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Arizona Uranium

The Search Heats Up

by H. Wesley Peirce

Increased demand and soaring uranium prices are the prime ingredients that are fueling a late-1970's world-wide uranium rush. It's a time for dusting off both old literature and aging geological consultants who gained valuable experience during the first uranium boom between 1946 and 1954.

In that time interval, as a consequence of incentive programs, the number of uranium mines in the western United States increased from about 15 to over 900. In Arizona, we now know of 404 documented uranium occurrences (Keith, 1970, p. 214) that serve to provide a substantial base for the intensive border-to-border search presently in progress.

In 1974, uranium ores were produced in six western states: New Mexico (5,400 short tons U_3O_8), Wyoming (4,000 tons), and 3,200 tons from the combined output of Colorado, Texas, Utah, and Washington. Seventy-five percent of U.S. production came from two states, New Mexico and Wyoming. For economic reasons there has been almost no Arizona uranium production for several years. Since 1953, uranium prices have declined almost continuously through 1973 when the average price per lb. U_3O_8 was $6.50. The price started upward in 1974 ($10.50), and in January 1975 was $15.00, August of the same year, $25.00, and at year's end 1976, the spot market price was about $41.00. Apparently, some contracts for delivery in 1980 involve prices in excess of $50.00 per lb. U_3O_8. These prices reflect the importance attached to the future use of nuclear fuels, especially in the generation of electrical power. In order to cover anticipated demand in the U.S., considerable expansion of domestic mining-milling capacity is required. First, however, exploration activity must pick up if the additional domestic resource base is to be discovered, outlined, and developed.

Present and anticipated uranium pricing is encouraging deeper (as well as more) drilling. Additional uranium reserves in New Mexico's Grants Mineral Belt are being developed at depths of between three and four thousand feet.

In 1956 there were 161 uranium mining operations in Arizona, representing 10 of the State's 14 counties. Although most operations were small, total production for that year was 1,341,600 lbs. of U_3O_8 for an average of just over 8,300 lbs. per operation. 136 of these 161 operations were in the three Plateau counties of Apache (60), Coconino (64), and Navajo (12), and the majority of these were on the Navajo Indian Reservation.

Only a very small portion of the State's all-time cumulative production of nearly 18,000,000 lbs. U_3O_8 came from the Basin and Range province. Now, early in 1977, there are indications that perhaps more uranium has been found in this province, in just one area of Yavapai County, than is represented in the State's all-time cumulative production.

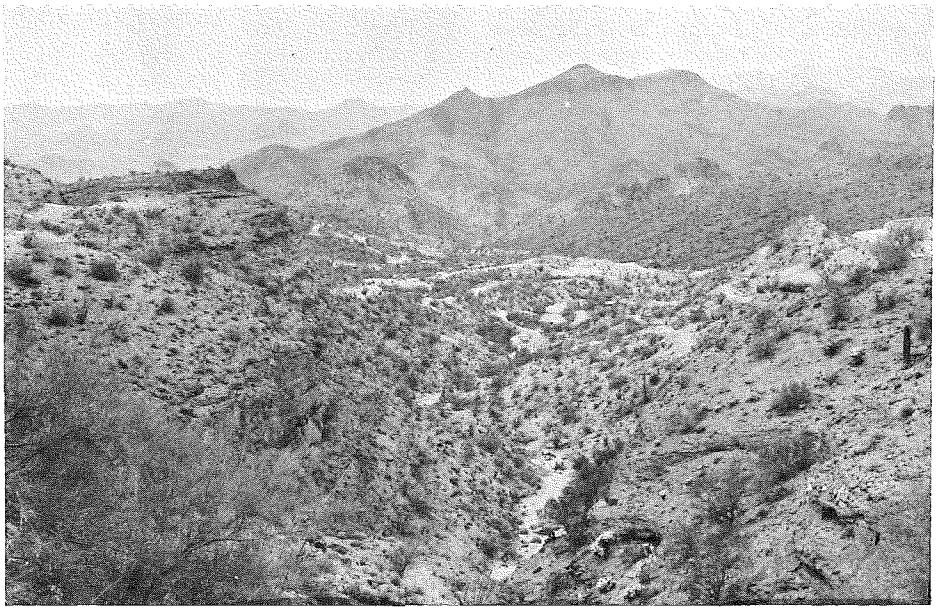
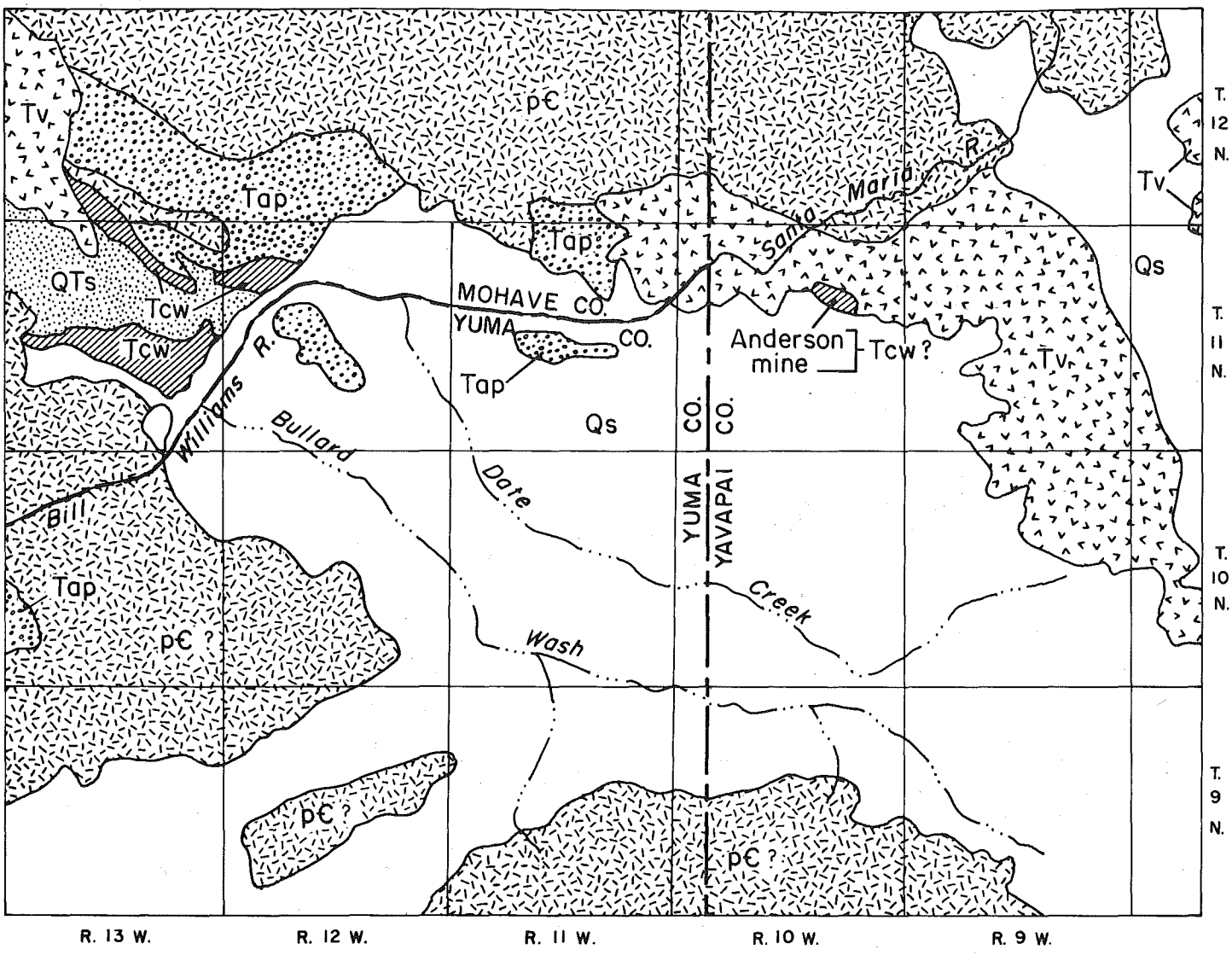


