

Arizona Geology

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THE STATE AGENCY FOR GEOLOGIC INFORMATION

MISSION

To inform and advise the public about the geologic character of Arizona in order to foster understanding and prudent development of the State's land, water, mineral, and energy resources.

ACTIVITIES

PUBLIC INFORMATION

Inform the public by answering inquiries, preparing and selling maps and reports, maintaining a library, databases, and a website, giving talks, and leading fieldtrips.

GEOLOGIC MAPPING

Map and describe the origin and character of rock units and their weathering products.

HAZARDS AND LIMITATIONS

Investigate geologic hazards and limitations such as earthquakes, land subsidence, flooding, and rock solution that may affect the health and welfare of the public or impact land and resource management.

ENERGY AND MINERAL RESOURCES

Describe the origin, distribution, and character of metallic, non-metallic, and energy resources and identify areas that have potential for future discoveries.

OIL AND GAS CONSERVATION COMMISSION

Assist in carrying out the rules, orders, and policies established by the Commission, which regulates the drilling for and production of oil, gas, helium, carbon dioxide, and geothermal resources.



What Makes "Red Rock Country" Beautiful?

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Director and State Geologist

In May, authors of USA WEEKEND Magazine's Annual Travel Report concluded that "Red Rock Country," Sedona, Arizona, is THE MOST BEAUTIFUL PLACE IN AMERICA!

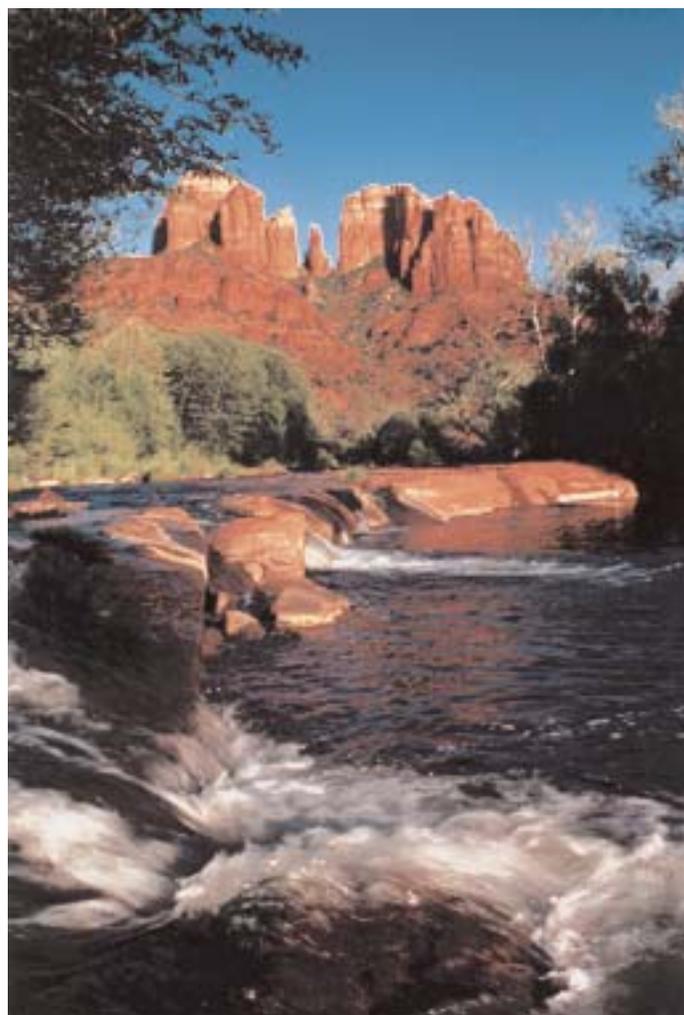


Figure 1. Cathedral Rock is adjacent to Oak Creek a few miles southwest of Sedona. A minimum of 1,600 feet and perhaps as much as 2,600 feet of rock that was once on top of Cathedral Rock has been eroded. Professional and amateur photographers from all across the nation and many other countries visit Sedona to shoot this spectacular landscape.

USA WEEKEND, which comes in your Sunday newspaper, reaches 49 million readers of almost 600 newspapers. Selection of Red Rock Country was based on the opinions of travel writers and photographers, outdoor enthusiasts, colleagues and others. Cathedral Rock viewed from Red Rock Crossing southwest of Sedona (Figure 1) is one of the most photogenic features in America.

