Arizona Geological Survey

ARIZONA GEOLOGY

(formerly *Fieldnotes*)

Vol. 18, No. 3 | Investigations • Service • Information | Fall 1988

Arizona Geological Survey: A New State Agency

by Larry D. Fellows
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The Arizona Geological Survey (AZGS) became an independent State agency July 1, 1988 in accordance with Senate Bill 1102, which was enacted in 1987. The administrative head of the AZGS, the State Geologist, is appointed by the Governor. The purpose of the AZGS – to assist the wise use of lands and mineral resources in Arizona by providing scientific and investigative research and information – was essentially unchanged.

To facilitate the conduct of research and investigations, the legislature specified in SB1102 that the AZGS offices be located in proximity to the University of Arizona in Tucson and that AZGS staff "shall have reasonable access to the data and other resources of the University of Arizona or any other State university in Arizona." Many AZGS projects are completed with the assistance of faculty and graduate students. Thirty-nine of the 64 items published by the AZGS during Fiscal Year 1987-88 were coauthored by University of Arizona faculty or graduate students. Sixteen of the 64 were coauthored by faculty or graduate students from other universities.

The ancestral AZGS began in 1881, when the Office of the Territorial Geologist was established by the Territorial Legislature. The primary duties were to collect and provide information about mineral resources. In 1893 the University of Arizona established a testing laboratory, known informally as the "Bureau of Mines." From then until statehood in 1912, Territorial Geologists were also affiliated with the "Bureau of Mines" and the university. A 1915 statute formally established the Arizona Bureau of Mines as a State agency administered by the University of Arizona, continuing, essentially unchanged, the functions of the "Bureau of Mines" and the Territorial Geologist. Data collection and research activities continued to be concentrated on mineral resources. Sixty-two years later, in 1977, the Bureau's enabling legislation was modernized and its name was changed to the Arizona Bureau of Geology and Mineral Technology. It continued to be administered as a division of the University of Arizona. The Bureau was charged with investigating geologic hazards and limitations, as well as the geologic framework and mineral resources of Arizona, in anticipation of population growth and increased competition for and conflict over land, mineral resources, and water.

Similar patterns of development and growth have taken place in other State geological surveys; most other States and surveys, however, have been in existence longer than Arizona and the AZGS. Twenty-nine State geological surveys were founded before 1860; 36 were established before the Office of the Territorial Geologist in Arizona Territory. Forty-nine States now have a geological survey. Thirty-six of the surveys are independent agencies or part of an executive-branch agency; 13 are part of a university. Twenty-six State geological surveys are on or adjacent to a university campus.

The name of this publication, the quarterly newsletter of the AZGS, has been changed from *Fieldnotes* to *Arizona Geology,* coincident with the statutory change, to reflect its contents more accurately. *Fieldnotes from the Arizona Bureau of Mines* was first published in March 1971. The Fall-Winter issue of 1977 was the first issue published by the Arizona Bureau of Geology and Mineral Technology. This issue of *Arizona Geology* was typeset in-house on a laser printer. All subsequent issues will be typeset accordingly.

The AZGS logo also differs from that of the former Bureau. As illustrated in the masthead, it is a miniature geologic map of Arizona that shows the Colorado Plateau, Transition Zone, and Basin and Range physiographic provinces.

Although the AZGS is now independent of the University of Arizona, it maintains close ties with the Department of Geosciences as well as other university departments. AZGS staff members hope to strengthen these working relationships and develop closer cooperation with the geology departments at Arizona State University and Northern Arizona University. Other AZGS plans include expanding its computerized database, preparing bibliographies, and providing geologic data to agencies and individuals concerned with the special problems in land and resource management caused by rapid population growth.

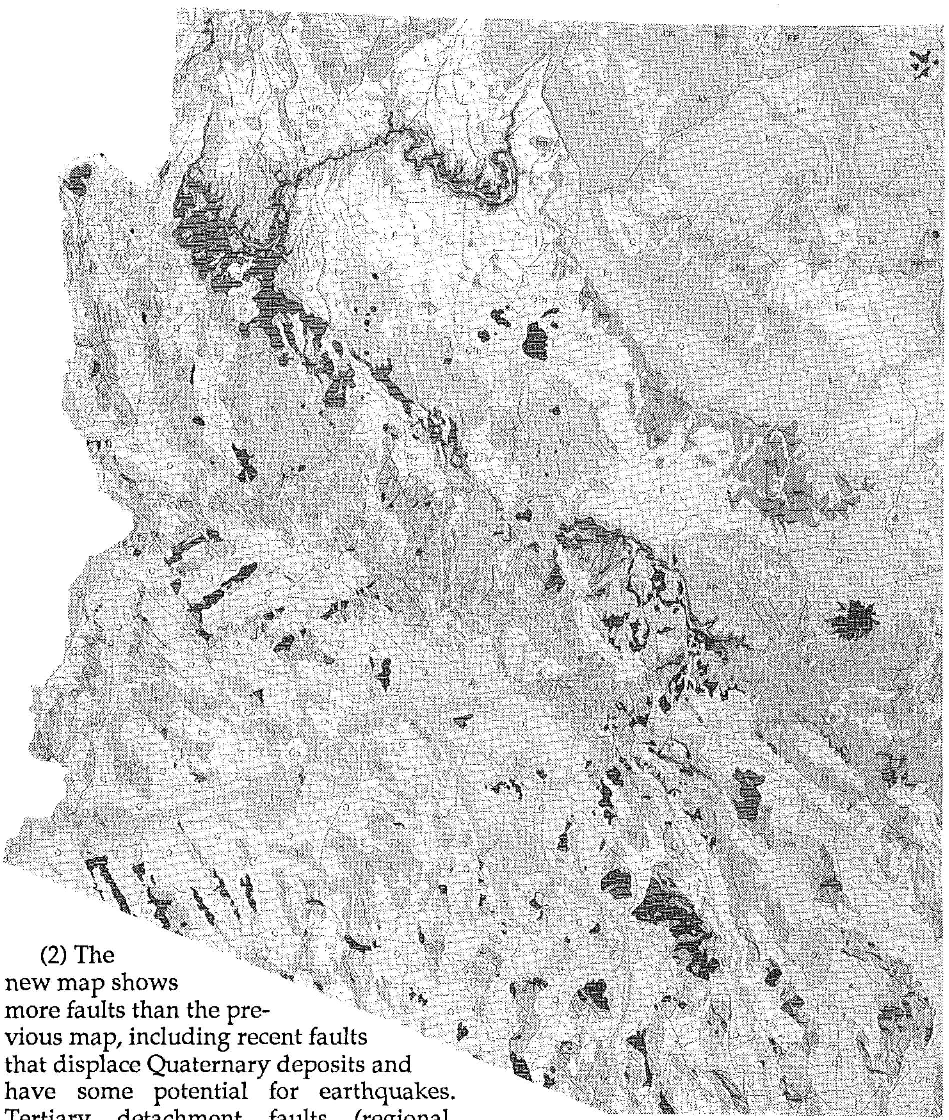
The AZGS offices are still located at 845 N. Park Ave. in Tucson. Office hours are from 8:00 a.m. to 5:00 p.m. Monday through Friday, except for a brief closure from 12:00 p.m. to 1:00 p.m. on Tuesdays. AZGS staff are present to assist those who use the library, buy publications, or consult with geologists during these hours.

Governor Mofford Appoints State Geologist

On July 6, 1988, Governor Rose Mofford appointed Dr. Larry D. Fellows Director of the Arizona Geological Survey (AZGS). Governor Mofford stated, "Larry has great support in the scientific community and we are delighted he accepted this position." Dr. Fellows has served as the State Geologist and Assistant Director of the Arizona Bureau of Geology and Mineral Technology since 1979. He received a Ph.D. degree in geology from the University of Wisconsin in 1963. He also obtained B.S. and M.A. degrees in geology from Iowa State College and the University of Michigan, respectively.

A New Geologic Map of Arizona

by Stephen J. Reynolds
Arizona Geological Survey



The Arizona Geological Survey (AZGS) has released a new 1:1,000,000-scale Geologic Map of Arizona (Figure 1). This map supersedes the 1:500,000-scale State geologic map published in 1969, which is out of print and mostly out of date because of more recent geologic studies. The new Geologic Map of Arizona incorporates numerous advances in the understanding of the geology of the State and bears little resemblance to its predecessor, either in content or in style of presentation. Although the new map is physically smaller than the 1969 map, it contains more information and is more detailed for many parts of the State.