Fig. 1. Anderson mine area showing erosionally exposed light-colored uranium-bearing host rocks in middle distance. Older volcanic rocks in far distance and covering younger rocks in foreground. Looking northwesterly.

Dr. Peirce is a geologist with the Arizona Bureau of Mines.

Also In This Issue:



10 0 10 miles

Scale

EXPLANATION

CENOZOIC

Sedimentary rocks

Qs

QTs

Tcw

Chapin Wash Formation

Tap

Artillery Peak Formation

Volcanic rocks

Tv

Undifferentiated Volcanics

PRECAMBRIAN

p€

Undifferentiated Crystallines

Generalized geologic map of west-central Arizona

U.S. Energy Research and Development Agency regional geologist Harlen Holen of Albuquerque, New Mexico, says that the uranium exploration now taking place in west-central Arizona is the most intense within his region (except for the Grants District of New Mexico), which embraces Arizona, New Mexico, and West Texas.

The area receiving most attention in Arizona at this time embraces at least 150 square miles in southwest Yavapai County and northeast Yuma County. Generally, it is east of the Bill Williams River and south of the Santa Maria River and includes the valley occupied by both the Date Creek and Bullard Wash drainages (see map on opposite page.)

The prime stimulus to exploration in this region stems from an outcrop discovery first made in 1955 by T.R. Anderson with the aid of an airborne scintillation counter. Numerous claims were located by the related Uranium Aire Corporation, and near-surface mining operations supported some ore shipments to the Atomic Energy Commission (AEC) ore-buying station at Cutter, Arizona, east of Globe. The property generally is known either as the Anderson mine or the Uranium Aire group – the former name will be used here.

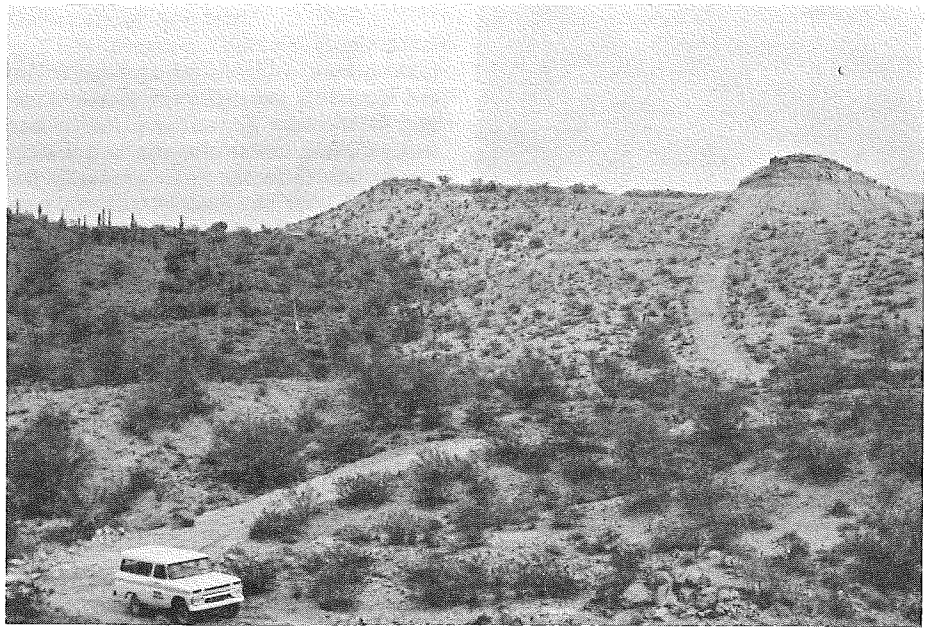


Fig. 2. Lower contact of Anderson mine host rocks with darker underlying andesitic volcanic rocks to left. Looking easterly.

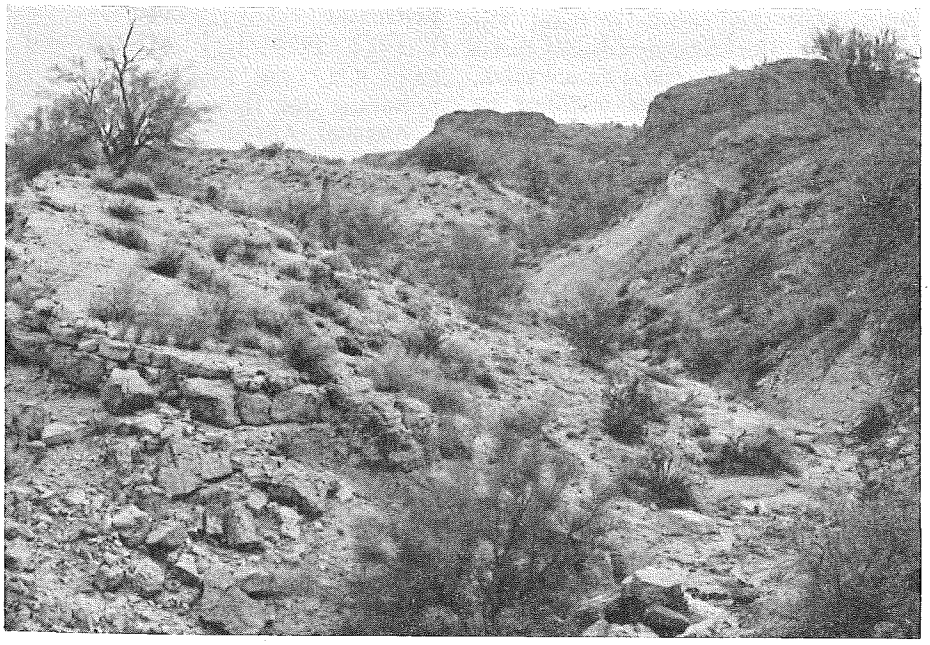


Fig. 3. Tilted Anderson host rocks showing cliff-making covering strata in distance. Looking easterly.

