UTAH GEOLOGICAL SURVEY

SURVEY NOTES

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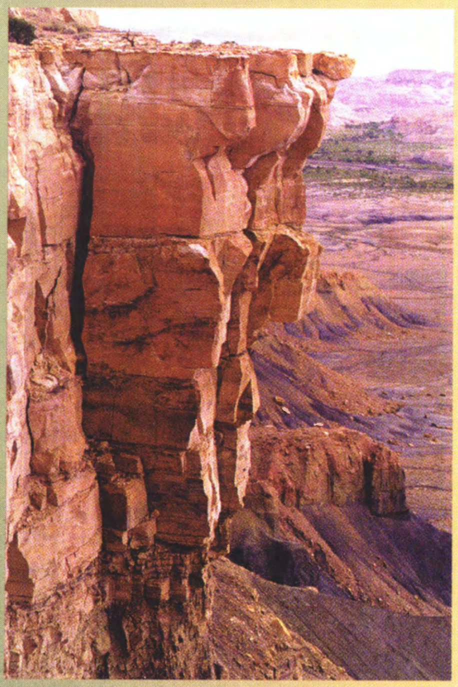

PALEOSEISMIC ISSUE

Ferron Sandstone Update!

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Design by Vicky Clarke
Cover photo: *Hurricane fault near the Utah/Arizona border. Photo by Bill Lund.*
Inset photo: *Ferron Sandstone, Western San Rafael Swell. Photo by Michael Laine.*

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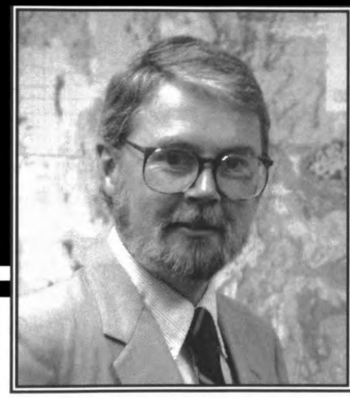
The Director's Perspective

by M. Lee Allison



Weeee're Baaack!

Utah oil production up for first time in 12 years

In 1997, Utah oil production posted its first yearly increase since 1985. Granted, it was only 0.35 percent but after more than a 50 percent overall decline in the state's production since the oil price collapse, this is much more significant than the relatively small numerical increase might suggest. In addition, state gas production decreased only 0.78 percent, compared to 9-11 percent declines in the preceding two years.

The increase can be attributed to more wells being drilled and new production techniques being used to recover more oil from existing fields. Companies filed 527 APDs (applications for permits to drill) in 1997, the highest number since 1984, which is an encouraging sign that the turn-around will continue.

Production improvements are occurring in the Uinta Basin, Paradox Basin, and Ferron Sandstone coalbed methane plays. Each is an area where the Utah Geological Survey is engaged in industry-government-academia partnerships to increase production or better understand petroleum reservoir characteristics.

In the Uinta Basin, the UGS Bluebell field demonstration project has fostered cooperation and sharing of previously confidential data among producers and service companies. Companies are trying techniques new to the area to find bypassed production zones and to avoid or mitigate some of the problems that have plagued wells for decades. The U.S. Department of Energy (DOE) and Quinex Energy of Ogden, Utah are the principal funders of the project. Another DOE-funded project, led by Inland Resources with assistance from the University of Utah, is carrying out waterfloods in zones thought to be unsuitable for this technology. They are so economically successful that the resulting increased federal royalties are enough to pay for the entire DOE national oil field demonstration program.

Horizontal drilling in the giant Aneth oil field in the Paradox Basin of southeastern Utah, combined with carbon dioxide flooding of the reservoirs, is increasing production there. The UGS, in partnership again with DOE and Harken Energy, is attempting to translate the technology to the nearly 100 small algal-mound oil fields in the basin to determine if similar results can be obtained. The demonstration phase of the project is just getting underway, but we will report our progress as it occurs.

Lastly, the development of coalbed methane (natural gas derived from coal beds) in the Ferron Sandstone, Utah, is turning out to be one of the premier plays in the country. River Gas Corp. is being joined by Anadarko Petroleum and Texaco as well as some independents in expanding the limits of this play. Coincidentally, the UGS started an extensive DOE-funded study of the Ferron Sandstone about the time the exploration started. The UGS project, with Mobil, Amoco, and the University of Utah as partners, is characterizing the Ferron as a classic example of a fluvial-deltaic reservoir, analogous to the most prolific oil reservoirs in the nation. The massive UGS data base is allowing a three-dimensional characterization and reservoir modeling of key geological components of the unit. Companies can use the models to simulate development strategies for similar fields anywhere in the world. Some of these results should also help operators better understand the complexities of the Ferron for methane development right here in Utah.

Increased oil and gas production has been a goal of the UGS for the past decade. We are pleased and proud that we have been able to play some small role in achieving that.

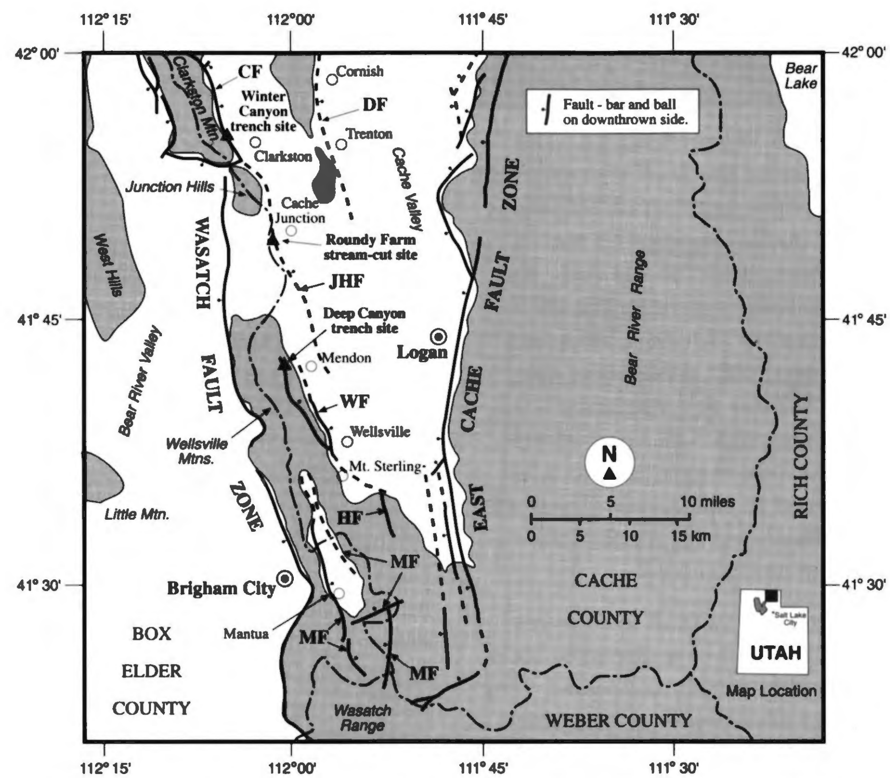
Survey Notes is published three times yearly by Utah Geological Survey, 1594 W. North Temple, Suite 3110, Salt Lake City, Utah 84116; (801) 537-3300. The UGS inventories the geologic resources of the state, identifies its geologic hazards, disseminates information concerning Utah's geology, and advises policymakers on geologic issues. The UGS is a division of the Department of Natural Resources. Single copies of *Survey Notes* are distributed free of charge to residents within the United States and Canada. Reproduction is encouraged with recognition of source.

Paleoseismology is the study of prehistoric earthquakes. Paleoseismic studies are used to assess the probability and severity of future earthquakes by mapping and analyzing evidence from past earthquakes. Large earthquakes (greater than magnitude 6.0-6.5) which rupture the ground surface leave evidence of their occurrence in the geologic record within a fault zone. Mapping of faults and associated geologic deposits, analysis of fault-zone features, trenching across scarps, and dating of Quaternary (0-1.6 million years ago) sediments can provide information to estimate the size and timing of these earthquakes. Gathering data from paleoseismic studies is fundamental to evaluating earthquake hazards and risk. This issue of Survey Notes highlights recent Utah Geological Survey paleoseismic studies throughout the state.