The most obvious difference between the new and old State maps is the choice of colors for map units. Most Quaternary deposits are now shown in shades of gray so that bedrock areas are not lost in a sea of yellow, as in the previous map. To emphasize their similarities, related map units are shown by shades of a single color, rather than by different colors. For example, all volcanic, granitic, and sedimentary rocks formed during an important episode of mid-Tertiary tectonism (mountain building) are shown in shades of orange. The new map also differs from the previous one in that it is printed on a synthetic water-resistant paper that should be more durable in wind and rain.

The most important changes, however, are in content. Although the 1969 map represented a major step forward and was as accurate as possible for its time, the new map contains thousands of significant improvements based on more detailed geologic mapping and conceptual breakthroughs. Although most changes in the map are in the Basin and Range Province and Transition Zone, where compilers of the 1969 version were forced to rely on reconnaissance mapping, numerous changes are also evident in the Colorado Plateau Province. Some of the most important geologic changes are listed below.

(1) Quaternary and upper Tertiary sedimentary deposits are subdivided into four units, rather than two, on the basis of age and geologic setting. For example, recent alluvium within large river channels and flood plains is shown separately from older deposits further from the rivers to highlight areas that may experience flooding.

(2) The new map shows more faults than the previous map, including recent faults that displace Quaternary deposits and have some potential for earthquakes. Tertiary detachment faults (regional, gently dipping normal faults) that were not recognized or were identified as thrust faults on the previous map are also shown on the new map, as are areas where rocks beneath the faults were affected by mylonitization (high-temperature shearing).

(3) Volcanic rocks erupted since 15 million years (m.y.) ago are subdivided into five map units on the basis of rock type and new radiometric age determinations. For example, the map shows areas where volcanic rocks erupted since 4 m.y. ago are present because these are the most likely sites of future volcanic eruptions.

(4) Because of numerous new radiometric age determinations, middle Tertiary volcanic rocks are more widespread on the new map than on the 1969 map, where they were depicted as Cretaceous, Tertiary, or Quaternary in age.

(5) The ages of granitic rocks are better known now than in 1969 and are more correctly reflected on the new map. This is especially important in mineral exploration because certain types of mineral deposits are commonly associated with granites of a specific age.

(6) The geology of west-central, southwestern, and south-central Arizona appears very different on the new map than on the 1969 map. Rocks depicted as Mesozoic schist on the old map are now recognized as mostly Jurassic volcanic and sedimentary rocks. Rocks shown on the old map as Cretaceous volcanic rocks and Quaternary to late Tertiary basalt are now known to be middle Tertiary in age. The new State map also shows newly recognized Paleozoic outcrops, Cretaceous thrust faults,

(continued on page 4)

Geologic Maps and Indexes Published by the Arizona Geological Survey

These publications were compiled by and may be purchased from the Arizona Geological Survey (AZGS). For price information, contact the AZGS offices at 845 N. Park Ave., Tucson, AZ 85719; tel: (602) 621-7906. The publication series are abbreviated as follows: B = Bulletin; FS = Folio Series; M = Map; OFR = Open-File Report.

Maps

B 195--Geology of the South Mountains, Central Arizona, by S.J. Reynolds, 1985, 61 p., scale 1:24,000.

FS 1--Environmental Geology of the McDowell Mountains Area, Maricopa County, Arizona, by G.E. Christenson, D.G. Welsch, and T.L. Péwé, 1978, scale 1:24,000.

FS 2--Environmental Geology of the Tempe Quadrangle, Maricopa County, Arizona, by T.L. Péwé, C.S. Wellendorf, and J.T. Bales, 1986, scale 1:24,000.

M 19--Map of Outcrops of Laramide (Cretaceous-Tertiary) Rocks in Arizona and Adjacent Regions [includes explanatory pamphlet], by Stanley B. Keith, 1984, scale 1:1,000,000.

M 20--Map of Mid-Tertiary Volcanic, Plutonic, and Sedimentary Rock Outcrops in Arizona, by R.B. Scarborough, 1986, scale 1:1,000,000.

M 21--Map of Post-15-m.y. Volcanic Outcrops in Arizona, by R.B. Scarborough, 1985, scale 1:1,000,000.

M 22--Map of Late Pliocene-Quaternary (Post-4-m.y.) Faults, Folds, and Volcanic Outcrops in Arizona, by R.B. Scarborough, C.M. Menges, and P.A. Pearthree, 1986, scale 1:1,000,000.

OFR 81-22--Preliminary Detailed Geologic Map and Cross Sections of the Clifton Hot Springs and San Francisco River Area, by J.E. Cunningham, 1981, scale 1:24,000.

OFR 81-30--Reconnaissance Geology-Salt River From Roosevelt Dam to Granite Reef Dam, Central Arizona, by R.B. Scarborough, 1981, 70 p., scale 1:24,000 and 1:1,260, 9 sheets.

OFR 82-6--Preliminary Geologic Map of the Western Harquahala Mountains, West-Central Arizona, by Stanley B. Keith, S.J. Reynolds, and S.M. Richard, 1982, scale 1:12,000.

OFR 83-21--Map of Basin and Range (Post-15 m.y.a.) Exposed Faults, Grabens, and Basalt-Dominated Volcanism in Arizona, by R.B. Scarborough, C.M. Menges, and P.A. Pearthree, 1983, 25 p., scale 1:500,000, 2 sheets.

OFR 83-24--Reconnaissance Geology of the Northern Plomosa Mountains, by R.B. Scarborough and Norman Meader, 1982, 35 p.

OFR 84-1--Late Pliocene and Quaternary Geology, Ajo Quadrangle, by R.B. Morrison, 1983, 6 p., scale 1:250,000.

OFR 84-2--Late Pliocene and Quaternary Geology, El Centro Quadrangle, by R.B. Morrison, 1983, 6 p., scale 1:250,000.

OFR 84-3--Late Pliocene and Quaternary Geology, Lukeville and Sonoyta Quadrangles, by R.B. Morrison, 1983, 6 p., scale 1:250,000.

OFR 84-4--Preliminary Geologic Map of the Aguila Ridge-Bullard Peak Area (Eastern Harcuvar Mountains), West-Central Arizona, by S.J. Reynolds and J.E. Spencer, 1984, 2 p., scale 1:24,000.

OFR 85-2--Geologic Cross Sections of Western Arizona Basin and Range, With Accompanying Geologic Maps and Other Information, by R.B. Scarborough, 1985, 10 p., scale 1:250,000, 35 sheets.

OFR 85-5--Reconnaissance Geologic Map of the Merritt Hills, Southwestern Yavapai County, Arizona, by S.J. Reynolds and J.E. Spencer, 1985, scale 1:24,000.

OFR 85-6--Reconnaissance Geology of Mineralized Areas in Parts of the Buckskin, Rawhide, McCracken, and Northeast Harcuvar Mountains, Western Arizona, by J.E. Spencer and J.W. Welty, 1985, 31 p.

OFR 85-9--Geologic Map of the Little Harquahala Mountains, West-Central Arizona, by J.E. Spencer, S.M. Richard, and S.J. Reynolds, 1985, 18 p., scale 1:24,000, 3 sheets.

OFR 85-11--Reconnaissance Geology of the Crest of the Sierra Estrella, Central Arizona, by J.E. Spencer, S.J. Reynolds, Phillip Anderson, and J.L. Anderson, 1985, 20 p.

OFR 85-14--Preliminary Geologic Maps of the Eastern Big Horn and Belmont Mountains, West-Central Arizona, by R.C. Capps, S.J. Reynolds, C.P. Kortemeier, J.A. Stimac, E.A. Scott, and G.B. Allen, 1985, 26 p., scale 1:24,000, 2 sheets.

OFR 86-2--Geologic Map of the Lincoln Ranch Basin, Eastern Buckskin Mountains, Western Arizona, by J.E. Spencer and S.J. Reynolds, 1986, 6 p., scale 1:24,000.

OFR 86-9--Geologic Map of the Planet-Mineral Hill Area, Northwestern Buckskin Mountains, West-Central Arizona, by J.E. Spencer, S.J. Reynolds, and N.E. Lehman, 1986, 13 p., scale 1:24,000.

OFR 86-10--Geologic Map of the Northeastern Hieroglyphic Mountains, Central Arizona, by R.C. Capps, S.J. Reynolds, C.P. Kortemeier, and E.A. Scott, 1986, 16 p., scale 1:24,000.