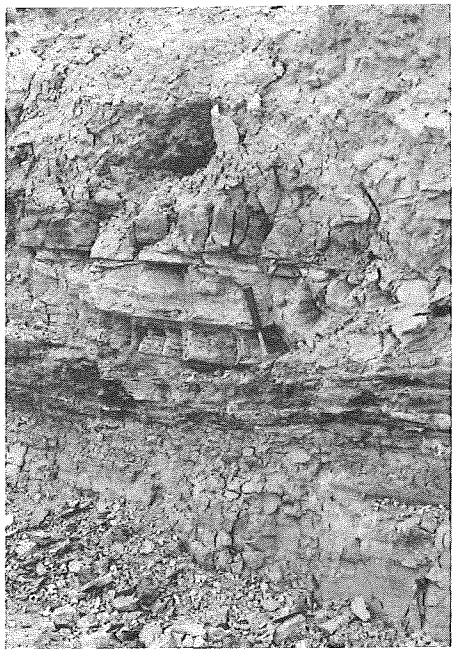
More specifically, the Anderson mine is located in the northeast quarter of T.11 N., R.10 W. A yet smaller area is best circumscribed on the geologic map of Yavapai County, which depicts an elliptically shaped geologic unit labeled QTL. It is similarly circumscribed on the State geologic map but is not labeled.

The geology of the Anderson mine and the general geologic setting of the larger region are topics of increasing interest. This is the result of a widening recognition of the possible existence of large volumes of buried mineralized rock, not only below and flanking the Anderson mine, but regionally beneath the present valley surface. Too, in addition to the more local applications, there are geologic questions, the answers to which might help shape a general uranium exploration philosophy for Arizona's Basin and Range province.

Of immediate local exploration interest is the continuity of the Anderson mine host rocks beyond the surface exposures. Drilling ventures now in progress hope to find this out. Preliminary data indicate that at least six companies are active in the larger region and that some drilling might have exceeded 2000-foot depths.

The Anderson mine host rocks are fine-grained (Figure 4), low-energy sedimentary rocks usually referred to as lake beds. Their existence is revealed by erosional down-cutting along a tributary to the Santa Maria River which, at the position of the mine, is partially controlled by the contact of the softer lake beds with harder, underlying Tertiary andesitic volcanics (Figures 1, 2). These rocks are tilted towards the south, therefore the tendency is for erosion to move the lower contact southward. The Anderson host rocks are about 200 feet thick in the mine area and are overlain by younger sediments and a thin basalt flow where the host rocks pass beneath cover to the south. The lake beds are fossiliferous, faulted and folded (Figure 3), have been locally silicified, and contain lensing lignitic units. The principal uranium mineral is carnotite, the source of which is not known.

The isolated, window-like exposure of these lake beds renders regional stratigraphic correlation imprecise. The only attempts made at correlating with previously named and mapped geologic units have been to the west in the Alamo-Bill Williams River-Artillery Peak area on either side of the Yuma-Mohave County boundary. Lasky and Webber (1946) originally defined an older Artillery Peak Formation and a younger Chapin Wash Formation. Tentative corre-



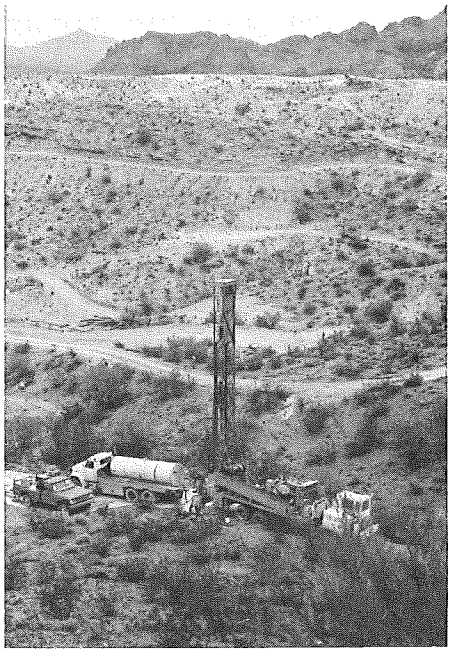


Fig. 4 (far left). Fine-grained Anderson host rocks exposed in cut. Note rock pick for scale.

Fig. 5. (left). Exploration drilling of underlying Anderson host rocks. Older volcanics in distance; Anderson rocks in middle distance. Looking northerly from capping younger strata.

lation of the Anderson host rocks with the Chapin Wash Formation has been made by Reyner, et al., 1956, and by Jones, 1970, in an unpublished report. This correlation seems to have considerable merit even though the respective units are at least 10 miles apart. On both the county and State geologic maps all three of these units are assigned different ages, the Anderson host rocks being the youngest. However, in my opinion, the Anderson rocks almost certainly are older than is depicted on these maps. It is interesting to observe that in the Chapin Wash-Artillery Peak area it is the older Artillery Peak Formation that contains known uranium occurrences whereas the Chapin Wash Formation does not (Keith, Plate 18 and Table K). These formations as well as the Anderson host rocks potentially underlie, at variable and unknown depths, much of the piedmont surface east of the Bill Williams River. Many claims have been staked and drilling has been active in various parts of the region.

The Chapin Wash Formation was designated lower Pliocene (?) by Lasky and Webber, and the Anderson mine host rocks were similarly designated by Reyner et al. Lindsay and Tessman (1974, p. 4) assign a mid-Miocene age to the Anderson rocks on the basis of vertebrate fossils that include a camel and a rhinoceros. An unpublished date on a basalt (Cobweb Basalt of Lasky and Webber) that conformably overlies the Chapin Wash Formation suggests that the latter is not younger than mid-Miocene (no younger than 12 million years). Another unpublished age date on a basalt in the older Artillery Formation further suggests that the Chapin Wash Formation is no older than lowest Miocene (25 million years). If correlation of the Anderson host rocks with the Chapin Wash Formation is assumed, then it appears likely that the Anderson host rocks are lower- to mid-Miocene in age.

