FIELD NOTES FROM THE ARIZONA BUREAU OF MINES

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THE ECONOMIC IMPORTANCE OF MINERAL INDUSTRY LAND USE IN ARIZONA

By
Dr. George F. Leaming
Research Specialist
Division of Economic & Business Research
The University of Arizona

The mineral industries use a relatively small amount of Arizona's surface land area compared to other economic activities. In 1966, the state's mineral industries occupied approximately 93,000 acres, only 0.13 percent of the entire area of the state. Despite the relatively small amount of land used, the industry produced mineral commodities worth almost $622.1 million.[1] This was equivalent to a gross annual output of approximately $6,700 worth of minerals from each acre of ground used by the industry. By the end of the 1960's the amount of land occupied by Arizona mineral producers had increased to about 117,000 acres, and the value of the state's mineral output had risen to almost $860 million per year, thereby increasing the yield per acre to over $7,300.[2] These per-acre yield figures are averages and as such are not applicable to all types of mineral industry land use. Some types of industry activity undoubtedly produce more per acre while others produce less.

Gross output value is, of course, not the only economically significant aspect of mineral industry land use in Arizona. The land used to produce mineral commodities is also involved in the generation of jobs and personal income. In 1969 the 0.16 percent of the state's land area used for mineral production provided $176 million in wages and salaries, 4.5 percent of the state total.[3] This indicates an average personal income yield from the state's mining lands of $1,500 per acre per year. This is a minimum, however, since it does not include personal income realized as rent on mining land, profits, or interest on investments in mineral industry enterprises within the state.

Despite mining's major significance in the economy of Arizona, it is far from being one of the larger users of the state's land. In recent years, grazing has been the largest user of Arizona land, with such activity occupying over 40 million acres, more than 55 percent of the state's total

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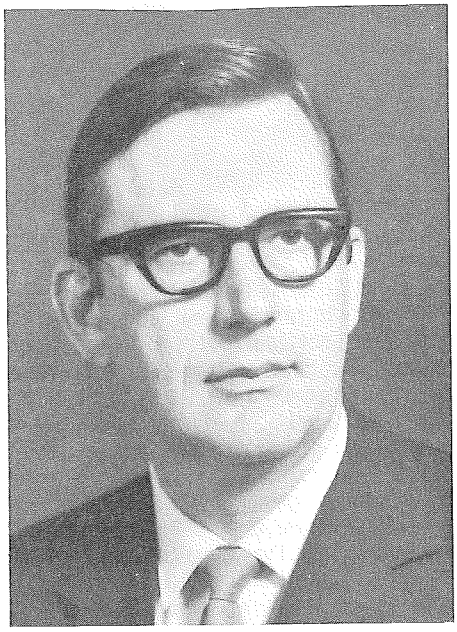
BUREAU WELCOMES NEW DIRECTOR



Dr. William H. Dresher, new director of Arizona Bureau of Mines and dean of College of Mines.

Dr. William H. Dresher, former project manager for fibrous ceramic materials, Union Carbide Corp., assumed his duties Sept. 1, as the new dean of the College of Mines, University of Arizona. He is also serving as director of the Arizona Bureau of Mines and as professor of metallurgical engineering.

His appointment was announced jointly by UA President Emeritus Richard A. Harvill and Dr. John P. Schaefer, who assumed the UA presidency July 1.

The 41-year-old process metallurgical engineer joined Union Carbide in 1956 after earning a Ph.D. degree in metallurgy at the University of Utah. He earned the B.S. degree in chemical engineering in 1953 at Drexel Institute of Technology.

Dresher's major accomplishments include the development of the first cloth to be made out of ceramic material. He was responsible for the zirconia cloth from the research discovery in the laboratory to product development and production.

Dr. Richard M. Edwards, associate dean of the college, said Dresher is nationally known for his work. In 1966 the industry honored the new dean for being the creative force behind two of the 100 most significant technological achievements of the year.

In the middle 1960s, Dresher served as a consultant on the management and organization of U.S. Treasury Dept. laboratories.

The metallurgist, who has four of his discoveries patented and another application pending, developed a process for producing an improved asbestos product for use in vinyl-asbestos tile.

He is also credited with developing a new process for the separation of tungsten from molybdenum for manufacturing a high-purity molybdenum chemical.

He was attached to Union Carbide's Sterling Forest Research Center, Tuxedo, N.Y. He had served in the firm's Nuclear, Mining and Metals and Corporate Research Divisions.

Dresher is the 1972 vice chairman of the American Institute of Mining, Metallurgical and Petroleum Engineers' Extractive Metallurgy Division.

Dr. Richard M. Edwards, associate dean of College of Mines.

Dr. Richard M. Edwards is now serving as associate dean of the College of Mines. He was assistant dean when named acting dean and acting director of the Arizona Bureau of Mines for the past academic year.

MINERAL INDUSTRY (Continued)

area. The large amount of land attributed to this single economic use is somewhat deceptive, however, for many areas of the state are suitable for little other than grazing. As a result, estimates for Arizona's grazing acreage are often derived as residuals, with such activity occupying all the land remaining after all other uses have been accomodated. Furthermore, grazing is not necessarily an exclusive use, but land devoted primarily to grazing is also used for certain recreational activities and other uses.

The great extent of Arizona land devoted to grazing is only partly reflected in the value of the state's livestock output. In the late 1960's, cash receipts obtained by Arizona ranchers and feeders for the sale of livestock and animal products averaged a little more than $300 million per year.[4] This amounts to an average annual gross output from grazing land of about $7.50 per acre. The per-acre figure is deceptively high, however, since a substantial portion of the value of Arizona's livestock output is realized from sales from feed lots and not from open range or pasture. Thus, the actual gross yield from grazing land in Arizona is probably much less than one-tenth of one percent of the gross annual yield from mining land.

Other agricultural activities are also significant users of Arizona land, but the amount that they involve is far less than the amount used for grazing. In 1970, crop raising occupied about 1.22 million acres in the state. From this land a total output valued at approximately $284.7 million was produced.[5] This represents an average annual yield of a little more than $233 per acre. This also is an average and is therefore not uniformly applicable to all agricultural lands.

Farm and ranch land, like mineral land, is also used to produce jobs and personal income. In 1969 the more than 41 million acres used for the raising of livestock and crops provided wages, salaries, and profits amounting to $237 million.[6] This was a little more than four percent of the state's total personal income. Although the total personal income contributed by agricultural use of Arizona land has been somewhat greater than the contribution of the mineral industry, it has required 350 times as much land. Personal income provided by agricultural land use in Arizona in 1969 averaged less than $6 per acre per year as against approximately $1,500 per acre per year obtained from mineral industry use.

The second largest use (or non-use) of Arizona land involves recreation. This category actually involves a multitude of activities, however, and therefore should probably be separated into several distinct classifications. As estimated by the Arizona Outdoor Recreation Coordinating Commission, the largest class of recreational land use in the state involves some 15 million acres that are termed "national environmental areas." Another four million acres, in the state are included in wilderness areas, and an additional one million acres are in what the Commission has called "scenic splendor areas." This relatively low density recreation use thus occupies a total of approximately 20 million acres of Arizona land.[7]

The economic return from low density recreational use is difficult to measure, and such measurement may not even be appropriate. Nonetheless, in 1965, a study of the economic impact of hunting and fishing in Arizona estimated that those using the state's land for hunting made related expenditures in the state of about $21.4 million.[8] Considering that the 15 million acres categorized as "natural environment" were used primarily for hunting, then the gross yield from this recreational land use was less than $1.50 per acre. Measurement or even reasonable estimation of the average gross annual output of Arizona land for other recreational purposes is virtually impossible. Even if the highest available estimates of the gross revenue of the tourism and recreation industry in the state were used, and even if all of that revenue ($450 million in 1966)[9] were attributable to the 23.1 million acres of Arizona land used for both low and high density recreation, the average yield from such use would be only about $20 per acre per year.