OFR 87-2--Geologic Map of the Swansea-Copper Penny Area, Central Buckskin Mountains, West-Central Arizona, by J.E. Spencer and S.J. Reynolds, 1987, 10 p., scale 1:12,000.

OFR 87-4--Geologic Map of the Maricopa Mountains, Central Arizona, by Dickson Cunningham, Ed DeWitt, Gordon Haxel, S.J. Reynolds, and J.E. Spencer, 1987, scale 1:62,500.

OFR 87-9--Geologic Map of the Wickenburg, Southern Buckhorn, and Northwestern Hieroglyphic Mountains, Central Arizona, by J.A. Stimac, J.E. Fryxell, S.J. Reynolds, S.M. Richard, M.J. Grubensky, and E.A. Scott, 1987, 13 p., scale 1:24,000, 2 sheets.

OFR 87-10--Geologic Map of the Northeastern Vulture Mountains and Vicinity, Central Arizona, by M.J. Grubensky, J.A. Stimac, S.J. Reynolds, and S.M. Richard, 1987, 7 p., scale 1:24,000.

OFR 88-1--Geologic Map of the Southern Hieroglyphic Mountains, Central Arizona, by D.E. Wahl, S.J. Reynolds, R.C. Capps, C.P. Kortemeier, M.J. Grubensky, E.A. Scott, and J.A. Stimac, 1988, 6 p., scale 1:24,000.

OFR 88-4--Quaternary Geologic Map of the Salome 30 x 60-Minute Quadrangle, West-Central Arizona, by K.A. Demsey, 1988, scale 1:100,000.

OFR 88-9--Geologic Map of the Southeastern Vulture Mountains, West-Central Arizona, by M.J. Grubensky and S.J. Reynolds, 1988, 16 p., scale 1:24,000.

OFR 88-10--Geologic Map of the Vulture Mine Area, Vulture Mountains, West-Central Arizona, by S.J. Reynolds, J.E. Spencer, Ed DeWitt, D.C. White, and M.J. Grubensky, 1988, 5 p., scale 1:24,000.

Indexes

M 17--Index of Published Geologic Maps of Arizona, 1903-1982, by R.B. Scarborough and M.L. Coney, 1982, scale 1:1,000,000, 6 plates.

OFR 84-5--Index of Published Geologic Maps of Arizona, November 1982-June 1984, by R.B. Scarborough and T.G. McGarvin, 1984, scale 1:1,000,000.

OFR 86-4--Index of Published Geologic Maps of Arizona, July 1984-December 1985, by T.G. McGarvin, 1986, scale 1:1,000,000.

OFR 87-1--Index of Published Geologic Maps of Arizona-1986, by T.G. McGarvin, 1987, scale 1:1,000,000.

OFR 87-5--Index of Unpublished (Pre-1969) Geologic Maps in Arizona Done by the Arizona Bureau of Mines and the U.S. Geological Survey, by M.J. Grubensky and S.J. Reynolds, 1987, scale 1:250,000, 14 sheets.

OFR 88-16--Index to Published Geologic Maps of Arizona-1987, by T.G. McGarvin, 1988, scale 1:1,000,000.

Arizona Gazetteer Available

Geographic names are part of the language of maps. They enable users to locate places, identify areas of administrative responsibility, define political boundaries, and carry legal weight in determining property, mineral, and water rights. A geographic dictionary of more than 36,000 names for places, features, and area's (except roads) within Arizona has been published by U.S. Geological Survey (USGS). It is the most comprehensive gazetteer for Arizona.

Some of the more colorful names include Bathtub Water (a lake), Coffee Pot Well, Do Nothing Canyon, Napoleons Tomb (an island), Secret Pocket (a basin), Sore Fingers (a summit), and Total Wreck Mine. The gazetteer also provides information on the naming of the State. The name *Arizona* was derived either from the Spanish Basque words for "good oak trees" or "valuable ores" or from the Papago Indian words *ali*, meaning "small," and *shonak*, meaning "place of the spring."

Each entry in the gazetteer identifies the type of feature, its location by county and geographic coordinates, its elevation (if appropriate), and the names of the USGS quadrangle maps on which it is shown.

Copies of the 722-page report, titled *The National Gazetteer of the United States of America--Arizona, 1986* and published as USGS Professional Paper 1200-AZ, are available for $31 each from the U.S. Geological Survey, Books and Open-File Reports Section, Box 25425, Federal Center, Denver, CO 80225.

(continued from page 2)

and areas of Mesozoic or early Cenozoic metamorphism.

(7) Precambrian rocks throughout the State have been subdivided into new categories. The older Precambrian metamorphic rocks, shown as gneiss and schist on the 1969 map, have been subdivided, where sufficient information exists, into metasedimentary rocks, metavolcanic rocks, and metamorphosed granitic rocks. Precambrian granitic rocks, previously shown as one map unit, have been subdivided into two suites of different ages.

(8) The ages assigned to many bedrock exposures have changed because of recent data. For example, rocks shown on the 1969 map as Mesozoic or Tertiary gneiss in southwestern Arizona are now shown as Precambrian gneiss, Precambrian granite, Jurassic granite, and Tertiary to Cretaceous granite. Some areas originally shown as Precambrian gneiss are instead Tertiary, Cretaceous, and Jurassic granites that were affected by Mesozoic metamorphism and Tertiary mylonitization.

The new State map, although printed at a scale of 1:1,000,000, was compiled at 1:500,000 (the scale of the 1969 State map) and photographically reduced to 1:1,000,000 prior to color separation by computer. A new 1:500,000-scale State geologic map is planned, but will not be printed until additional geologic mapping in western Arizona and in the Transition Zone is completed, probably after 1990. Until then, the 1:1,000,000-scale map will represent an interim statement concerning what is and what is not known about the geology of Arizona.

To obtain a copy of the new Geologic Map of Arizona, send $5.00 plus a postage and handling fee (add $1.75 for a folded map; add $2.75 for a rolled map). All orders must be prepaid. Make the check or money order payable to the Arizona Geological Survey and mail it to the AZGS offices at 845 N. Park Ave., #100, Tucson, AZ 85719.

DEBRIS FLOW THREATENS ARIZONA HOMES

In July 1988, a significant debris flow threatened several homes near a small tributary of Ash Creek in the Huachuca Mountains of southeastern Arizona. A forest fire in June denuded vegetation from the middle and upper portions of this drainage. During an intense thunderstorm in the area, water runoff and fine-grained sediments from the steep slopes of the upper portion of the drainage formed a slurry, which entrained boulders from the stream channel. The above photo shows boulders that were deposited on an alluvial fan where the stream exits the mountains. Although houses on the alluvial fan were not seriously damaged, yards were rearranged as debris flowed among several houses. Before this event, researchers and regulatory agencies had not considered debris flows a serious threat in the area. The Arizona Geological Survey (AZGS) is involved in a study to (1) determine the physical properties of this debris flow; (2) assess the frequency of debris flows in this drainage; and (3) evaluate evidence for debris flows in other drainages in the Huachuca Mountains. This information will enable AZGS staff members to assess the extent of debris-flow hazards in this mountain range.

Alternatives in Flood-Plain Management in Desert Areas

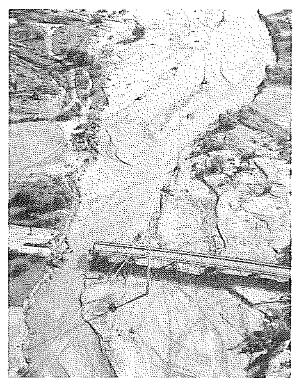
by Marie Slezak Pearthree [1]
and Victor R. Baker [2]

One of Arizona's most damaging geologic hazards has been water runoff from normally dry desert lands. Processes associated with this phenomenon are especially troublesome in the lowlands of the Basin and Range province, where more than 90 percent of the State's rapidly expanding population resides. Runoff intensity can range from low flows contained within erodible banks to overbank flooding onto adjacent flood plains. Less attention has been given to the management problems associated with shifting banks during "low" flows than to those caused by classic flooding.

In the southwestern United States, frequent changes in the morphology and position of alluvial ephemeral-stream channels create uncertainties for flood-plain management. These stream channels are developed within unconsolidated fluvially deposited sediments and convey flows resulting from direct precipitation or snowmelt (Gary and others, 1974; Maddock, 1976). The channels are usually dry for long periods or carry only occasional low flows. Infrequent high flows may exceed channel capacities and locally inundate adjacent flood plains (Condes de la Torre, 1970). A flood plain is geologically defined as the nearly level land adjacent to a stream channel that is constructed by the stream and is subject to flooding (Gary and others, 1974).