Structural deformation in the form of folding, tilting, and faulting is evident in both the Chapin Wash and Anderson units (Figure 3). Although others have characterized these rocks as being playa and/or lake deposits (basin-fill deposits), it is important to note that they accumulated in a basin whose origin preceded the onset of latest Tertiary (upper Miocene) basin-making (Peirce, 1976, p. 325). As such, these uraniferous Anderson rocks are remnants and caution is indicated in developing exploration philosophies that pertain to them. For instance, the original sedimentation limits of these units is not clear. I do not think, however, that they were confined by paleogeographic elements coincident with today's bounding topographic highs (Figures 1, 5). This is to suggest that the later tectonic events that deformed these rocks significantly altered the structural-physiographic setting that had prevailed during deposition. The present topography is impressed upon this later (post-deposition) episode.

Much exploration attention is being given to the so-called lake bed, basin-fill deposits of Cenozoic age within the Basin and Range province of southwestern Arizona. Uranium occurrences are known in many localities and host rock ages are notably variable.

Cenozoic (last 60 million years) geologic history in southern Arizona is very complex. However, it appears likely that portions of this history were more conducive to the potential creation of large volumes of uranium mineralization than others. Indications are that enhanced Cenozoic potential exists in sedimentary host rocks deposited prior to latest basin-making under climatic and tectonic conditions different than generally have prevailed over the last 10 million years. The question is: Are significant volumes of these rocks preserved, and, if so, where?

The purpose of this article is to point out that some are preserved in west-central Arizona where they presently constitute the basis of an exploration effort that portends to be of national energy significance. Where else similar host rocks might still exist in Arizona's Basin and Range country is a substantial geologic question. It is a puzzle with many pieces and it seems likely that many explorationists are destined to be challenged to attempt to put it together.

For the nation's sake, we wish them success.

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Reyner, M.L., Ashwill, W.R., and Robison, R.L., 1956, Geology of uranium deposits in Tertiary lake sediments of southwestern Yavapai County, Arizona: U.S. Atomic Energy Commission, RME 2057, 33 p.

SEAM-The Surface Environment and Mining Information Dissemination Program

by Dick Haney
Office of Arid Lands Studies

A specialized bibliographic information system related to the effects of surface minig on the environment has been developed and is underway at the University of Arizona.

"The program, Surface Environment and Mining (or SEAM), is a cooperative undertaking involving the Office of Arid Lands Studies (OALS), and the Colleges of Mines, Agriculture, and Architecture," explained Dr. Kennith E. Foster, project principal investigator and OALS associate director.

SEAM is a U.S. Forest Service project investigating the effects of mining on surface environs in the western United States, west of the 100th meridian to the Pacific Coast, said Mercy A. Valencia, bibliographic coordinator for the grant. (The 100th meridian passes through the United States just east of Bismarck, North Dakota in the north and between Sweetwater and Abilene, Texas in the south.) However, land-use practices recorded in other regions having application to mined-surface reclamation are included in "SEAMALERT."

OALS produces and distributes "SEAMALERT," a monthly publication described by Ms. Valencia as an informational alerting service for Forest Service personnel as well as for other governmental agency personnel and persons in the public and private sectors.

Bibliographic information about literature related to mining and its effects on surface environs and about reclamation programs and research is provided in each "SEAMALERT" issue. New citations in each issue total 150.

Printed media ranging from government documents to proceedings of scientific and technical colloquia are surveyed as well as books, periodicals, bulletins, and research findings in providing citations for the publication. Documents dated from 1970 to the present are included in the survey.

"We limit the citations to published documents," Ms. Valencia said, "so that persons wishing to make use of 'SEAMALERT' will have actual access to the documents cited." Citations contain full bibliographic information, including author, date, title of publication, publishing source, and, if available, ordering information.

"The 'SEAMALERT' staff is partially involved in document delivery," Ms. Valencia said. "We do aid subscribers in getting copies of documents cited in the publication when other avenues fail," she added.

Citations from each issue of 'SEAMALERT' are computerized to produce a cumulative informational base. Specific information stored will be retrievable later in 1977 through queries using any index terms published in SEAMALERT. This system will be known as SEAMINFO. Currently, queries are met with issues of SEAMALERT which contain the requested information.

"The products of the project, then, are two," Dr. Foster notes. "One is the current literature alerting bulletin and the other will be the computerized information storage and retrieval system which will make use of existing OALS computer software."

The two-year project is funded to September 1, 1978. It is sponsored and funded by the U.S. Department of Agriculture Forest Service, Rocky Mountain Forest and Range Experiment Station at Fort Collins, Colorado; the Environmental Protection Agency, Washington, D.C.; and the Intermountain Forest and Range Experiment Station SEAM office at Billings, Montana.

Report Given on Mogollon Rim History

At the 1976 annual meeting of the Geological Society of America (GSA) held in Denver on November 7-11, Bureau geologist Dr. H. Wesley Peirce delivered a paper titled "The Colorado Plateau Margin in Arizona – Normal Faulting and Uplift, Drainage Reversal and Canyon Cutting."

The paper was co-authored by Drs. Paul E. Damon and M. Shafiqullah of the Laboratory of Isotope Geochemistry, Dept. of Geosciences, University of Arizona.

Peirce reported that Arizona's so-called Mogollon Rim is fault-controlled and that erosional retreat of escarpments was comparable to range-front retreats in the Basin and Range province. Principal faulting occurred in the interval 20 to 12 million years ago (Miocene), and represents a time of topographic and drainage reversal. This is in contrast to previously reported reversals between 10-5 million years ago.

Also, the interesting "Rim" gravels on the Ft. Apache Indian Reservation near Show Low, derived from southwesterly sources in Precambrian-Laramide-aged rocks, fall within a time span of 54-25 million years (Eocene-Oligocene), according to the authors. Previous workers had assigned ages ranging from Cretaceous through Pliocene times.

Peirce suggested that modern canyons such as Grand Canyon need not necessarily indicate contemporaneous regional uplift; rather, the required elevational differentials were acquired during the Miocene rim-making episode of normal faulting and the canyons subsequently cut after integration of the Colorado-Gila rivers system.

