS through competitive examination, is being assigned to Webb AFB, Tex., for pilot training.

A 1932 graduate of Paonia (Colo.) High School, he has received his professional degree in Metallurgical Engineering in 1949 from the Colorado School of Mines.

Peters Promoted by Cominco to Assistant Superintendent of Magmont Lead Mine

JOHN W. PETERS, E.M., 1960, has been promoted to assistant mine superintendent by Cominco American, operator of the Magmont lead mine near Butte, Mont. In his new capacity, Mr. Peters will assume Superintendent A. F. "Gus" Brehmke in the various mine department functions.

Magmont, a mine and mill complex located in the "new lead belt," is owned jointly by Cominco American Incorporated of Spokane, Wash., and Diamond Mines Inc., at Dallas, Tex.

Mr. Peters has served as the mine engineer he joined the Magmont operation in 1967. He is a 1953 graduate of the Colorado School of Mines and his family reside in Salida, Colo.

Mike Carr Opens Denver Office

MICHAEL E. CARR, P.E., 1967, consulting petroleum engineer, has opened offices in Midland Savings Building, Denver, and in McComb, Neb. A native of Colorado School of Mines, Mr. Carr formerly was a senior petroleum engineer for Pueblo Petroleum Corp.

Ferguson Reappointed by Humble to Eastern Marine Division

ALAN R. FERGUSON, Geol.E., 1959, has been appointed to the position of vice president of geological and geophysical exploration of Humble Oil & Refining Co.'s Eastern Marine Division, New York, N. Y., a subsidiary of Humble Oil & Refining Co.

Ferguson's promotion is in recognition of outstanding professional achievement in the field of subsurface geology. He began his geological career with Humble Oil & Refining Co. upon graduating from Colorado School of Mines with a mining engineering degree in 1952; his geological engineering work. He was on various assignments in Gulf Coast states before joining the Eastern Marine Division in 1967.

L. A. Garfield Forms New Consulting Firm

LAWRENCE A. GARFIELD, E.M., 1969, a vice president of White Pine Copper and Nickel Mines, has resigned from that company to offer a consulting service in mining and construction industries. The new firm will specialize in engineering services and development of equipment and methods for open-pit and underground mines and rapid excavation projects of all types. Mr. Garfield, who is married to Miss Sally J. Cavallo, has lived in Colorado Springs since 1950.

B. R. Johnson and his wife have one daughter and are residents of Lakeview, Col.

Barry K. McMahon Transferred to Denver & Moore Denver Office

BARRY K. McMASON, B.S., 1960, has been transferred from Denver & Moore's Denver office to its Australian subsidiary in Brisbane, Queensland, on the Australian mainland. This is his return home after obtaining his degree from the Colorado School of Mines.

A geologist with particular experience in coal mining, Mr. McMahon has traveled widely in his profession, with Denver & Moore's subsidiary in Spain and a pioneer foundation study in Australia.
Outstanding CSM Athletes Recognized

Four Colorado School of Mines athletes have been honored by the Outstanding College Athletes of America, and will be honored in the 1970 volume of their publication, National College, by their schools earlier this year. These athletes were chosen as Outstanding Athletes in their respective sports. In this award presentation, the basis of their achievements is the following:

Outstanding College Athletes of America is sponsored by the Outstanding American Foundation, a nonprofit organization dedicated to honoring America's achievement.

Jim Taylor, a senior in mathematics, led the Miners in their 4-1 win over Red Rocks in the RMAC tournament. He also led the Miners in their 2-2 record.

Ron Haines picked up one of the Miners' 10 hits in the seventh inning. Mines had 10 hits to 9 for Denver.

Mines had 10 hits to 9 for Denver.

April 10, and defeated Metropolitan State College, 21-0, and drove in three runs. Mines had 10 hits to 9 for Denver.

Jeffery Scott, a senior in mathematics, received recognition in the RMAC for outstanding basketball achievements for the past four years. During this period, Jeffery Scott scored 1,900 points, ranking third in the RMAC.

