Vol. 29, No. 1
Spring 1999

Arizona Geology

Published Quarterly by the Arizona Geological Survey

ARIZONA GEOLOGICAL SURVEY

Information to Arizonans since 1889

MISSION

To provide unbiased information to enhance public understanding of geologic processes, materials, and resources in Arizona and assist citizens, businesses, governmental agencies, and elected officials in making informed decisions relative to managing land, water, mineral, and energy resources.

GOALS

- Provide information about geologic processes, materials, and resources in a timely, courteous manner.
- Map and describe the bedrock and surficial geology of Arizona. Current emphasis is on the Phoenix-Tucson urban corridor, which contains 80 percent of the State's population.
- Investigate and document geologic processes and materials that might be hazardous to the public or limiting to land and resource management.
- Administer the rules, regulations, and policies established by the Arizona Oil and Gas Conservation Commission.

Oil and Gas in Arizona: Good News and Bad News

Larry D. Fellows, Director
Arizona Geological Survey

Many people are surprised to learn that oil and natural gas are produced in Arizona. About 700 wells have been drilled specifically for oil, gas, or helium. The first known attempt to find oil in Arizona was in 1905, when a dry hole was drilled in Chino Valley, 20 miles north of Prescott. Shell Oil Company made the first oil discovery in Arizona in 1954 when it drilled the #1 Navajo well in the Four Corners area.

To date 75 wells, all on the Navajo Reservation in northeasternmost Arizona (Fig. 1), have produced oil or gas. Twenty wells currently produce oil and six produce gas. Total production from all Arizona wells has been about 20 million barrels of oil and 28 billion cubic feet of gas.

More than 85 percent of the oil produced in Arizona has come from the Dineh-bi-Keyah Field, in which the reservoir is fractured igneous rock that intruded carbonate strata. The #4 Navajo well in that field has produced more than 3.5 million barrels of oil since it was drilled in 1967 and is still producing.

Helium was discovered in the Holbrook basin, about 30 miles east of Holbrook, in a well drilled in search of oil. More than 9 billion cubic feet of gas containing more than 740 million cubic feet of helium were produced from the Coconino Sandstone. The gas averaged 90 percent nitrogen, 8-10 percent helium, and 1 percent carbon dioxide. All wells were abandoned in 1976

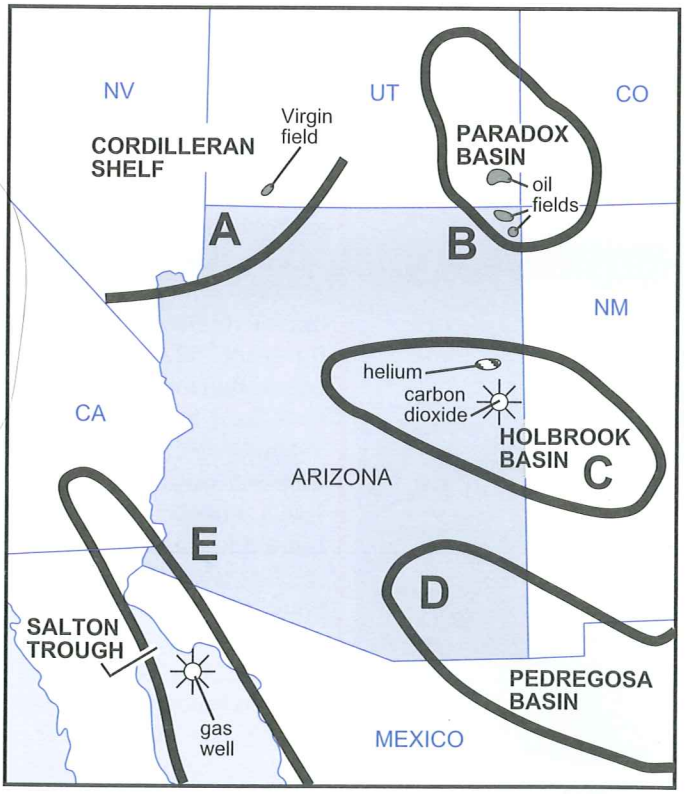

Figure 1. Areas with the highest potential for future discoveries of oil and gas in Arizona.

Oil and Gas in Arizona *(continued)*

Arizona **Geology**

is published quarterly by the Arizona Geological Survey to provide information about geologic materials and processes and their potential impacts on the development and use of Arizona's land, water, mineral, and energy resources. We encourage your comments and suggestions.

Design and layout:
Peter F. Corrao

and the helium extraction plant was subsequently dismantled.

A carbon dioxide discovery was made near St. Johns by Ridgeway Arizona Oil Company in 1994 in a well that was drilled in search of oil. Two wells have been completed as carbon dioxide wells and eight others are being tested to determine how much carbon dioxide is present.

Good news and bad news. The good news about oil and gas in Arizona is that geologic conditions are favorable for future discoveries. This conclusion is based on past oil and gas production and the presence of tar seeps, outcrops of petroliferous rocks, shows of oil and gas in drilled wells, and the presence of extensive regions of untested strata that include both reservoir and source beds.