New ABM Circular on Black Mesa Coal

"Chemical Analyses of Coal Samples from the Black Mesa Coal Field, Arizona" is now available from the Arizona Bureau of Mines as Circular 18.

The 14-page circular contains 10 pages of tables, including Btu and sulfur analyses and trace-element composition of representative coal samples from the Peabody mines on Black Mesa.

The U.S. Geological Survey funded the Arizona Bureau of Mines' coal sampling project which resulted in the publication of this circular.

Dr. Richard T. Moore, Bureau Principal Geologist, was assisted by Charles W. Kiven with the collection of the samples; analyses were completed by personnel of both the U.S.G.S. and the U.S. Bureau of Mines.

Circular 18 costs 50¢ per copy; for mail orders please include 10% of the amount of the order (25¢ minimum) for postage and handling.

Index of Geologic Maps of Arizona

The U.S. Geological Survey has recently compiled a comprehensive index of geologic mapping for this State. The published material listed in the following pages should be available through local libraries. Depositories of U.S.G.S. open-file reports are coded parenthetically; uncoded, they are:

NC: Library, Rm. 4A100, National Center, 12201 Sunrise Valley Dr., Reston VA 22092

Da: Library, 1526 Cole Blvd. at West Colfax, Golden CO (Mail address: Stop 914, Box 25046, Federal Center, Denver CO 80225)

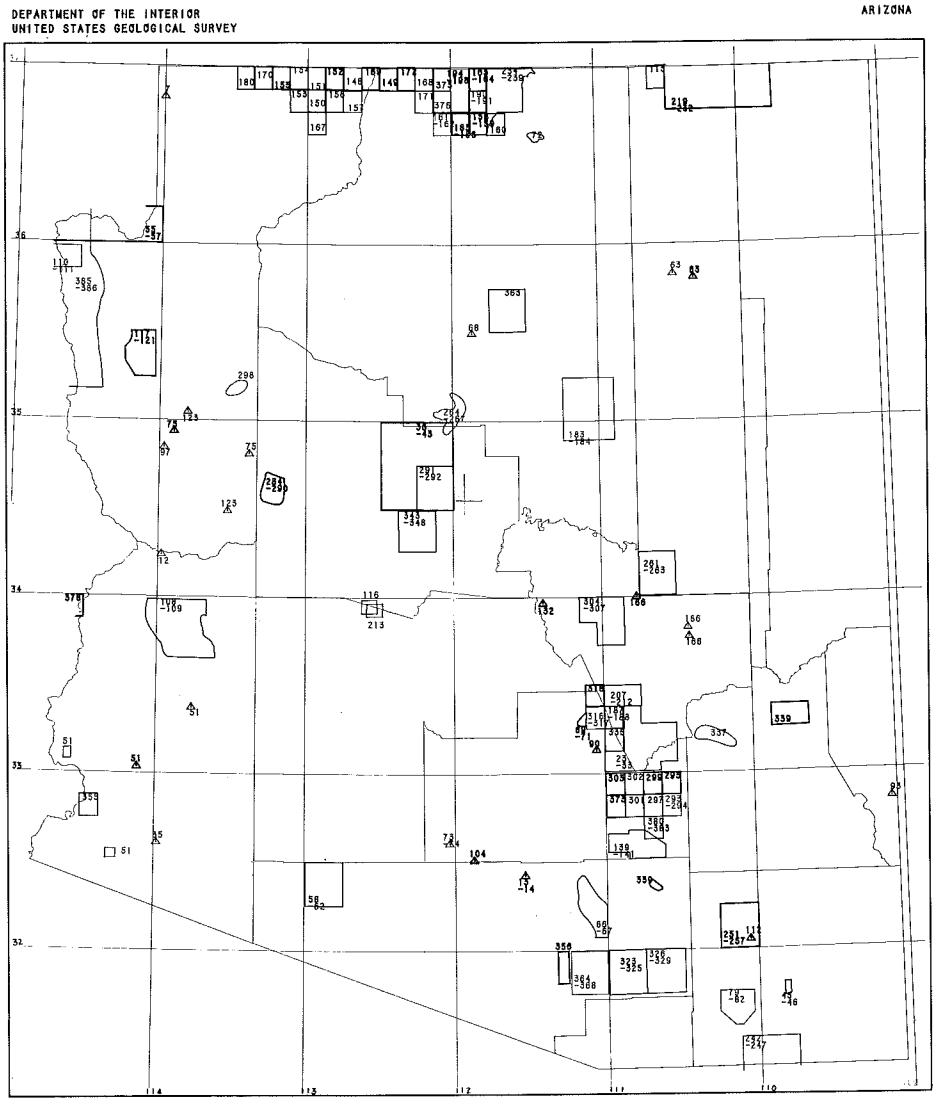
Db: Public Inquiries Office, Rm. 1012, Federal Bldg., 1961 Stout St., Denver CO 80202

LA: Public Inquiries Office, Rm. 7638, Federal Bldg., 300 N. Los Angeles St., Los Angeles CA 90012

M: Library, 345 Middlefield Rd., Menlo Park CA 94025

SF: Public Inquiries Office, Rm. 504, Customhouse, 555 Battery St., San Francisco CA 94111

U: Public Inquiries Office, Rm 8105, Federal Bldg., 125 S. State St., Salt Lake City UT 84138.



1. **Dutton, C.E.**, 1882. Tertiary history of the Grand Canyon district: U.S. Geol. Survey Mon. 2. Sheets 7 and 8, 1:63, 360.

2. **Jagger, T.A., Jr., and Palache, Charles**, 1905, Description of the Bradshaw Mountains quadrangle, Arizona: U.S. Geol. Survey Geol. Atlas, Folio 126. 1:125,000.

3. **Lindgren, Waldemar**, 1905, The copper deposits of the Clifton-Morenci district, Arizona: U.S. Geol. Survey Prof. Paper 43. Pl. 1, 1:62,500, also detailed maps.

4. **Lindgren, Waldemar**, 1905, Description of the Clifton quadrangle, Arizona: U.S. Geol. Survey Geol. Atlas, Folio 129, 1:62,500.

5. **Reber, L.E., Jr.**, 1916, The mineralization at Clifton-Morenci: Econ. Geology, v. 11. Fig. 28, 1:221,760.

6. **Butler, B.S., and Wilson, E.D.**, 1938, Some Arizona ore deposits: Arizona Bur. Mines Bull. 145. Pl. 16, 1:24,000.

7. **Hewett, D.F., and others**, 1936, Mineral resources of the region around Boulder Dam: U.S. Geol. Survey Bull. 871. Fig. 47, 1:5,400.

