FIELD NOTES FROM THE ARIZONA BUREAU OF MINES

Vol. 1, No. 2 Earth Science and Mineral Resources in Arizona *June 1971*

SEARCH AND RESEARCH

by
S. B. Keith

MINERAL EXPLORATION IN ARIZONA

The search for mineral substances has been an important function in human development ever since early man became aware that certain rocks, minerals, and metals not only were useful but in many cases essential to his well-being. Man started looking for these mineral materials and began to associate their occurrence with certain localities or types of rocks. The men who specialized in finding desirable minerals were the first prospectors. Mineral exploration started as an art, depending on man's physical senses of sight, feel, and taste, rather than a science based on geologic knowledge of the origin and occurrence of mineral substances.

Archaeological records indicate that the aborigines of Arizona were agrarians. They fashioned simple tools and weapons from suitable rocks found exposed on the surface. They fashioned pottery from clay found along stream channels or in old lake beds. Mineral pigments of iron, manganese, copper, and uranium were used for coloring and the mineral turquoise was used in special decorations. Salt beds in the Verde River Valley were mined at an early date and the observation that lightning could set on fire the exposures of high volatile coal in the Black Mesa area of northeastern Arizona led to the mining of coal for fuel as early as 1300. Although they may have been aware of particles of gold in some stream gravels, of wire silver in weathered vein outcrops, and of native copper in the exposures of the copper deposits, these materials did not attract them either for ornaments or for tools. Exploration for metals in Arizona awaited the arrival of Europeans in the middle of the 16th century.

The earliest explorers, the Spanish conquistadors, were not hunting for mineral deposits, but later expeditions under Espejo and Oñate, in the late 1500's and early 1600's, prospected for precious metals in northern and western Arizona. Some precious metals were located by those expeditions but were not worked. About the same time small and spotty superficial deposits of oxidized silver ore were found and mined in mountains bordering the Santa Cruz Valley and the Spaniards tried to work the Ajo deposit for copper. However, there does not appear to have been any large scale mining activity in Arizona during the periods of Spanish and Mexican occupation.

Arizona Historical Society

PROSPECTING IN THE PAST

The first Americans entering Arizona territory were trappers and it was not until the United States took possession through the Treaty of Guadalupe-Hidalgo (1848) and the Gadsden Purchase (1853) that mineral exploration by Americans started in earnest. In 1853 the Poston party and others were actively exploring and developing lead and silver deposits in the Santa Rita, Cerro Colorado and neighboring mountains. By 1857 prospecting parties also were moving eastward into Arizona territory from California, finding a succession of small but rich gold placers and gold and silver lodes. Prospecting methods were simple and geology played a small part in the early discoveries.

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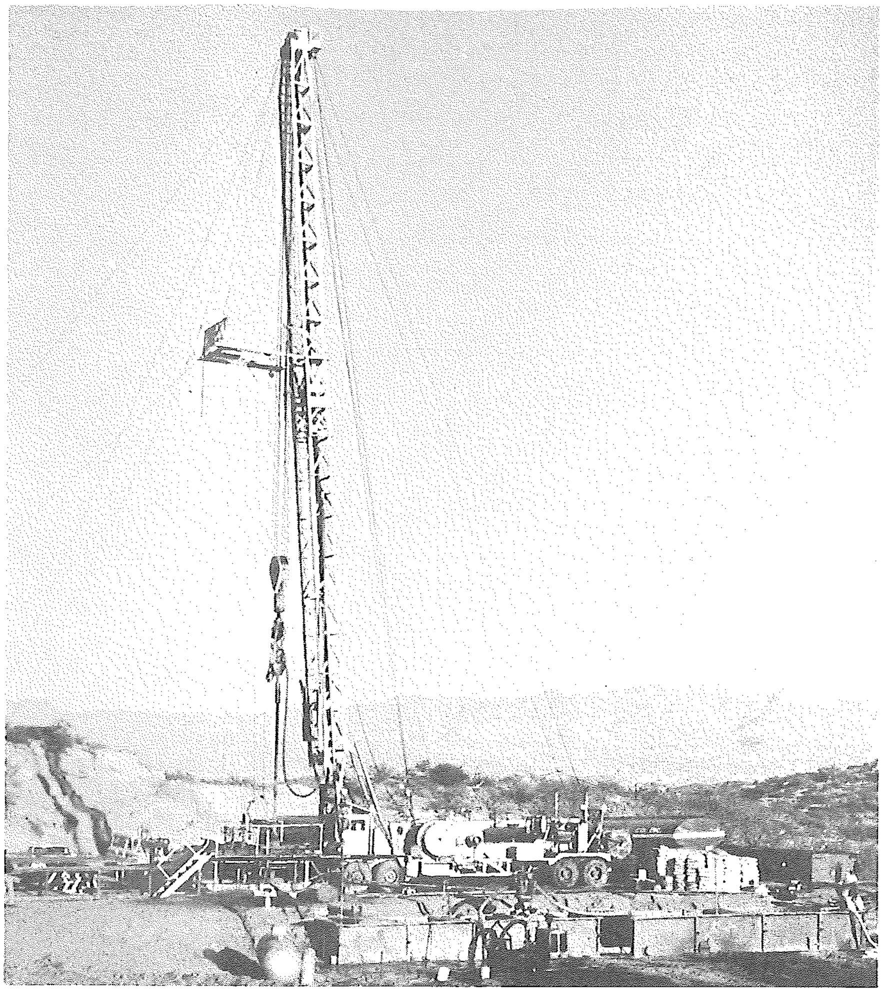
Search and Research (continued)

The science of geology was developing rapidly by this time and geologic information on Arizona was being reported by scientific personnel attached to boundary commissions, railroad surveys, and military expeditions. One of the first geologic descriptions of southern Arizona, by Antisell, was published in 1855 and the first maps showing geologic features of the Territory appeared in the 1850's. Technical geologic reports on mineral deposits in Arizona, by Blake and others, began to appear in the late 1850's and early 1860's. Except for the disruption brought on by the Civil War, mineral exploration activities in Arizona increased rapidly. Most of the major mineralized districts had been found by the late 1800's and many had seen their peak periods of development and production by 1900. The U.S. Geological Survey publications on mining districts in Arizona started appearing in the early 1900's and by 1915 mineral exploration and mining had attained such an important role in Arizona that the Arizona Bureau of Mines was established to assist the mining industry in the development of the mineral resources of the State. Within a few years geologic investigations became an important function of the Bureau, largely through the efforts of the late Dr. Eldred Wilson who became a staff geologist in 1919. Since that time a major share of the Bureau's activities has been directed to furnishing basic information on the geology and mineral resources of the State, acting in general as a geological survey.