Large Earthquakes on the West Cache Fault Zone, Cache County, Utah

by Bill D. Black

Three major active fault zones are in and adjacent to Cache Valley that pose a seismic (earthquake) risk to citizens living in Cache Valley and northern Utah. These are the Wasatch, East Cache, and West Cache fault zones. All of these faults displace the surface and show evidence of large earthquakes in recent geologic time. Paleoseismic studies to identify the size and timing of prehistoric earthquakes have been conducted for both the Wasatch and East Cache fault zones, but not for the West Cache fault zone. The Utah Geological Survey (UGS), with partial funding from the U.S. Geological Survey National Earthquake Hazards Reduction Program (NEHRP), is conducting a paleoseismic study to establish the size and timing of prehistoric earthquakes on the West Cache fault zone. This study will improve estimates of seismic hazard and risk in Cache Valley and northern Utah.



Index map of Cache Valley showing locations of nearby active faults and investigation sites on the West Cache fault zone. CF - Clarkston fault, JHF - Junction Hills fault, WF - Wellsville fault, DF - Dayton fault, HF - Hyrum fault, MF - faults in the Mantua area. CF, JHF, and WF comprise the West Cache fault zone; DF, HF, and MF are associated faults.

West Cache Fault Zone Investigations and Results

The West Cache fault zone (WCFZ) was mapped in 1996 in a project (also partially funded by NEHRP) conducted by UGS geologist Barry J. Solomon. He showed that the fault zone in Utah extends for about 35 miles along the west side of Cache Valley from the Utah-Idaho border to about 4 miles south of Wellsville, and consists of three faults dipping eastward beneath Cache Valley. These are the Clarkston, Junction Hills, and Wellsville faults (from north to south). Faults in three nearby areas may also be associated with the WCFZ, but are not generally included in it. These nearby faults are, from north to south, the Dayton and Hyrum faults and faults in the Mantua area. We conducted no investigations on these nearby faults due to their apparent lack of late Quaternary activity.

The Clarkston fault is about 22 miles long (7 miles in Utah, 15 miles in Idaho) and generally consists of a discontinuous fault that displaces Quaternary deposits and bedrock. Two areas on the Clarkston fault have evidence of possible surface faulting in the past 10,000 years. The first area is at the mouth of Winter Canyon, roughly 2 miles west of Clarkston, Utah, and the second is 0.5 miles north of Winter Canyon at the mouth of Raglanite Canyon. We excavated one trench across the fault north of

◀ *South view of fault in the Winter Canyon trench exposure, Clarkston fault, Cache County, Utah.*

▶ *North view of fault in the Roundy Farm stream-cut exposure, Junction Hills fault, Cache County, Utah.*

the mouth of Winter Canyon. The trench exposed the fault and evidence for one surface-faulting earthquake. The earthquake caused 11.5 feet of displacement down to the east. Radiocarbon results indicate the earthquake occurred around 4,500 years ago. Topographic profiling of the scarps at Winter and Raglanite Canyons show 11.5-12.8 feet of displacement, which is similar to what we observed in the trench. Thus, all this displacement is probably the result of one earthquake.

The Junction Hills fault is 16 miles long and consists of a discontinuous fault that is generally concealed. The only conclusive evidence of Quaternary surface faulting on this fault is associated with three short fault scarps. The fault is exposed near the southern end of one of these scarps in a stream cut at Roundy Farm near Cache Junction, Utah. We mapped the north wall of the stream cut, which exposed direct evidence for one surface-faulting earthquake and indirect evidence for at least one older earthquake. The younger earthquake caused 9.5 feet of displacement down to the east. Radiocarbon results indicate the younger earthquake occurred around 8,450 years ago; we could not determine an age for the older earthquake. We performed no topographic profiling at Roundy Farm because the scarp has been mostly removed.

The Wellsville fault is 12 miles long and consists of a branched (Y-shaped) fault that generally marks the boundary between bedrock and Quaternary deposits of Cache Valley to the east. At the north end of the Wellsville fault, the western branch of the fault displaces Quaternary deposits near Deep Canyon, about 2 miles west of Mendon, Utah; the eastern branch is covered by Quaternary deposits. We excavated one trench across the western branch north of the mouth of Deep Canyon. The trench exposed evidence for two surface-faulting earthquakes. Both earthquakes displaced sediments down to the east, but we could not determine the amount of displacement in the trench. Radiocarbon results indicate the younger earthquake occurred around 3,700 years ago; the older earthquake likely occurred some time after 25,000 years ago (how long after is uncertain). Topographic profiling of the scarp north of Deep Canyon, near the trench site, shows 21.0-22.3 feet of displacement. If all this displacement resulted from two earthquakes, the average displacement per earthquake would be about 10.8 feet.

Correlation of earthquakes on the various faults in the WCFZ can be used to help assess how the faults are related to each other. Our radiocarbon age estimates indicate timing for the most recent surface-faulting earthquake on the Junction Hills fault is older than that for the Clarkston fault to the north and Wellsville fault to the south. This evidence suggests that the faults move independently. A difference in Bonneville shoreline elevations across the Junction Hills and Clarkston faults also suggests independent surface faulting on these two faults.

Several questions regarding the WCFZ remain unanswered. Although individual fault lengths vary between 12 to 22 miles, average displacement per earthquake is similar for all three faults and ranges from 9.5 to 12.8 feet. Worldwide observations of historical surface faulting indicate a correlation exists between maximum displacement and fault length. Mathematical relations based on these observations indicate the average displacement per earthquake on the Wellsville fault, which is the shortest of the three faults, is abnormally high. Is the scarp at Deep Canyon on the Wellsville fault the result of more than two earthquakes (which would reduce the average)? Does surface rupture on the Wellsville fault continue on the Junction Hills fault (which would make the Wellsville fault longer)? Could evidence of a younger earthquake on the Junction Hills fault be obscured at the Roundy Farm stream-cut site? Does the older earthquake on the Wellsville fault correlate with timing for the earthquake on the Junction Hills fault? With additional work we hope to answer some of these questions and refine our understanding of prehistoric earthquakes on the WCFZ.

Utah and Arizona Geological Surveys Cooperate to Evaluate Seismic Hazards

by William R. Lund

The Utah Geological Survey (UGS) and the Arizona Geological Survey (AGS) are conducting a cooperative research project to evaluate the potential for large, damaging earthquakes on the Hurricane fault, an active fault that extends for 156 miles from Cedar City, Utah to south of the Grand Canyon in Arizona (figure 1). The study is funded in part by the U.S. Geological Survey through the National Earthquake Hazards Reduction Program. Goals of the study include estimating average rates of fault movement (slip rate) over a variety of geologic time periods, assessing how much of the fault has ruptured in individual large prehistoric earthquakes, and estimating the age and size of those earthquakes. Assessing seismic hazard in this region is particularly important because southwestern Utah and northwestern Arizona are experiencing a population and construction boom that is projected to continue unabated into the future. The results of this study will greatly improve our understanding of the seismic hazard in this rapidly growing region at a time when the information can be used to evaluate land use and design standards for building practices.

Seismic hazard in southwestern Utah and northwestern Arizona is poorly understood because of a lack of information about the size and frequency of large earthquakes. No historical surface-faulting earthquakes have occurred in southwestern Utah or northwestern Arizona. However, the region has experienced numerous earthquakes greater than magnitude (M) 4 this century (figure 2). The largest and most damaging events were the M 6.3 Pine Valley earthquake in 1902 (Williams and Tapper, 1953) and the M 5.8 St. George earthquake in 1992 (Christenson and Nava, 1992). Although the Pine Valley earthquake is poorly located, the epicenter was probably west of the Hurricane fault. The St. George earthquake probably did occur on the Hurricane fault (Pechmann and others, 1995).