It is conceptually important to distinguish between flood and flow events in the semiarid Southwest. Much confusion has arisen because of a lack of appreciation for the contrasting processes involved in these two types of runoff events. A flood occurs when the capacity of an active channel to contain the flow is exceeded. In other words, a true flood refers to distinct overbank flow. If there is no flooding, the runoff event is simply a flow event. Flooding may locally occur, but elsewhere along the same stream channel, runoff may be totally contained within well-defined banks. Flooding is an unusual condition, whereas confined flow is the norm.

Federal flood-plain management regulations, formulated by the U.S. Congress in response to past and potential loss of life and property from flooding, form the basis for local flood-plain management. These regulations, however, do not take into account regional differences in stream-channel behavior. The Federal regulations mainly address in-channel and overbank inundation produced by a 100-year flood, which has a 1 percent chance of occurring in any given year (U.S. Code Congressional and Administrative News, 1968). The limits


Channel Change Along the Rillito Creek
System of Southeastern Arizona
1941 Through 1983
Implications for Flood-Plain Management

by Marie Slezak Pearthree and Victor R. Baker
Special Paper 6

of the resulting 100-year flood plain generally occur within the geologic flood plain.

Land-use restrictions are mandated within the regulatory flood plain, which currently consists of the 100-year flood plain, by Federal regulations for communities that want to participate in the National Flood Insurance Program. In the southwestern United States, however, channel-bank erosion often presents an equal or greater hazard to property than does flooding. This additional hazard is not addressed in the Federal regulations, nor is it often brought to the attention of communities enacting flood-plain management programs.

Changes in channel morphology (cross-sectional channel shape and plan-view patterns) and position, including both abrupt and long-term bank erosion, have modified the limits of 100-year flood plains. The computational methods generally used to predict the water-surface level of a 100-year flood along a stream, and thus determine the limits of its 100-year flood plain, assume that neither the morphology nor the position of the channel will change significantly before or during the flood (Burkham, 1972). This assumption is often invalid when applied to the alluvial channels of ephemeral streams in semiarid regions. Such streams frequently alter the positions of their channel banks and elevations of their streambeds during flows of lesser magnitude and greater frequency than the 100-year flood. Temporal variability of 100-year flood-plain limits makes land-use zoning based on nationally mandated regulatory procedures invalid in the semiarid Southwest.

It is crucial in terms of land use to determine if property near a stream channel is potentially subject to bank erosion, flooding, or both. There is, therefore, a need to modify Federal flood-plain management regulations in semiarid regions to include the effects of channel change on the extent of the regulatory flood plain and the potential erosional damage associated with both flood and nonflood flows. If the definition of the regulatory flood plain were to take into account (1) past channel positions and (2) potential sites of bank erosion and lateral channel migration, regulatory flood plains would be less dependent upon present stream-channel morphologies and positions, and thus less prone to short-term fluctuations. Accordingly, for management purposes, the concept of the regulatory flood plain should be amended to include both historical channel positions and river margins potentially subject to erosion or flooding. Flood-plain management should include management of the stream channels and their margins, as well as the flood plains.

A recent publication released by the Arizona Geological Survey explores the historical behavior of the Rillito Creek system of southeastern Arizona. This ephemeral-stream system drains 934 square miles (2,419 square kilometers) within the Basin and Range Province. Based on investigations of this system, alternatives to the flood-plain management regulations currently applied to semiarid regions have been proposed.

The Rillito Creek system was chosen because severe bank erosion and lateral channel migration have occurred during the past few decades within the rapidly expanding Tucson metropolitan area. The study area lies within the Tucson basin primarily to the north and east of the current city limits. Population growth, exemplified by the influx of approximately 195,000 persons into Pima County

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between 1965 and 1985, has created substantial pressure to urbanize the stream margins of this drainage system (Pima County Planning and Development Services, oral commun., 1985). An understanding of the nature of this system is therefore required for setting development restrictions.

The behavior of the Rillito Creek system was investigated primarily by mapping Tanque Verde Creek, Pantano Wash, and Rillito Creek from aerial photographs generated between 1941 and 1979. From these photos, channel-width measurements were obtained at selected locations along each stream channel and comparisons were made of channel plan-view patterns and positions through time. In addition, historical observations of channel change were gathered from newspaper accounts. Longitudinal profiles from the Pima County Department of Transportation and Flood Control District provided insight into fluctuations in streambed elevations. This investigation was subsequently updated using aerial photographs to include the effects of the flow event of October 1983.

The results of this study were organized to provide an understanding of (1) the nature of channel change within ephemeral-stream systems in semiarid regions and (2) the management problems that such change creates. Observed variations in channel morphology and position were evaluated with respect to streamflow history and bank compositions. The effects of in-channel sand-and-gravel extraction on channel morphology were also considered.

The study delineates Federal flood-plain management regulations through a survey of the legislation that led to the establishment of the National Flood Insurance Program. Pima County and City of Tucson flood-plain management ordinances are also outlined. Applicability of Federal regulations to ephemeral-stream systems in semiarid regions is discussed, using the Rillito Creek system as an example. Recommendations are then made for more effective flood-plain management in such regions.

Channel Change Along the Rillito Creek System of Southeastern Arizona, 1941 Through 1983: Implications for Flood-Plain Management was published as Special Paper 6. This 58-page study includes a 1:24,000-scale map showing the historical channel boundaries of this river system. A copy may be obtained by sending $16.00, plus $4.25 for postage and handling, to the Arizona Geological Survey, 845 N. Park Ave., Tucson, AZ 85719. All orders must be prepaid.

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TUCSON STORMWATER MANAGEMENT STUDY

The City of Tucson is developing a comprehensive plan to mitigate drainage problems associated with runoff from storms. The Tucson Stormwater Management Study team will search for solutions that incorporate (1) a balance between solving drainage problems and protecting the natural environment; (2) costs for improving and maintaining facilities; and (3) requirements for forming and running an organization that will manage the program. After the study team determines acceptable solutions, it will review funding options for the program and develop guidelines for its annual review and update. Meetings to gather public input to help shape the program will be held in November 1988, January 1989, and March 1989. Locations will be announced later.

STAFF NOTES

Thomas G. McGarvin was a panelist on the Sunday-morning series titled "Arizona Alumni," which aired on June 19 on KGUN-TV (Channel 9, ABC affiliate). The program included discussions on the history of gold mining and the geology of gold deposits in Arizona, as well as a demonstration of gold panning.

Stephen J. Reynolds presented a talk on Tertiary volcanism at the CACTIS meeting, which was held in Flagstaff in May. At an industrial minerals workshop held in Tempe in May, he discussed sources of geologic information in Arizona. Reynolds appeared on the program "Horizon" on KAET-TV (Channel 8, PBS affiliate), which was shown on October 3, to discuss the geology of Papago Park in Phoenix. He also led a field trip to the Rincon Mountains near Tucson for faculty and graduate students from the University of Arizona and a visiting professor from Germany.

Jon E. Spencer presented a talk titled "Mesozoic and Cenozoic Geology and Mineral Deposits of West-Central Arizona" to the Arizona Geological Society on October 4.

John W. Welty was a guest on the program "Horizon," which aired July 25 on KAET-TV. Titled "Arizona SSC Project Update," the program focused on the geologic setting and constructability of the Superconducting Super Collider (SSC). The proposed SSC site in Arizona encompasses the Maricopa Mountains southwest of Phoenix. Welty, Project Geologist for the Arizona SSC Project, has been "on loan" to the SSC team from the AZGS staff since April 1987.

Bibliographies on the Geology of Arizona

These publications were compiled by and may be purchased from the Arizona Geological Survey (AZGS). For price information, contact the AZGS offices at 845 N. Park Ave., Tucson, AZ 85719; tel: (602) 621-7906. The publication series are abbreviated as follows: B = Bulletin; C = Circular; O = Open-File Report. The number in parentheses after the series is the publication date.