Many residents and visitors have known about the beauty of Red Rock Country, which includes Sedona and Oak Creek Canyon, for years. The population there has quadrupled since 1980 and about 4 million tourists visit every year. Many people who read the USA WEEKEND report will probably go there in the near future to enjoy its beauty—and to have the satisfaction of saying that they visited the most beautiful place in America!



Figure 2. The Mogollon Rim (in background) is an escarpment that stretches diagonally across the center of Arizona from northwest to southeast. The escarpment is about 2,500 feet high. Lava, which covered much of this area in the last 8 million years, cooled to form a cap on the high surface. As much as 1,000 feet of rock may have been eroded *before* the lava covered the area.

Red Rock Country is beautiful because of its geology—colorful rocks shaped by natural weathering and erosion processes. The area, in addition to being beautiful, also has had a fascinating geologic past.

What is now red rock was originally soft mud and sand that were deposited during a 50-million-year time period that began about 320 million years ago. During that time the area was a low, arid coastal plain next to a shallow sea. As usually happens in nature, many changes took place—rivers, wind, and ocean waves and currents deposited sediment at different times. When sea level rose, layers of mud accumulated on the sea floor on top of the river deposits. When sea level fell, wind-blown sand and dunes covered the area. Later on, all of the sediment was changed to hard rock (lithified).

The red color of the rocks is caused by a thin coating of iron oxide on the particles in the rocks. The iron oxide was formed by chemical weathering of iron-bearing minerals in the rocks in the arid setting.

At one time about 1,900 feet of red rock covered the entire Sedona area. Oak Creek and its tributaries have eroded large amounts of the rock. The broken rock was transported to the ocean by way of Oak Creek and the Verde, Salt, and Colorado Rivers. If it weren't for erosion, there

would be no Red Rock Country for us to enjoy and USA WEEKEND to honor.

Sedona is situated at the base of a highly irregular row of cliffs (Figure 2) that extends discontinuously across Arizona from northwest (near Las Vegas) to southeast (between Clifton and Alpine), more than 300 miles. This row of cliffs is known as the Mogollon Escarpment or, more simply, the Mogollon Rim. The Mogollon Rim has been retreating slowly toward the northeast for about 25 million years because of erosion. This accounts for its irregular configuration. The escarpment is not continuous because at several places lava flows, which cooled to form a black rock called basalt, and other volcanic rocks covered it. The highway between Sedona and Payson, which goes through Camp Verde, Strawberry, and Pine, crosses a large area of basalt and other volcanic rocks several miles east of Camp Verde. The Mogollon Rim is buried beneath those volcanic rocks and totally hidden. Just before the highway enters Strawberry, however, the Rim is clearly exposed again. Strawberry is at the base of the Mogollon Rim in much the same setting as Sedona.

Oak Creek Canyon north of Sedona is one of the most scenic parts of Red Rock Country. The Canyon is there



Figure 3. Slide Rock is a popular scenic spot along Oak Creek in Slide Rock State Park north of Sedona. Oak Creek, which flows toward the viewer in this photograph, has cut a narrow channel or “slide” into the underlying rock. When the air is warm and the water is not too high, thrill-seeking visitors flock to the park to float down the creek through the slide.

because the rock has been shattered and displaced by the Oak Creek fault. This made the rocks much easier to erode than in other places. The highway crosses the Oak Creek fault at several places in Oak Creek Canyon.

Erosional features are especially scenic and easily accessible at two localities in Oak Creek Canyon. One is Slide Rock State Park, where Oak Creek is cutting into a slightly harder layer of red rock. The creek keeps the sand and gravel washed away so that bare rock is exposed (Figure 3). When the air is warm and the water is cool, hundreds of visitors get in the water and float swiftly through the narrow groove the creek has cut in the rock.

At the second locality, a little more than 3 miles north of the state park, the West Fork of Oak Creek has cut a narrow canyon about 1,200 ft deep through the red rock and the sandstone and basalt on top of it (Figure 4). A hiking trail extends up the West Fork for several miles. Access to the trail is reached from a special parking area. A fee is charged to hike on this spectacular trail.

Erosion has formed several natural bridges in the area, all of which are reached by trail. The Devil’s Bridge, about 3 mi north of west Sedona, is only about a half-mile east of the road (Figure 5).

One has an excellent view of Sedona and Oak Creek Canyon from Schnebly Hill Road east of Sedona. (It’s a good idea to ask about road conditions before you drive up Schnebly Hill Road – it’s steep and rough!) The road goes past the “merry-go-round,” a circular feature capped by the Fort Apache limestone (Figure 6). This limestone, which is about 10 feet thick at the merry-go-round, can be traced in wells toward the east and southeast. The Fort Apache limestone is as much as 100 feet thick near the town of White River on the Apache Indian Reservation, where it crops out. Rocks deposited at the same time as the red rocks at Sedona contain carbon dioxide, helium, and possibly petroleum in the subsurface between St. Johns and Springerville, more than 140 mi east.