Based on historical seismicity alone, seismic hazard in the region is considered moderate. However, the area's geologic setting suggests that the seismic hazard is greater. The area is in the transition zone between the Colorado Plateaus and Basin and Range physiographic provinces, a region that is broken by a series of major, west-dipping, potentially active faults, including the Hurricane, Toroweap-Sevier, Washington, and Grand Wash fault zones (figure 2). All of these faults have evidence of Quaternary movement (Hecker, 1993), and likely represent a significant seismic hazard to southwestern Utah and northwestern Arizona. The Hurricane fault is the longest of these features and in places exhibits thousands of feet of Quaternary displacement (figure 3).

Initial field reconnaissance has identified two sites in Arizona (Cottonwood Canyon and Honeymoon Trail) and four sites in Utah (Murie Creek, Shurtz Creek, and two unnamed sites, about a half mile north and one mile south of Shurtz Creek, respectively) where the Hurricane fault displaces

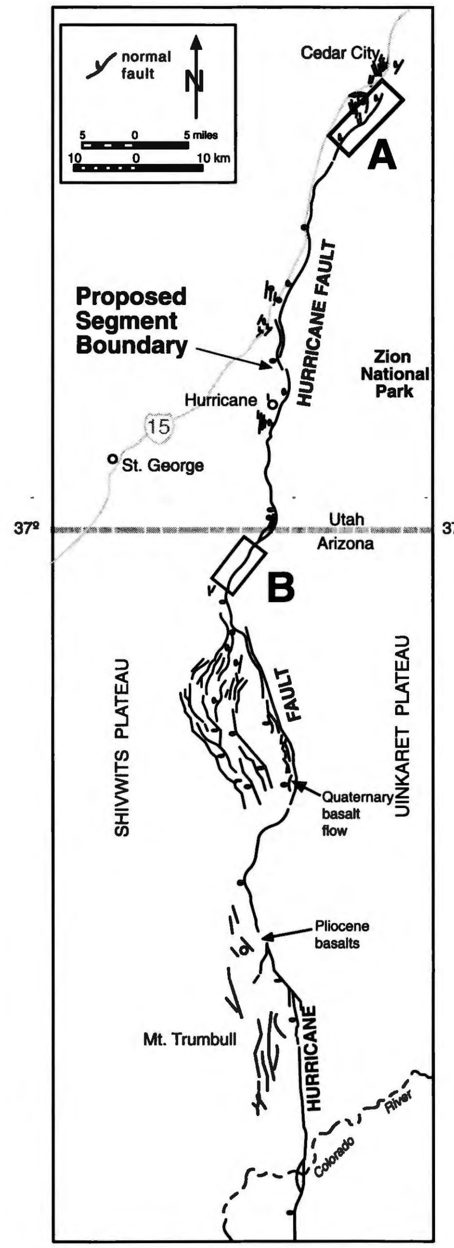


Figure 1. Hurricane fault and subsidiary structures in southwestern Utah and northwestern Arizona. Box A + Shurtz Creek, Murie Creek, and two unnamed sites where the Hurricane fault displaces unconsolidated deposits. Box B + Cottonwood Canyon and Honeymoon Trail sites.

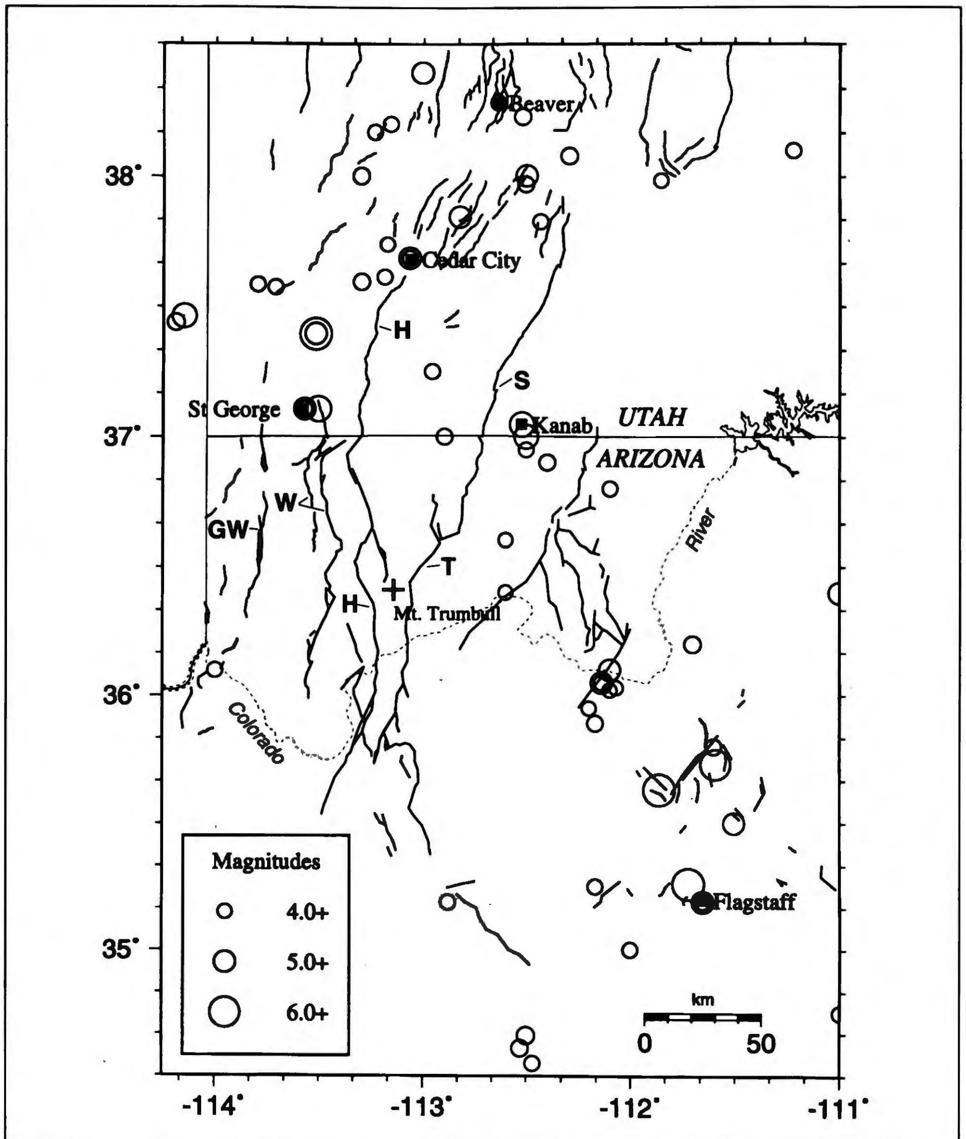


Figure 2. Map of Quaternary faults and historical earthquakes in southwestern Utah and northwestern Arizona. GW = Grand Wash fault, W = Washington fault, H = Hurricane fault, S = Sevier fault, T = Toroweap fault.

unconsolidated (basin-fill) Quaternary deposits (figure 1). Scarps on unconsolidated deposits have long been recognized along the Hurricane fault in Arizona, but with the exception of the prominent fault scarp at Shurtz Creek developed on probable 80,000 to 120,000 year-old deposits (figure 4), fault scarps on unconsolidated deposits were previously unknown in Utah. Preliminary mapping indicates that probable early to middle Holocene (5,000 to 10,000 years old) deposits are faulted at Murie Creek, Cottonwood Canyon, and Honeymoon Trail, implying that at least one, and possibly two, large surface-faulting earthquakes have occurred on the Hurricane fault in the recent geologic past.

We have measured topographic profiles across scarps of different ages at several sites to determine displacement on the fault. In cooperation with the U.S. Geological Survey and Lawrence Livermore National Laboratory, we have collected samples for dating from a displaced surface at Shurtz Creek and from surfaces at Cottonwood Canyon. When complete, the age estimates will allow us to calculate a slip rate (mm/yr) for the past 100,000 to 200,000 years at these two locations. Soil-profile development on the Shurtz Creek and Cottonwood Canyon surfaces varies depending on the age of the surface. Soil scientists from Utah State University will make a laboratory determination of calcium carbonate and clay enrichment in the soils. That information, combined with the ages of the displaced surfaces, will allow us to determine how soil profiles develop over time in the study area. We will use that information to estimate the age of other surfaces along the Hurricane fault where age-dates are not available.