Commercial forestry is also a substantial user of the land in Arizona, but the total area devoted to such use ranks far behind grazing and recreation. In the late 1960's the state had an estimated 3.9 million acres in commercial forest use including large areas under the jurisdiction of the United States Forest Service and the White Mountain and San Carlos Apache Indian Tribes. From this acreage, a total output of forest products valued at more than $37.5 million per year was obtained during the last three years of the past decade.[10] This represents an average annual gross yield of less than $10 per acre. The yield in wages and salaries has been far less. Over the period from 1967 through 1969, the payrolls of Arizona's forest industries averaged $21.1 million annually, reflecting a personal income yield from commercial forestry land use of less than $5.50 per acre per year.[11]

Close behind commercial forestry as a user of land in Arizona is national defense. Military installations and other Department of Defense facilities controlled more than 3.1 million acres of Arizona land in the late 1960's. The economic yield from such use of the land is difficult to ascertain, however. Certainly such activities provide personal and business income to residents of the state, but the yield is not consistently related to the amount of land occupied, and the value of the gross output of such activity is virtually indeterminate. As an example, however, of the economic impact of Defense Department land use in Arizona, the 113,000 acres occupied by Fort Huachuca in 1970 provided a combined military and civilian employee payroll of approximately $67.4 million.[12] This indicates a personal income yield of about $600 per acre per year. Much of Fort Huachuca, however, is part of an urban complex that includes the Fort itself and nearby towns. Its personal income yield is thus more comparable to the yield obtained from urban residential, commercial, and industrial uses than that obtained from the large acreages occupied by other defense installations in Arizona and in particular from the large desert tracts used for bombing and gunnery ranges in the southwestern corner of the state.

A variety of other uses occupy more land than the mineral industries in Arizona. Even though the state has a semi-arid climate and much of it is classified as desert, the surface area of lakes and running streams amounts to approximately four times the area involved in mineral resource utilization. A similar amount of land (more than 370,000 acres) is covered by rural roads and highways. An additional 49,000 acres are covered by roads in the state's many national parks, monuments, and forests. Urban uses, mostly residential sites, occupy another 320,000 acres of Arizona land.[13]

The only major economic activities that occupy less space in Arizona than the mineral industries are the railroads and the gas and electric utilities. Railways in the state cover about 54,000 acres, while public utility lines, including both high tension transmission lines and gas pipe lines, use about 60,000 acres of Arizona land. If electrical transmission lines of less than 22,000 volts are included, then the rights of way for electric power lines alone occupy more land than the state's mineral industries.[14] The economic yield from interurban public utility lines, railways, and highways is almost impossible to evaluate, and in any event is not usually related simply to the size of the area that is occupied.

Although the economic return from land utilization is not measureable for a number of activities, an analysis of comparative land use in Arizona indicates that in economic terms mineral resource utilization is the highest use of land outside of the intensive commercial and

industrial uses found in the state's urban areas. Even when some multiple use yields (e.g. grazing, recreation, and forestry), are added together their combined yield is substantially less than the annual gross income per acre obtained from mineral industry activity.

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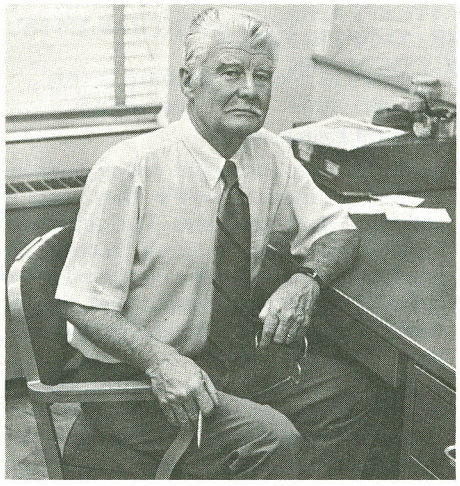
MINING ENGINEER HIRED

David D. Rabb has been appointed Associate Mining Engineer for the Arizona Bureau of Mines.

He has received three degrees from the University of Arizona, including a B.S. in Mining Engineering, 1937 (with distinction); an M.S. in Metallurgy, 1939; and a Professional Degree in Mining Engineering, awarded in 1964.

In 1939, he went to work for the Inspiration Consolidated Copper Company as a metallurgist and continued working there until he went into the U.S. Army in 1941. After World War II, he specialized in metallurgical research and plant design at the Battelle Memorial Institute in Columbus, Ohio. He was recalled to active duty in 1952 and, as a Lt. Colonel, served the U.S. Army Ordnance Corps until released from active duty in 1957.



Mr. David D. Rabb, has recently joined the staff of the Bureau as Associate Mining Engineer.

For the past 14 years, he has been working for the Lawrence Radiation Laboratory, University of California. His work assignments there included metallurgical studies and work associated with underground nuclear test operations. Rabb planned, supervised, and executed drilling and mining re-entry into underground nuclear explosion areas.

Rabb is a member of Tau Beta Pi; American Institute of Mining, Metallurgical and Petroleum Engineers; American Institute of Chemists; and the American Ordnance Association. He is also a registered professional engineer in the states of California, Ohio, and Arizona.

The Bureau is pleased to welcome Dave to its staff.

ENVIRONMENTAL CORNER

ATMOSPHERIC ANALYSIS LABORATORY

The Arizona Mining Assn. board of directors will tour the Atmospheric Analysis Laboratory (AAL) at the University of Arizona Sept. 28.

Nearly a year ago the association granted the UA $545,179 to establish and operate the AAL for a three-year period.

Development of precise atmospheric analysis methodology is a primary goal of AAL, according to Dr. Henry Freiser, UA chemistry professor and senior coinvestigator for the project. Dr. Quintas Fernando, also a chemistry professor, is the other senior coinvestigator.

"We will be looking critically at existing analytical techniques as well as developing our own methods," noted Dr. Jarvis Moyers, AAL director.

Moyers came to the UA from the University of Rhode Island Graduate School of Oceanography where he was a research associate involved in a study of global transport of air pollutants and particulate matter from continental sources.

He earned the Ph.D. in 1970 at the University of Hawaii. Thesis research called for the design of sampling equipment, collection of samples and development of analytical procedures related to the study of marine atmosphere.

AAL will also be involved with training environmental scientists and technicians; studying the interactions between atmospheric pollutants; and analyzing atmospheric pollutants, Freiser said.

The 13-member board will be accompanied by 8 or 10 mining association representatives and personnel.

Since the grant was made, a laboratory staff has been assembled, equipment selected and ordered and two-way communications with other investigators throughout the world have been established.

On Oct. 15, a six-member mining association technical committee composed of representatives from across the country will visit the laboratory.

AAL consultants are Drs. Michael F. Burke and George S. Wilson, both assistant professors in the analytical division of the UA Chemistry Dept. Freiser and Fernando are also faculty of the division.

MUSEUM OF NORTHERN ARIZONA

The Museum of Northern Arizona, located at Flagstaff, has established a Department of Environmental Studies whose principal business is to administrate CPEAC (Colorado Plateau Environmental Advisory Council). The latter is composed of more than 70 diverse groups including the Navajo and Hopi Indian tribes. CPEAC also issues a monthly newsletter.

The Department of Geology, under the direction of Mr. William J. Breed, is always a dynamic unit, but its facilities are particularly taxed during the summer season. Although the Grand Canyon country attracts scientists of many disciplines, many of them are geologists who thrive on stimulating conversation, open space, clean crisp air, and excellent outcrops that embrace a wide diversity of geologic problems. The geologic efforts are brought together at the end of the season each year in the form of a symposium on the geology of Arizona with emphasis on the Plateau. This year the symposium was on September 3, the Friday before Labor Day. If you have missed this year's meeting plan on attending the session next year.

SOME OBSERVATIONS AND REFLECTIONS ON THE CO-OP PROGRAM IN THE COLLEGE OF MINES

By Jay C. Dotson
Professor of Mining & Geological Engineering

Nine years ago the first student in the present college-wide cooperative education program was employed by the San Manuel Division of the Magma Copper Company. Since then, 25 employers have made it possible for 73 students to participate in the program.

The College of Mines program was conceived and initiated by the late John B. Cunningham, professor of metallurgical engineering and retired head of the department of mining and metallurgical engineering. From his own personal experience, "Prof" Cunningham recognized the value of work experience both in the development of character and in the enhancement of an academic program. He first became aware of the benefits of cooperative education while observing the successful program offered by the General Motors Institute located in his home state of Michigan. In addition, he worked his way through college as a chemist and found that the experience enhanced his academic studies. With this background and his abiding interest in students, it was only natural that Prof. Cunningham should be the first to advocate and to administer the program in the College of Mines. In 1967, Prof. Jay Dotson, a long-time member of the co-op committee became the second director of the program, a position he presently holds.