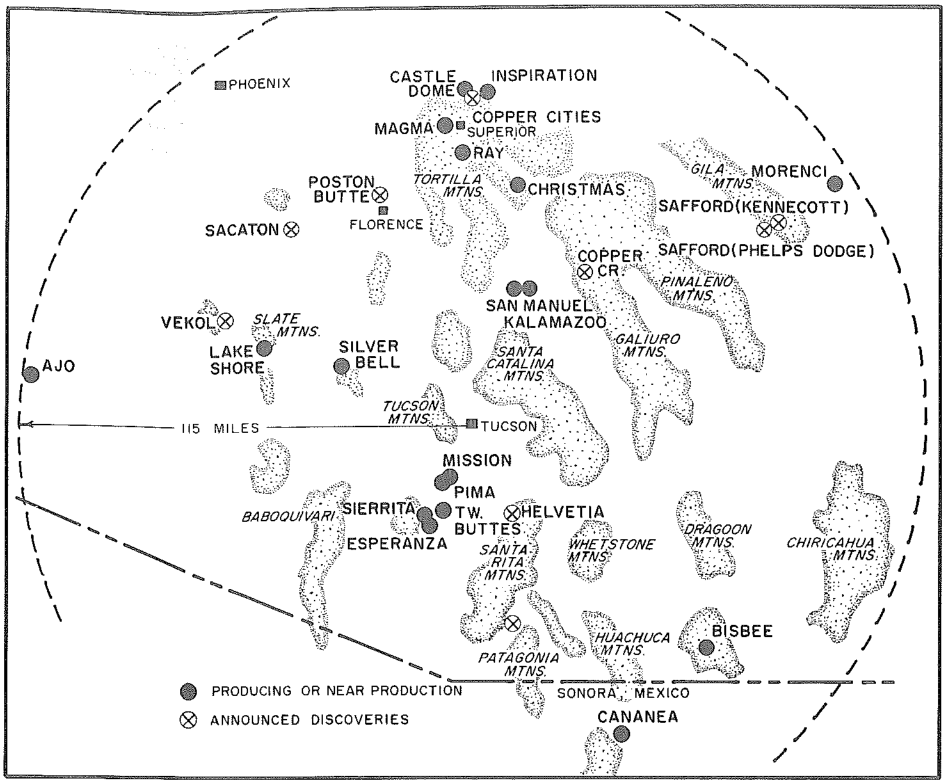
PROSPECTING IN THE PRESENT

Through the years mineral exploration has become a science in itself. The early prospecting methods - the pick, shovel, and gold pan - have been supplemented by detailed mapping of the geology, recording features such as stratigraphy, structure, igneous intrusions, mineral zoning, and rock alteration. The microscope has complemented the hand lens and the naked eye. Drilling methods permitted more rapid examination and sampling of rocks beneath the surface. A variety of geophysical and geochemical methods and airborne instrumentation have made possible the detection of hidden mineral occurrences. Even more sophisticated "tools" for the mineral explorationist are being developed. The individual prospector may still have a place in the discovery of mineral resources exposed at the surface but to a large extent he is being replaced by well-trained and well-equipped parties of exploration geologists.

In Arizona, mineral exploration for most metals has been carried out thoroughly and successfully for some 120 years and it is doubtful that any exposed metallic mineral occurrence of present economic consequence has been missed. The same situation does not apply to many nonmetallic mineral occurrence such as clays, zeolites, fluorspar, etc., which often are not readily recognized in the field. The value and utilization of many nonmetallic minerals has been poorly understood. Exploring for mineral deposits is always a gamble and the primary sources of mineral products occur only where they exist in the earth's crust. They can not be grown, made or moved at will. Mineral resources of economic importance, outside of some common materials such as sand, gravel and stone, make up a very small percentage of the earth's crust. On the average only one out of a hundred or more metal prospects may be worthy of a detailed examination, and of a hundred given careful study, only one may turn out to be an economical or feasible mining operation. For many nonmetallic mineral materials a similar ratio of discovery to economic exploitation would apply. Thus the odds of finding an economic deposit are long and the risks in time and money are great.

It is certain that the demand for mineral products will increase and the problems of satisfying the demand will become more complex. Readily accessible reserves of many mineral materials are being depleted, the costs and technical difficulties of discovering and exploiting new resources are increasing, and the requirements for protecting the environment are becoming more stringent. Today's mineral explorationists must take all these factors into consideration. He must acquire a sound basic understanding of all geologic factors and carefully use and evaluate the results of all appropriate and available technical tools and technique at his disposal. Over all it will require hard work, imagination and ingenuity, vast sums of money, and a high degree of cooperation and understanding between scientist, government agencies, and the public if man's requirements for minerals and his desired satisfactory environment are to be achieved. The Arizona Bureau of Mines has and will continue to help provide the basic geologic information and service needed to meet these objectives.

ARIZONA MINERAL RESOURCES



Prof. S. R. Titley

MAP SHOWING PORPHYRY COPPER DEPOSITS IN ARIZONA

Arizona is a mineral-rich state as indicated by the preliminary valuation of its mineral production in 1970, a record of almost $1.16 billion. Copper production, 910,000 tons and 53 percent of the U.S. total, accounted for 92 percent of the State's total mineral production value. Production of molybdenum, 14 million pounds; silver, 7 million troy ounces; and gold, 111 thousand troy ounces accounted for 2.0, 0.6, and 0.3 percent of the mineral production value of the State, and in amounts rate Arizona's production respectively as third, second, and fourth in the United States. The production of these latter three metals results almost entirely as by-products of copper production.

Other sizeable amounts of mineral products produced in Arizona in 1970 were sand and gravel, 15.7 million short tons; zinc, 10.2 million tons; stone, 2.7 million tons; petroleum, 1.8 million barrels (42 gallons per barrel); natural gas, 1.2 billion cubic feet; and pumice (volcanic scoria), 0.9 million tons. Other mineral products produced in Arizona in 1970 in relatively less amounts or for which the amounts are not made public are: asbestos, cement, clay, diatomite, feldspar, gem stones, gypsum, helium, iron ore, lead, lime, mercury, mica (scrap), perlite, pyrites, and tungsten.

New mining operations are opening up each year in the State and new prospective mines are being found and evaluated as to their possible exploitation. In 1970 the two new major operations were Duval's 72,000 ton a day Sierrita open pit mine and mill south of Tucson and Peabody Coal's strip coal mine at Black Mesa on the Navajo and Hopi Indian Reservation. The latter is scheduled to reach a production of 13 million tons a year by 1976. New major copper orebodies to be brought into production in the near future are San Manuel's Kalamazoo at San Manuel, Phelps Dodge's Metcalf near Morenci, and the Hecla and El Paso Gas mine at Lake Shore, South of Casa Grande. Prospective copper mines undergoing exploration, development or feasibility studies include San Manuel's Vekol Hills deposit to the south of Casa Grande, Anaconda's Santa Rita Mountains (Helvetia-Rosemont) deposits, Kerr-McGee's Red Mountain discovery in Patagonia, Miami's faulted extension of the Miami-Inspiration orebody and the Pinto Valley occurrence near Castle Dome, Phelps Dodge's and Kennecott's Safford deposits, Continental Oil's Poston Butte copper occurrence near Florence, A.S. & R's Sacaton prospect north of Casa Grande and several investigations in the Copper Creek area east of Mammoth. The location of these active and prospective mines is shown on the adjoining map. The prospective copper production from these discoveries plus the announced expanded output from established operations should maintain Arizona for many years in the future as the number one copper producing state in the United States, as well as a leading copper-rich area in the world.

In the nonmetallic field, new mining industries are being developed for salt and clay in the Phoenix area and for limestone in the Santa Rita Mountains south of Tucson. Interest in other nonmetallic mineral products should increase in the future as their importance is recognized.

The importance of Arizona's mineral resources is emphasized by the predictions of all sectors of the mineral and fuel industries that greatly increased demands for mineral products will occur in the next few decades. The U.S. Bureau of Mines foresees a yearly increase in world demands for minerals in the next thirty years of between 3.6 and 5.5 percent. This means, for example, that world copper production must rise from about 7 million to 14 million tons, lead from some 3.8 million to 7 million tons and zinc from about 5.6 million to 10 million tons. World petroleum consumption in the next twenty years will almost equal the total presently known reserves of the non-communist world and the U.S. consumption alone for the period, an estimated 150 billion barrels, will exceed presently proven U.S. reserves. Requirements for natural gas in the U.S. for the same period are expected to exceed 4 hundred trillion cubic feet and the predicted need for uranium for nuclear energy is about 2.5 times presently estimated reserves. U.S. reserves of extractable coal, some 600 billion tons, are ample for many years but increased costs of production due to environmental, health, and safety laws; depletion of the more available deposits; and higher costs of mining and transportation make it more difficult for the producers to remain competitive with other fuels.

In general, the limiting factor in producing the required minerals and fuels for the future is not one of availability but the cost of access, recovery, and environmental protection. It would appear that advances in the technology of discovery and exploitation, although expensive to develop and use, are the only ways that the cost limitations and related environmental problems can be overcome.