The Hurricane fault displaces Quaternary lava flows at several locations (figure 3). Geologists from the UGS Geologic Mapping Program have sampled a number of displaced flows for dating. Once the ages of the flows are known and their displacements accurately determined, we will calculate long-term (possibly for the past 2 million years) slip rates for the fault. Comparison of these long-term rates with the rates obtained from the displaced late Quaternary surfaces at Shurtz Creek and Cottonwood Canyon will provide new insights into how activity on the Hurricane fault has varied over time. As an additional check on the age of the lava flows and to determine their direction of flow, UGS Visiting Scientist Mike Hozik from Stockton College in New Jersey is conducting a study of the remnant magnetic field contained in the flows displaced by the fault.

To investigate the most recent activity on the Hurricane fault, we have excavated two trenches across scarps at Cottonwood Canyon in Arizona that displace young (probably Holocene) and intermediate (probably late Pleistocene) age surfaces. The trench across the scarp on the young surface revealed nearly three feet of down-to-the-west displacement. This faulting represents the most recent surface-faulting earthquake on this part of the fault and, based on soil-profile development on the terrace, may be as young as mid-Holocene. In the trench across the intermediate surface, the ages of the most recent and possibly

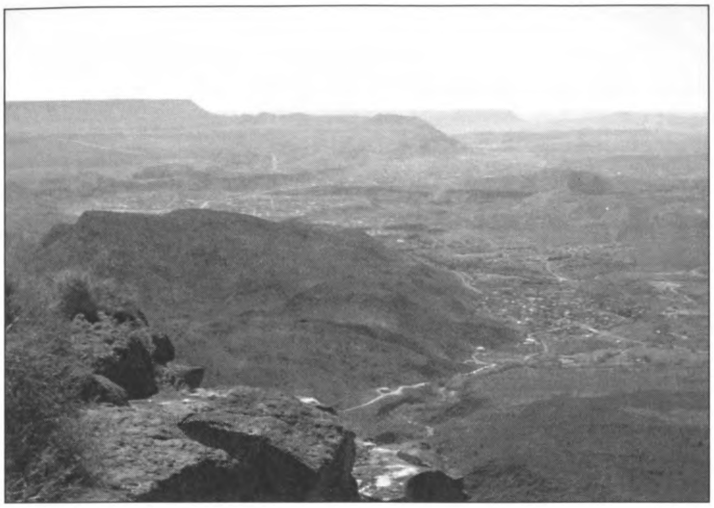
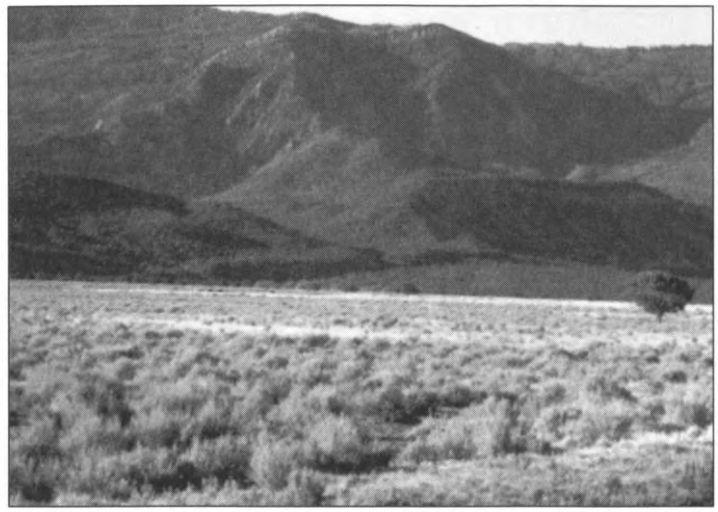


Figure 3. Quaternary lava flow in foreground (lower left) correlates with the flow at the base of the Hurricane Cliffs in the lower right corner of the photograph. Displacement of the flow across the Hurricane fault at this location is about 1,400 feet. View is to the south; town of Toquerville is in the middle of the photograph.



Fault scarp at Shurtz Creek (casting linear shadow) is 50 feet high and displaces the surface down to the west.

older events are as yet unknown.

In a later phase of this project, we plan to open trenches at Murie Creek in Utah where a probable Holocene-age deposit is displaced across a 10-foot-high fault scarp. A trench across this scarp should provide information about the most recent surface faulting along this part of the fault. In addition, a trench across a 35-foot-high, multiple-event scarp formed on older colluvium at Murie Creek may help determine the size and timing of the past two and possibly earlier surface-faulting events. If the age and offset of Holocene and latest Pleistocene events can be determined at the two sites, we will be able to calculate a third set of slip rates for the Hurricane fault encompassing the fault's most recent geologic history. Again, comparing these geologically young slip rates (for the past 5,000 to 35,000 years) with those obtained from displaced surfaces and lava flows will show how activity on the Hurricane fault has changed through time. Additionally, comparison of the timing of the most recent and earlier events at the two sites will show if the 156-mile-long Hurricane fault is divided into shorter segments that are each capable of producing their own earthquakes, as is common for other long, normal faults in the western United States. On the basis of structural evidence in bedrock, Stewart and Taylor (1996) postulate that a segment boundary exists between the two sites near Toquerville where the Hurricane fault makes a large S-bend to the west and north (figure 1). If timing of events at the two sites is the same, then both locations experienced the same surface-faulting earthquakes and there is no segment boundary between them. However, if the timing is different, then a segment boundary separates the two sites. If the Hurricane fault is segmented, and if we can determine the history of surface faulting on each segment, we will be able to characterize potentially varying levels of seismic hazard along the fault.

Although not yet complete, the joint UGS/AGS project to investigate the Hurricane fault has already produced new information about seismic hazard in southwestern Utah and northwestern Arizona. We have documented the presence of faulted deposits of probable Holocene age in both states, indicating that the Hurricane fault has produced at least one and possibly two large surface-faulting earthquakes in the recent geologic past. As additional work on the fault is completed, we will be better able to characterize seismic hazard in this rapidly growing region.

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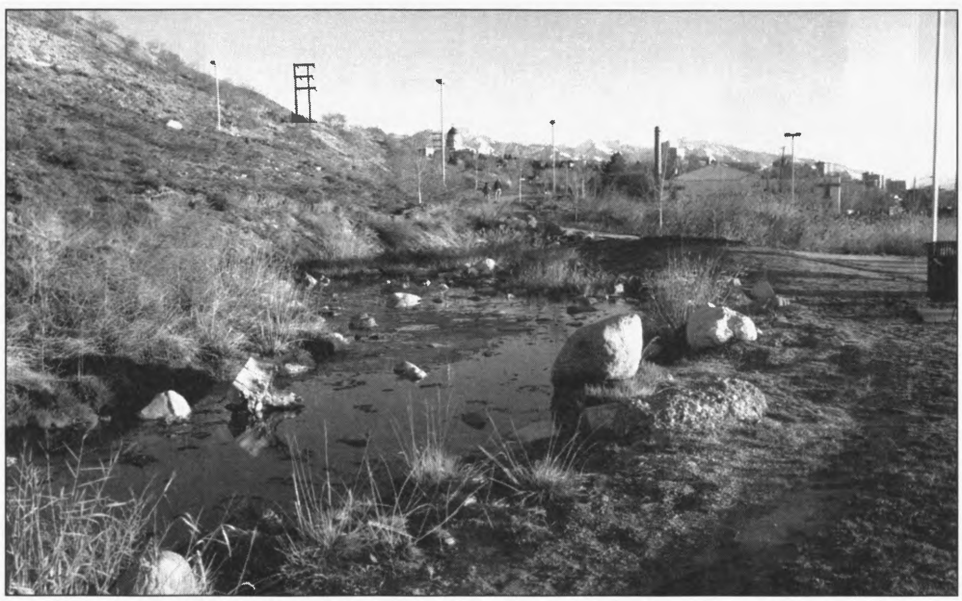
"Glad You Asked"

by Mark R. Milligan

Do I have to travel all the way to Yellowstone, or can I see beautiful hot springs here in Utah?