Oredigger Sports

Elmer R. Wilfley, '14

Wilfley Centrifugal Pumps

Oredigger Track and Field

In weekend play, the CSM baseball team split their doubleheader with Mines, winning the first game 4-3 and losing the second game 8-7. The Miners had 10 hits to 9 for Denver.

CSM Baseball Nine Split Their Season

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Vocational Education

Elmer R. Wilfley, '14

Wilfley Centrifugal Pumps

Oredigger Track and Field

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Earth Sciences

Mineral Exploration

Consulting and Services

Dana Stevens '65

Doug Bross '65

Bill Cooper '65

George Rosillo '64

"Energy, Science, and Technology"

Mines Assist IBM in Training Program

IBM personnel toured the CSM Metallurgy Department to give IBM employees an overview of the department's operations. IBM personnel visited Mines to give IBM employees an overview of the department's operations. IBM personnel visited Mines to give IBM employees an overview of the department's operations.

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Charles Crew, Awarded CEC Silver Medal

Charles Crew, graduating senior at Colorado School of Mines, received the Colorado Engineering Council Silver Medal award during the opening ceremonies of the 38th Annual Engineers' Day on the CSM campus Friday, April 17.

Crew, whose hometown is Golden, will graduate in metallurgy. It is spring during the May commencement. During his four years at Mines he has served as Senior Class President, three years on the Student Council and two on the varsity tennis team. He is a member of Theta Tau and Kappa Sigma fraternities and also has professional affiliations with the American Institute of Mining, Metallurgical and Petroleum Engineers and the Society of American Military Engineers. Charles was granted an Adelphi Omega Annual Leadership Scholarship during his Freshman year and maintained his membership for his four years at CSM.

Last Performance in Guggenheim Hall

The Golden Thespians, a local theatrical group, performed in their 40th year and the oldest continuous group in the area, a three-act comedy, "Here Lies Jeremy Troy," by Jack Sharkey in the Annual Engineers' Day, May 17, Guggenheim Hall Audition April 16.

This production was the last to be performed in Guggenheim Hall Auditorium on the Colorado School of Mines campus following 30 consecutive years of use by this group. Renovation of the building will force the group to locate and build a facility for future productions.

Two NSF Grants Totaling $30,000

Colorado School of Mines has received two grants, supported by the National Science Foundation, which became effective April 1, 1970, and amount in value to $15,000 each.

The first grant was awarded to the Basic Engineering Department, under the direction of Dr. Donald E. Small, to support a visiting scientist from the University of California, San Diego, in the area of electronics research. This grant will extend for a period of 18 months.

The second grant was received by the Physics Department and will deal with "Research Initiation—Studies of Permeability Alloy." The director of research will be Joseph A. Magalski with the period of research being 18 months

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- Low power consumption
- Simple to use
- Compact and portable

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Earthquake Research

Natural Gases

Of North America

The book, in four volumes by D. Warren Bees, editor, and Bruce F. Curtis, associate editor, contains 1,914 pages. The text is written in English and has an index. It includes an introduction to the study of natural gas and a survey of the geology of the United States. The book is divided into sections, each section focusing on a different aspect of natural gas. The book also includes a bibliography and an appendix with additional information. The book is available in paperback and hardcover versions.

Graphite Determinations

Silver-Bearing Copper

The book "Silver-Bearing Copper" is available in hardcover and paperback versions. It is written in English and has an index. The book covers the properties of silver-bearing copper and the techniques used to determine its presence. It includes a bibliography and an appendix with additional information. The book is available in paperback and hardcover versions.

Technological Developments

Geophysical Surveying Program in Wisconsin

The book, "Geophysical Surveying Program in Wisconsin," is available in hardcover and paperback versions. It is written in English and has an index. The book covers the techniques used for geophysical surveying in Wisconsin and includes a bibliography and an appendix with additional information. The book is available in paperback and hardcover versions.
1969 Mineral Production in U. S.