USE OF MINERAL WASTE PRODUCTS

The constructive and economic use of the waste products produced by the mineral industry in Arizona, particularly the copper industry, is receiving attention for both economic and environmental reasons. Some soil conditioning products have been made from selected, metallurgical waste products and relatively small amounts of iron-rich slags are used as cement additives. Copper smelting slags have been tried or used for road construction material, as railroad ballast, and in the production of slag wool. Several hundred thousand tons of copper smelter slags are produced annually that may contain as much as 35 percent iron, 38 percent zinc, and a few tenth's of a percent copper, lead and sulfur. As yet, attempts to recover economically any of these elements or compounds, or to utilize large amounts of slag, have not been successful.

No constructive use for the vast quantities of tailings from copper-ore milling operations has been found. This finely ground material generally is devoid of any recoverable mineral product and the sand and slime tailings produced have neither the cohesiveness of clay nor suitable qualities to be used as construction or industrial sand.

The main waste product from copper smelting, both for economic and environmental reasons, is the sulfur dioxide produced from the sulfur-rich copper-iron concentrates. Normally in the past the sulfur dioxide passed out as a gas in the smelter smoke but in order to meet the new emission standards, the copper smelters have or are installing equipment to extract sulfur dioxide from the waste gas. In most cases the end product will be sulfuric acid and when all current and proposed acid plants are in normal operation, as much as 8000 tons of acid may be produced daily. Sulfuric acid, due to its corrosive character, is difficult to store, expensive to ship any distance, and can not be disposed of as a waste product without chemical treatment to produce a less harmful material, such as gypsum (calcium sulfate).

The most economically promising local use of sulfuric acid is in the leaching of copper from low grade, oxidized and silicated, copper-bearing material. Some such material in Arizona leaches readily and economically with low acid consumption while other such material may contain high acid consuming minerals, such as calcite. The cost of the acid has been one of the main factors in determining the feasibility of a copper leaching operation. Another factor, particularly in material high in lime and other chemical substances, has been the formation of gypsum, silica gel, or other possible mineral forms that clog the pore spaces in the leach piles or tanks and thus prevent the necessary perculation of the acid throughout the material. The result is low copper recoveries even with high acid consumption. Cases are known where the consumption of acid in limy material is as high as 200 to 300 pounds of acid per ton of material since calcite consumes acid to form gypsum at a ratio of about one pound of acid to one pound of calcite.

The market price of sulfuric acid delivered to the site of use in Arizona has been relatively high, up to $60 per ton in some instances. Transportation has been a large factor in the price. The increase in acid production locally in Arizona is expected to create a surplus that will have to be disposed of either by neutralization with limestone or by finding or creating local markets within relatively short distances from the acid plants. As a waste product, the price should drop to a much lower figure, possibly to about $10 per ton or a price close to the cost of production, the cost of neutralizing the acid, or even the cost of delivery to the site of use.

The neutralization of acid to form gypsum does not appear to be a profitable method of disposal. The market for high quality gypsum within a reasonable shipping distance of Arizona sources, at present, is limited and the reserves and resources of natural gypsum deposits in Arizona are extensive. The average value of gypsum mined in Arizona in 1970 was about $5.10 per ton. Even if clean, colorless gypsum could be produced from sulfuric acid, it is very doubtful if the product could compete economically with commercially mined gypsum.

George Roseveare, Bureau metallurgist, believes that a new and different approach should be taken in copper leaching practice, particularly in respect to material having a relatively high lime content. He notes that the Timma Mining Industries Ltd. in southern Israel have developed a process where the limy copper-bearing material is ground to a pulp of not more than 10-mesh particles and then agitated in a battery of Pachuca tanks with acid at a density of 50 percent solids. The amount of acid added is controlled to give a strong application at the start to provide a higher differential attack on the copper minerals than on the lime. The copper-bearing solution is separated from the tailings by counter-current washing in thickeners. Acid consumption is relatively high but the value of the high copper recovery more than offsets the cost of the acid. Furthermore, soluble salts, gypsum, or other products formed in the process cause no serious problems, the process is continuous, and the plant easy to operate. The same process also is being used in Africa and South America with equally good results.

Arizona has a considerable potential reserve of oxidized and silicated, low grade, copper bearing material that might be leached profitably providing a suitable, high recovery processing method is used and the cost of acid delivered to the site is reasonably low. It is within reason to assume that under favorable conditions some 4000-6000 tons of sulfuric acid could be used daily in such operations. It is certainly a raw material source that should attract the interest of the exploration geologist and the mining industry as an economical and feasible use of excess acid.

The likelihood of excess and low cost acid being locally available in Arizona also has attracted the interest of industry and agriculture. The Cooperative Extension Service of the University of Arizona has initiated inquiries into the possible beneficial uses in proposed new industrial complexes and for agriculture. Some soil experts feel there may be a need for sulfur-bearing soil amendments in many parts of Arizona. It has also been pointed out that sulfuric acid, if low cost, might be used extensively in the treatment of water resources presently unsuitable for agriculture due to their high salt content. Although much general research has been done on possible uses of sulfuric acid or sulfur compounds in agriculture, it has not been compiled to give an accurate picture in respect to Arizona conditions. The preliminary discussions on these matters are being followed up with the possibility that a research program may result.

WORLDS OLDEST ROCKS?

The University of Arizona has been designated by the National Aeronautic and Space Administration (NASA) as a national repository of a collection of what may be some of the world's oldest sedimentary rocks, dated in part as at least 3.4 billion years old. Dr. Bartholomew Nagy, geoscience professor and chief scientist in the organic geochemistry laboratory, last summer collected about 1,000 pounds of rock samples in the Barberton Mountain Land of Eastern Transvaal, South Africa. The repository was established to make available for study what appears to be some of the oldest known sedimentary rocks and to permit their comparisons with the NASA lunar samples. In particular, Dr. Nagy hopes to discover if there was life on the earth and what the earth was like at that early date.

THE BUREAU MAILBAG

The Arizona Bureau of Mines receives many inquiries from people of all ages and from within and without the State concerning geological and mining matters. All inquiries are answered individually but readers of "Field Notes" may benefit also from the following generalized answers to some of the most frequently asked questions.

1. Inquiries concerning the general geology of Arizona.

A simplified description of the geology of Arizona, particularly in a letter to young people studying earth science, is indeed difficult. The best references we can supply are the excellent "A Resume of the Geology of Arizona" by Eldred Wilson, Arizona Bureau of Mines Bulletin 171, 1962 and the section "Geology and Topography" by Philip Hayes of the U.S. Geological Survey in "Mineral and Water Resources of Arizona", Arizona Bureau of Mines Bulletin 180, 1969. For those people requiring more details or seeking geologic information on specific areas, Bulletin 173, "Bibliography of the Geology and Mineral Resources of Arizona, 1848-1964" provides a comprehensive list of references that may be checked.

The Bureau has published colored geologic maps covering all counties of the State; geologic cross-sections; and outcrop maps of Precambrian, Paleozoic and Mesozoic, and Laramide (Cretaceous-Tertiary) rocks and of Tertiary and Quaternary igenous rocks. As shown in this issue, some of the highways of Arizona have been covered by geologic guidebooks. "Field Notes" Vol. 1, No. 1 of March, 1971 listed references and showed the location of most of the more recent publications containing maps of the geology of various areas in Arizona. Upon request a list of the Bureau's available publications will be sent without charge.

2. Inquiries concerning minerals of Arizona.

Arizona Bureau of Mines Bulletins 165, "One Hundred Arizona Minerals", 1966, and 181, "Minerals of Arizona", 1970 briefly describe the minerals found in the State, give simple means for their identification, and tell the general locations where they may be found. The Bureau is unable to supply specimens of Arizona minerals except to Arizona schools for instructional purposes. Requests by earth science teachers in Arizona schools for sets of typical Arizona rocks and minerals must be made on official school stationery. The Bureau is pleased to provide this service but the time and expense required to assemble sets make it imperative that they be shared to the fullest extent within each school.