No, you don't have to travel all the way to Yellowstone - over 100 hot springs adorn Utah. In fact, a wonderful hot spring, named Wasatch Warm Springs, is within walking distance of downtown Salt Lake City. Wasatch Warm Springs is the southernmost hot spring, in a series of four, located along three miles (5 km) of the Warm Springs fault zone. From north to south, the individual hot springs are Becks, Hobo, Clark, and Wasatch. Collectively this area is known as the Warm Springs fault geothermal area. Refer to the map in Barry Solomon's article, page 8.



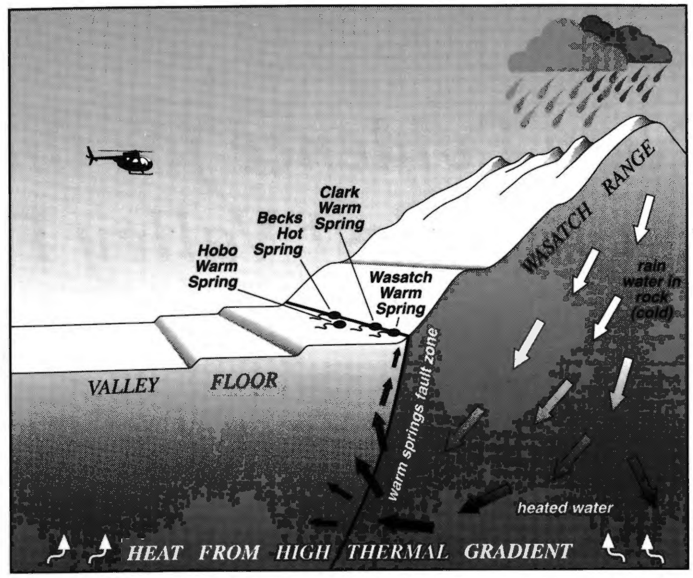
Southward view of Wasatch Warm Springs, with dome of State Capitol in background.

The City of Salt Lake has restored Wasatch Warm Springs and its accompanying wetlands, and is in the process of completing a new northern section of Warm Springs Park. Informational placards describing the history, ecology, and geology of the springs should be installed in time for the park's dedication this spring. The springs are viewable year round and are especially intriguing on a cold, snowy winter day. While stopping to view the springs is well worthwhile, bathing is no longer permitted.

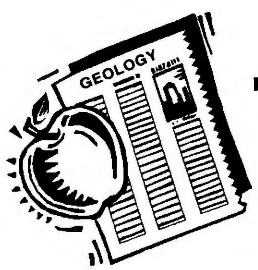
Where does the water come from and how does it get hot? The ultimate source of the water is snow and rain falling on the Wasatch Range. Much of this water travels to the valley in streams, gets used by plants, or evaporates. The remainder percolates into the ground. This ground water slowly migrates downward and basinward through steeply inclined bedrock with a network of fractures and faults. Heat originating from within the earth's interior warms the descending ground water and surrounding rock. From deep beneath the surface, the heated water travels back up through a conduit provided by the Warm Springs fault. The water rises so quickly, it does not have time to cool.

How hot is the water and how deep does it circulate? Water temperature of Wasatch Warm Springs fluctuates seasonally between 100 and 108°F (38/ 42°C). In part, the temperature depends upon how deep the water circulates and the rate at which the temperature of the earth's crust increases with depth (called thermal gradient). Assuming a thermal gradient of 93°F per mile of depth (32°C per km) and an average annual outside temperature (in the Wasatch Range) of 40°F (4.5°C), the water must reach a depth of approximately 3/4 mile (1.2 km) to obtain the maximum temperature of 108°F (42°C). However, upon ascending to the surface the hot water may be cooled by mixing with water near the surface and the surrounding rock. Therefore, the water must circulate through depths greater than this simple calculation suggests. The near-surface mixing probably accounts for seasonal temperature fluctuations.

How do I get there? The new northern portion of Warm Springs Park (location of the springs) is immediately north of the Children's Museum of Utah. The street address is 900 North 300 West. Due to construction, the 600 North exit on I-15 is closed until the year 2000. Therefore, drivers must take the 600 (6th) South/ City Center exit on I-15. From the 600 (6th) South exit ramp, take the 300 (3rd) West Northbound connector ramp. Travel 15 blocks north to 900 North. Park in the lot on the north side of the Children's Museum, which is on the right (east) side of 300 West. If walking or bicycling from downtown Salt Lake City, head north on 200 West. Where 200 West ends at Wall Street continue north through the old southern portion of Warm Springs Park.



Conceptual model cross section of ground-water flow from recharge in the Wasatch Range to discharge at Warm Springs Park.



Teacher's Corner

by Sandy Eldredge

Unique Opportunities for K-12 Science Teachers at the American Association of Petroleum Geologists Annual Convention

May 16, 18, 20, 1998
Salt Palace Convention Center
Salt Lake City, Utah

Utah is the place this year for the American Association of Petroleum Geologists (AAPG) annual convention. Workshops for credit, field trips for credit (fees range from only $5.00 to $15.00), complimentary passes to the convention, and a special Mars presentation will all take place during this convention - this year only!

In recognition of the importance of science education, the AAPG established a Teachers' Day Program in their conventions. Teachers will be guests of the AAPG and receive complimentary passes to tour the exhibit hall and attend scientific presentations. Teachers also may take one or two credited workshops - Rocks in Your Head and/or Antelope Island and Great Salt Lake Earth Systems. Rocks in Your Head is a nationally acclaimed workshop, and for its debut in Utah, the workshop will be specifically designed for Utah teachers to meet the state's new core curriculum standards for grades 2-9. Antelope Island and Great Salt Lake Earth Systems will be a combination field trip and classroom workshop, designed for teachers of several disciplines, including earth science, geology, chemistry, and biology. The workshop is open to all grade levels, and particularly meets the 9th-grade core curriculum standards.

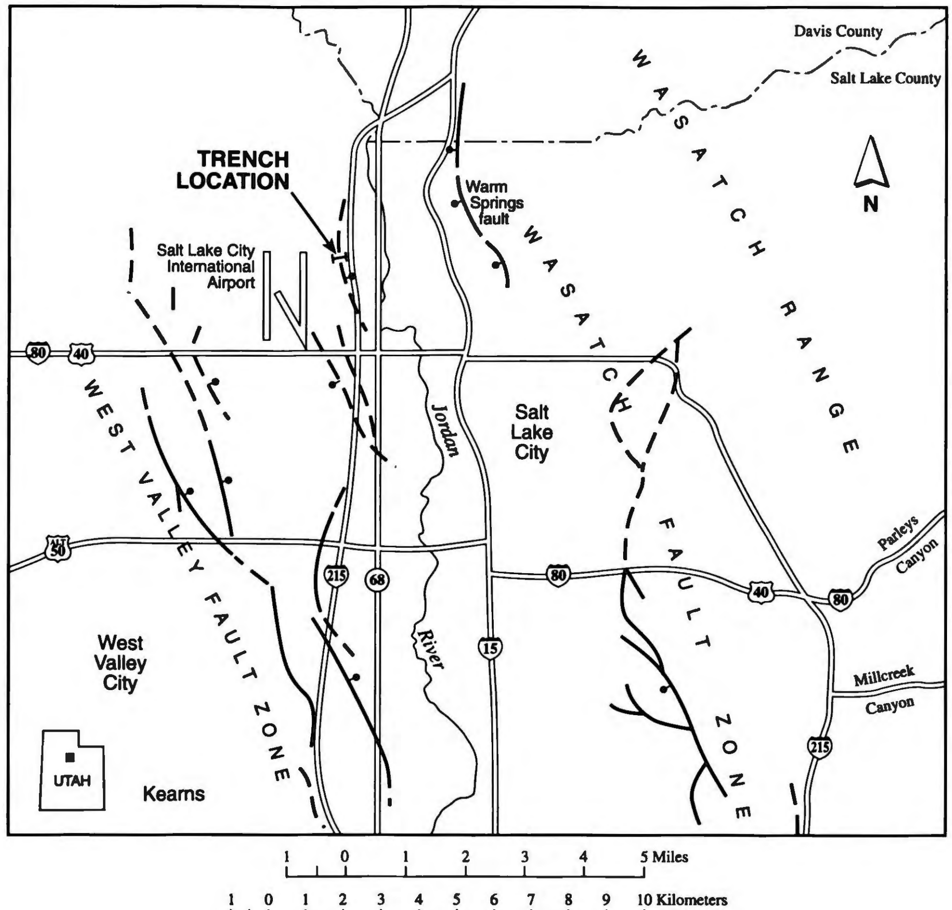
Another field trip offered at the special reduced price to teachers, Geology along the Wasatch Front, will take place in Salt Lake Valley, along the Wasatch Front, and up Little Cottonwood Canyon (not for credit). And, last, but certainly not least, an incredible presentation, Mars Geology: Pathfinder and Global Surveyor Results, will be open to teachers, students, and the public on Wednesday, May 20, 12:15-1:15 pm. The discussion of the exploration results will be illustrated with great visuals. Come and get your pair of 3D glasses to see an actual 3D movie filmed on Mars!!!