The basic idea behind Cooperative Education is that by having the student engage in a real life exposure to his field of study while he is obtaining the academic knowledge of the field, he not only reinforces the knowledge but also becomes more discerning and is able to gain more depth and greater insight into his life's work. The so-called practical or real life experience is integrated into the academic program by alternating periods (semester or summer session) of full-time employment with like periods of full-time study. An incidental although not insignificant advantage of the program is the opportunity for the student to become more independent, and perhaps for the first time in his life, to pay his own way.

The first recognized cooperative education program was started in 1906 at the University of Cincinnati by Herman Schneider, who was then professor of Civil Engineering and was later to become dean of the College of Engineering. Professor Schneider had worked his way through college by working in the coal mines and by assisting an architect part-time. From a study made as an instructor, Schneider found that nearly all of the more successful young engineers worked in industry while they were in college. These graduates had apparently bridged the gap between theory and practice and between the cloistered life of parental home and campus and the real world of work and individual responsibility.

Today, about 200 institutions of higher learning in the United States have cooperative education programs, not only in engineering, but in other professional fields as well. An estimated 70,000 college students are studying under the cooperative plan and almost every major employer of college graduates is participating in the program. All this is the result of Dean Schneider's basic concept, "principles may be studied in the abstract, but their applications should be presented concretely."

The co-op program in the College of Mines and in the recently formed College of Earth Sciences is established on nationally* recognized principles as follows:

1. Student employment should be related as closely as possible to his field of study and individual interest within the field.
2. The employment must be considered to be a regular, continuing, and essential element in the educational process, and some minimum time of employment (in our case, one year) and minimum standard of performance must be met to be certified a co-op graduate.
3. The work experience should increase in difficulty and responsibility as the student progresses in his curriculum and in general shall parallel as closely as possible his progress in the academic phases.

What has transpired in nine years of operation of the College of Mines program? It has grown through the years from the one initial student to 28 active student participants in the second semester of the 1971-72 academic year. An interesting observation is that the growth in the number of active co-ops (students on the program) parallels very closely the growth in the total number of companies which have participated in the program to date. The number of actively participating employers, those who employ students within a given year, have grown about half as fast as the student growth rate, indicating that the number of co-op students employed by each employer of the actively participating ones is growing.

Table 1 lists the employers that have at one time or another participated in the program. Four employers, Duval, ASARCO, Kennecott, and Magma, have employed two-thirds of all the co-ops or 50 of the 73 students who have participated in the program. The company which has employed the most co-ops (15 students) is the Duval Corporation. Duval currently (summer 1971) employes eight co-op students. The maximum to be hired by a single company for any work period. The total number of co-op employers by the units or divisions shown in Table 1 is twenty-five, but a much larger list of employers interested in participating in the program numbers over sixty (list available from author on request).

Playing the numbers game will reveal what has happened to the co-op students as a group. Deducting the number currently in the program (24) from the total number of co-op students (73), we find that 49 students have terminated the program. Of these 49, 18 co-ops or 37% have fulfilled the minimum co-op requirements and have graduated, 22 co-ops or 45% have transferred out of the College or withdrawn from the University. Nine co-ops or 18% have dropped out of the co-op program but remained in the College of Mines and subsequently graduated. Of the 18 co-op students graduating, 7 co-ops or about 40% have been retained in the employment of their co-op employer. The retention nationwide of graduating co-op students in permanent employment with their participating co-op company is estimated to be about 50 percent.

Some interesting and pertinent questions remain to be answered regarding the co-op program in the College of Mines and the new College of Earth Sciences. Some of the above statistics would seem to refute long standing allegations regarding the co-op program, such as the superiority of the co-op program in comparison to the regular program; its supposed penchant for instilling motivation, for providing deeper insights, and for showing relevancy, all of which should aid in keeping students in the program and in the College. An in-depth study would be necessary to verify or to refute these and other contentions. Certainly, a few statistics prove very little, but let us compare the co-op statistics with those for university students as a whole.

A Carnegie Foundation study indicates that in a ten-year period, almost 50% of university students in state-supported

*Cooperative Education Association and Cooperative Education Division of the American Society for Engineering Education.

Table 1
CO-OP EMPLOYERS AND STUDENT PARTICIPATION

Participating Employer	No. of Students Employed	No. of Student Work Period
1. Agriculture Research	2	5
2. AMAX	1	1
3. Anaconda Extractive Met. Research	2	6
4. Anaconda Twin Buttes	1	1
5. ASARCO Exploration	1	2
6. ASARCO Mission	8	20
7. ASARCO Silverbell	4	11
8. Bagdad	2	3
9. Banner	1	1
10. Bear Creek*	1	3
11. City Service, Miami Copper	4	15
12. Duval, Tucson area**	15	31
13. Duval, Mineral Park	2	6
14. Heinrichs Geoex	1	1
15. Hudson River Valley Comm.	1	2
16. Infilco	3	6
17. Inspiration	3	9
18. Kennecott Ray Mines	10	25
19. Magma, San Manuel	10	18
20. Mountain States	1	1
21. New Jersey Zinc	1	1
22. Pan American World Airways	1	1
23. Phelps Dodge Corp.***	2	2
24. Pima	3	7
25. Standard Metals, Silverton	1	1
TOTALS	81 (contains duplicates)	173

Note: 73 individual co-op students have participated in the program for a combined total of 173 work periods or about 58 man-years.

* No longer officially participating.
** Includes Tucson office, Esperanza and Sierrita operations.
*** Not officially participating in the co-op program.

schools will drop out of college and just slightly over 50% will get a baccalaureate degree in the time period. Over 55% of the students will change their major, their college, or their university at least once.

The College does not have information on what has happened to all of the 22 co-op students who have left the College of Mines, but most of the students we know of have remained in school and nearly all of these have or will graduate. Most of those who have dropped out of school have joined the military service, and most of this group has indicated a desire to return to school. Taking another look at the 49 co-op students who terminated the program, we see 18 students, or 37%, graduated as co-ops, 9 students, or 18%, graduated in the College of Mines (but not as co-ops), at least 11 students, or 22%, graduated in some other college, and that a total of 77% graduated.

A substantially larger percentage (77%) of students exposed to and aided by the co-op program graduated within a given period of time than university students as a whole (53%). Also, substantially fewer co-op students (45%) change colleges than do university students as a whole (55%). How much, if any, of the better performance and stability of the co-op student is owing to the co-op program is a moot question. A more revealing comparison would be to compare the co-op students and the non-co-op students in the College of Mines, but these data are not available at this time.

An observation one may draw from the long list of employers interested in hiring and training co-op students and the low or nil employment record of all but a few companies is that the unfilled co-op positions represent wasted opportunities for young people. The task of filling these positions must fall to far-sighted employers, high school teachers and counsellors, and to university faculty and administrators.

It will be interesting to see what another decade will bring in the co-op program in the College of Mines and College of Earth Sciences. Will our program keep pace with the co-op movement that is sweeping the country? Will our co-opportunities grow and will they be utilized? Time will tell.

TUCSON GEM & MINERAL SOCIETY

The Tucson Gem & Mineral Society was organized late in the year 1946 by a small group of eager "rockhounds." Now, 25 years later, it can boast a membership of nearly 250, including a small group of Junior members.

The aim of the society is to encourage interest in Earth Sciences, and their activities evidence this. It awards an annual scholarship to an advanced student in the Department of Geosciences, University of Arizona; donates prizes for the annual Southern Arizona Regional Science Fair; yearly donates a number of mineral specimens to the University of Arizona Mineralogical Museum; and has arranged an exceptional display of minerals at the Tucson Chamber of Commerce Building, which is viewed by hundreds of visitors.

The society annually holds a 3-day gem and mineral show, a show that has become one of the largest and considered by collectors and dealers one of the most important in the country. Thousands of visitors from all over the United States and several foreign countries are drawn to their spectacular event. On display are many hundred of the finest mineral specimens in the world.