ACCORDING to estimates by the Bureau of Mines, U.S. Depart- ment of the Interior, total value of U.S. mineral production for these states in 1969 was as follows:

North Carolina, $53.1 million, an increase of 3 per cent above 1968. The increase in value was due mainly to higher prices of production of coal, cement, lime, and sand and gravel.

Arizona, $380.5 million, 38 per cent above the 1968 total and an all-time record. This State led the nation in value of production (797,369 short tons), ranked second in amount produced (615,046 tons), and was fourth in gold production (150.5 ounces).

California, $1.8 billion, up 4 per cent from $1.8 billion in 1968. Increases reported for mineral fuels (5 per cent) and nonmetallic minerals (3 per cent) most likely were compensated for a decrease in metal production (4 per cent).

Colorado, $370.9 million, 88 million more than the previous high set in 1968. Part of the increase was due to greater production and higher prices of lead, molybdenum, vanadium, and zinc.

Florida, $261.9 million, a decrease of 1 per cent below 1968. The overall decline in value of mineral production is attributed to sharp phosphate sales and lower prices. Nonmetallic minerals (12 per cent) accounted for 94 per cent of the state's total minerals production value.

Georgia, $321 million, an increase of 17 per cent over the previous year. This increase in 1969 Minerals produced were predominantly nonmetals, but a small percentage were metals. Bauxite nearly doubled in quantity and value.

Kentucky, $482 million. The state ranked second in U.S. coal production with 1.3 billion tons valued at $4.6 billion. About 80 per cent of the state's mineral wealth was from coal.

Nebraska, $370.5 million, 44 per cent higher than that of 1968. Copper production accounted for 67 per cent of the total value of the state's mineral production. Dominant minerals were iron ore, lead, zinc, and tungsten, with more than 60 per cent of the value due to production of copper, gold, silver, molybdenum, and lead.

New Mexico, $960.5 million, an increase of $752.2 million over 1968. Dolomite was the greatest gain in mineral fuels with natural gas and petroleum leading; percentages the value of metal production made the greatest increase (copper, lead, and zinc).

North Carolina, $53.1 million, an increase of 3 per cent by the $52.2 million by 1968. The increase was due mainly to higher prices of production of coal, cement, lime, sand and gravel, and mica, diminution in quantity and decrease of industrial value.

South Carolina, $652.3 million or 3 per cent above the 1968 total and all-time record. These records were set in the production of manganese, copper, molybdenum, and feldspar and vermiculite. The state ranked second in production of manganese, 9th in production of coal, 10th in production of mica, and 11th in production of feldspar.

Tennessee, $320 million, an increase of 5 per cent over the $303.5 million reported in 1968. Nonmetallic minerals (23 per cent) most likely were compensated for a decrease in metal production (17 per cent).

Utah, $151.5 million, or 20 per cent more than the previous high in 1968. Values of the metal groups increased $74.4 million and showed only in the production of lead, molybdenum, and vanadium. All commodities except natural gas showed gains in value.

Texas Gulf Sulphur Joins Cleveland Cliffs Iron in Australian Project

Texas Gulf Sulphur Co. has agreed in principle to join with Cleveland-Cliffs Iron Corporation in a joint venture for the development of the $300-million Robe River Iron Ore Project in Western Aus­ tralia. That announcement was made by Capt. Otis W. Swainson of Cleveland-Cliffs, president, on Jan. 30, 1970, to the officers and directors of the American Chamber of Commerce and the Australian Financial Press in Sydney, Australia. That announcement was made on Jan 30, 1970, to the officers and directors of the American Chamber of Commerce and the Australian Financial Press in Sydney, Australia.

Clyde I. True

CLYDE I. TRUE, R.M. 1945, died at his home (404 Maple St., Golden) on Dec. 13, 1969. At the time of his death he was employed by the Atomic Energy Commission, Corp, Canon City, Colo.