For further information, contact Sandy Eldredge at phone 801-537-3325, fax 801-537-3400, or E-mail nrugs.seldredg@state.ut.us.

New Evidence for the Age of Faulting on the West Valley Fault Zone

by Barry J. Solomon

The West Valley fault zone (WVFZ), the western boundary of a fault-bounded basin in the center of the Salt Lake Valley, is in an urban area as close as three miles to downtown Salt Lake City. The eastern boundary of the basin is marked by the Wasatch fault zone (WFZ), the longest and most active fault in Utah. Numerous studies of the WFZ have contributed to our knowledge of its geologically recent earthquake history, but studies of the WVFZ are few and its history is more obscure. A significant piece of the WVFZ puzzle was recently found, however, when a new date was obtained from material collected from a fault exposed in a trench excavated in northern Salt Lake City by AGRA Earth and Environmental, Inc. AGRA geologists Jennifer Helm and Greg Schlenker recognized the potential importance of the trench exposure during the course of their study of the surface fault-rupture hazard at the site of proposed construction near the Salt Lake City International Airport. They informed the Utah Geological Survey of the exposure and we responded to sample the trench and obtain a radiocarbon age date. UGS geologists Bill Black, Rich Giraud, and Barry Solomon collected samples for dating and logged the trench to document the geologic setting. Analyses of the samples gave us the first estimate of the age of faulting along the northern part of the WVFZ.



Map showing the location of the fault trench excavated by AGRA Earth and Environmental, Inc., along the West Valley fault zone, Salt Lake County, Utah.

The average age of two samples of peat collected from the trench is roughly 2,200 years. One sample was collected from material eroded from the fault scarp and deposited within the upper part of the fault, and the other was collected from the upper layer of pre-fault-event material deposited in a depression next to the fault (a sag pond). The fault displaced sand, silt, and clay layers by about 1.5 feet. The trench lies astride the northeasternmost strand of the WVFZ, at an elevation slightly lower than that of the highest shoreline of Great Salt Lake during the last 10,000 years, commonly referred to as the Holocene highstand. The Warm Springs fault, the northernmost fault of the Salt Lake City segment of the WFZ, lies to the east, opposite this part of the WVFZ. These two faults bound a downdropped portion (graben) of the northern Salt Lake Valley, and are inclined towards the

Continued on page 13 . . .

The Rockhounder

by Stanley C. Hatfield

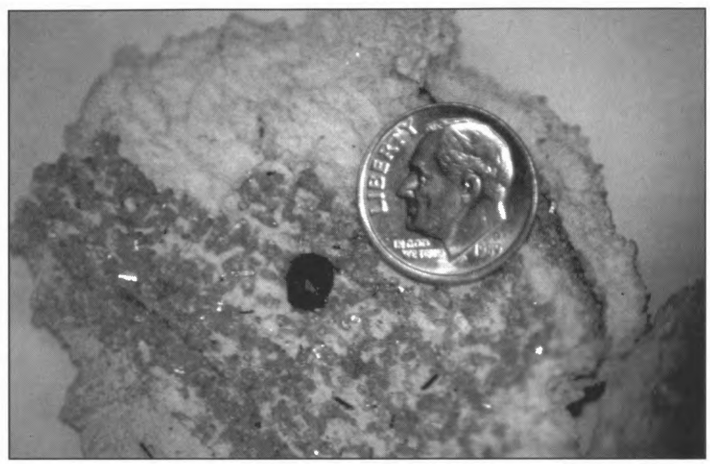
Bixbyite, Rutile, and Amethyst Crystals near Marysvale, Piute County

Geologic information: The Marysvale area is dominated by Tertiary igneous rocks ranging from intermediate to silicic compositions with both volcanic and plutonic representatives. The especially thick volcanic section is thought to be the result of a large stratovolcano complex and associated calderas that existed during mid-Tertiary time. One of the common units found near Marysvale is a white to dark gray rhyolite with extremely well-developed flow banding. The crystals, which are found in cavities in the rhyolite, formed in gas pockets that were trapped in the lava flow as it cooled. Bixbyite, a rare iron-manganese oxide, occurs as black, metallic, euhedral crystals up to 3/8 of an inch across. The crystals are generally complex combinations of various isometric forms including cubes, octahedrons, and dodecahedrons. Rutile is less common and appears as needle-like or bladed crystals up to 1/4 inch long. The amethyst crystals, ranging up to 1 inch in length, display excellent crystal form in various shades of purple. The small size of the bixbyite and rutile is more than compensated for by the excellent crystal forms of these relatively rare minerals.

How to get there: Travel 2.8 miles north on Center Street in Marysvale on US Route 89. As you begin to enter Sevier Canyon, look for an unmarked gravel road (exactly at 2.8 miles) and turn left (west). Continue approximately 300 hundred yards where you can park alongside the gravel road.

Where to collect: The rhyolite unit does not crop out within viewing distance of the collecting site. The area along the gravel road is a gently sloping field with a small dry wash running through it. Boulders and cobbles of the rhyolite unit are scattered everywhere in the field and many good samples can be found just by careful examination of cavities in the rhyolite. Look for lighter colored pieces of rhyolite with a porous texture of abundant cavities and break them with a large hammer. Be careful as the rhyolite is hard and fragments are sharp. The best samples are found by carefully prying open the cavities in the smaller, broken pieces.

Useful maps: Beaver and Richfield 1:100,000-scale metric topographic maps, and a Utah highway map are best for navigational purposes. The Marysvale 1:24,000-scale topographic map may also be useful.



Large bixbyite crystal surrounded by smaller, dark rutile and lighter amethyst crystals. Note dime for scale.

Land ownership: Bureau of Land Management (BLM) public lands.

BLM collecting rules: The casual collector may take small amounts of gemstones and rocks from unrestricted federal lands in Utah without obtaining a special permit if collection is for personal, non-commercial purposes. Collection in large quantities or for commercial purposes requires a permit, lease, or license from the BLM.

Miscellaneous: A hat and water are recommended, as are the following tools: safety glasses, a five-pound or larger sledge hammer, chisel, and newspaper or other suitable wrapping material. Have fun collecting!

About the author:

Stanley C. Hatfield is a geology professor at Southern Utah University where he teaches a variety of topics including mineralogy, igneous petrology, and metallic mineral deposits. Originally from Ohio, he has taught in Utah for over five years. Much of his free time is spent collecting rocks and minerals and conducting field trips throughout southern Utah.