B 173	(1965)	Bibliography of the Geology and Mineral Resources of Arizona, 1848-1964
B 190	(1974)	Bibliography of the Geology and Mineral Resources of Arizona, 1965-1970
C 22	(1981)	Index to Road Logs and River Logs in Arizona, 1950-1980
C 23	(1982)	Geothermal Resources in Arizona: A Bibliography
O 85-10	(1985)	Theses and Dissertations on Arizona Geology, 1891-1978
C 24	(1986)	Bibliography for Metallic Mineral Districts in Cochise, Graham, and Greenlee Counties, Arizona
C 25	(1986)	Bibliography for Metallic Mineral Districts in La Paz, Mohave, and Yuma Counties, Arizona
C 26	(1986)	Bibliography for Metallic Mineral Districts in Pima and Santa Cruz Counties, Arizona
O 88-14	(1988)	Bibliography of Arizona Landslide Maps and Reports

CACTIS Meeting Examines Crustal Transect

by John H. Sass, Gordon B. Haxel, and Ivo Lucchitta

U.S. Geological Survey
Flagstaff, AZ 86001

A workshop examining the geology, evolution, structure, and tectonics of the eastern two-thirds of the U.S. Geological Survey Pacific to Arizona Crustal Experiment (PACE) transect was held in Flagstaff May 6-8, 1988. The meeting, called "California-Arizona Crustal Transect: Interim Synthesis" (CACTIS), was organized by personnel from the U.S. Geological Survey and Northern Arizona University. A total of 88 persons representing several disciplines and about 20 institutions attended.

The workshop was characterized by an atmosphere of informality, fostered in large part by the absence of formal presentations and the availability of abundant poster space. Nine 1-hour panel discussions were held and more than 30 posters were displayed during the workshop. Each panel consisted of 5 to 7 persons familiar with the topic under discussion; audience participation was usually lively.

The four panel discussions held on May 6 focused on a synoptic view of the transect, from the Colorado Plateau westward through the Transition Zone into the Sonoran Desert of the Basin and Range Province. The highly extended terranes on both sides of the Colorado River were discussed during one session; other discussions were devoted to the Mojave block and eastern Mojave Desert. Many new insights were developed regarding the present state of the transect. Seismic refraction and reflection data recently obtained by PACE, COCORP, and CALCRUST were especially significant. Spirited discussions were held on the "Bagdad reflection sequence" and the "bulge of pain," a midcrustal anticlinal structure under the metamorphic core complexes. The specter of significant velocity anisotropy in layered mid- to lower-crust rocks was raised by evidence from velocity measurements on core from a hole in the Appalachian Piedmont metamorphic province. New and somewhat controversial geobarometric data provided evidence of considerable variability in the depth of formation of metamorphic core complexes: some are shallow, others are deep.

On the second day, emphasis shifted from the current physical state of the lithosphere to the evolution of the present terranes and the processes that controlled this evolution. Topics included Proterozoic through Tertiary inheritance, as well as lower-crust/lithospheric processes, with emphasis on the significance of seismic reflectors and refractors (once again raising the specter of velocity anisotropy) and lithosphere rheology. The role of thermal time-constants in the contemporary thermal expression of previous thermal and tectonic events was emphasized. A lively debate on extension and magmatism revolved around the geologic evidence that substantiates various hypotheses concerning the order of their occurrence and whether one can occur without the other. The panel discussions ended with a plate-tectonic panorama featuring shallow subducting slabs, thin-skin tectonics, drips, and gaps.

On the last day, participants synthesized what had been learned during the meeting and made some progress toward greater interdisciplinary and interinstitutional cooperation within the transect. Several fascinating questions were raised: (1) What happened between 30 and 40 m.y. ago (Figure 1), from which time little tectonic or magmatic activity can be documented? Were tectonic events occurring, but to the east? (2) How can deep crust (core complexes) be exposed by extension? (3) Was the region once as high as today's Tibetan Plateau? (4) What is the relation between Mesozoic crustal thickening and Tertiary crustal extension? These and other questions will be addressed in a special issue of the *Journal of Geophysical Research*, which will be published in late 1989.

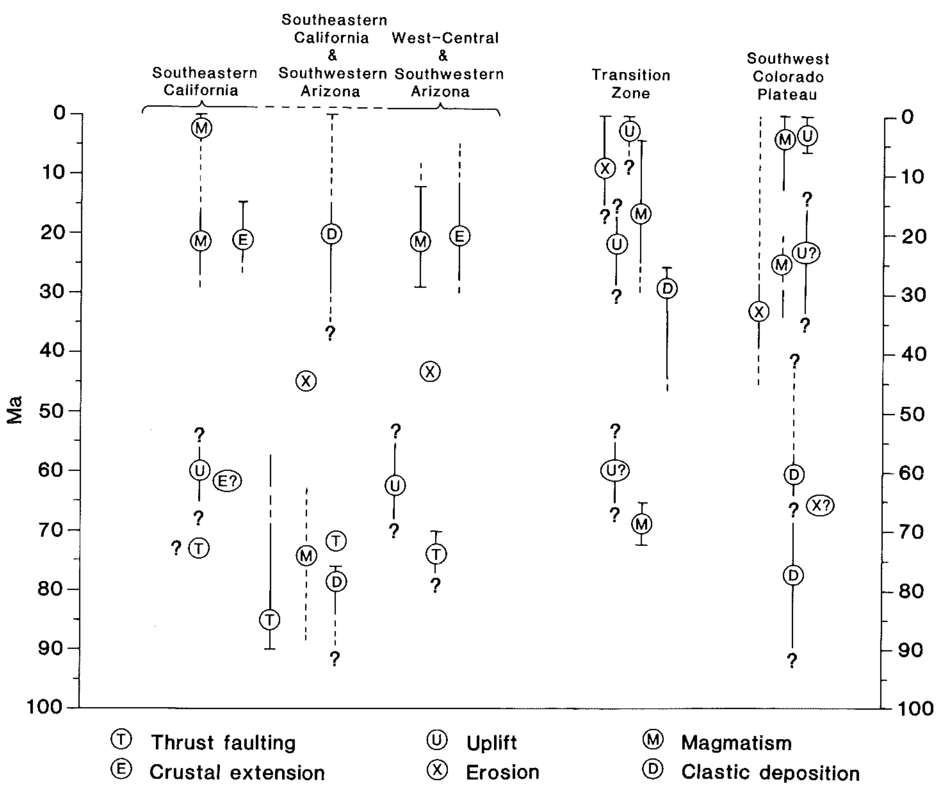

Figure 1. Approximate occurrence of major tectonic activity along the California-Arizona Crustal Transect. Source: consensus of CACTIS attendees.

Dangers In and Around Abandoned Mines

The following article was originally released as a brochure by the Education and Training Division of the Arizona State Mine Inspector's Office. For further information, write to Arizona State Mine Inspector's Office, Abandoned Mines Program, 1616 W. Adams, Suite 411, Phoenix, AZ 85007-2627, or call (602) 255-5971.

Abandoned mines pose numerous hazards to the unwary curiosity seeker or amateur prospector. Whatever the potential for undiscovered treasure, the doubtful rewards are not worth the almost inevitable costs in disaster, dismemberment, or even death. The dangers that could be encountered in an abandoned mine include shafts, cave-ins, timber, ladders, explosives, water, bad air, and rattlesnakes.

Shafts

The collar or top of a mine shaft is especially dangerous. The fall down a deep shaft is just as lethal as the fall from a tall building, with the added disadvantage of bouncing from wall to wall and the likelihood of having falling rocks and timber for company. Even if a person survived such a fall, it might be impossible to climb back out.

The rocks at the surface are often decomposed. Timbers may be rotten or missing. It is dangerous to walk anywhere near a shaft opening; the entire area could slide into the shaft, along with the curious explorer.

A shaft sunk inside a tunnel is called a winze. In many old mines, winzes have been boarded over. If these boards have decayed, a perfect trap is awaiting the next hapless visitor.

Cave-Ins

Cave-ins are an obvious danger. Areas that are likely to cave in are often hard to detect. Minor disturbances, such as vibrations caused by walking or speaking, could cause a cave-in. If a person were caught, he or she could be crushed to death. An even worse scenario would involve being trapped behind a cave-in when no one else is aware of the situation. Death could occur through starvation, thirst, or gradual suffocation.

Timber

The timber in abandoned mines can be weak from decay. Other timber, although apparently in good condition, may become loose and fall at the slightest touch. A well-timbered mine opening can look very solid when, in fact, the timber can barely support its own weight. There is the constant danger of inadvertently touching a timber and causing the tunnel to collapse.

Ladders

Ladders in most abandoned mines are unsafe. Ladder rungs may be missing or broken. Some will fail under the weight of a child because of dry rot. Vertical ladders are particularly dangerous.

Explosives

Many abandoned mines contain old explosives left by previous workers. These are extremely dangerous. Explosives should never be handled by anyone who is unfamiliar with them. Even experienced miners hesitate to handle old explosives. Old dynamite sticks and caps can explode if stepped on or even touched.