The bad news comes in several forms. First, oil production in Arizona has declined steadily since 1968. Second, geologists know little about the subsurface in Arizona. On average only one oil test has been drilled for every 162 square miles. In comparison, five to six wells have been drilled, on average, for each square mile of Texas and Oklahoma. Finally, drilling for oil, like exploration for all other mineral and energy resources, is driven by economics. In this case it's the price of crude oil. Because crude is now only about $8-9 per barrel, the lowest it has been since the Great Depression of the 1930s, there is little incentive for drilling. In 1981, when the price of crude oil was $30-32 per barrel, more than 4,500 drilling rigs were working in the United States. In early February 1999, only about 550 were active.

Oil and gas potential. Rocks on the Cordilleran shelf (Fig. 1, A) in northwestern Arizona extend northward beneath southwestern Utah. Oil has been produced from these same strata in the Virgin field just 15 miles north of the State line. Tar seeps, oil shows in numerous wells (including free oil reported in one well), and low drilling density in northwestern Arizona give encouragement for additional drilling and potential discovery.

Northeastern Arizona (Fig. 1, B) is on the southwestern flank of the Paradox basin, most of which is in Utah, Colorado, and New Mexico. More than 400 million barrels of oil have been produced from the Paradox basin. All of Arizona's oil production has been from rocks that are similar in age and character to those farther out in the basin. Extensive areas underlain by these rocks in northeastern Arizona have not yet been drilled.

Some strata in the Holbrook (Fig. 1, C) and Pedregosa (Fig. 1, D) basins are similar in age and character to rocks in the prolific Permian basin of West Texas. Salt is present in the Holbrook and Permian basins and reefs are present in the Pedregosa and Permian basins. Shows of oil and gas have been encountered in numerous wells in the Holbrook basin. Substantial areas in both basins have not yet been evaluated by drilling.

A Pemex well in the Sea of Cortez near Puerto Penasco in northern Sonora, Mexico produced up to 5.7 million cubic feet of gas per day. Reservoir rocks in this well may extend northward into Yuma basin (Fig. 1, E), but drilling has not yet been sufficiently deep to reach them. Some geologists believe that the Yuma basin may have formed adjacent to the prolific Los Angeles basin, which was subsequently displaced northward along the San Andreas fault system.

Regulation. The Arizona Oil and Gas Conservation Commission (AOGCC) regulates the drilling for and production of oil, gas, helium, and geothermal resources. The AOGCC is composed of five members appointed by the Governor and one *ex officio* member, the State Land Commissioner. Appointed members are J. Dale Nations (Chairman), Donald C. Clay, James C. Lanshe, Lisa C. Worthington, and Zed Veale. J. Dennis Wells is the State Land Commissioner.

Information. The Arizona Geological Survey administers the AOGCC and provides staff support. Steven L. Rauzi, a member of the AZGS staff, is the Oil and Gas Program Administrator. Numerous reports, maps, and data about Arizona's subsurface geology and oil and gas are available. Please contact Rauzi for information.

Just Released

The Arizona Geological Survey released the following items since the Winter 1998 issue of *Arizona Geology* was published:

$^{40}Ar/^{39}Ar$ dates from the Harquahala and Little Harquahala Mountains, west-central Arizona. Part I: S. M. Richard, M.O. McWilliams, and P. B. Gans, 1998, Arizona Geological Survey Open-File Report 98-25 (Pub. number OFR 98-25), 25 p. $4.50 plus shipping and handling

Samples of Browns Canyon granite, Granite Wash Granodiorite, amphibolite gneiss, and sericitized granite tectonite were analyzed to constrain the cooling history and timing of mineralization in this area.

A compilation of the geology and hydrology of the Black Mountains-Bullhead City area, Arizona: R. C. Harris, 1998, Arizona Geological Survey Open-File Report 98-26 (Pub. number OFR 98-26), 42 p. $7.00 plus shipping and handling

This report, done in cooperation with the U. S. Geological Survey, includes summaries of land status and use, geology, geomorphology and soils, mines and mineralization, stream sediments, surface- and ground-water quality, and land use and potential water quality impacts. The report also contains an index of geologic maps, a compilation geologic map, a list of references, and a description of mines in the Black Mountains-Bullhead City area.

Sanidine, single crystal, laser-fusion $^{40}Ar/^{39}Ar$ geochronology database for the Superstition volcanic field, central Arizona: W. C. McIntosh and C. A. Ferguson, 1998, Arizona Geological Survey Open-File Report 98-27 (Pub. number OFR 98-27), 74 p. $11.00 plus shipping and handling

This is a catalog of data for 66 high precision radiometric dates of rocks in the Superstition volcanic field that were sampled by Arizona Geological Survey geologists during mapping. Analyses, funded by the STATEMAP program, were done at the New Mexico Bureau of Mines and Mineral Resources. Results indicate that (1) most of the volcanic rocks were erupted 19 to 18 million years ago and (2) there is only one regional ash-flow tuff, the Apache Leap tuff (a conclusion also verified by new mapping), which was erupted 18.56 million years ago.