8. **Lee, W.T.**, 1905, Underground waters of Salt River Valley, Arizona: U.S. Geol. Survey Water-Supply Paper 136. Pl. 7, 1:96,000, and detailed maps.

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10. **Schrader, F.C.**, 1909, Mineral deposits of the Cerbat Range, Black Mountains, and Grand Wash Cliffs, Mohave County, Arizona: U.S. Geol. Survey Bull. 397. Pl. 1, 1:250,000.

11. **Veatch, A.C.**, 1911, Coal deposits near Pinedale, Navajo County, Arizona: U.S. Geol. Survey Bull. 431. Pl. 12, 1:48,000.

12. **Bancroft, Howland**, 1911, Reconnaissance of the ore deposits in northern Yuma County Arizona: U.S. Geol. Survey Bull. 451. Fig. 5, 1:24,000.

13. **Stewart, C.A.**, 1912, The geology and ore deposits of the Silverbell mining district, Arizona: Am. Inst. Min. Eng. Bull., v. 65, (See Trans., v. 43, 1913). Fig. 1, 1:24,000.

14. **Kerr, P.F.**, 1951, Alteration features at Silver Bell: Geol. Soc. America, Bull., v. 62, no. 5. Pl. 1, 1:24,000.

15. **Robinson, H.H.**, 1913, The San Francisco volcanic field, Arizona: U.S. Geol. Survey Prof. Paper 76. Pl. 5, 1:96,000, also other maps.

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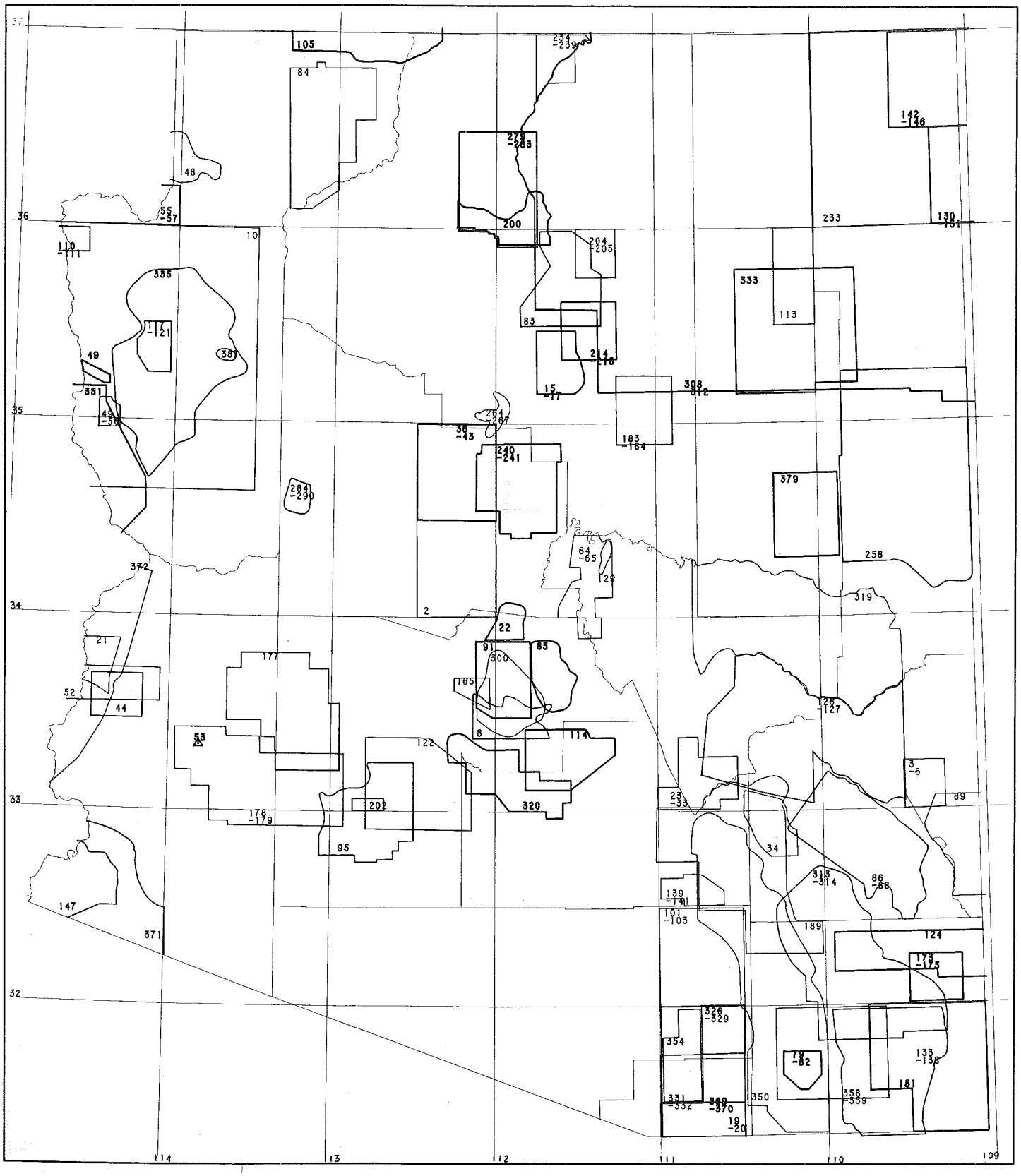