3. Inquiries concerning mining activity and mineral production.

The most recent and reliable source of public information on mining activity and mineral production in Arizona is contained in the annual "Mineral Yearbook" volumes published by the U.S. Bureau of Mines. The volume entitled "Area Reports: Domestic" contains a chapter "The Mineral Industry of Arizona". Some statistics on individual companies is withheld as being company confidential and the data given may be up to two years behind the current date. The U.S. Bureau of Mines also publishes preliminary annual mineral production figures for Arizona in the first quarter of each year for the preceding year.

The Arizona Department of Mineral Resources publishes bi-annually an "Active Mine List" which lists the names, location, approximate number of men employed, product, and operator's name and address. Copies of this report may be acquired from that department, Mineral Building, Fairgrounds, Phoenix, Arizona 85007.

4. Inquires on prospecting and locating mining claims in Arizona.

In general any U.S. Citizen, intended citizen, association of citizens or qualified corporation may prospect and locate mining claims upon public domain of the United States or upon State land subject to certain limitations. An excellent guide to the understanding of the major features of mining laws and regulations governing prospecting and mineral location in Arizona is contained in a booklet "Laws and Regulations Governing Mineral Rights in Arizona" by Victor H. Verity, published by the Arizona Department of Mineral Resources. Any prospective prospector is well advised to review the contents of this booklet which is available also from the Arizona Bureau of Mines. The Bureau is pleased to provide whatever assistance and service it can give in the form of geologic, mineralogic, and metallurgical information but can not and does not make specific recommendations as to areas that might be prospected. Elsewhere in this issue, there is a further discussion of mineral and mineral land owership in "Who's Digging in Your Backyard".

A few words of caution are added for the prospective prospector uninitiated to the conditions he might find in Arizona. Prospecting is a healthy and enjoyable occupation or hobby providing one fully understands the laws and regulations, is aware of the possible hazards, and recognizes his own limitations. The following simple rules are suggested.

A. Obey all laws and regulations. Whether the land is private or public, the valid owners of the surface and any mining claims have certain rights that should be respected. Find out from the proper authorities or owners if prospecting on the particular property can be done.

B. Take care that the surface, vegetation and any existing structures are not unnecessarily or willfully damaged or disturbed.

C. Be suitably attired and make ample provisions, especially for water, for the characteristics of the area to be prospected.

D. Use extreme caution around old mine workings, particularly old shafts, dumps and timbered tunnels. Such indications of past mining activity are attractive but often hazardous. In most cases they are still privately owned and should be protected against entry.

5. Inquiries concerning inactive or defunct mines and mining companies.

The Bureau may be able to furnish some information on the location, general geology, and production of presently inactive mines or mining companies and when they were operating, but it does not keep official records. Companies doing business in Arizona register with the Arizona Corporation Commission, Capital Annex, 1688 West Adams, Phoenix 85007 and that agency can inform the inquirer if a registered company is still active. If defunct, the filed records are held on microfech by Library and Archives, State Capitol Building, 1700 Washington, Phoenix 85007. Copies of the records can be acquired, free to residents of Arizona and for one dollar per company by non-residents.

6. Inquiries concerning hazards from old mine workings.

The Mining Code of the State of Arizona (Sec. 27-318) states, "All abandoned shafts, prospect holes or other excavations endangering life or safety shall be securely covered, fenced, or otherwise protected and warning signs posted. Any person removing or destroying any warning sign, covering, fencing, or other protection placed on or around any shaft, prospect hole, or other excavation is guilty of a misdemeanor as provided in Section 27-302." This latter section provides for enforcement of the Mining Code by the State Mine Inspector and fines of not less than fifty nor more than three hundred dollars for violations of any provisions of the regulations. Violations of these statutes should be reported to the State Mine Inspector or his deputies.

Continued on page 6

Mailbag (continued)

7. Inquiries on mineral collecting in Arizona.

Mineral collecting falls under the same general regulations as prospecting. In general, and by custom, there is little objection to persons picking up small specimens of common minerals for private use. However, the collector should not violate established mineral rights of legal owners, and in many areas, such as national and state parks, collecting is prohibited. If there is any doubt, inquiry in advance is always advisable.

The Bureau can furnish a list of Arizona gem and mineral clubs that have been brought to our attention and a list of mineral dealers compiled by the Bureau from various sources. However, the inclusion of any mineral dealer should not be construed as a recommendation by the Bureau.

8. Inquiries on fossil collecting in Arizona.

Well preserved fossil specimens are not common in most rocks in Arizona and the State Antiquities Act prohibits the removal of fossils, archaeological artifacts, and any material of interest to the history of Arizona. A copy of this law may be obtained from the Arizona State Museum, University of Arizona, Tucson, Arizona 85721. Mrs. Jan Wilt of the Bureau is currently preparing an index of Arizona fossils.

Some of the mineral dealers noted in the listing supplied by the Bureau may have for sale fossil specimens from Arizona.

WHO'S DIGGING IN YOUR BACKYARD

In order to accommodate Arizona's growing population, more and more land is being developed for homes in and near areas known or suspected to contain economic mineral products. The Bureau frequently receives inquiries from alarmed residents concerning apparent mineral prospecting and exploration in or close to personal property or housing developments. An understanding of the rights of property owners in such cases requires an understanding of the basic mining laws which in most cases separates surface ownership from surface and subsurface mineral ownership. No simple explanation of the laws would cover all cases and sound legal advice is advisable whenever conflict arises but the following brief outline may explain some of the basic principles of federal and state laws concerning mineral and mineral land ownership. Much of the following is based on an informal talk given recently by Prof. Jay Dotson, Department of Mining and Geological Engineering, College of Mines, at the U of A Student Union.

The basic laws governing the acquisition of mineral rights on federal land were established in 1872 and applied to certain areas or states, mainly in western United States. In effect, these enactments reserve the rights to minerals on and under federal land to the government, and provide for the disposition of all federal mineral lands by location and patent. Location can be made by lode claims, where the minerals occurred in veins or lodes in bedrock, and by placer claims, where the mineral occurs in the earth, sand, or gravel and not fixed in the bedrock. States also may make regulations concerning mineral claims on federal land if not in conflict with federal laws. Mineral claims can only be patented upon proof that valuable mineral is present within the claim and by the performance of other requirements.

In 1920 certain mineral deposits deemed essential to the public and national security were withdrawn from location and included under a Leasing Act. Under this act, mining rights to deposits of oil, oil shale, gas, potassium, sodium, phosphate, and coal can only be acquired by lease from the Federal Government. More recently in 1955, the Multiple Surface Use Act permitted and regulated the use of public lands, wherein the Federal Government retained mineral rights, for both mining operations under the mining laws and leasing operations under the Leasing Act. Further in 1955, the mining laws were amended to limit the rights of owners of unpatented claims in the use of the surface and surface resources, such as vegetation and water. Under this latter act, deposits of common varieties of sand, stone, gravel, pumice, pumicite or cinders, or of petrified wood, unless having very distinct and special value, can not be located by mining claims. Disposal of such materials is regulated by the government. The ramifications of the Multiple Surface Use Act of 1955 are broad and complex and affect the status of both the surface and unpatended mineral claim owners.

State land, where surface and minerals are owned by the state of Arizona, may be located for the purpose of acquiring a mineral lease for a maximum of 20 years, providing it is not already leased for some other purpose. Lode claims on State land can not be patented and placer claims are not allowed.

Although, in the broadest sense, mining claims may be staked on federal and state lands and on private lands in which the United States has retained the mineral rights, all such lands are not open to mining or mineral location. The list of excepted areas in which mining and mineral location is restricted or prohibited include:

Private lands in which government has not retained mineral rights.

National Parks and Monuments

Areas withdrawn for Reclamation, Recreation and other Public uses.

Wilderness Areas and Game Refuges

Experimental Forests and Ranges

Military Reservations

Agricultural Homesteads

Indian Reservations

Railroad Lands

Other miscellaneous reserve or restricted areas.