Water

In many tunnels, water forms deep pools or conceals holes in the floor. Pools of water are also common at the bottom of shafts. It is usually impossible to estimate the depth of the water; a false step could lead to drowning.

Bad Air

"Bad air" contains poisonous gases or insufficient oxygen. Poisonous gases can accumulate in low areas or along the floor. A person may enter such areas breathing the good air above the gases, but the motion caused by walking will mix these gases with the good air, producing a possibly lethal mixture to be inhaled on the return trip.

Because little effort is required to go down a ladder, the effects of "bad air" may not be noticed. When climbing out of a shaft, however, a person requires more oxygen and will breathe more deeply. The result is dizziness, followed by unconsciousness. If the gas doesn't kill, the fall will.

Rattlesnakes

Old mine tunnels and shafts are among the rattlers' favorite haunts, to cool off in summer or to search for rodents and other small animals. Any hole or ledge, especially near the entrance of the tunnel or shaft, can conceal a snake.

Rescue Problems

No inexperienced person should attempt to rescue the victim of a mine accident. The county sheriff should be called instead because he or she is in the best position to organize a rescue operation.

Attempting to rescue a person from a mine accident is usually difficult and dangerous for both the victim and the rescuer. Even professional rescue teams face death or injury, though they are trained to avoid all unnecessary risks. It makes no sense to kill one person to rescue another. Everyone, adults as well as children, should consider these extreme dangers when they are tempted to enter abandoned mines.

Vandalism

Those who remove tools, equipment, building materials, and other objects from mines and buildings near mines do not go home with souvenirs, but with stolen property. Many mines that look abandoned are private property; they are only idle, waiting to be reworked. Warning signs and fences are there for a reason. Unauthorized removal or damage to signs or fences is a class 6 felony.

Safety Summary

There is only one safe way to deal with abandoned mines: stay out!

Workshop on Industrial Minerals of Arizona

The Arizona Geological Survey (AZGS) and the U.S. Geological Survey (USGS) cosponsored a workshop, titled "Industrial Rock and Mineral Resources of Arizona: Problems, Opportunities, and Recommendations," in Tempe, Arizona, May 17-18, 1988. Approximately 30 representatives from State and Federal government, the mining industry, Indian Nations, and academia, who produce or use resource data, were invited to participate in informal discussion sessions to identify research and data needs. A final session was devoted to presenting program recommendations to the AZGS and USGS, including better ways to meet user needs while maintaining applied and basic research competence. Workshop proceedings are being prepared for publication.

Additions to the Arizona Geological Survey Library

The following publications were recently added to the Arizona Geological Survey library, where they may be examined during regular working hours. Copies may also be obtained from the respective publishers.

U.S. Bureau of Mines

Bulletin

689--Pankratz, L.B., Mah, A.D., and Watson, S.W., 1987, Thermodynamic properties of sulfides, 427 p.

Information Circulars

9131--Sousa, L.J., Yaremchuk, E.H., and Graham, A.P., 1987, Foreign direct investment in the U.S. minerals industry, 24 p.

9152--Boldt, C.M.K., and Scheibner, B.J., 1987, Remote sensing of mine waste, 43 p.

9170--Stebbins, S.A., 1987, Cost estimation handbook for small placer mines, 94 p.

9182--Sanders, M.S., and Peay, J.M., 1988, Human factors in mining, 153 p.

9183--USBM, 1988, Mine drainage and surface mine reclamation, v. 1, mine water and mine waste, 413 p.

9184--USBM, 1988, Mine drainage and surface mine reclamation, v. 2, mine reclamation, abandoned mine lands and policy issues, 401 p.

Mineral Land Assessment Reports

MLA-34-87--Lundby, William, 1987, Mineral resources of the Coyote Mountains Wilderness Study Area (AZ-020-202), Pima County, Arizona, 25 p., scale 1:24,000.

MLA-80-87--Kreidler, T.J., 1987, Mineral investigation of the Ragged Top Wilderness Study Area (AZ-020-197), Pima County, Arizona, 14 p., scale 1:24,000.

MLA-7-88--Korzeb, S.L., 1988, Mineral investigation of the Sierra Estrella Wilderness Study Area (AZ-020-160), Maricopa County, Arizona, 12 p.

MLA-9-88--Almquist, C.L., 1988, Mineral investigation of the Mount Tipton Wilderness Study Area (AZ-020-012/042) and proposed additions, Mohave County, Arizona, 12 p.

MLA-11-88--Wood, R.H., II, 1988, Mineral resources of a part of the Muggins Mountains Wilderness Study Area (AZ050-053A), Yuma County, Arizona, 17 p.

MLA-25-88--Lane, M.E., 1988, Mineral investigation of additional parts of the Arrastra Mountain Wilderness Study Area (AZ-020-059), La Paz, Mohave, and Yavapai Counties, Arizona, 25 p., scale 1:62,500.

Reports of Investigations

9122--Lei, K.P.V., and Carnahan, T.G., 1987, Silver-catalyzed oxidative leaching of an arsenical copper sulfide concentrate, 14 p.

9126--Pahlman, J.E., Rhoades, C.A., and Chamberlain, P.G., 1987, Dual leaching method for recovering silver and manganese from domestic manganiferous silver deposits, 8 p.

9138--Dannenberg, R.O., Gardner, P.C., Crane, S.R., and Seidel, D.C., 1987, Recovery of cobalt and copper from complex sulfide concentrates, 20 p.

9150--Pahlman, J.E., and Khalafalla, S.E., 1988, Leaching of domestic manganese ores with dissolved SO_2, 15 p.

9181--Eisele, J.A., Hunt, A.H., and Lampshire, D.L., 1988, Leaching gold-silver ores with sodium cyanide and thiourea under comparable conditions, 7 p.

Special Publications

McColly, R.A., and Anderson, N.B., 1987, Availability of federally owned minerals for exploration and development in western states, Arizona, 1986, 27 p.

USBM, 1988a, Bureau of Mines research 87, a summary of significant results in mineral technology and economics, 93 p.

_____ 1988b, Issues and needs of the mining industry, a Bureau of Mines perspective, 28 p.

U.S. Geological Survey

Bulletins

1671--McIntyre, D.H., 1988, Volcanic geology in parts of the southern Peloncillo Mountains, Arizona and New Mexico, 18 p.

1672--Billingsley, G.H., 1987, Geology and geomorphology of the southwestern Moenkopi Plateau and southern Ward Terrace, Arizona, 18 p.

1683-A--Wenrich, K.J., Van Gosen, B.S., Balcer, R.A., Scott, J.H., Mascarenas, J.F., Bedinger, G.M., and Burmaster, Betsi, 1988, A mineralized breccia pipe in Mohawk Canyon, Arizona, lithologic and geophysical logs, 66 p.

1685--Franczyk, K.J., 1988, Stratigraphic revision and depositional environments of the Upper Cretaceous Toreva Formation in the northern Black Mesa area, Navajo and Apache Counties, Arizona, 32 p.

1693--Cox, D.P., and Singer, D.A., eds., 1986, Mineral deposit models, 379 p.

1694--Bush, A.L., ed., 1987, Contributions to mineral resources research, 1984, 104 p.

1701-A--Gray, Floyd, Miller, R.J., Hassemer, J.R., Hanna, W.F., and Brice, J.C., III, 1987, Mineral resources of the Big Horn Mountains Wilderness Study Area, Maricopa County, Arizona, 14 p., scale 1:62,500.

1701-B--Miller, R.J., Gray, Floyd, Hassemer, J.R., Hanna, W.F., Brice, John, III, and Schreiner, Russell, 1987, Mineral resources of the Lower Burro Creek Wilderness Study Area, Mohave and Yavapai Counties, Arizona, 22 p.

1703-C--Simons, F.S., Theobald, P.K., Tidball, R.R., Erdman, J.A., Harms, T.F., Griscom, Andrew, and Ryan, G.S., 1987, Mineral resources of the Black Rock Wilderness Study Area, Graham County, Arizona, 9 p., scale 1:24,000.

1798--Schmitt, L.J., 1988, A review of the association of petroliferous materials with uranium and other metal deposits in sedimentary rocks in the United States, 18 p.

1802--Wheeler, R.L., and Krystinik, K.B., 1987, Evaluating coinciding anomalies along a fault trace or other traverse, simulations and statistical procedures, 12 p.

Maps

GQ-1603--Sargent, K.A., and Philpott, B. C., 1987, Geologic map of the Kanab quadrangle, Kane County, Utah, and Mohave and Coconino Counties, Arizona, scale 1:62,500.