MAPS AT SCALES SMALLER THAN 1:63,360

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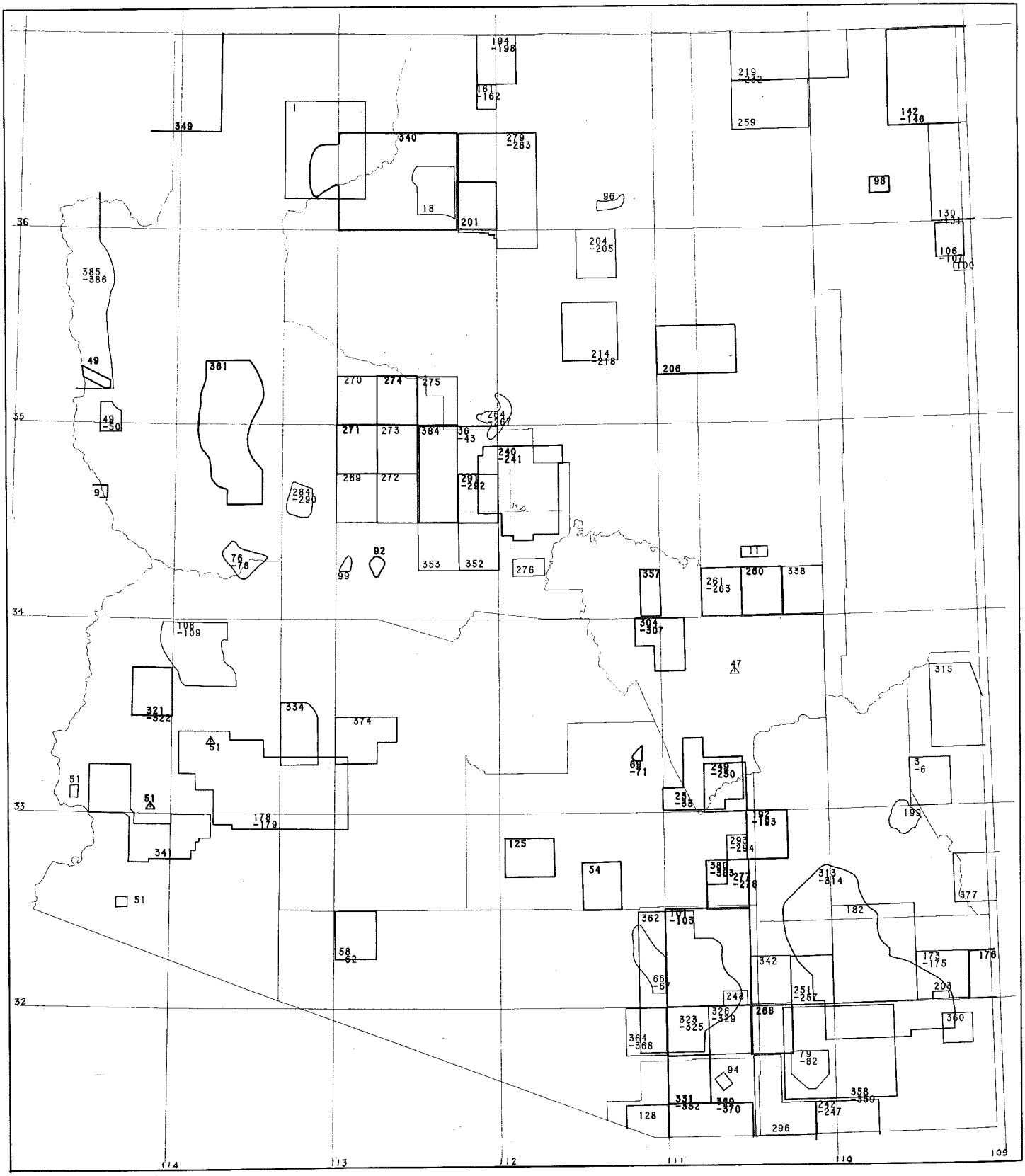

MAPS AT SCALES SMALLER THAN 1:24,000 THROUGH 1:63,360

17. **Feth, J.H.**, 1953, A geologic and geophysical reconnaissance of the Doney Park-Black Bill Park area, Arizona, with reference to ground water: U.S. Geol. Survey Circ. 233. Pl. 1, 1:93,750.

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21. **Jones, E.L., Jr.**, 1916, Gold deposits near Quartzsite, Arizona: U.S. Geol. Survey Bull. 620. Pl. 4, 1:187,500.

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27. **Ross, C.P.**, 1925, Ore deposits of the Saddle Mountain and Banner mining districts, Arizona: U.S. Geol. Survey Bull. 771. Pls. 1 and 17, 1:62,500, also detailed map.

28. **Darton, N.H.**, 1925, Resume of Arizona geology: Arizona Bur. Mines Bull. 119. Pl. 72, 1:125,000.

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30. **Hazen, G.E., and Turner, S.F.**, 1946, Geology and ground-water resources of the upper Pinal Creek area, Arizona: U.S. Geol. Survey open-file rept. Pl. 1, 1:56,000, (NC).

31. **Kiersch, G.A.**, 1949, Structural control and mineralization at the Seventy-Nine Mine, Gila County, Arizona: Econ. Geology, v. 44, no. 1. Fig. 1, 1:14,400.

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34. **Ross, C.P.**, 1925, Geology and ore deposits of the Aravaipa and Stanley mining districts, Graham County, Arizona: U.S. Geol. Survey Bull. 763. Pl. 1, 1:125,000, also detailed maps.

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37. **Provot, F.A.**, 1916, Jerome mining district geology: Eng. and Min. Jour., v. 102. Fig. 1, 1:62,500.

38. **Fearing, J.L., Jr.**, 1926, Some notes on the geology of the Jerome district, Arizona: Econ. Geology, v. 21, no. 8. Fig. 1, 1:9,000.

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41. **Creasey, S.C.**, 1952, Geology of the Iron King Mine, Yavapai County, Arizona: Econ. Geology, v. 47, no. 1. Fig. 3, 1:6,400.

42. **Anderson, C.A.**, 1951, Older Precambrian structure in Arizona: Geol. Soc. America Bull., v. 62, no. 11. Fig. 4, 1:187,500.

43. **Arizona Bureau of Mines**, 1933, Arizona gold placers and placering: Arizona Bur. Mines Bull. 135 (Reprinted as Bull. 168, 1961). Fig. 5, 1:125,000.

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The Tucson Gem and Mineral Society

A multifaceted organization

by Nile O. Jones

Each February at the Tucson Community Center, a glittering display of magnificent gems and minerals draws dealers and collectors of rare minerals from all over the world. This internationally known event is the Tucson Gem and Mineral Show.

Most people who attend the show don't know that the organization which has staged this event for 23 years is the Tucson Gem and Mineral Society.

Back in the early 1950s, an ad was put into the newspaper asking if anyone would be interested in getting together to collect minerals on weekends. A handful of people responded to the ad. As time went by this handful of collectors increased in number; as their numbers grew, so did their pride of achievement. In 1954 they held their first annual show. There was no Community Center then, so local churches and a grade school provided the space for the members to set up their displays in those early years. As the Society grew, so did their need for space. Eventually, they established a home for their annual show in old quonset huts at the former Pima County Fairgrounds.

The increase in exhibition space seems to have coincided with increasing interest in the hobby of mineral collecting. This growth was not confined to the immediate community, because each year more and more people from out of state were traveling to Tucson for the sole purpose of attending the show.

The construction of the Tucson Community Center and the growth of the Society's membership were the magic ingredients needed to thrust this annual event into international prominence.