Open to mineral location, but often with restrictions and limitations, are national forests, grazing districts, land exchange areas, stock-raising homesteads, and some parts of areas otherwise closed. It should be noted that small tracts of land acquired from the Federal Government for residential use carry a reservation to the United States of all minerals. Whether such land is open or not to location or leasing depends on how the Secretary of the Interior has or has not prescribed regulations concerning the mining rights. A careful search of the records is often required.

The location of a lode claim on open public land entails the following general steps:

1. Make a discovery of mineral in place within the surrounding country rock. The discovery should be of a nature to warrant a prudent man to expend time and money in working the claim in the expectation of developing a mine.
2. Put up a discovery post or monument and mark the outline of the claim as required by law.
3. Post on the claim a location notice and record the notice in the proper county courthouse. The forms for such notices may be acquired from some blueprint or printing companies or dealers in mining equipment. County recorders sometimes have blank forms available.
4. Perform the required location work as specified by law.

To keep title to a claim, the locator must do annual assessment work, to a value of $100, that improves or develops the claim. Notice of performance of assessment work should be posted at the claim and, although not required by law, should also be recorded in the proper county courthouse.

Returning to the question "Who's digging in your backyard?", it behooves prospective buyers of property in Arizona to check on the status of the land they are considering in respect to the mining rights that pertain to that property and also as to the possibilities of economic mineral being found in or under that property. Unless the land is exempted from mineral entry, or comes within certain restrictions, the law allows the staking of a valid mining claim on any property. The surface owner may be able to receive compensation for excess damage done to the surface of his property but he can not exclude a bona fide locator.

ENVIRONMENTAL CORNER

The general public, industry, and government have all become aware of the need for cleaner air and water, and the most beneficial use and care of the earth's surface. Government regulations are being set up to control the discharge into the environment of pollutants, contaminants, waste products, and heat that may be detrimental. Industry is spending millions of dollars in research and equipment to control their contribution. Hopefully the general public also is beginning to recognize its responsibility. Pollution of the environment, whether from natural or man-made sources, has been present on the earth long before man started to take notice but only within the past few years has he begun to react to the growing danger of his adding additional pollution to his surroundings. Characteristically we point accusing fingers only at the most visible causes without recognizing that all segments of our modern society share the responsibility for both causes and solutions. A sound and factual understanding of the problems and possible solutions, by all segments of our society, is required. The Arizona Bureau of Mines will continue to present in this column news items and published commentaries concerning environmental matters related to the field of earth science which we think will contribute to a general understanding of both problems and the steps being taken to solve them.

MERCURY

Recent news stories of mercury poisoning in Japan and New Mexico and the disclosure of the high mercury content in swordfish and some tuna has caused wide-spread concern in the public mind. To bring out some of the known facts concerning the occurrence, behavior, distribution and effects of mercury, the U.S. Geological Survey has published Professional Paper 713 (1970) and Dr. Roger L. Caldwell of the U. of A. has provided a commentary (Arizona Daily Wildcat, Univ. of Ariz., April 22, 1971), both entitled "Mercury in the Environment". The following information is abstracted from those articles.

Mercury is the only metallic chemical element occurring as a liquid at normal earth temperatures and pressures. It is 13½ times heavier than water but like water can be vaporized and condensed with variations in temperature and pressure. Mercury is readily absorbed and held tightly by many materials and reacts readily with many organic and inorganic compounds. It is widely dispersed in varying amounts in rocks, soil, air, water and living organisms. The most common natural source of mercury is cinnabar, a red mercury sulfide occurring in veins, fractures and impregnations. In Arizona, cinnabar occurs in sufficient concentrations to have been mined in the Dome Rock Mountains of Yuma County and the Mazatzal Mountains along the northern border of Maricopa and Gila counties. Mercury has been considered as a strategic material since only one-half of the U.S. requirements have come from domestic sources. It has been widely used in electrical equipment; in chlorine and caustic soda production; in plastics; in paint preservatives; in agricultural and industrial insecticides, fungicides, and bactericides; in dental and pharmaceutical preparations; and in some other miscellaneous products or processes. The U.S. consumption in 1970 was estimated by the U.S. Bureau of Mines as almost 4.8 million pounds.

Detection of mercury in trace amounts (1 part per trillion in the atmosphere and 0.1 parts per billion in water and earth materials) has only been possible in recent years. The content in rocks varies considerably but except around mercury and some other mineral deposits does not average more than 100 parts per billion (one pound of mercury per billion pounds of rock). The amount of mercury in the atmosphere is normally very low, probably not more than 0.003 parts per billion. As would be expected, abnormally high readings are recorded over mercury deposits and recent tests indicate that the air over active volcanic areas also may contain a relatively high mercury content. Small amounts of mercury also have been detected in association with precious metal and base metal sulfide deposits which may give readings 10 to 50 times the normal background at the surface. The amounts in the air vary with temperature and pressure and decrease rapidly upward. Rain washes the mercury out of the atmosphere and once on the surface it is rapidly trapped in the soil or extracted out of the surface water by organic and inorganic materials, forming compounds or being absorbed by plant and animal life. Fossil fuels - coal and petroleum - also contain higher than normal concentrations of mercury.

Mercury occurred in the earth's environment long before man existed. The absolute tolerance of animal and plant life to mercury is not yet established but the Food and Drug Administration has set a guide-line of 0.5 parts per million as a standard beyond which the effects of mercury in man's diet may become deleterious. Great care must be taken in handling mercury, mercury-containing products or around areas where mercury has been used. In Arizona, except for the limited tests over mercury, precious metal, and open pit copper mines, the contents of mercury in the soil, air, food, plants and animals are largely unknown but they are probably well below the presently established guide-line.

As Dr. Caldwell points out, mercury is wide spread in our environment and to a large extent is a naturally occurring contaminant. What is important in respect to man's possible contribution to mercury contamination is the relative small margin of safety between natural levels that man, other animals, and plant life have and can tolerate and the harmful toxic levels that may result from improper safeguards.