If you’d like to visit Sedona and Oak Creek, check out the website of the Sedona-Oak Creek Canyon Chamber of Commerce (www.VisitSedona.com) for additional information. The Chamber also has a photo gallery at www.ExperienceSedona.com. Once you get to Sedona and would like more information about the area’s fascinating geologic history, look in the bookstores for *Sedona Through Time: Geology of the Red Rocks*, written by Wayne Ranney.

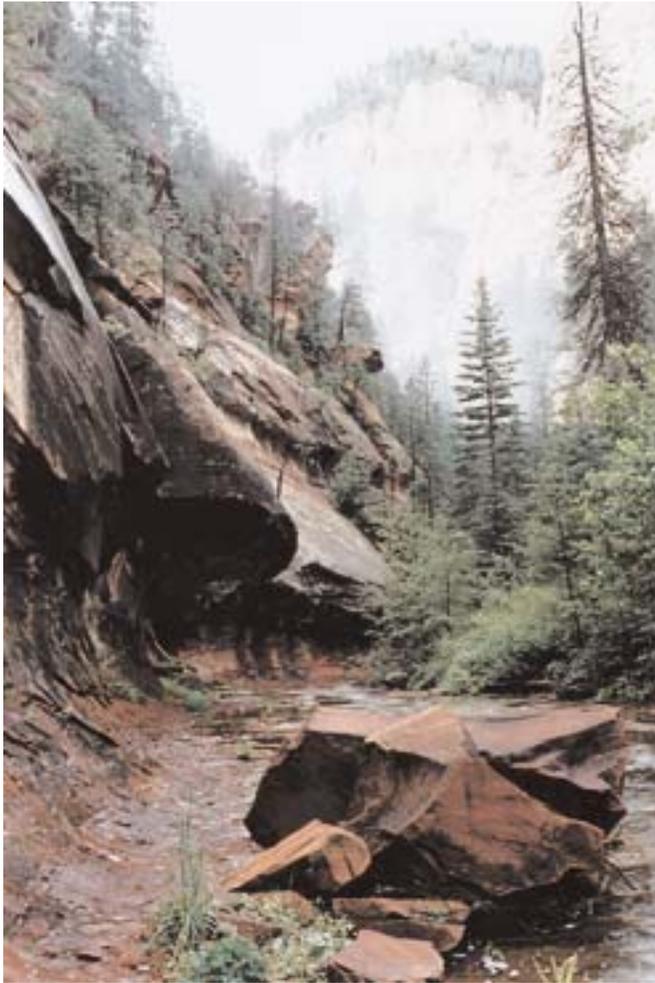


Figure 4. The west fork of Oak Creek has cut a deep canyon into the rock. The creek is eroding the comparatively soft red rock. Harder younger rock layers are exposed higher up the canyon walls. A trail follows the canyon for several miles.