I-1310-E--Watts, K.C., and Hassemer, J. R., 1988, Geochemical interpretive and summary maps, Silver City 1° x 2° quadrangle, New Mexico and Arizona, scale 1:250,000, 2 sheets.

I-1662--Drewes, Harald, 1987, Geologic map and cross sections of the Dragoon Mountains, southeastern Arizona, scale 1:24,000.

I-1778--Sutphin, H.B., and Wenrich, K.J., 1988, Map showing structural control of breccia pipes on the southern Marble Plateau, north-central Arizona, scale 1:50,000.

I-1793--Billingsley, G.H., 1987, Geologic map of the southwestern Moenkopi Plateau and southern Ward Terrace, Coconino County, Arizona, scale 1:31,680.

I-1892-A--Laney, R.L., and Pankratz, L. W., 1987, Investigations of land subsidence and earth fissures near the Salt-Gila aqueduct, Maricopa and Pinal Counties, scale 1:36,000.

I-1941–USGS, 1987, Landsat and spot-image display, Phoenix, Arizona area, various scales.

MF-1602-C–Light, T.D., and McDonnell, J.R., 1987, Mine and prospect map of the Crossman Peak Wilderness Study Area, Mohave County, Arizona, scale 1:48,000.

MF-1644-B–Martin, R.A., 1987, Aeromagnetic map of the Hell's Gate Roadless Area, Gila County, Arizona, scale 1:48,000.

MF-1834-B–Peterson, J.A., Cox, D.P., and Gray, Floyd, 1987, Mineral-resource assessment of the Ajo and Lukeville 1° by 2° quadrangles, Arizona, scale 1:250,000.

MF-1834-C–Theobald, P.K., and Barton, H.N., 1987, Maps showing anomalous copper concentrations in stream sediments and heavy mineral concentrations from the Ajo and Lukeville 1° by 2° quadrangles, Arizona, scale 1:500,000.

MF-1834-D–Theobald, P.K., and Barton, H.N., 1988, Maps showing anomalous concentrations of lead, molybdenum, bismuth, and tungsten in stream sediment and heavy-mineral concentrate from parts of the Ajo and Lukeville 1° x 2° quadrangles, Arizona, scale 1:500,000.

MF-1918–Simons, F.S., 1987, Geologic map of the Black Rock Wilderness Study Area, Graham County, Arizona, scale 1:24,000.

MF-1919–Simons, F.S., 1987, Geologic map of the Fishhooks Wilderness Study Area, Graham County, Arizona, scale 1:24,000.

MF-1951–Peterson, J.A., Tosdal, R.M., and Hornberger, M.I., 1987, Geologic map of the Table Top Mountain Wilderness Study Area, Pinal and Maricopa Counties, Arizona, scale 1:24,000.

MF-1956–Ulrich, G.E., and Bailey, N.G., 1987, Geologic map of the SP Mountain part of the San Francisco volcanic field, north-central Arizona, scale 1:50,000.

MF-1957–Wolfe, E.W., Ulrich, G.E., and Newhall, C.G., 1987, Geologic map of the northwest part of the San Francisco volcanic field, north-central Arizona, scale 1:50,000, 2 sheets.

MF-1958–Newhall C.G., Ulrich, G.E., and Wolfe, E.W., 1987, Geologic map of the southwest part of the San Francisco volcanic field, north-central Arizona, scale 1:50,000.

MF-1959–Wolfe, E.W., Ulrich, G.E., Holm, R.F., Moore, R.B., and Newhall, C.G., 1987, Geologic map of the central part of the San Francisco volcanic field, north-central Arizona, 86 p., scale 1:50,000, 2 sheets.

MF-1960–Moore, R.B., and Wolfe, E.W., 1987, Geologic map of the east part of the San Francisco volcanic field, north-central Arizona, 46 p., scale 1:50,000, 2 sheets.

MF-2023–Mariano, John, and Grauch, V. J.S., 1988, Aeromagnetic maps of the Colorado River region including the Kingman, Needles, Salton Sea, and El Centro 1° by 2° quadrangles, California, Arizona, and Nevada, scale 1:250,000, 3 sheets.

Open-File Reports

86-423–Nealey, L.D., Ward, A.W., Bartel, A.J., Vivit, D.V., and Knight, R.J., 1988, Petrochemistry of rocks from the Mohon Mountains volcanic field, Yavapai and Mohave Counties, Arizona, 19 p.

86-458C–Wenrich, K.J., Billingsley, G.H., and Huntoon, P.W., 1987, Breccia pipes and geologic map of the northwestern Hualapai Indian Reservation and vicinity, Arizona, 32 p., scale 1:48,000.

86-482–Anderson, S.R., 1987, Potential for aquifer compaction, land subsidence, and earth fissures in the Tucson basin, Pima County, Arizona, scale 1:250,000, 3 sheets.

87-66–McHugh, J.B., and Nowlan, G.A., 1987, Analytical results and locality map for 82 well-water samples from the lower Santa Cruz basin, Pinal County, Arizona, 12 p., scale 1:250,000.

87-80–Meremonte, M.E., and Rogers, A. M., 1987, Historical catalog of southern Great Basin earthquakes, 1868-1978, 203 p.

87-96–Kieffer, S.W., 1987, The rapids and waves of the Colorado River, Grand Canyon, Arizona, 69 p.

87-144–Van Gosen, B.S., and Wenrich, K.J., 1987, Lithology and stratigraphy of a drill core from the vicinity of the Hack Canyon mines, Mohave County, northern Arizona, 11 p.

87-163–Adrian, B.M., Fey, D.L., Bradley, L.A., O'Leary, R.M., and Nolan, G.A., 1987, Analytical results and sample locality maps of stream-sediment, panned-concentrate, and rock samples from the Baboquivari Peak, Coyote Mountains, and Table Top Mountains Wilderness Study Areas, Pima, Pinal, and Maricopa Counties, Arizona, 23 p., scale 1:24,000.

87-333–USGS, 1987, Aeromagnetic map of the Woolsey Peak-Dendora Valley area, southwestern Arizona, scale 1:50,000.

87-359–Roller, J.A., 1987, Fracture history of the Redwall Limestone and Lower Supai Group, western Hualapai Indian Reservation, northwestern Arizona, 33 p.

87-406–Donnelly, M.E., Conway, C.M., and Earhart, R.L., 1987, Records of massive sulfide occurrences in Arizona, 42 p.

87-450-V–Butler, W.C., 1988, The rationale for assessment of undiscovered, economically recoverable oil and gas in central and northern Arizona; play analyses of seven favorable areas, 145 p.

87-614–Thorman, C.H., and Naruk, S.J., 1987, Generalized bedrock geologic map and distribution of mylonitic rocks in the eastern Pinaleño Mountains, Graham County, Arizona, scale 1:48,000.

87-666–John, B.E., 1987, Geologic map of the Chemehuevi Mountains area, San Bernardino County, California and Mohave County, Arizona, 10 p., scale 1:24,000.

Professional Papers

1200-AZ–USGS, 1987, The national gazetteer of the United States of America, Arizona 1986, 722 p.

1361–Theodore, T.G., Blair, W.N., and Nash, J.T., 1987, Geology and gold mineralization of the Gold Basin-Lost Basin mining districts, Mohave County, Arizona, *with sections on* K-Ar chronology of mineralization and igneous activity, by E.H. McKee, *and* Implications of the compositions of lode and placer gold, by J.C. Antweiler and W.L. Campbell, 167 p., scale 1:48,000.

Dr. Fellows Elected President of AASG

Dr. Larry D. Fellows, State Geologist, was elected President of the Association of American State Geologists (AASG), effective July 1, 1988. During the preceding 2 years, he served as Vice President and President Elect. Dr. Fellows has been a member of the AASG since 1979. The AASG comprises the administrative heads, commonly identified as the State Geologists, of all State geological surveys in the Nation. Currently 49 States have either a State Geologist or a State geological survey.

Other elected officers of the AASG are as follows: Donald C. Haney (Kentucky), President Elect; Ernest A. Mancini (Alabama), Vice President; Donald A. Hull (Oregon), Secretary-Treasurer; Robert C. Milici (Virginia), Editor; Morris W. Leighton (Illinois), Statistician; and Norman K. Olson (South Carolina), Historian.

New Publications From the Arizona Geological Survey

The following publications may be purchased over the counter or by mail from the Arizona Geological Survey (AZGS), 845 N. Park Ave., Tucson, AZ 85719. For price information on these and other AZGS publications, contact the AZGS offices at (602) 621-7906.