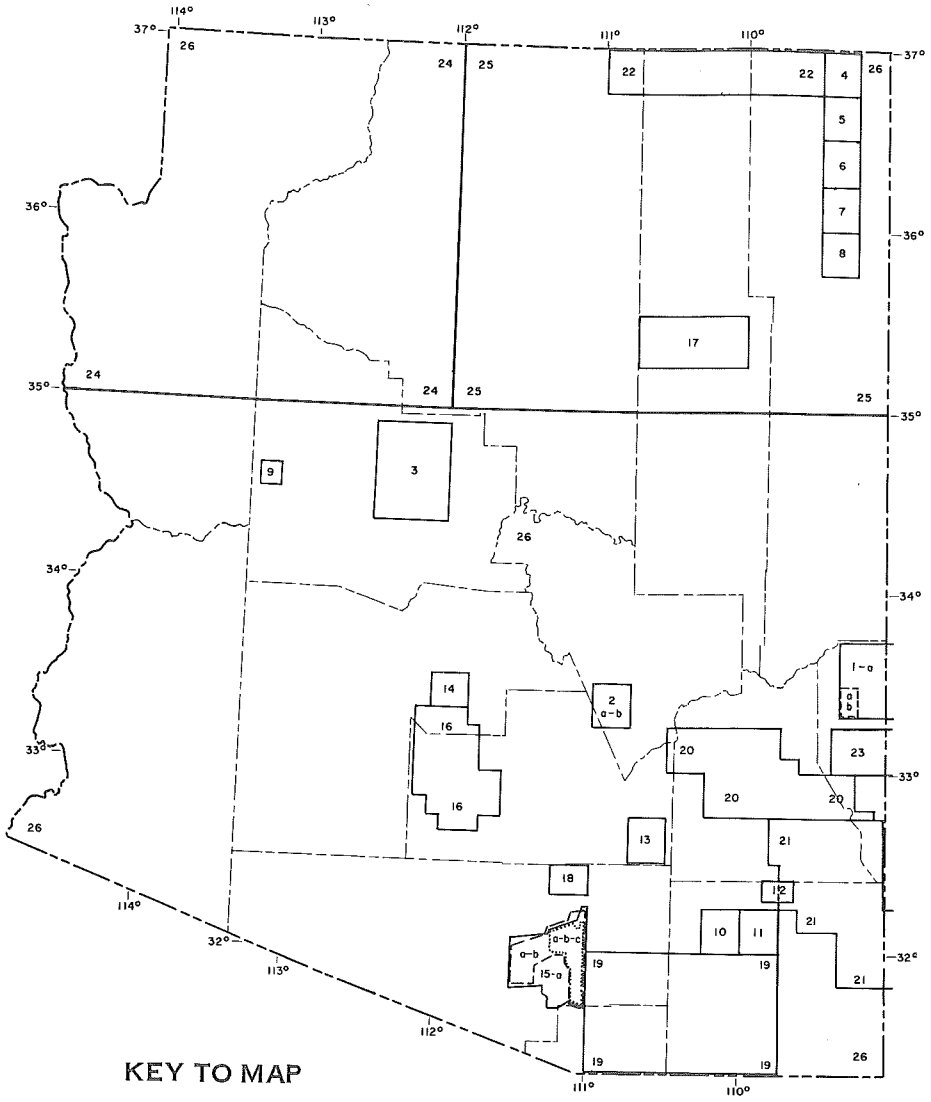
Meetings are held in Room 111 of the Economics & Business Administration Building of the U of A campus at 7:30 p.m. on the first Monday of each month, with the exception of July and September when it meets on the second Monday. A bulletin, "Rock Talk", is sent monthly to all members.

Visitors are very welcome. Inquiries concerning the society should be addressed to the Tucson Gem & Mineral Society, Inc., Box 6363, Tucson, Arizona 85716.

THE UNIVERSITY OF ARIZONA LIBRARY

Whether one is prospecting, rock hunting or simply curious about this part of the country, the University Library is a good place to go. The Main Library and its subordinate science Library boast well over a million-and-a-half items, a fair portion of which is devoted to Arizoniana. At the Main Library, the Map Collection has about 10,000 maps just on Arizona (they have over 105,000 sheets all told); and for those interested in the economic aspects of mining or in geography, thousands of volumes of books, journals and government documents are available. At the Science Library, there is a wealth of material on the geology and mineral resources of our State, including State Bureau of Mines and U.S. Bureau of Mines publications. Photocopying facilities are available, so if the user can't check out what he needs, he can probably get it copied.

AEROMAGNETIC MAP INDEX OF ARIZONA



KEY TO MAP

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10. 1963. Dempsey, W.J., Fackler, W.D., and others, Aeromagnetic map of the Dragoon quadrangle, Cochise County, Arizona: GP-412, scale 1:62,500.
11. 1963. Dempsey, W.J., Fackler, W.D., and others, Aeromagnetic map of the Cochise quadrangle, Cochise County, Arizona: GP-413, scale 1:62,500.
12. 1963. Dempsey, W.J. and Hill, M.E., Aeromagnetic map of parts of the Willcox and Luzena quadrangles, Cochise County, Arizona: GP-418, scale 1:62,500.
13. 1963. Dempsey, W.J. and Hill, M.E., Aeromagnetic map of the Mammoth quadrangle, Pinal and Pima Counties, Arizona: GP-419, scale 1:62,500.
14. 1963. Dempsey, W.J. and Hill, M.E., Aeromagnetic map of parts of the Phoenix, Mesa, Camelback, and New River SE quadrangles, Maricopa County, Arizona: GP-420, scale 1:62,500.
15. 1963. (a) Andreasen, G.E., and Pitkin, J.A., Aeromagnetic map of the Twin Buttes area, Pima and Santa Cruz Counties, Arizona: GP-426, scale 1:62,500.
    1962. (b) Andreasen, G.E. and Pitkin, J.A., Aeromagnetic map of the Twin Buttes area, Pima and Santa Cruz Counties, Arizona - flown at 4,000 feet barometric elevation: U.S.G.S. Open-file, scale 1:62,500.
    1962. (c) Andreasen, G.E. and Pitkin, J.A., Aeromagnetic map of the Twin Buttes area, Pima and Santa Cruz Counties, Arizona - flown at 500 feet barometric elevation: U.S.G.S. Open-file, scale 1:62,500.
16. 1965. Mitchell, C.M. and Zandle, G.L., Aeromagnetic map of the Casa Grande area, Maricopa and Pinal Counties, Arizona: GP-548, scale 1:62,500.
17. 1966. Mitchell, C.M. and Vargo, J.L., Aeromagnetic map of Hopi Buttes and vicinity, Navajo County, Arizona: GP-575, scale 1:125,000.

OTHER AEROMAGNETIC MAPS ON OPEN-FILE

18. 1952. Dempsey, W.J., Aeromagnetic map of part of Cortaro quadrangle, Pima County, Arizona: U.S.G.S. Open-file.
19. 1965. Andreasen, G.E., Mitchell, C.M., and Tyson, N.S., Aeromagnetic map of Tombstone and vicinity, Cochise and Santa Cruz Counties, Arizona: U.S.G.S. Open-file, scale 1:125,000.
20. 1966. Andreasen, G.E. and Galot, G.A., Aeromagnetic map of Safford and vicinity, Graham and Greenlee Counties, Arizona: U.S.G.S. Open-file, scale 1:125,000.
21. 1966. Andreasen, G.E. and Galot, G.A., Aeromagnetic map of the San Simon Valley area, Cochise, Graham, and Greenlee Counties, Arizona, and Hidalgo County, New Mexico: U.S.G.S. Open-file, scale 1:125,000.
22. 1970. U.S. Geological Survey, Aeromagnetic map of the central Colorado Plateau, Utah, Colorado, and Arizona: U.S.G.S. Open-file, scale 1:250,000.
23. 1970. U.S. Geological Survey, Aeromagnetic map of the Morenci-Monticello area, southeastern Arizona and southwestern New Mexico: U.S.G.S. Open-file, scale 1:62,500.