GEOTHERMAL ENERGY

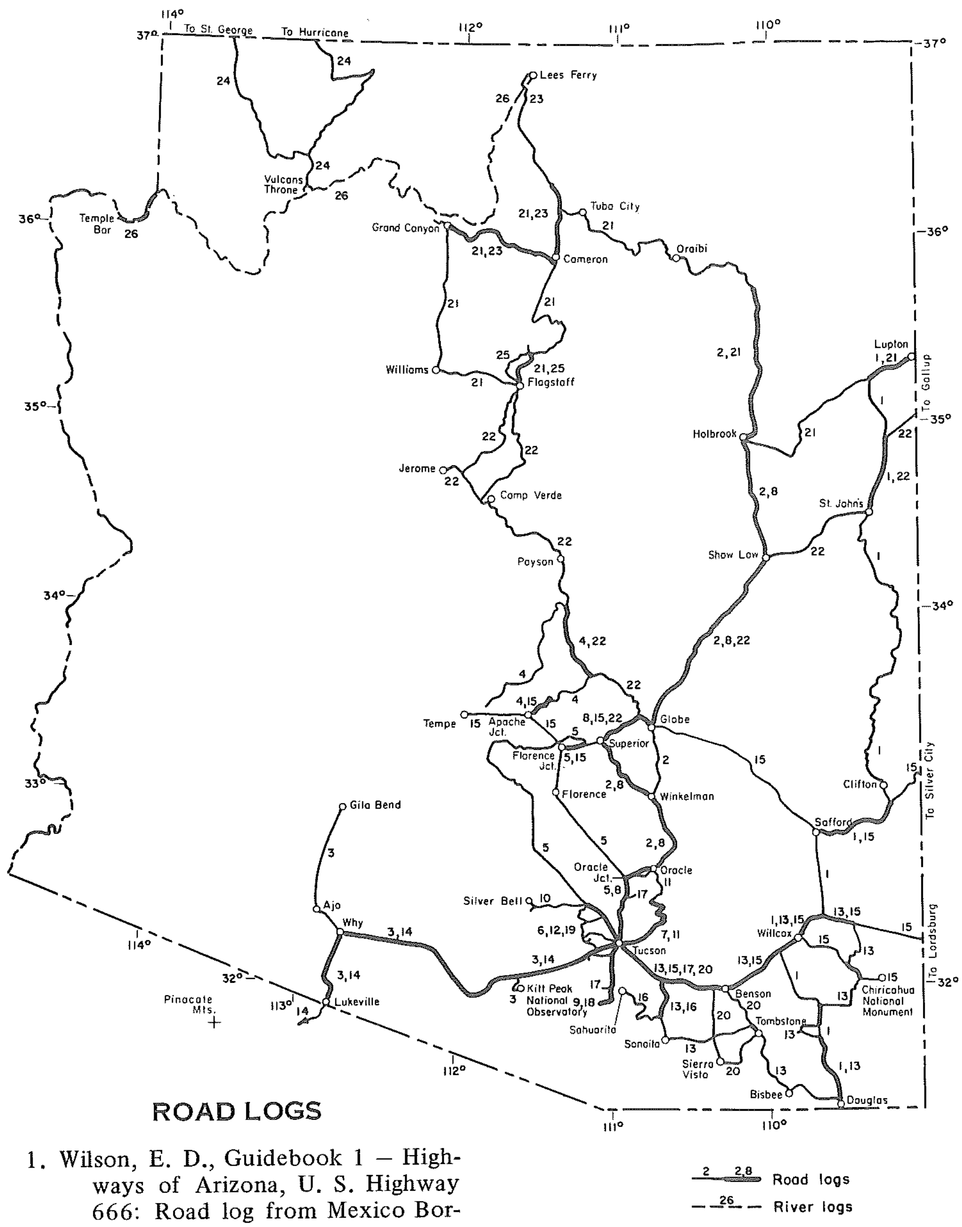
The Department of the Interior has announced the publication in the Federal Register of the first report by the U.S. Geological Survey on the nation's "hot spots", known geothermal resource areas (KGRAs), where exploration for such resources appear to be most promising. Geothermal resources include energy and any associated mineral products which can be extracted from steam and hot water emitted from the earth. Geothermal energy, derived from the steam tapped by drill holes and carried to generator units, is a potential source of pollution-free power.

As indicated in the last issue of "Field Notes", areas of recent volcanic activity, such as in California, Nevada, Oregon, and Washington hold the greatest promise for geothermal development. Although known to have some hot water springs and wells, Arizona has not yet been cited as having KGRAs.

OLD MINING CAMPS

Old mining camps, whether relics of the past or still alive and active, are fascinating subjects for a visit or for study. Recently the mining town of Bisbee in Cochise County was the subject of a photographic study of a class in advanced photojournalism at the U of A. The project, 'A Portrait of Bisbee' will cover the town, its people, and their activities. An exhibit of the best pictures is to be displayed in Bisbee and at the UA Student Union. When asked, "Why Bisbee?', Thomas Cooper, journalism lecturer, replied "Because the town is small enough and a confined area geographically. Besides it is photogenic and has lots of character."

INDEX TO ROAD AND RIVER LOGS IN ARIZONA



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3. Keith, S. B., Geologic Guidebook 3 – Highways of Arizona, Arizona Highways 85, 86, and 386: Road log for Highway 86 from Tucson to Ajo, Highway 85 from Ajo north to Gila Bend and south from Why to Lukeville. Highway 386 south from Highway 86 to Kitt Peak National Observatory. Arizona Bureau of Mines Bulletin 183 (1971).
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17. Lacy, W. C.; Engineering Geology, Tucson and Benson Areas: Arizona Geological Society, Guidebook 3 Southern Arizona (1968).

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Cooley, M. E.; Road Log from Gray Mountain Trading Post to Flagstaff via U.S. Highway 89.

Cooley, M. E.; Road Log from Flagstaff to Gray Mountain Trading Post via Schulz Pass, Sunset Crater, and Wupatki.

Chenoweth, W. L., and Akers, J. P.; Road Log from Gray Mountain to the Gap and thence to Desert View.

Chenoweth, W. L.; Exit road Log, Grand Canyon rim drives and Orphan Mine.

Chenoweth, W. L.; Exit road log, Flagstaff via Williams Junction: New Mexico Geological Society, Guidebook of Black Mesa, Ninth Field Conference (1958).

22. Foster, R. W., and others; Road log from Gallup to Globe via Zuni, St. Johns, Show Low, and Salt River Canyon.

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Breed, W. J.; Alternate route from mile 152.4 to Flagstaff via Black Canyon Highway: New Mexico Geological Society, Guidebook of the Mogollon Rim Region, East-Central Arizona, Thirteenth Field Conference (1962).

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Hamblin, W. K., Rigby, and Keith, J.; Part 2 – Phantom Ranch in the Grand Canyon National Park to Lake Mead, Arizona-Nevada: Brigham Young University, Geology Studies Vol. 16 Part 2 (1969).

PUBLICATIONS

The following, arbitrarily selected list of publications and references that deal with various phases of earth science has been compiled with the assistance of Mrs. Jan Wilt, Assistant Geologist. Inclusions or exclusions of any publication does not imply any judgement or recommendation of merit. The selection consists mainly of paperbacks that might not normally come to the attention of the general public.

An extensive list of paperback books dealing with earth science has been compiled by Cleo V. Proctor, Jr. and published in the Journal of Geological Education (Vol. 15, No. 1, p. 30-55, 1966, and Vol. 16, No. 2, p. 65-68, 1967). Copies may be available also from the Council of Geological Education, 2201 M Street N. W., Washington, D. C. 20037 or Director of Education, American Geological Institute, 1444 N Street N. W., Washington, D. C. 20005.

The Earth Science Curriculum Project (ESCP) Phamphlet Series, edited by Robert E. Boyer (1971), has been published by Houghton Mifflin Co. for the American Geological Institute's Earth Science Curriculum Project (1971). $1.60 each; $14 a set. School prices: $1.20 each; $10.50 a set. Included are:

Field guide to rock weathering by Robert E. Boyer (PS-1) 38 p.

Field guide to soils by Henry Foth & Hyde S. Jacobs (PS-2) 38 p.

Field guide to layered rocks by Tom Freeman (PS-3) 46 p.

Field guide to fossils by James R. Beerbower (PS-4) 54 p.

Field guide to plutonic and metamorphic rocks by William D. Romey (PS-5) 53 p.

Color of minerals by George Rapp, Jr. (PS-6) 30 p.

Field guide to beaches by John H. Hoyt (PS-7) 46 p.

Field guide to lakes by Jacob Verduin (PS-8) 46 p.

Field guide to astronomy without a telescope by William A. Dexter (PS-9) 54 P.

Meteorites by Carleton B. Moore (PS-10) 46 p.

This series, prepared by earth scientists, contains photographs and background data and also describes original ways to find, record, and interpret features of the environment.

Resources and man by the Committee on Resources and Man, Division of Earth Sciences, National Academy of Science–National Research Council: W. H. Freeman & Co. (1969), San Francisco, 259 p. $2.95.

A study of the problem of resource adequacy including the ecology and geography of resources in relation to man, demographic trends, and the adequacy of food, mineral, and energy resources to meet current and expected demands.

Invitation to geology: the earth through time and space by William H. Mathews III. Natural History Press (1971) 148 p. Cloth $5.95; Paper $1.45.

'A broad-brush treatment of the more fundamental aspects of the study of the Earth. . .It is not only an invitation to geology, but to the world of the geologist: what he is, what he does, and how he goes about doing it.'

Opportunities in geology and geological engineering by Alfred K. Snelgrove. Vocational Guidance Manuals (1970), 235 East 45th Street, New York, 10017. 157 p. Cloth $3.75; Paper $1.95.

Continued on page 10

Publications (continued)

A reference for those interested in geology as a career.

Vital views of the environment edited by Mary L. Hawkins. National Science Teachers Association (1970) 32 p. $1.50

Concepts and major ideas for use of science teachers.