Reynolds, S.J., 1988, Geologic map of Arizona: Map 26, scale 1:1,000,000.

See "A New Geologic Map of Arizona" on pages 2 and 4.

Welty, J.W., 1987, Volume 3, geology and tunneling of the Maricopa Superconducting Super Collider site proposal: Open-File Report 88-7, 260 p.

In 1983 the State of Arizona began a statewide search for an appropriate site for the Superconducting Super Collider (SSC). Of the many criteria outlined for site evaluation by the U.S. Department of Energy (DOE), the greatest weight was given to geology and tunneling and its impact on construction and operational costs. This report is a copy of the Geology and Tunneling chapter filed with the DOE. Topics include geology, geohydrology, seismicity, faulting, tunneling and underground construction, and estimated project costs and schedules for the Maricopa site.

Welty, J.W., 1987, Volume 3, geology and tunneling of the Sierrita Superconducting Super Collider site proposal: Open-File Report 88-8, 270 p.

Although the DOE did not accept the Sierrita site for the SSC, the geologic, hydrologic, and geophysical investigations provided a wealth of information about this area. This report is a copy of the Geology and Tunneling chapter filed with the DOE.

Grubensky, M.J., and Reynolds, S.J., 1988, Geologic map of the southeastern Vulture Mountains, west-central Arizona: Open-File Report 88-9, 16 p., scale 1:24,000.

The Vulture Mountains in west-central Arizona lie between the Big Horn and Harquahala Mountains on the west and the Wickenburg Mountains on the east. This geologic map of the southeastern portion of the range, which covers the northern part of the Wickenburg SW 7.5-minute quadrangle, is important for three reasons: (1) the Vulture Mountains are largely unmapped; (2) the Vulture Mountains contain an excellent record of the mid-Tertiary structural and volcanic history of the region; and (3) west-central Arizona offers much potential for undiscovered ore deposits. Areas where the rocks have been altered or mineralized have been noted on the map. This open-file map is a printed, not a blueline, copy.

Reynolds, S.J., Spencer, J.E., DeWitt, Ed, White, D.C., and Grubensky, M.J., 1988, Geologic map of the Vulture mine area, Vulture Mountains, west-central Arizona: Open-File Report 88-10, 5 p., scale 1:24,000.

The Vulture Mountains directly southwest of Wickenburg contain one of Arizona's premier historic gold deposits, the Vulture mine. This mine yielded about 340,000 ounces of gold and 260,000 ounces of silver, with average grades of 0.35 oz/ton gold and 0.27 oz/ton silver. Despite this significant production, the mine has received relatively little geologic study until recently. This geologic map, which covers approximately 10 km^2 centered on the mine, was completed to increase the understanding of the geologic setting of this historically important gold deposit.

Spencer, J.E., Emer, D.F., and Shenk, J.D., 1988, Background radioactivity in selected areas of Arizona and implications for indoor-radon levels: Open-File Report 88-11, 14 p.

This nontechnical summary of Open-File Report 88-12 (listed below) was prepared with special funding from the Arizona State Legislature. It describes the results of a reconnaissance survey of radioactivity caused by the natural decay of uranium in rocks and soil. These breakdown processes also produce radon gas, which can accumulate in buildings. Long-term inhalation of radon may cause lung cancer in a small percentage of exposed individuals. The amount of radon generated is proportional to the amount of uranium and uranium-decay products in surrounding rocks and soil. Radon was not measured in this study -- only natural radioactivity levels of rocks and soil.

The study involved a survey of 38 localities within or near populated areas in Arizona. Portions of 6 of these areas had radioactivity levels higher than the "normal" reading for this study: Prescott (Granite Dells), Cave Creek, Camp Verde, Phoenix (a small area 1 mile northeast of North Mountain Park), Tombstone, and Kirkland.

Emer, D.F., Shenk, J.D., and Spencer, J. E., 1988, Reconnaissance gamma-ray spectrometer survey of radon-decay products in selected populated areas of Arizona: Open-File Report 88-12, 88 p.

This technical report describes the results of a reconnaissance survey that measured radiation from bismuth-214, a radon-decay product, in the rocks and soil of 38 inhabited areas in Arizona. It outlines the methodology, lists the radiometric values, and includes radioactivity profiles and topographic maps of the surveyed areas. Technical data are included in this report; interpretations of the results are given in Open-File Report 88-11 (listed above).

Horstman, K.C., VandenDolder, E.M., and Reynolds, S.J., 1988, Bibliographic conventions of the Arizona Geological Survey: Open-File Report 88-13, 22 p.

The Arizona Geological Survey maintains a computerized database, named AZBIB, containing more than 1,200 complete citations of publications on the geology of Arizona and neighboring regions. While developing this database, we established a set of bibliographic conventions to maintain a consistent format. The conventions presented in this report largely follow those established by the U.S. Geological Survey and Geological Society of America, but are more comprehensive. For this reason, we are making these conventions available to persons outside the Arizona Geological Survey. The database format and bibliographic conventions are described in this open-file report and are illustrated with examples of the most commonly cited types of publications.

Welty, J.W., Roddy, M.S., Alger, C.S., and Brabb, E.E., 1988, Bibliography of Arizona landslide maps and reports: Open-File Report 88-14, 13 p.

This report, the second in a series, is an outgrowth of the U.S. Geological Survey's ground-failure hazards-reduction program. It lists 146 maps and reports that identify more than 500 known Quaternary mass movements in Arizona. The report provides a basis for increased understanding of the geologic settings that are prone to mass wasting in the State.

Scarborough, R.B., and Pearthree, P.A., 1986, Reconnaissance assessment of Quaternary faulting in the Gila River region from San Carlos Reservoir to Coolidge, Arizona: Open-File Report 88-15, 12 p., scale 1:250,000.

This map and report summarize evidence of Quaternary faulting along the Gila River in central Arizona. The goal of the study was to delineate possible

Quaternary faults near existing and potential dam sites. The study included interpretation of aerial photographs, helicopter overflight, and field reconnaissance of suspicious features. Few features were identified as possible Quaternary faults.

McGarvin, T.G., 1988, Index to published geologic maps of Arizona -- 1987: Open-File Report 88-16, scale 1:1,000,000.

This index lists 49 sources of geologic maps of the State published during 1987. References include publications of the U.S. Geological Survey, Geological Society of America, Arizona Geological Society, Arizona Bureau of Geology and Mineral Technology (Geological Survey Branch), and other organizations. The accompanying map identifies the areas within Arizona covered by each reference.

Arizona Geology

Vol. 18, No. 3 Fall 1988

State of Arizona: Governor Rose Mofford

Arizona Geological Survey

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RADON UPDATE

In September 1988 the Arizona Radiation Regulatory Agency (ARRA) and the U.S. Environmental Protection Agency released, in summary form, the results of their statewide indoor-radon survey. Seven percent of the 1,700 homes tested in Arizona contained greater than 4 picocuries per liter (pCi/l) radon. Only 11 measurements, from widely scattered locations, were greater than 10 pCi/l. Of the seven States surveyed, Arizona had the lowest percentage of homes that measured above the 4 pCi/l guideline level. Approximately 30 percent of homes in the other six States exceeded the 4 pCi/l level. More information on the State radon survey may be obtained from the ARRA in Phoenix (602-255-4845).

The Arizona Geological Survey (AZGS) recently released the results of a reconnaissance survey of background uranium levels in populated areas in Arizona. This survey was conducted to determine the normal range of uranium levels and to outline the location and distribution of geologic materials in populated areas that contain greater-than-normal levels of uranium. Because uranium is the ultimate source of radon, homes built in areas with anomalous uranium levels are at greater risk for high indoor-radon concentrations. Results of this survey indicate that some rock types in Prescott, the Cave Creek area, the Phoenix Mountains, Camp Verde, Kirkland, and Tombstone are slightly to moderately higher in uranium than typical geologic materials in Arizona. (An area in southwestern Tucson was previously known to be anomalous in uranium.) A summary of results has been released as AZGS Open-File Report 88-11; data and a description of technical aspects of the survey are presented in AZGS Open-File Report 88-12.

USGS and USBM Establish Joint Office in Tucson

A joint field office for the U.S. Geological Survey (USGS) and U.S. Bureau of Mines (USBM) has been established at the University of Arizona in Tucson. The two Federal agencies will operate from offices in the Gould-Simpson building. Activities will focus on mineral exploration in the Basin and Range Province.

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