Robert C. Earlougher, ’34, Registered Engineer

R. C. EARLOUGHER, P. E., formerly with the United States Atomic Energy Commission, has rejoined Earlougher Engineering Consultants, P.O. Box 4597, 3316 E. 21st St., Denver, Colo. 80223 (Earlougher Engineering), a firm of consulting engineers, for a position as a registered engineer.

Herbert A. Jackson

WALTER H. JACKSON, E. M. 1941, died several months ago. On Jan. 30, 1970, we received a return envelope with the word " desconocido" stamped on it. Mr. and Mrs. Jackson were living at the Everlast Homes, 720 Somes St., Seattle, Wash. 98101.

Capt. Otis W. Swainson


During his 38-year career with the Geodetic Survey, he conducted experiments which determined the correct path of sound in seawater and in the air, which became the basis of great precision for submarine navigation. His other affiliations included the National Academy of Sciences, the American Philosophical Society, the Royal Geographical Society, and the American Geophysical Union.

Cleveland-Cliffs Iron Co. in Butte, Mont.; Shenandoah-Engineers as a first Lieutenant, he received his Mining Engineering degree from the Colorado School of Mines, his master's degree in physics from the University of California, and his doctorate in physics from the Colorado School of Mines; his master's degree in physics from the University of California, and his doctorate in physics from the Colorado School of Mines; his master's degree in physics from the University of California, and his doctorate in physics from the Colorado School of Mines; his master's degree in physics from the University of California, and his doctorate in physics from the Colorado School of Mines.

In principle to join with the Cleveland-Cliffs Iron Corporation in an additional $300 million Robe River venture through a new corporation which would have a 40 per cent participation in the Robe River project, and institutions and investors would have a 30 per cent participation in the project.

Charles H. Cotterell

CHARLES H. COTTERELL, E. M. 1967, geologist, 55, died in a skiing accident in Las Vegas, Nev. on Dec. 5, 1969. He was survived by his widow, Mrs. Frances Cotterell.

Donald N. Shepard

CAPT. DONALD N. SHEPPARD, E. M. 1967, was killed in an air-raid in New York. He completed his high school education there and enrolled at the Colorado School of Mines, graduating in 1968 with a degree in Mining Engineering. Capt. Sheppard is survived by his wife, Mrs. Donald Sheff, formerly of Denver, and two daughters, Rhonda Mae, two years old, and Elizabeth Ann, one year old. Mr. Sheff was survived by his father, Henry Sheff, 106 Parkridge Avenue, Trenton, N. J., and three brothers.

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Air Force Base in New Mexico, in 1969. His other affiliations included the National Academy of Sciences, the American Philosophical Society, the Royal Geographical Society, and the American Geophysical Union.

For eight or a half years, Mr. True was mine superintendent of the Schwartzwater Uranium Mine near Golden. He had employed him as a mining engineer with the Atomic Energy Commission at Grand Junction, Colo.

He was a member of the Professional Engineers and Land Surveyors, Retired Officers Association, Colorado Engineers Association, A.M.T.A., Prater Society, American Legion Post 178, Masonic Lodge, and the Rotary Club. He was also a retired officer in the U.S. Navy, having served for five years in the South Pacific, and was a member of the American Society of Civil Engineers, and the American Society of Mechanical Engineers. His other affiliations included the National Academy of Sciences, the American Philosophical Society, the Royal Geographical Society, and the American Geophysical Union.

He also was officer-in-chief of the Northeastern Section of the Division of Terrestrial Magnetism and Seismology (now Geophysics) of the National Academy of Sciences, Washington, D. C. He retired in 1963. Capt. Sheppard was on the board of directors of several organizations de­ voted to the improvement of naviga­ tion and research.”

During the course of the sound wave experiments, he invented a device which was used to monitor the impact of water with a small device that could be lowered to any depth of water without losing its sensitivity.

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