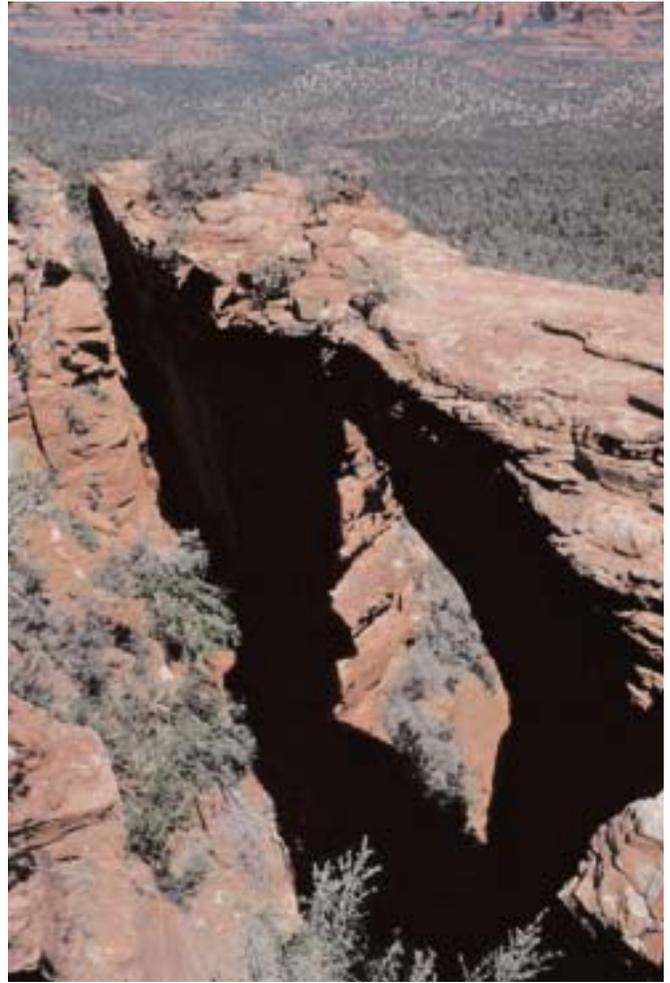


Figure 5. Devil's Bridge is one of a number of natural arches that have developed in the red rocks in the Sedona area. Most visitors never see these beautiful arches because it's necessary to hike to get to them.

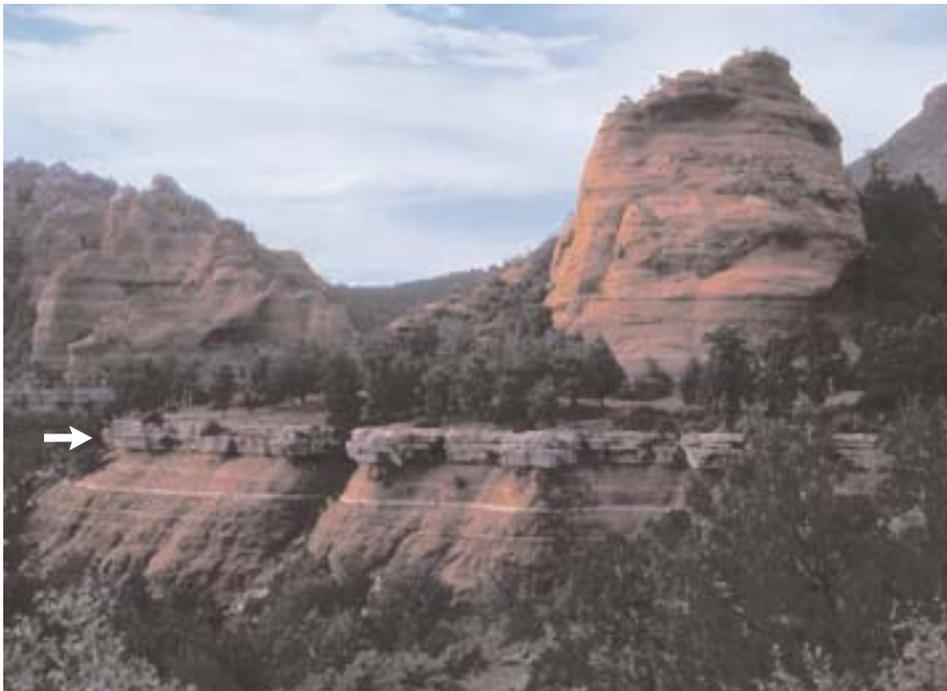
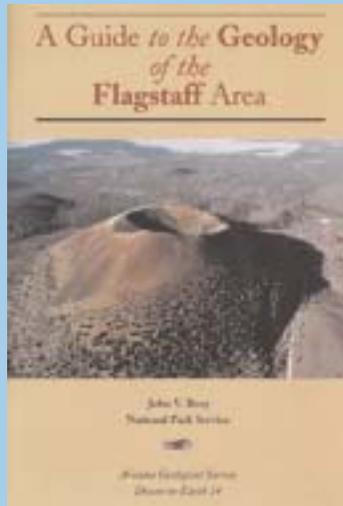


Figure 6. The “merry-go-round” is just a short distance west of Schnebly Hill Road. The hard gray layer (arrow) is the Fort Apache limestone, which is about 10 feet thick. Over near White River, about 120 miles to the southeast, this limestone unit is about 100 feet thick. The limestone is present throughout much of the Sedona area, including Cathedral Rock, but is thinner and not as easy to see as it is at this locality.