What is this Society and who are the people who work behind the scenes to put on such a prestigious event? The 350 current members are a cross-section of the community—retired folk, working families, and many children. There are several professional mineralogists and mineral dealers in the club, but the majority are hobbyists – and many became interested in mineral collecting through attending one of the previous shows.

Since the majority of the members have no prior formal training in mineralogy, the Society provides a means by which they can learn and therefore increase their enjoyment of the hobby. The club provides a number of classes dealing with all aspects of mineralogy, from basic mineral identification to the complex chemistry of mineral formation. Classes are provided for adults and for children, for novices and for experts.

The educational process goes beyond the self-help stage. The Tucson Gem and Mineral Society is a non-profit organization which has grown with the community and takes an active part in its interests. Each year the Society provides a scholarship at the University of Arizona for a deserving student in the Earth Sciences. A loan fund is maintained for use by the financially deserving student. The club donates money and mineral specimens to the Mineralogical Museum located on the University of Arizona campus, and to the Arizona-Sonora Desert Museum. Many of the members donate their time and expertise to these institutions, and many are also willing to give talks to schools and civic groups.

It should be noted that many of the active members joined the Society in a non-participatory manner. As their interest in the hobby grew, so did their enthusiasm for these allied activities.

In summary, the Tucson Gem and Mineral Society is made up of ordinary people who enjoy mineral collecting and have a strong sense of community pride. They are "doers" and they take great joy in presenting each year what has come to be known as "The Greatest Mineral Show in the World."

Arizona Geological Society Publications

The following Arizona Geological Society publications are available over the counter from the Publications Office of the Arizona Bureau of Mines, 845 N. Park, Tucson.

For mail orders, write to: Arizona Geological Society, Publications, P.O. Box 4585, Tucson AZ 85717.

Highway Geologic Map

The Arizona Geological Society has recently reprinted its popular Arizona Highway Geological Map, which was originally published in 1967. The folded map costs $3.00 (postage included), and advance payment is requested.

The 28½ by 48 inch full-color map depicts the many rock types present in Arizona, with 30 different colors on a map scaled at 1:1,000,000. The explanation includes a summary of the structural events (such as episodes of mountain building), and the economic products of each geologic period as well as rock descriptions.

The reverse side contains an excellent summary of the geologic history of Arizona, written for the knowledgeable layman. This 6,000-word summary is accompanied by eight maps showing the position of mountains and seas at various times in the past 600 million years. In addition, ten sketches of scenic favorites and their geologic explanations highlight an 8½ by 11 physiographic map of Arizona.

Guidebook III

Published in 1968, this guidebook is the latest in a series produced when Cordilleran Section meetings of the Geological Society of America are held in Tucson. The papers serve as important references to the geology of southern Arizona and include road logs for many field trips in southern Arizona and southwestern New Mexico.

Articles cover geochronology of Precambrian and Cenozoic rocks in Arizona, geologic descriptions of the Pena Blanca Lake area and the Dos Cabezas, Roskruge, and Tucson mountains, volcanic stratigraphy in southern Arizona, stratigraphic summaries of Paleozoic and Cretaceous strata in Arizona, the geology of the Esperanza and Ray ore deposits, and miscellaneous papers treating engineering geology, structural geology, and hydrology of the region.

Guidebook III, an 8½ by 11" hardbound volume, contains 354 pages and is profusely illustrated with photographs, maps, and diagrams. The cost is $10.00.

Digests

The Digests are periodically offered by the AGS as informal bulletins of technical papers and progress reports of geological research in Arizona and the Southwest.

Tectonic Digest (Volume 10, 1976)

The Tectonic Digest is the most recent and the largest volume in this series; 19

Continued on page 20

AGS Publications *continued*

papers cover 430 pages with 115 figures, and four large plates are in a separate map pocket. The general tectonic framework of Arizona is shown by cross sections and a free-air gravity anomaly map. Other papers chronologically develop detail in the structural history of Arizona in the Paleozoic, Mesozoic, Laramide, and late Tertiary. Other papers explore the tectonics of local areas such as the Prescott region in the Precambrian, southeastern Arizona in the late Devonian, the Tucson Mountains, northwestern Arizona, the central Dragoon Mountains, Picacho Peak, Saguaro National Monument, and Black Mountain near Tucson.

Widely differing theories and conclusions are offered, ranging from gravity gliding to thrusting and a variety of ages of Basin and Range faulting. The final paper is a thorough review of intrusive fragmental rocks by Dr. Evans Mayo. Digest 10 costs $11.50, including postage.

Digest 9 (1972)

Digest 9 contains 16 papers covering a broad range of topics; earthquake history, geochemistry, geophysics, stratigraphy, and geomorphology are included. Detail studies focus on local areas such as the Tucson Mountains, Tucson basin, Isla Mejia, Dragoon Pass, Ruby Star Ranch, Kendrick Peak, and the Pinacates in Mexico. Digest 9 contains 265 pages, 66 figures, and sells for $4.00.

Digest 7 (1964)

14 papers are included in Digest 7, ranging from geochronology, geomagnetic pole positions, geochemistry, structural geology, petrography, and economic geology, to ten writing rules for geologists. Specific areas studied include southeastern Arizona, the Tucson area, the Hualpai Indian Reservation, Graham County, the West San Xavier mine, and Mono County in California. Containing 171 pages and 59 figures, Digest 7 costs $2.50.

"Mineralogy of Arizona" Now in Print

605 different minerals have been identified in Arizona, ranging from acanthite, a silver sulfide found in nine counties, to zunyite, a rare mineral found so far only in Pinal and Yuma counties.

All are catalogued in "Mineralogy of Arizona," a new book from the University of Arizona Press authored by John W. Anthony, Sidney A. Williams, and Richard A. Bideaux. Anthony is a UA professor of Geosciences and Curator of the Mineralogical Museum on campus; Williams is with Phelps Dodge Corp.; and Bideaux is president of Tucson-based Computing Associates, a consulting firm.

The book contains 50 line drawings of crystals and 70 full-color photographs. Most of the pictures were taken by Julius Weber, associate in the Department of Mineralogy of the American Museum of Natural History, New York, and by Jeffrey Kurtzeman of Phoenix. A grant from Phelps Dodge Corp. allowed their inclusion in the book.

Besides cataloguing the Arizona minerals, the book has several other chapters, including those on uranium, vanadium, meteorites, and copper.

The 225-page book sells for $9.75 in soft cover and $22.50 in hardback. It can be purchased at most Arizona bookstores; soft-cover copies are available over the counter from the Arizona Bureau of Mines. Mail orders should be sent to the University of Arizona Press, Box 3398, Tucson AZ 85722.

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