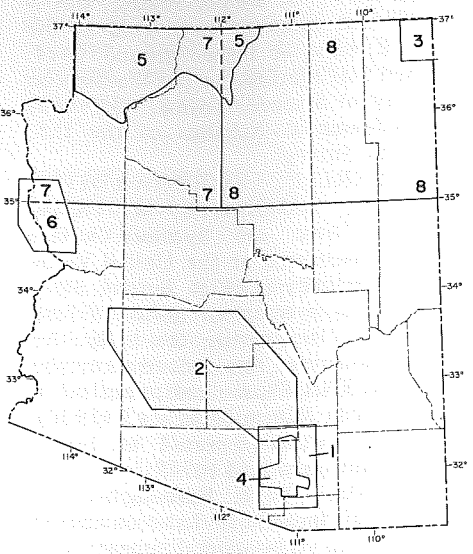
U.S.G.S. MISCELLANEOUS GEOLOGIC INVESTIGATIONS MAP I SERIES

24. 1968. Zietz, I. and Kirby, J.R., Transcontinental Geophysical Survey (35°-39°N) Magnetic map from 112°W longitude to the coast of California: I-532-A, scale 1:1,000,000.
25. 1968. Zietz, I. and Kirby, J.R., Transcontinental Geophysical Survey (35°-39°N) Magnetic map from 100° to 112°W longitude: I-533-A, scale 1:1,000,000.

OTHER AEROMAGNETIC MAPS

26. 1971. Sumner, J.S. and Sauck, W.A., Residual Aeromagnetic map of Arizona: scale 1:1,000,000. Map may be obtained from the Department of Geoscience, College of Earth Science, University of Arizona, Tucson, Arizona 85721, at a cost of $3.00.

GRAVITY MAP INDEX OF ARIZONA



KEY TO MAP

1. 1961. Plouff, D., Gravity Survey near Tucson, Arizona: U.S.G.S. Professional Paper 424-D p. 258 Figure 384.2.
2. 1968. Peterson, D.L., Bouguer Gravity map of parts of Maricopa, Pima, Pinal, and Yuma Counties, Arizona: GP-615 scale 1:250,000.
3. 1958. Plouff, D., Bouguer Gravity Anomaly map of the Carrizo area, Arizona and New Mexico: Figure 5 U.S.G.S. Open-file.
4. 1962. Plouff, D., Bouguer Gravity Anomaly map of the Twin Buttes area, Pima and Santa Cruz Counties, Arizona: U.S.G.S. Open-file.
5. 1968. Popenoe, P., Complete Bouguer Gravity Anomaly map of the area north of the Grand Canyon in Arizona: U.S.G.S. Open-file, scale 1:250,000.
6. 1969. Peterson, D.L., Bouguer Gravity map of the Needles area, San Bernardino County, California, Mohave County, Arizona, and Clark County, Nevada: U.S.G.S. Open-file, scale 1:125,000.
7. 1968. Compiled by the United States Air Force Aeronautical Chart and Information Center, Transcontinental Geophysical Survey (35°-39°N) Bouguer Gravity map from 112°W longitude to the coast of California: U.S.G.S. Map I-532-B, scale 1:1,000,000.
8. 1968. Compiled by the United States Air Force Aeronautical Chart and Information Center, Transcontinental Geophysical Survey (35°-39°N) Bouguer Gravity map from 100° to 112°W longitude: U.S.G.S. Map I-533-B, scale 1:1,000,000.

PUBLICATIONS

NEW U.S. GEOLOGICAL SURVEY PROFESSIONAL PAPERS

Professional Paper No. 521-C entitled "Gelology of the Paleozoic Rocks, Navajo and Hopi Indian Reservations, Arizona, New Mexico and Utah," recently released can be obtained from the Superintendent of Documents, Government Printing Office, Washington, D.C. 20402, price: $1.25.

Also newly released and obtainable from the Superintendent of Documents is Professional Paper No. 521-D entitled "Hydrogeology of the Cenozoic igneous rocks, Navajo and Hopi Indian Reservations, Arizona, New Mexico, and Utah," by J.P. Akers, J.C. Shorty, and P.R. Stevens, price: $1.25.

NOTE

Note: Publications and maps issued by agencies other than the Arizona Bureau of Mines must be ordered directly from the issuing agency. Arizona Bureau of Mines publications and maps may be purchased at, or ordered from the Arizona Bureau of Mines, University of Arizona, Tucson, Arizona 85721.

ERRORS AND OMISSIONS

The editors of "Fieldnotes" are human and in spite of careful checking, typographical mistakes, errors, and omissions do creep into the finished copy. For these, we offer our sincere apologies.

In the Vol. 1, No. 2, on page 11, under Arizona State University, Dr. Péwé's first name should be Troy and not Roy and in listing the faculty we failed to include Dr. Chester F. Royse, Assistant Professor of Geology, who specializes in physical and chemical sedimentology of Tertiary and recent fluvial, lacustrine, and shallow marine deposits, and in paleo-environmental reconstruction.

We have been reminded that in the same number on page 6, column 2, under the discussion of the Multiple Surface Use Act, petrified wood was removed from location under the mining law by a 1962 amendment.

We gratefully appreciate the several letters and information received concerning omissions in the "Geologic Map Index of Arizona" and "Index to Road and River Logs in Arizona" that were included in the first two editions. These indices are to be updated periodically in future issues of "Fieldnotes" and the items missed will be included.

BUREAU BULLETIN REVIEWED

Arizona Bureau of Mines Bulletin 182, *Coal, Oil, Natural Gas, Helium, and Uranium in Arizona* by H. Wesley Peirce, Stanton B. Keith, and Jan Carol Wilt, 1970, was reviewed by Martin Van Couvering in the August 1971 issue of the bulletin of the American Association of Petroleum Geologists. Jack Conley of the Arizona Oil & Gas Conservation Commission, Phoenix, originally asked Mr. Van Couvering if he would consider making such a review. It concludes with the statement that "No geologist interested in the subjects it covers can afford to be without a copy. Nothing like it is available anywhere else." The Arizona Bureau of Mines thanks Mr. Conley, Mr. Van Couvering, and AAPG for making this fine review possible.

MINERALS FIRST DESCRIBED FROM ARIZONA

A list of minerals first described from Arizona has been compiled by Mrs. Therese (Rocky) Murchison, Assistant Curator of the Mineralogical Museum, University of Arizona. Rocky has graciously permitted us to print the following list in this edition of our newsletter.

ANTLERITE: First found at the Antler mine, Mohave County, it was described by Hillebrand in 1889. Further work was done by Charles Palache on material from Bisbee and published in the American Mineralogist, v.24 (1939).

ANDERSONITE, SWARTZITE & BAYLEYITE: The American Mineralogist, v.36 (1951), contains a report by a group of four scientists on these three minerals which were found at the Hillside mine in Yavapai County by Charles A. Anderson of the U.S. Geological Survey.

AJOITE: A copper silicate, this mineral was first collected at the New Cornelia mine, Ajo, by Harry Berman in 1941, and was described in the American Mineralogist, v.43 (1958).

BERMANITE: Occuring with triplite, this mineral was collected near the Bagdad Copper mine, about 25 miles west of Hillside, in 1929. Cornelius Hurlbut visited the location in 1931 for additional material and made a report on it in the American Mineralogist, v.21 (1936). He named it in honor of Harry Berman for his many contributions to the science of mineralogy.

BIDEAUXITE: Only two samples of this mineral have been found. R.A. Bideaux recently detected this mineral on boleite specimens collected many years ago from the Mammoth mine at Tiger. The mineral was named after Bideaux by S.A. Williams, writer of the article announcing the find in the Mineralogical Magazine, v.37, no. 290 (1970).

BISBEEITE: A copper silicate, this is one of four minerals discovered at the Shattuck mine at Bisbee around 1914. The find was reported in the Washington Academy of Science Journal, v.5 (1915) by Waldemar T. Schaller of the U.S. Geological Survey.

BUTLERITE, GERHARDTITE, GUILDITE, LAUSENITE, & YAVAPAIITE: These are hydrous sulfate minerals discovered at the United Verde Copper Company mine at Jerome. They originated as a result of a fire of long duration in the pyritic ore body. An article reporting this occurrence was written by Carl Lausen and published in the American Mineralogist, v.13 (1928); they were further reported on by C. Osborne Hutton in v.44 (1959).

CHALCOALUMITE: Forming botryoidal crusts of limonite, and also on azurite and malachite, this mineral appears on a number of specimens from Bisbee, where it was first noted. A paper defining the mineral was presented in the American Mineralogist, v.10 (1925).

CORONADITE: W. Lindgren and W.F. Hillebrand published notes on this find in 1905, and further summarized it in the American Mineralogist, v.18 (1938). It was named for the Coronado vein of the Morenci mine, the location of the original find. Specimens were later found at Imini, Morocco.