Energy News

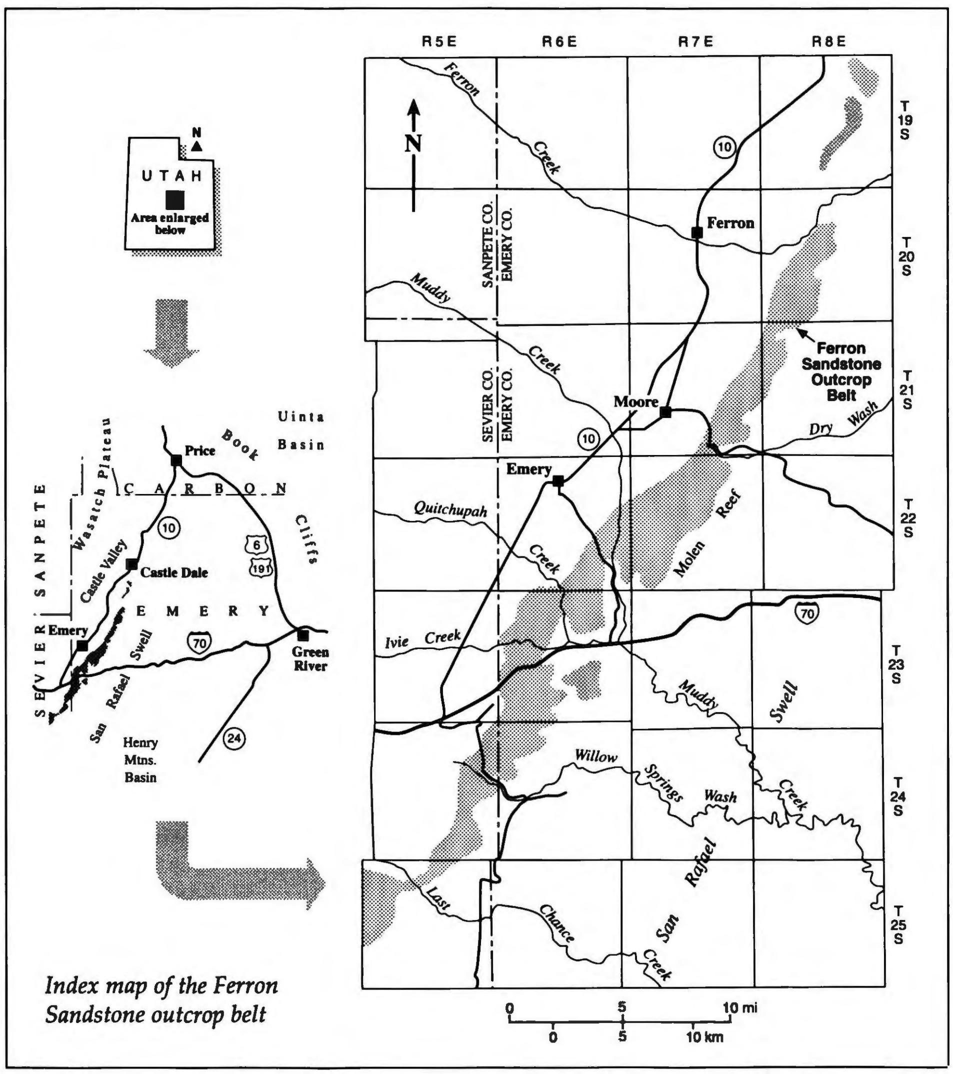
Ferron Sandstone Project Nears Completion, Generates International Interest

by Tim Madden

An investigation by the Utah Geological Survey (UGS) of the Ferron Sandstone outcrop as a possible model for oil and gas reservoir management is nearly complete, and its results are attracting interest from petroleum producers worldwide.

Oil and gas industry scientists have long recognized the Ferron Sandstone outcrop in east-central Utah as having geologic characteristics remarkably similar to those in highly productive oil and gas reservoirs in the Alaskan North Slope, Gulf Coast, and Rocky Mountain regions as well as the North Sea. In addition, the gas-bearing coalbeds of the Ferron are currently the most active targets for drilling in Utah.

The four-year project, funded for $1.6 million by the U.S. Department of Energy (DOE), uses the outcrop to construct realistic modeling techniques for improved oil-field development in similar types of reservoirs worldwide. The results of the study could improve reservoir management through modified drilling strategies, reduced economic risk, increased petroleum recovery, and more reliable reserve calculations.



Index map of the Ferron Sandstone outcrop belt

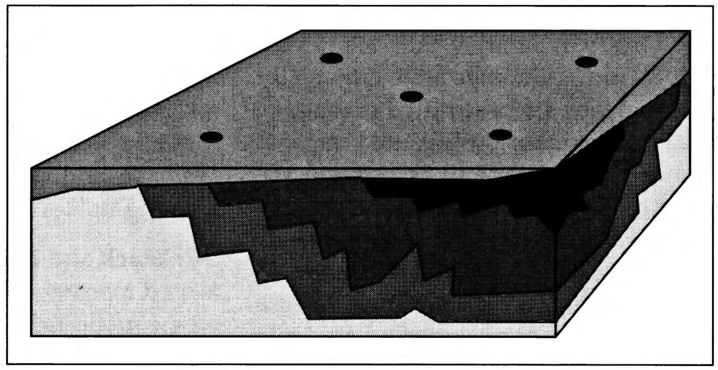
The project has produced an immense amount of raw and interpreted data, all of which is available to the public. The data include more than 1,800 color digital images and 160 photo mosaics of the outcrop, more than 2,000 permeability measurements, 586 feet of conventional core, and 19 paleogeographic maps.

By incorporating data from drill holes, photo mosaics of the exposed outcrop, layer-by-layer descriptions of these rocks, and petrophysical analyses, the project team created a three-dimensional model of a subsurface reservoir. Because the model is a much more detailed representation than one constructed using only drill-hole data, which is the currently available standard in the industry, the team was able to use state-of-the-art computers and software to simulate how as much as 50 percent more oil might be recovered from existing and new fields that are similar to the Ferron outcrop.

Photo mosaic view to the north near I-70 (unannotated) displaying contrasting beds of the Ferron

M. Lee Allison, state geologist and director of the UGS, is the principal investigator. Thomas C. Chidsey, a senior scientist with the UGS, is the program manager. Robert Lemmon of the Technology Office of the DOE in Tulsa, Oklahoma, is the Geoscience/Reservoir Characterization Program contract manager. Project collaborators include Paul Anderson and Tom Ryer, both consulting geologists, and the University of Utah, Brigham Young University, Utah State University, Mobil Exploration/Producing Technical Center, and Amoco Production Company.

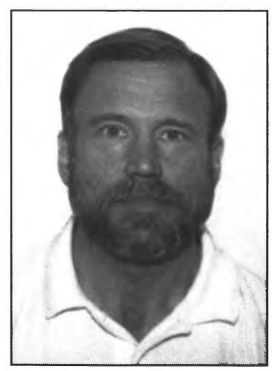
More information about this project can be found on the UGS home page at http://www.ugs.state.ut.us.



3-D simulation view of reservoir model

Utah Geological Survey Opens Southern Regional Office

In July 1996, the Utah Geological Survey (UGS) opened its first regional office, on the campus of Southern Utah University in Cedar City. The UGS Southern Regional Office was established in response to southwestern Utah's now more than decade-long population and construction boom. The combined population of Washington and Iron Counties alone is fast approaching 100,000, and has increased by more than 100 percent in the past 20 years. Even faster growth is predicted for the future. Therefore, the initial focus of the Southern Regional Office is on geologic hazards, water-resource development and protection, and providing assistance to cities, towns, counties, and other government agencies on issues where geology is a concern. William R. Lund, Senior Scientist in the Applied Geology Program and former UGS Deputy Director, heads the new office which serves the seven-county area of Washington, Iron, Beaver, Kane, Garfield, Piute, and Wayne Counties. The office also provides a local contact for those interested in other UGS programs and services including mineral and energy resources, paleontological resources and paleoenvironmental studies, geologic mapping, teacher/education outreach, geologic databases, and map and publication sales.