Annual Report of the Arizona Geological Survey, 1998: L. D. Fellows, 1998, Arizona Geological Survey Open-File Report 98-28 (Pub. number OFR 98-28), 20 p. $4.00 plus shipping and handling

As part of the strategic planning process the Arizona Geological Survey (AZGS) identified four goals. This report is a summary of progress made in completing those goals during Fiscal Year 1997-98. Additional information is included about organization structure, personnel, and expenditures. The report also highlights accomplishments made from 1989-1998, the first ten years the AZGS has been a stand-alone State agency.

Geochemistry of mafic dikes and sills from the lower McCoy Mountains Formation, La Paz County, western Arizona: J. D. Gleason, J. E. Spencer, and S. M. Richard, 1999, Arizona Geological Survey Open-File Report 99-01 (Pub. number OFR 99-01), 24 p. $5.00 plus shipping and handling

The McCoy Mountains Formation consists of a several-kilometer-thick sequence of latest Jurassic to Cretaceous siltstone, sandstone, and conglomerate. The lower part of this sequence is believed to be about the same age as the Bisbee Formation in southeastern Arizona, which was deposited in a rift basin connected to the opening Gulf of Mexico. Geochemical and neodymium isotope data presented in this report suggest that the lower McCoy Mountains Formation was deposited in a similar rift basin and that the age and tectonic setting of the two basins were similar.

Hydrologic and geomorphic characteristics of the Bill Williams River, western Arizona: P. K. House, M.L. Wood, and P. A. Pearthree, 1999, Arizona Geological Survey Open-File Report 99-04 (Pub. number OFR 99-04), 46 p. 2 sheets, scale 1:24,000. $21.00 plus shipping and handling

Just Released, continued on page 4

Ordering Information

You may purchase publications at the AZGS office or by mail. Address mail orders to AZGS Publications, 416 W. Congress St., Suite 100, Tucson, AZ 85701. Orders are shipped by UPS, which requires a street address for delivery. All mail orders must be prepaid by a check or money order payable in U.S. dollars to the Arizona Geological Survey or by Master Card or VISA. Do not send cash. Add 7% sales tax to the publication cost for orders purchased or mailed in Arizona. Order by publication number and add these shipping and handling charges to your total order:

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Just Released,
continued from page 3

The Bill Williams River extends from Alamo Dam, just downstream from the confluence of the Big Sandy and Maria Rivers, to the Colorado River at Lake Havasu. The objectives of this study are to characterize the general geomorphology and hydrology of the river.

The geology, leasing, and production history of the uranium-vanadium mines on North Star Mesa, Apache County, Arizona and San Juan County, New Mexico:
W. L. Chenoweth, 1999, Arizona Geological Survey Contributed Report 99-A (Pub. number CR 99-A), 24 p. $4.50 plus shipping and handling

Uranium and vanadium minerals on North Star Mesa were some of the first to be discovered in the Carizzo Mountains in northeastern Arizona and northwestern New Mexico. The Salt Wash Member of the Morrison Formation (Jurassic age) is the host rock for the ore deposits. This area was first leased for radium ore in the 1920s, but little mining was done. Mining resumed in 1949, under the U. S. Atomic Energy Commission's ore-procurement program. Mining continued intermittently through 1957, with final shipments made in 1962. About 800 tons of uranium-vanadium ore were produced.

Mark Your Calendar

Arizona-Nevada Academy of Sciences, Northern Arizona University, Flagstaff, April 17. Telephone Ken Cole at (520) 556-7466, ext. 230.

35th Forum on the Geology of Industrial Minerals, Salt Lake City, April 30-May 7. Telephone Bryce T. Tripp, Utah Geological Survey, at (801) 537-3317 or e-mail to nrugs.btripp@state.ut.us.

9th Biennial Symposium on Artificial Recharge of Groundwater, Embassy Suites, Tempe, June 10-12. Telephone Suzanne Kirk at (602) 861-7452.

Arizona Hydrological Society Symposium, Hon Dah Resort, Hon Dah, September 8-10. This symposium is being cohosted by the Phoenix and Flagstaff Chapters of the AHS. Telephone Courtney Brand at (602) 371-1110 or e-mail to phxccb@dames.com.

ADMMR

Willis D. (Doug) Sawyer became Director of the Arizona Department of Mines and Mineral Resources (ADMMR) January 19. The ADMMR is a State agency whose mission is to promote the development of mineral resources in Arizona. Sawyer holds B. S. (1980) and M. S. (1984) degrees in geological engineering from the University of Arizona. He has worked for Kennecott Copper Company, Dames & Moore, Waste Management Inc., and EMCON. In May 1997 he became ombudsman and manager of the Compliance Assistance Section at the Arizona Department of Environmental Quality. We welcome Doug to his new position and look forward to working with him and his staff.

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