EMMONSITE: The mineral is a ferric tellurite found sometime prior to 1885 in the Tombstone district, accompanying cerussite. It was reported by Hillebrand in the proceedings of the Colorado Science Society, v.2. Later it was discovered in three other locations, the material from Honduras first called "durdenite" being proved to be emmonsite, as defined by Dana and Wells in the American Journal of Science, v.40 (1890). The mineral was named in honor of Samuel Franklin Emmons of the U.S. Geological Survey.

FLAGSTAFFITE: F.N. Guild, a former professor at the University of Arizona, came across this hydrocarbon in the cracks of fossil logs near the San Francisco Peaks at Flagstaff. He published reports on this unusual find in the American Mineralogist, v.5 (1920) and v.6 (1921) and as an abstract in Science, v.55. H. Strunz and B. Contag, German scientists, did further work on the crystallography as noted in the American Mineralogist, v.50 (1965).

HIGGINSITE: This is a variety of conichalcite which was uncovered at the Higgins mine near Bisbee. Palache & Shannon wrote the first description which was published in the American Mineralogist, v.5 (1920). New data were reported in that publication in v.36 (1951), by L.G. Berry.

HEMIHEDRITE: The Florence Lead-Silver mine in the Tortilla Mts., Pinal County, is the original location for this new mineral. S.A. Williams and J.W. Anthony summarized it in the American Mineralogist, v.55 (1970).

KINOITE: The recently recognized mineral was found in a drill core produced during mining explorations in the vicinity of Helvetia in the Santa Rita Mts. John W. Anthony, author of the reporting article which appeared in v.55 (1970) of the American Mineralogist, chose to name the mineral in honor of Padre Kino.

MURDOCHITE: This copper lead oxide from the Mammoth mine at Tiger was unknown until C.L. Christ and Joan R. Clark reported on its crystal structure in the American Mineralogist, v.34 (1954). It was further described by J.J. Fahey, American Mineralogist, v.40 (1955). The late Percy W. Porter, who first noticed this mineral, requested that it be named for Prof. J. Murdoch.

NAVAJOITE: The original discovery of this mineral was in material collected at the Monument No. 2 mine on the Navajo Indian Reservation, Apache County, by several U.S. Geological Survey geologists in 1951. Brief announcement was made by Weeks, Thompson & Sherwood, American Mineralogist, v.39 (1954) and further work on the specimens was recorded in v.40 (1955). The mineral was named for the Indian tribe.

PAPAGOITE: This copper silicate, like ajoite, which had been found in the same locality two years previously, came from the New Cornelia mine at Ajo. C. Osborne Hutton and Angelina C. Vlisides were the authors of the report published in the American Mineralogist, v.45 (1960).

PARAMELACONITE: In 1890, A.E. Foote discovered the only two specimens of this mineral which have been found to date at the Copper Queen mine at Bisbee. Koenig did preliminary work on these in 1891. Further work was done by Clifford Frondel, who summarized his work in the American Mineralogist, v.26 (1941).

SHATTUCKITE: Schaller reported in the Washington Academy of Science Journal, v.5 (1915) on this new mineral found the previous year at the Shattuck mine at Bisbee. Like bisbeeite, with which it is associated, it is a copper silicate. When found in the massive form, it makes a fine semi-precious gemstone.

SPANGOLITE: This mineral was found in the vicinity of Tombstone, though the exact location is not known, and the find was reported in the American Journal of Science, v.39 (1890) by Penfield. The mineral was later recognized in material from the Copper Queen and Czar mines at Bisbee, and

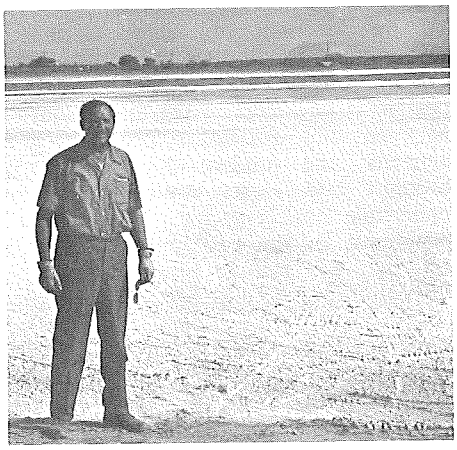
from several other locations. Clifford Frondel summarized the known data on the mineral in the American Mineralogist, v.34 (1950). It was named for Norman Spang, who provided the original specimen.

WHERRYITE: This new mineral was first described in the American Mineralogist, v.35 (1950) by Fahey, Daggett and Gordon after the find was made at the Mammoth mine at Tiger. More complete work was done on this copper-lead mineral by W. John McLean, as reported in the American Mineralogist, v.55 (1970).

WICKENBURGITE: Although discovered at a number of locations in the region of Wickenburg, the Potter-Cramer claims area is considered to be the type locality. It was described in the American Mineralogist, v.53 (1968) by S.A. Williams, who was the discoverer.

SOUTHWEST SALT CO. INITIATES PRODUCTION

Jerry Grott, chief executive officer of Southwest Salt Co., has been running full speed for a long time, and the purpose of it all—producing salt in Arizona—has finally begun. Trial shipments of salt to



Jerry Grott, of Southwest Salt Company, stands beside one of seven solar ponds in which one of man's and beast's vital needs is being produced — SALT.

water softening companies are being made and one major company has declared that the salt is the best that it has ever tested. The recent rail strike emphasized rather pointedly what it has meant for Arizona to be totally dependent on outside sources for salt. Slowly, but surely, it is likely that Southwest will increase its production as it diversifies its product line.

Jerry discovered salt close to 1,000 feet below the surface at a point just west of Glendale, Arizona. The salt is mined by injecting fresh water and then pumping brine to the surface for evaporation in solar ponds. Engineers Testing Laboratories, Inc. is monitoring possible seepage and recently has reported that no measurable seepage has occurred. Pond bottoms are specially prepared against losses because a brine loss means a dollar loss.

THE DEPARTMENT OF GEOSCIENCES - REPORT FOR 1970-71

On July 1, 1970 the Departments of Geochronology and Geology were merged to form the Department of Geosciences. Edgar J. McCullough, Jr. is serving as Department Head and Terah L. Smiley as Associate Head. On July 1, 1971 the School of Earth Sciences became the College of Earth Sciences composed of the Department of Geosciences, the Department of Hydrology and Water Resources, the Laboratory of Tree Ring Research and the Office of Arid Lands Studies with Dr. James H. Zumberge as Dean.

The Department of Geosciences is organized into an academic group and a research group. A faculty of 31 serves both groups. The Department has formalized five academic options leading to a degree in the College of Earth Sciences, a degree program in the College of Liberal Arts and a degree program in the College of Education. Academic options in the College of Earth Sciences, at both the undergraduate and graduate levels, exist in Geology, Geobiology, Geochemistry, Geochronology and Geophysics. The options are directed by faculty curriculum committees and because of the diverse interests of the faculty most serve on two committees and some on three. The curriculum committees are responsible for the academic program of the option as well as the advising of students selecting the option. The options are not necessarily permanent in that some may be eliminated when they outlive their usefulness and others may be added as needs become apparent. The degree program in the College of Liberal Arts is primarily for those persons not desiring to pursue a professional career in the geosciences. The curriculum gives the student a well-rounded program in Geology supplemented by a foundation in other basic sciences, as well as an opportunity for broadening his background through a selection of courses in non-scientific subjects. In the remaining degree program the student spends his first two years in the College of Earth Sciences, his last two years in the College of Education and graduates with the B.S. in Education degree (Earth Sciences Teaching Major). Students may also work toward a Master of Science Teaching degree specializing in Earth Sciences Teaching within the College of Education.

Terah L. Smiley also serves as Chief of the Research Laboratories. Present formalized laboratories are: the Laboratory of Paleontology, the Laboratory of Paleoenvironmental Studies, the Laboratory of Isotope Geochemistry, the Laboratory of Organic Geochemistry, the Laboratory of Petrology and the Laboratory of Geophysics. These Laboratories are manned by departmental faculty and students and do not have non-teaching faculty level personnel. Faculty members not associated with the formalized laboratories also conduct research programs involving students and other faculty.