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Services:

- Respond to public, industry, and government inquiries
- Perform site evaluations for critical public facilities
- Respond to geologic emergencies
- Review geologic reports for municipalities and counties
- Provide a local contact for UGS programs, information, and products

Survey News

People

Welcome to new employees **Garth Blanchard** and **Greg McDonald**. Garth is the new Associate Director and comes from the Intrepid Consulting Group in Sandy, Utah. He has an MBA from California State University in Hayward and a certified management accountant professional certification. He also taught accounting at the University of Puget Sound and the University of Idaho. Greg joins the Economic Program and comes from Maxim Technologies Inc., where he was a project geologist on geologic hazards and environmental projects in Utah, Wyoming, Montana, Colorado, Kansas, and New Mexico. Greg will be working on energy and mineral resource studies of Utah.

Promotions

Kevin McClure was promoted from a temporary to a permanent position in the Economic Program. Kevin will continue to work on deliverable maps and reports for three Department of Energy-funded oil and gas contracts.

Presentations

Grant Willis was the guest speaker at the February meeting of the Utah Westerners, a society of professional and amateur historians dedicated to western history. Grant's topic was "Traders, Trappers, and Surveyors: The History of Geographic and Geologic Mapping in Utah Prior to 1900."

Craig Morgan was an invited presenter at the Petroleum Technology Transfer Council's workshop in Denver in January. The topic was advanced application of wireline logging for improved oil recovery. His presentation was "Use of dipole shear anisotropy, dual burst thermal decay time, and isotope tracer logs for recompletion design and post-recompletion evaluation in complex reservoirs."

Mike Lowe and **Janae Wallace** presented a paper entitled "Hydrogeologic implications of increased septic-tank soil absorption system density for valley-fill aquifers in Utah" at the Utah Ground Water Association meeting in Nevada in January.

Bill Black and **Barry Solomon** presented a poster session, " Surficial geologic mapping and paleoseismic investigations on the West Cache fault zone, Cache County, Utah" to the Seismological Society of America meeting in March and at the Geological Society of America regional meeting in May.

Conferences

UGS staff are involved in planning two major earth science conferences in 1998. UGS Director **Lee Allison** is the general chair for the American Association of Petroleum Geologists annual convention in May. **Roger Bon** serves as the entertainment chair, **Doug Sprinkel** is the field trips chair, **Charlie Bishop** is the field trip chair for the Division of Environmental Geosciences, and **Sandy Eldredge** is the science teachers program chair.

State Paleontologist **David Gillette** is the chair of the host committee for the Society of Vertebrate Paleontology's 58th Annual Meeting in September. **Martha Hayden** is also on the committee.

Kudos

The Department of Energy (DOE) report card on the Ferron Sandstone study shows excellence across the board. **Tom Chidsey**, the program manager for the project, was credited with an "excellent job," and top ratings were given for quality, cost control, timeliness of performance, business relations, and customer satisfaction. Some of the comments included, "Constantly high-quality research," "The administration and management side was consistently responsive to DOE requests," and "They have actively transferred the results of their research to oil operators and to the scientific community."

The new Core Sample Library is rapidly nearing completion. At the stage shown, the project is about 80 percent finished and is scheduled for dedication late this spring. With the exterior on, workers began installing electrical, plumbing, and other interior finishing. Once all that is done, the shelving will go in.

New Publications of the UGS

Paleoseismic investigation at Rock Canyon, Provo segment, Wasatch fault zone, Utah County, Utah, by W.R. Lund and B.D. Black, 21 p., 2 pl., SS-93 . . . . **$8.00**

Great Salt Lake information sheet, J.W. Gwynn, 1 p., PI-8 (revised to 1/98) . . . . **Free**

Utah: a geologic history from Paleozoic to Present, by R.W. Reading, A.E. Godfrey, and D.A. Prevedel, poster 35" x 18", PI-54 . . . . . . **$2.00**

Geologic map of Grand Staircase-Escalante National Monument, Utah, Grant C. Willis, postcard, PI-56 **.25¢**

Technical Reports for 1997, Applied Geology Program, compiled by B.H. Mayes, 126 p., RI-236 . . . **$4.50**

A summary of the geology and hydrogeology of the Cedar Valley drainage basin, Iron County, Utah, Chris Eisinger, 14 p., OFR-360 . . . . **.$1.50**

The potential impact of septic tank soil-absorption systems on water quality in the principal valley-fill aquifer, Tooele Valley, Tooele County, Utah - assessment and guidelines, by Janae Wallace and Mike Lowe, 10 p., RI-235 . . . . **$4.00**

Geology of the Sheeprock thrust, central Utah - new insights, by M. Mukul and G. Mitra, 56 p., MP98-1 . . . . **.$7.95**

. . . continued from page 8

center of the valley. The timing of the event from the WVFZ trench, shoreline fluctuations, and earthquakes along the Salt Lake City segment of the WFZ suggests that a surface-faulting earthquake occurred along this part of the WVFZ shortly after Great Salt Lake receded from the Holocene highstand (about 3,400 years ago) and at about the same time as the next-to-the-last (penultimate) surface-faulting earthquake along the Salt Lake City segment (about 2,450 years ago).

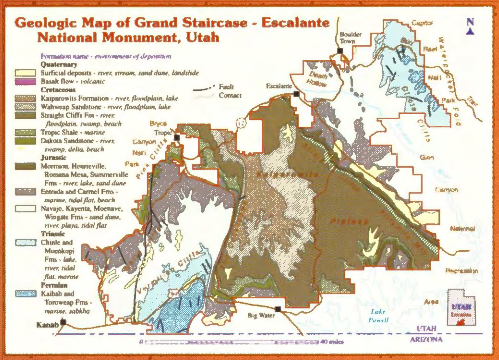
This sequence of events raises an intriguing question -- did the Salt Lake City segment of the WFZ and the WVFZ (a fault that moved in the opposite direction than the WFZ) rupture during a single large earthquake about 2,200 to 2,450 years ago, downdropping the northern Salt Lake Valley graben? And even if not, what are the true seismic risks posed by the WVFZ? These questions have been raised before, but the new dates from the AGRA trench provide new information to help us evaluate the importance of the WVFZ for earthquake-hazard analysis along the Wasatch Front.

Correction: In the previous issue of Survey Notes, we mistakenly described the gases found by Conoco in their Reese Canyon State 2-32 exploratory well as being principally methane. Conoco in fact found a mixture of gases, both inert gases and hydrocarbons, of which methane was one component. We regret this error.

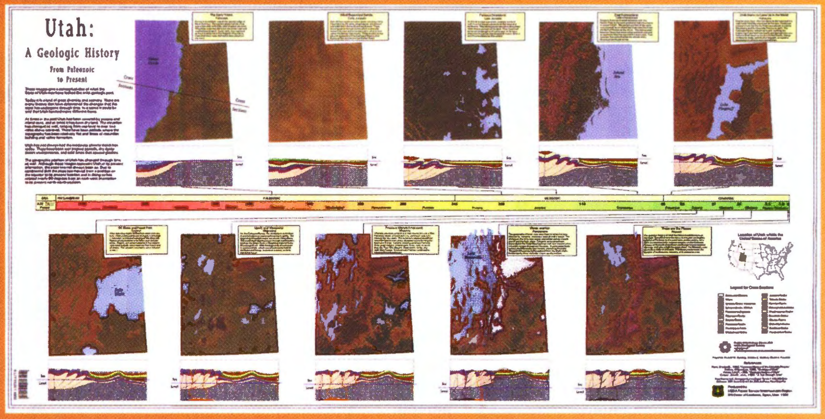
Society of Vertebrate Paleontology, 58th Annual Meeting is on September 30 to October 3 at Snowbird Resort in Little Cottonwood Canyon, Utah. Contact Martha Hayden at (801)537-3311, email at *nrugs.mhayden@state.ut.us*, or David Gillette at (801)537-3307, email at *nrugs.dgillette@state.ut.us.*

The American Association of Petroleum Geologists Annual Meeting in Salt Lake city is May 17-20 at the Salt Palace. Contact AAPG Convention Department at (918)584-2555, *www.AAPG.org.*

Good Stuff from UGS!!!



Our new geologic postcard of the Grand Staircase - Escalante National Monument.



Our new poster of Utah through the ages

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Survey Notes

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