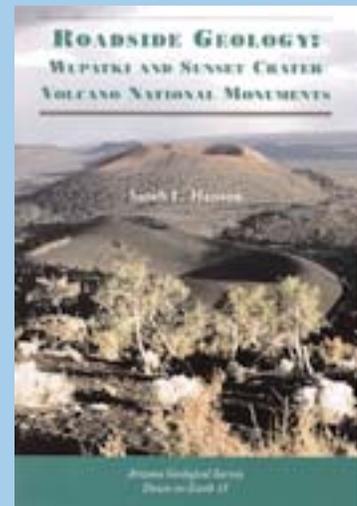
A guide to the geology of the Flagstaff area: Bezy, J.V., 2003, Arizona Geological Survey Down-to-Earth 14, 56 p. *\$7.95 plus shipping and handling.*

This book, written for those who have had no education or training in geology, includes descriptions of geologic features in the following areas: Mount Elden, San Francisco Mountain, Sunset Crater Volcano National Monument, Wupatki National Monument, Red Mountain, White Horse Hills, SP Crater, Black Point, Grand Falls, Walnut Canyon National Monument, and Meteor Crater. Twenty-three geologic features are described and illustrated with color photographs and diagrams in this 6 x 9 inch book.

This book will be especially useful for those who have several days to spend in the Flagstaff area. The features are widely spaced (tens of miles apart) and ample time should be taken to observe and fully appreciate each one.

Roadside geology: Wupatki and Sunset Crater Volcano National Monuments: Hanson, S.L., 2003, Arizona Geological Survey Down-to-Earth 15, 32 p. *\$6.95 plus shipping and handling.*

The author describes geologic features at 14 localities along the paved 35-mile loop road that connects Wupatki and Sunset Crater Volcano National Monuments. Even though the monuments are side-by-side, the geology within them is substantially different. In the Sunset Crater area, one can observe a variety of features formed by volcanic eruptions, including cinder cones, lava domes, aa flows, squeeze-ups, hornitos, and xenoliths. Although Wupatki is noted primarily for its spectacular pueblos, well developed, easy-to-observe geologic features are also prominent. The 6 x 9 inch book is written for those who have had no formal training in geology. Features described are illustrated with color photographs.



Geologic map of the Tortolita Mountains, Pinal and Pima Counties, Arizona: Ferguson, C.A., Johnson, B.J., Skotnicki, S.J., Maher, D.J., Spencer, J.E., Gilbert, W.G., Richard, S.M., Youberg, Ann, Demsey, K.A., and House, P.K., 2003, Arizona Geological Survey Digital Geologic Map 26 (DGM 26), 46 p, 2 sheets, scale 1:24,000. *\$15.00 plus shipping and handling.*

Sixteen $^{40}\text{Ar}/^{39}\text{Ar}$ geochronology analyses from southeastern Arizona: Peters, Lisa, Ferguson, C.A., Spencer, J.E., Orr, T.R., and Dickinson, W.R., 2003, Arizona Geological Survey Open-File Report 03-02 (OFR 03-02), 37 p., 8 p. appendix. *\$7.50 plus shipping and handling.*

Eighteen new $^{40}\text{Ar}/^{39}\text{Ar}$ thermochronologic analyses from southern and central Arizona: Spell, Terry, Zanetti, Kathleen, Spencer, J.E., Richard, S.M., Ferguson, C.A., Skotnicki, S.J., and Orr, Tim, Arizona Geological Survey Open-File Report 03-03 (OFR 03-03), 63 p. *\$10.50 plus shipping and handling.*

Preliminary geologic map of the Meddler Wash 7.5' Quadrangle, Gila County, Arizona: Skotnicki, S.J., 2003, Arizona Geological Survey Open-File Report 03-04 (OFR 03-04), 1 sheet, scale 1:24,000. *\$2.00 plus shipping and handling.*

The geology, leasing, and production history of the uranium-vanadium mines on Eurida Mesa, Apache County, Arizona: Chenoweth, W.L., 2003, Arizona Geological Survey Contributed Report 03-C (CR 03-C), 24 p. *\$4.25 plus shipping and handling.*

The geology, leasing, and production history of the Rattlesnake No. 1/Shorty No. 1 uranium-vanadium mine, Apache County, Arizona: Chenoweth, W.L., 2003, Arizona Geological Survey Contributed Report 03-D (CR 03-D), 14 p. *\$2.75 plus shipping and handling.*

Please refer to ordering instructions on back page.

PUBLICATION 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 7.6% 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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ANNOUNCEMENT

The annual report of the Arizona Geological Survey (AZGS) for Fiscal Year 2003, which ended June 30, 2003, is posted on the AZGS website (www.azgs.az.gov) and may be downloaded. Paper copies of the report will not be distributed. The report includes descriptions of major projects that were in progress or completed, a summary of information and service provided, a list of persons employed, information about the budget and expenditures, and a complete list of all geologic reports and maps that were released.

STATE OF ARIZONA Janet Napolitano, Governor

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