In December the American Council on Education released a report in which the Department of Geosciences graduate program received the top rating for all graduate geoscience programs from the Rock Mountain States as well as Oregon and Washington. The Department has received in excess of 500 letters of inquiry concerning admittance to the graduate program for 1971-72 and of these 230 made formal application. Thirty four of these applicants have been accepted and have stated they will enter the University in September 1971.

During the 1970-71 academic and summer school year the Department of Geosciences conducted instruction for 2,989 students in some 103 courses. Students working on undergraduate degrees numbered 151 while 71 graduate students were working on the M.S. program and 51 on the Ph.D. program; 20 students completed work on the B.S. degree, 1 on the B.A. degree, 21 on the M.S. degree and 8 on the Ph.D. degree during the year.

The Department of Geosciences hosted interviews for seven companies seeking to employ geologists, geophysicists and geochemists. The Department was able to make a conference room available and scheduled students who were seeking employment. The situation was ideal for both companies and students.

Financial support for 29 undergraduate and graduate students totaling some $42,000 was received from industry and the federal government. This was in addition to the state-funded teaching and research assistantships.

Support for science education activities of the Department increased during the year. The National Science Foundation funded the following projects: "Three-Year Summer Sequential Institute for Secondary School Teachers of Science and Mathematics", under the direction of Drs. Everett Lindsay and John Sturgul, "Three-Year Academic Year In-service Program for Secondary School Teachers

Continued on page 10

GEOSCIENCES (Continued)

of Science and Mathematics", under the direction of Drs. Lindsay and Sturgul, "Eight Day Field Conference for Secondary Teachers of Earth Science in Arizona, New Mexico, Utah and Colorado" under the direction of Dr. Lindsay and Dr. Richard Moore (Principal Geologist, Arizona Bureau of Mines) and a "Four Week Cooperative College-School Science Program" between the Department and Tucson School District Number One junior high school science teachers under the direction of Dr. Edgar J. McCullough, Jr.

Research activities included National Science Foundation support for Dr. Paul Martin on *Pollen Analyses and Pleistocene Events in the Grand Canyon* and Dr. John Sumner on *A Regional Gravity Survey of the State of Arizona;* National Aeronautics and Space Administration support for Dr. Bartholomew S. Nagy on *Lunar Samples Organic Geochemical Analyses, Analysis of Carbonaceous Meteorites,* and *Apollo 14 Lunar Sample Geochemical Analysis;* Research Corporation of America support for Dr. Bert E. Nordlie on *Investigations of the Composition and Behavior of Magmatic Gases* and Dr. Austin Long on *Isotopic Characterization and Dating of Water in the Tucson Basin Valley Fill Aquifer.* During the year thirty-one lectures, seminars and/or field trips were conducted by distinguished visitors to the Department of Geosciences.

HYDROLOGY FIELD CAMP

For the seventh consecutive year Dr. Jerome J. Wright, Department of Geosciences, University of Arizona, conducted the annual Field Hydrology course during the first term of the 1971 summer session. For the past three years the headquarters for the course has been located on the campus of Eastern Arizona College at Thatcher, Ariz. Originally organized to train University of Arizona Hydrology students, the course has attracted the attention not only of other departments on the campus but also that of other universities throughout the country. The course is unique in that it is the only one of its type offered at any university in the world.

The Safford Basin and the Gila River drainage area was chosen as the working site for the field camp because it offers such a wide variety of hydrologic conditions for study.

The students are introduced to the methods and techniques used in gathering and interpreting hydrologic data in the field. Included in the course are exercises in geology, geophysics, geomorphology and other facets of the earth sciences which are important to the hydrologist or engineer who plans to make a career in water resources.

Dr. Wright was assisted in the effort by Dr. Martin Fogel, Dr. Wm. Bull and Robert Staley of the U of A, and by Richard Culler, Buck Eddington and Ben Bryce of the U.S. Geological Survey and Mr. Gene Etter of Safford.

MINING CLUB EXHIBITS ART

The Beckett art collection, a unique collection of oil paintings depicting copper miners of the Southwest, has been on display at the Mining Club of the Southwest since early June.

Due to the popularity of the exhibit during the months of June, July and August, the Mining Club, located in the Aztec Inn, 102 North Alvernon Way, Tucson, Arizona, has been granted an extended showing through September, 1971.

DRILLING

Dr. P.G. Beckett, consultant and former vice president of Phelps Dodge Corporation, had given the University of Arizona College of Mines this collection. The oil paintings had been hanging in the Geology Building Mineralogical Museum up to the time they went on loan to the Mining Club. After the showing at the Club, the paintings will be returned to the Museum for viewing.

W.D. White, the artist of the 17 oil paintings being shown, was commissioned by Dr. Beckett during the 1920's to provide permanent illustrations of underground and open pit practices followed in the Southwest at that time.

These paintings are remarkable, realistic reproductions of the mining practices used during the 1920's.

REPORT FROM THE DEPARTMENT OF MINING AND GEOLOGICAL ENGINEERING

Dr. Willard C. Lacy, Head of the Department, has accepted the Foundation Chair in Geology at James Cook University in North Queensland, in Townsville, Australia beginning January 1, 1972. The position offers the challenge of establishing an applied geology program in keeping with the needs of a developing frontier.

Townsville is the site of Freeport Sulphur's new lateritic nickel deposit, the port for Mt. Isa, and the "jumping off" place for exploration in the South Pacific.

In March Bill Peters left on sabbatical leave to try to determine how mining in Europe has managed to cope with society and environmental problems in urban areas these many centuries. He is visiting professor at Institut de Mineralogie Universite de Geneva, Switzerland. He returns in September.

Two short-courses on porphyry copper deposits were presented this past year by the Department in Tucson for U.S. Bureau of Mines personnel and for professors and students from the University of Mexico.

The Department has established the practice, at the request of mining and geological engineers working in the Tucson area, of scheduling at least one of the regular upper-division or graduate courses in the evening. This permits practicing engineers in the area to enroll in continuing education programs and benefits the undergraduate who is brought into closer contact with the operating engineer and "real world" problems. In the Fall semester evening offerings will include Geol. Engrg. 208, Introduction to Ocean Engineering (Lacy) and Min. Engrg. 225, Mine Environments (Dotson).

Research interests of the Department's faculty range from problems of ore genesis and metallogenic zones, soil stabilization, conservation practices, mine environment control, tunnel and shaft sinking cost prediction, pit slope design and stabilization, residual stress in rocks, nature and effects of rock discontinuities, metal price and cost prediction models, to analyses of risk and tax structure.

ARID LANDS INFO CENTER

The University of Arizona is slated to become the hub of a proposed regional arid lands information network under the provisions of a $66,300 National Science Foundation grant.

Five institutions of higher learning, in addition to the UA, will take part in designing The Regional Arid Lands Information Network, said Patricia Paylore, principal investigator.

Participants will be the Universities of Nevada (Desert Research Institute), California at Davis and Colorado (Geography Dept.) and Texas Tech at Lubbock and Utah State University (Desert Biome Headquarters).

The UA Office of Arid Lands Studies (OALS), a division of the new College of Earth Sciences, is recognized as the national information center by arid lands researchers, Miss Paylore noted.

OALS receives requests for information from all over the world, Miss Paylore noted, and added that to process the queries speedily she has devised an "arid lands vocabulary."

The vocabulary is cross-indexed and stored in the UA Computer Center memory banks. A word or a short phrase tossed into the computer begets a related topic bibliography and the specific abstract desired.

From this base the network will grow—gathering data from Western research centers, cataloging that data and feeding it in to the OALS program at the UA Computer Center where the information will be readily available. It will be an electronic library specializing in arid lands "books."

If the system proves feasible, the five participating institutions will plug into the OALS memory banks to make data "deposits" and "withdrawals."

A design meeting will be held at each of the network schools, with the first scheduled at the UA Oct. 14-15. Miss Paylore has arranged for a demonstration of the OALS electronic library system for those attending the session.

MEXICAN PROPERTY LAW

Frequently, the Arizona Bureau of Mines is called upon to supply general information related to the mining laws of Mexico.

To those interested in the subject of Mexican property law, the following news release from the University of Arizona News Bureau is called to their attention.

Mexican law concerning real property dominates a late issue of the Arizona Law Review, quarterly publication of the University of Arizona College of Law.

Many of the articles originated at a joint seminar of the Arizona and Sonora Bar Associations in Hermosillo, Mexico.