Man's impact on environment by Thomas R. Detwyler. McGraw-Hill (1971) 731 p. $5.95.

Discussion of changes in the environment brought about by man on the surface and in the subsurface.

This island Earth edited by Oran W. Nicks. National Aeronautics & Space Administration SP-250 (1970) 182 p. $6.00. For sale by U. S. Government Printing Office, Washington, D. C. 20402.

Contains numerous photographs of the earth from space.

Geologic time–the age of the Earth by the U. S. Geological Survey (1970), Washington, D. C. 20242. Free.

Earthquakes by the U. S. Geological Survey (1970), Washington, D. C. 20242. Free.

Streamflow in the Upper Santa Cruz River Basin, Santa Cruz and Pima Counties, Arizona by A. C. de la Torre. U. S. Geological Survey 1970 (1971) Water Supply Paper 1939-A, p. A1-A26, Plates. $1.50. For sale by the U. S. Government Printing Office, Washington, D. C. 20402.

Water resources of the Tucson basin.

Special Map–Phoenix, Arizona (1969). Experimental edition. Scale 1:250,000 (1 in. = 4 miles) Sheet 24x34 inches. $1.50. For sale from Distribution Section, U. S. Geological Survey, Federal Center, Denver, Colorado 80225.

FROM THE BUREAU FILES

The files of the Arizona Bureau of Mines contain a collection of newspaper and journal clippings and reports on Arizona mines and mining companies dating from about 1915. Such information, reliable or not, is often meager in details but may be the only available written clue to the past mining activity in some areas. The following report, reproduced in type exactly as written in long hand by its author, is an example. Even such a report may reveal useful facts providing one can reconstruct the spelling and grammar.

HILLTOP, ARIZONA 5/19/34

"To whom it may concern

I will hear make a Short Report on the Humbolt mine. Situated and Located in the California ming District in Cochise County State of Arizona it consists of 9 unpatented mining claims Country Rock Massive Limestone A Shaft on north Contact of a Daysite Porphyry intrusion 68 feet thick shaft Depth 200 feet on a 45 Degree Dip to the north following the ore all the way Down the ore not frozen to either wall Bouth walls Selvage

At 90 feet Down in Shaft one Drift Ran on the Vein 30 feet and a Drift Ran to the East A Bout 50 feet in At the 200 Level of Shaft Ore Crosscut Ran South 68 feet While Cuts through the Porphyry and Picks up the Top Édg of the Same ore and quartz gang that is on the north Contact.

Also from the Bottom of the Shaft a Drift Runs A Bout 35 feet on the vein and a Raise a Bout 40 feet from the Drift

Strike of vein East West Dip at a Bout 45 Degrees to the north this is Easy of Access a Bout 13 miles from Railroad at Rodeo New Mexico a good Road in 14½ miles of the mine and a Fairly good Road to the Collar of the Shaft

A Bout 400 feet of Development work done and ít all Except 68 feet is Run in a Contact vein carying a Quartz gange and a alibandite ore in a White Quartz gang in all the workings the ore will average 5 feet 6 inches thick the gang Dont Cary anything Detrimental

Conditions the mine is in a Present it has a Plant of machinry all in Place a hoist air Compressy All under a good Roof and I Believe in good shape. The Collar of the Shaft has a Bout 10 feet Down is Some What out of Order A About 6 Stulls and a few Laggin will fix that The gallas frame with some Repar will work the Shaft has 60 feet of watter in it crosscut 68 feet and a 20 foot Drift and a 40 foot Drift and a 35 foot Raise full of water I unwattered this mine once 3 min and ½ to Bucket and it took 8 days and then it Dont make But A Bout 100 gallon Per Day

I Believe Plenty of water a Bout 1000 feet away from Shaft to Run a 20 ton mill a man can get a good Idea of the mine By fixing the Collar of the Shaft I was operating this mine A Bout 15 years past for some parties that had it Leased and I taken 5 Assay samples Below the 40 foot Level but a Cross the 5 foot 6 inch vein and it made a assay of 20 ozs Silver per ton

this mine can be taken over on a Long Lifed Bond and Lease at a Low price the Title is all in good shape iff I was a Bit Better Financed I would fix the Collar of the Shaft and fix the Ladders Down to the Bottom and unwatter the Shaft"

AT THE UNIVERSITIES AND COLLEGES

U OF A STUDENT FEATURED

The February commemorative issue of 'Mining Engineering', the official publication of the Society of Mining Engineers, a constitutent society of AIME, featured, on its cover, the picture of Dave Bollas, a senior student in extractive metallurgy, ore dressing option, at the University of Arizona. Dave was selected as an example of the coming generation of mineral specialists who will "hold the future of mining in their hands." Dave noted that "I have given a lot of thought to problems I will face with the industry . . . I think the present-day mining industry is too wasteful . . . specialization has caused many engineers to subordinate everything to doing their job the cheapest and fastest way. In the future this won't be enough. The (future) engineer in the mineral industry will be responsible not only for mining, concentrating, and smelting, but also for the resultant wastes . . ."

PROFESSIONAL DEGREES

Six University of Arizona College of Mines alumni will receive professional engineer degrees at the U of A commencement exercises May 29 of this year. Professional mining engineer degrees will be awarded Jack W. Still, (1921), Tucson, and Carl W. Appelin, (B.S., 1950), Grand Junction, Colorado. Norman E. Dausinger, (B.S., 1954), Hermosillo, Sonora, Mexico, and Donald F. Hammer, (B.S., 1952, M.A., 1961), San Manuel, will receive professional geological engineering degrees. Monroe Harris, (B.S., 1948), New York City, and Robert C. Meaders, (B.S., 1943), Clarkson, Ontario, Canada will be presented professional metallurgical degrees.

PRESCOTT COLLEGE

Blended into the rolling Precambrian granitic terrain north of Prescott, in Yavapai County, is the relatively new campus of Prescott College. The charter class entered this small private liberal arts college in 1966 and the student body now numbers about 250 and the faculty 45. The curriculum is organized into five Teaching and Research Centers; The Center for Contemporary Civilizations, the Center for Language, The Center for Man and Environment, The Center for the Person, and The Center for Systems. Geology is one of four major programs in

The Teaching & Research Center for Man & Environment which stresses ecological concepts and uses the natural features of the location of the college as a field laboratory. The geological studies are developed along two lines; one for students preparing to follow geologic careers and who plan to continue their studies in graduate school, the other for those desiring a broad geologic background for other environmental studies. Individual research is strongly encouraged for both groups. At present some 20 students are taking the general geologic courses and five students are majoring in geologic sciences.

The two man faculty in the geology section are Assoc. Professor Douglas C. Brew and Assoc. Professor Vernon A. Taylor. Dr. Brew's principal interests lie in the fields of paleontology and stratigraphy and his research has been centered on field and laboratory studies of the Pennsylvanian rocks of the Mogollon Rim region of central and east-central Arizona. Dr. Taylor has a background in petroleum exploration and his current research interests are the geochemistry of mineral alteration, and carbonate deposition in the Grand Canyon region. He is also studying the weathering effects at the strip coal mine in Black Mesa.

We are please to note that the Center for Man and Environment at Prescott College has established a close association with the staff and research center at the Museum of Northern Arizona in Flagstaff and hope that such contacts with other institutions dealing with earth science in Arizona can be widened further.

ARIZONA STATE UNIVERSITY

Dr. Roy L. Pewe, Professor of Geology and Chairman, Department of Geology, Arizona State University, Tempe 85281, has kindly furnished us information on the activities and interests of his department. The Department of Geology at ASU is in the College of Liberal Arts and offers B.S. and M.S. degrees in Geology and B.A. and M.A. degrees in Education in Geology. Established in 1957, this department has recently had a faculty of eleven, 70 undergraduate students and 26 graduate students. The department has had a close affiliation with the well-known Center for Meteorite Studies and its research facilities and has initiated an interchange with the geologic staff at Northern Arizona University and the Museum of Northern Arizona in Flagstaff.

The teaching and research interests of the faculty in geology at ASU cover a broad field as summarized below:

Buseck—Mineralogy and geochemistry. Meteorites; ore mineral synthesis; ore genesis and processes of ore deposition; electron microprobe studies.

Fisher—Mineralogy of phosphates. Goniometric, X-ray and optical crystallography; refractometry; fuel, areal and stratigraphic geology; pegmatites.

Holloway—Igneous petrology. Experimental determination of phase equilibrium in silicate systems; origin of basaltic rocks.

Larimer—Geochemistry and petrology. Composition and mineralogy of meteorites, experimental petrology; abundance and distribution of the elements.

Lundin—Paleontology and stratigraphy. Silurian-Devonian Ostracoda, conodonts and stratigraphy; Late Tertiary and Quaternary fresh water Ostracoda; Mississippian conodonts.

Miller—General geology and earth science for public school teachers.

Moore (Director, Center for Meteorite Studies)—Geochemistry and petrology. Chemistry and petrology of meteorites and lunar rocks; petrology of igneous and metamorphic rocks. Analytical geochemistry.

Pewe—Geomorphology. Pleistocene, glacial, and periglacial geology.

Ragan—Structural geology. Structures, fabrics, and deformational processes in metamorphic rocks; alpine dunites and glacier ice; physics of magmatic and ash flow.

Sheridan—Igneous and metamorphic petrology; volcanology and optical mineralogy; remote sensing in geologic mapping; sulfate synthesis.

Two new faculty members are to be added in 1971, in the fields of Sedimentology and Solid Earth Geophysics.

NEW HIGHWAY GUIDEBOOKS

As may be noted in this issue, in the listing and map under "Index to Road and River Logs in Arizona," the Bureau has recently published two new Geologic Guidebooks - Highways of Arizona (Nos. 3 and 4). Bulletin 183, Arizona Highways 85, 86, and 386, by Stanton B. Keith, covers the north-south road between Gila Bend, Maricopa County, and Lukeville, on the Mexican border, in Pima County; the road between Tucson and Why, at the intersection of Highways 85 and 86; and the short spur road up to Kitt Peak. Many points of interest are covered, including the open pit copper mine and metallurgical installations at Ajo and the Organ Pipe Cactus National Monument along Highway 85; the Papago Indian Reservation along Highway 86; and the Kitt Peak National Observatory at the end of Highway 386.

Bulletin 184, Arizona Highways 87, 88, and 188, by Chester F. Royse and Michael F. Sheridan of ASU and H. Wesley Peirce of the Bureau, describes the interesting scenery and geology of an area to the northeast of Phoenix often visited by tourists and residents. The described route starts on Highway 88, at Apache Junction, proceeds along the Apache Trail to the Roosevelt Dam and then north along Highway 188, on the west side of Theodore Roosevelt Lake and the Tonto Basin to Slate Creek Road, where the route cuts west to Highway 87. The latter Highway, known as the Beeline Highway, is followed southward across the Mazatzal Mts., along Sycamore Creek, and into the Salt River Valley to Mesa.

These guidebooks, including the previously published Bulletins 174 "Guidebook 1 - Highways of Arizona, U.S. Highway 666" by Eldred D. Wilson, 1965 and Geologic Guidebook 2 - Highways of Arizona, Arizona Highways 77 and 177 by H. Wesley Peirce, 1967, are designed to provide residents and tourists, whether amateurs or professionals, a brief outline of the natural features, geology, and happenings along the routes covered. Additional guidebooks covering other popular routes and areas are planned for future publication.

NEWS FROM AND ABOUT OTHERS

THE ARIZONA HISTORICAL SOCIETY

The picture on the front page, showing prospectors of the past, is a Ray Manley photograph of a painting in the Arizona Historical Society museum, 949 East Second Street, Tucson 85719. The artist is unknown but the picture was painted about 1884 and the locale is probably the Superstition Mountains to the east of Phoenix. It is evident from the looks and actions that the prospectors have once more missed 'striking it rich'.

The Arizona Historical Society, formerly known as The Arizona Pioneers' Historical Society, was founded in 1884. It has been designated as the state historical society, collecting and exhibiting artifacts and documents pertaining to the history of Arizona and the Southwest from the arrival of the Spaniards to 1912, when Arizona became a state. The museum and library offers fertile ground for research and personal investigations through informative exhibits; collections of maps and documents; and items used by the military and early settlers. Plans have been completed to double the size of the museum with one section devoted to early mining

Continued on page 12

NEWS FROM OTHERS *(continued)*

history. The Society is anxious to acquire through gifts or loans any pictures of or items used in the mineral industry in those early years.

ARIZONA GEOLOGICAL SOCIETY

Some twenty-one years ago the Arizona Geological Society was organized in Tucson to promote and encourage interest in geology of the State of Arizona. Membership is open to all who are professionally interested in the geology of the State. The annual dues are $3.00, excepting graduate students of universities and colleges whose membership is free.

Activities of the Society include monthly dinner meetings between September and June, usually on the first Tuesday, at which guest speakers give talks on earth science or related subjects; acting as host for periodic meetings of the Cordillera Section of the Geological Society of America in Tucson and publishing guidebooks for those meetings; publishing the Arizona Geological Society Digests containing short papers on earth science subjects relating to Arizona and the Southwest and items on general earth science activities in Arizona; the publication of an Arizona Highway Geologic Map; and arranging informal field trips under the leadership of geologists working in or having detailed knowledge of specific areas in Arizona.

Inquiries concerning the Society may be addressed to the Secretary, Asst. Prof. Donald E. Livingston, Geology Building, University of Arizona, Tucson 85721. Inquiries concerning publications of the Society should be addressed to the Arizona Geological Society, P.O. Box 4489, University Station, Tucson, 85717.

U. S. BUREAU OF MINES

We welcome the following report received from Mr. Floyd D. Everett, Liason officer, Phoenix office, U.S. Bureau of Mines.

"The Federal Bureau of Mines has issued Bulletin 650, which includes updating the 1965 version of Bulletin 630, "Mineral Facts and Problems." This publication, which has been reissued every five years since 1960, is the most comprehensive of the series and is available from the Superintendent of Documents, Government Printing Office, Washington, D.C. (20402) for $10.75. Also recently published were the combined volumes I and II of the 1969 Minerals Yearbook, which comprises statistical data for metals, nonmetals and fuels.

"The status of Bureau activities in Arizona is summarized as follows:

"Preliminary testing by the Salt Lake City Metallurgy Center of sodium citrate absorbtion for SO_2 removal from smelter gases at San Manuel has been completed and a paper on the results will be presented at the AIME Environmental Conference for the extractive industries at Washington, D.C., June 7-9. The next phase of testing the method will be on a larger scale, probably at some smelter. The method will be further tested by Getty Oil Company at petroleum refining facilities at Delaware City, Delaware.

"The Salt Lake Center is beginning small scale testing using the citrate absorbtion method to recover low concentration SO_2 gas from assimilated coal-burning power plant stack gases.

"The environmental section of the Salt Lake Center recently assisted the fish and wildlife management of the Lynx Lake recreational area near Prescott in methods of controlling harmful qualities of copper and zinc ions. The metals probably were from drainage of old mine tailings and were adversely affecting fish growth in Lynx Lake.

"Studies are being continued by the Intermountain Field Operation Center on availability of copper under various economic conditions. This study, when completed, will present a review of known domestic reserves and the economics of copper and byproducts recovery under varying costs.

"Personnel from the Denver Operation Center have been assisting the Papago Indian Mining Council in making a financial analysis of copper mining and processing to determine the effects of varying royalty payments on profit ability.

"The Bureau part of the field work to determine what mineral values may occur in proposed wilderness areas (a cooperative effort of the Bureau and the U.S. Geological Survey) has been completed for the Chiricahua area in Cochise County and is starting in the Galliuro wilderness area in Graham County."

FIELD NOTES

State of Arizona
Governor . . . . Hon. Jack Williams
University of Arizona
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