Included are "Investment in Real Property in Mexico" by Gilberto Gutierrez Quiroz, Hermosillo attorney; "An Introduction to Secured Real Estate Transactions in Mexico" by Octavio Rivera Farber, a Mazatlan lawyer; "The Mexican Land Registry" by Boris Kozolchyk, UA law professor; and "The Mexican Mining Concession" by Gustavo Perez, a Mexico City lawyer.

Eugenio Revilla, foreign law librarian in the UA College of Law, has contributed "A Select Bibliography on Mexican Real Property Law."

Single copies of the Arizona Law Review, Vol. 12 No. 2, may be secured from the Arizona Law Review Office, University of Arizona, Tucson, Arizona 85721; price, $2.00.

NEWS FROM AND ABOUT OTHERS

U. S. BUREAU OF MINES

The final tabulations for copper produced in Arizona for 1970 total 917,918 tons, an increase of 116,555 tons over 1969. Pima County yielded 335,586 tons or 36 percent of all the copper produced in the State. The value of the copper mined in Arizona was $1,059,277,000.

The training function of the metal and nonmetal Health and Safety Division of the Bureau for Arizona will be directed in the future from a new Bureau office in Reno, Nevada, H. J. McCreary, Acting Chief. Formerly, the health and safety training functions for Arizona were directed from the Rocky Mountain District Office at Denver, Colorado, and the Subdistrict Office at Phoenix. The staffing for the new office still is incomplete.

A few of the investigative and research activities of the Federal Bureau that may be of interest to mineral producers in Arizona are summarized in the following:

A project of the Intermountain Field Operations Center—Mineral Resources, at Denver, has been monitoring the Black Mesa by aerial photography for more than a year. Photography for this project is performed under contract with the U.S. Air Force and, when available, will be done by NASA from space staellites. The objectives of the project are for experimental data and to monitor the mining and reclaiming of the land.

Several members of the Bureau's Environmental Group will visit Black Mesa in Navajo County in the latter part of September as part of a Department of Interior committee studying the effects of coal mining on the enrivonment of the area.

The Mining Research Center at Denver continues to study the practices, problems, and theories of caving. Test sites in Arizona for this research are at San Manuel and Safford.

The Salt Lake City Metallurgy Research Center will continue research on the recovery of sulfur from smelter and power plant gases. A demonstration plant is planned at the Center for the removal of SO_2 and recovering of sulfur from waste gases by the citrate method previously studied at the San Manuel copper smelter. A 20-cubic-feet-per-minute test plant will be operated on a simulated power plant gas by burning natural gas and air and introducing SO_2 in concentrations of 0.1 to 0.2 percent.

A new project will be started to develop an alternate method of smelting for processing copper sulfide flotation concentrates with a minimum of air pollution by fluid-bed roasting and leaching to recover copper and by-product sulfur.

Another project is the leaching of copper mine waste, mill tailings, and silicate ores for additional recovery of products.

Personnel at the Center will continue to study vegetative and chemical stabilization of mining and mineral processing wastes. One of the objectives of the studies is to reduce water and air pollution derived from the solution effluents and mineral matter in the dikes and berms of tailing ponds. Suitable treatment procedures will be developed for the effluents and appropriate stabilization methods tested for the dikes. Lynx Creek site near Prescott is one of the areas where field application tests are planned.

The Reno Metallurgy Research Center has tested the application of an electro-oxidation process for separating and recovering by-product molybdenum and rhenium from low-grade copper ores. The low-grade copper ores of the Western United States account for about one-third of the domestic molybdenum production and are the sole source of rhenium, an attractive catalyst for reforming non-leaded gasoline. Several of the major copper and molybdenum producers have requested the Reno Center to test their materials.

The Reno Center recently studied methods of recovering elemental sulfur from nonferrous minerals by ferric chloride leaching of chalcopyrite concentrate. Report of Investigation . 7474 discusses this method of copper recovery as an applicable method in the effort to reduce air pollution.

OIL AND GAS CONSERVATION COMMISSION

The Arizona Oil and Gas Conservation Commission reports that there is expanded activity near Holbrook related to the development of subsurface LPG (liquid petroleum gas-propane, etc.) storage facilities. Initially, in Holbrook, a single cavity was washed out of Permian salt. Apparently, this operation is to be expanded by the creation of additional cavities.

Continued on page 12

OIL AND GAS (Continued)

Another solution mining project is underway near Adamana on the Santa Fe railroad about 20 miles east of Holbrook. Initial coring tests are reported to have encountered a salt unit 260 feet thick about 750 feet below the surface. Two cavities are to be constructed by solution mining methods. These relatively cheap storage facilities, remote from refining operations and near railroads, materially enhance logistical efficiency.

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Bill Allen and Ed Koester, members of the Commission staff, and Frank Moore, Commissioner from Cochise County, visited Mexico last April to observe and discuss Mexico's program to evaluate the petroleum possibilities of northern Chihuahua. Any favorable development in Mexico's drilling program is likely to have immediate consequences in southwestern New Mexico and southeastern Arizona.

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Jim Scurlock, Director of the geological staff, is revising the Commission's structure map of northeastern Arizona. Jim reports that the revision is about complete and that copies should be available by the time that this issue of Fieldnotes is off the press.

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Jack Conley, geologist with the Arizona Oil and Gas Conservation Commission, has completed an index of Arizona well samples. Jack has inventoried the well samples stored in both the Commission's library in Phoenix and in the Arizona Bureau of Mines' library at the U of A in Tucson. Included are 448 wells drilled for oil, flammable gas, helium or stratigraphic information, and 1,523 wells drilled for water. This free publication is distributed from the commission's offices at 4515 North 7th Avenue, Phoenix, Arizona 85013 to earth scientists and other interested persons. This effort is a part of a continuing program to gather and distribute basic data and information. Additional well information is currently being prepared by a joint effort of the Arizona Bureau of Mines and the Commission.

U. S. GEOLOGICAL SURVEY

LAND SUBSIDENCE-
Eight Feet in Parts of Arizona

According to a U.S. Geological Survey news release (July 18, 1971) Joseph F. Poland, hydrologist in charge of subsidence research at the Survey's Sacramento, Calif., project office, thinks that land surface sinking will probably become more common and more serious in vulnerable areas throughout the world. According to Poland "Areas of known subsidence probably will multiply many fold in the next few decades as a result of accelerated withdrawal of water, oil, and gas to meet the demands of a burgeoning world population and associated mineral development." The release also points out that the proceedings of the land subsidence symposium at Tokyo have been published by the International Association of Scientific Hydrology, headquartered in Gentbrugge, Belgium.

One of the articles is by Herb Schumann assigned to the U.S. Geological Survey ground water office in Phoenix. Herb states that "Ground-water withdrawal has been correlated with damage to irrigation systems, highways, railroads, etc., because of land subsidence in western Pinal County, southcentral Arizona. Water levels have lowered as much as 200 feet during the period 1948-1967, with subsidence totaling about 8 feet." Herb is chairman of a subcommittee on Land Subsidence and Earth Fissures and a report on this subject as it applies to Arizona is imminent.

Land subsidence will be the subject of the first Arizona Geological Society dinner meeting to be held October 5, 1971, at the Pioneer Hotel in Tucson. The 8:00 p.m. program will be coordinated by Dr. W.B. Bull, Asso. Professor of Geology, University of Arizona.

ARIZONA DEPARTMENT OF MINERAL RESOURCES

The Arizona Department of Mineral Resources, Mineral Building, State Fairground, Phoenix, Arizona 85007, advises us that they have available the following recently released publications: *Inventory of Arizona Lands* (June 30, 1970), *Consulting Mining, Metallurgical and Geological Engineers Registered and Residing in Arizona,* and *Directory of Arizona's Mining Activity.* The latter is available in complete form or in any of the following parts: Active Mines (includes supervisory personnel and approximate number of employees), Active Exploration Companies, and Active Prospects.

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Field engineer Ted Johnson from the Department's Phoenix office is now serving on Mondays and Tuesdays in the Tucson office.

FIELD NOTES

State of Arizona
Governor .....Hon. Jack Williams
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Arizona Bureau of Mines
Director .....William H. Dresher
Editor .....R.T. O'Haire

ARIZONA BUREAU OF MINES
THE UNIVERSITY OF ARIZONA
TUCSON, ARIZONA 85721