

U T A H G E O L O G I C A L S U R V E Y

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Granite Peak Mountain, A Geologic Mystery Revealed

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Design: Liz Paton

Cover: UGS geologist Bob Biek examines numerous white pegmatite dikes and dark-gray granodiorite on the east side of Granite Peak Mountain (see article on p.1).

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THE DIRECTOR'S PERSPECTIVE

This issue of *Survey Notes* marks one of the first publications to use our new logo (see insert). The Department of Natural Resources wants a more unifying theme and image for its seven divisions while still allowing for the unique identity of each division. To recognize the Department theme of "where life and landscapes connect," all division logos include the same elements of the stylized outline of the state, the UTAH-DNR labels, and the mountain range. Each division has its own icon superimposed, which for the Utah Geological Survey (UGS) is the well-known hoodoo from Bryce Canyon National Park, Thor's Hammer. The UGS logo has its own color, an earth tone.



An instantly recognizable logo is just one element of how an agency is perceived and valued. We recently compiled our annual "outreach" indicators for fiscal year 2006 (FY06), and they show impressive interaction with both the geologic community and the public. Almost 6000 public inquiries were handled, not counting the questions that many of our bookstore customers ask. This implies that on average, our staff is handling a public inquiry every 20 minutes, and we strive to answer each the same day (see article about our more challenging questions, page 12). Half of the inquiries were energy related, with the majority of these being questions on renewable energy and energy efficiency topics. Although we have seen growth in the number of all types of public inquiries, Web site visits appear to have stabilized at between 1200 and 1400 per day (about 500,000 per year). Interestingly, putting more information

on our Web site has not diminished the e-mail and telephone inquiries. We now get many inquiries from people wanting to clarify or expand what they read on our Web site.

Our bookstore sales grew by 3 percent this year (\$293,000), with hard copy map sales continuing to be strong (22,000 maps per year) and not showing an obvious impact due to increasing availability of digital map products (212 product sales). During FY06, the UGS ran five booths at professional conferences, held two teacher workshops and 11 petroleum-industry workshops in our Core Research Center, supplied a judge to five local science fairs, and introduced 570 fourth graders to the wonders of geology during Earth Science Week.

In addition to these outreach activities, our geologists maintained previous scientific output levels with involvement in 79 publications (44 UGS publications, and 35 national or international scientific papers). In addition, 41 abstracts were presented at national and regional conferences, and 57 contract-deliverable and technical reports were completed as part of our grant and contract responsibilities and local government requests for advice. When these figures are combined with the other forms of outreach discussed above, I believe the citizens of Utah can be proud of the amount and scope of information the UGS provides.

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GRANITE PEAK MOUNTAIN

A Geologic Mystery Revealed

by Donald L. Clark, Utah Geological Survey and
Eric H. Christiansen, Brigham Young University

Think of a remote island known to few people. Are you thinking of the South Pacific or some other exotic locale? We in Utah have such an island located just 100 miles southwest of Salt Lake City. Informally named Granite Peak Mountain, this “island” is a little-known, uninhabited mountain that rises abruptly from the flats of the Great Salt Lake Desert south of Interstate 80.

Granite Peak Mountain is near the center of Dugway Proving Ground, a 1250-square-mile, high-security, U.S. Army installation used for military testing and training operations, and known as “The Nation’s Chemical and Biological Defense Proving Ground.”

Because of its location on a high-security military base, few geologists have ever seen or studied the geology of Granite Peak Mountain. But last summer, a team of Utah Geological Survey (UGS) geologists was invited to produce a geologic map of the mountain. The UGS is collaborating in this effort with researchers from Brigham Young University (BYU), Weber State University, and the U.S. Geological Survey (USGS). When we started this project, many basic geologic questions about Granite Peak Mountain remained unanswered: (1) What are the rock types? (2) How old are these rocks? (3) What orogeny (mountain-building event) affected these rocks? (4) How did this mountain block become uplifted far above similar rock under the surrounding valley floor?

History

In the late 1800s and early 1900s, Granite Peak Mountain was home to miners and bootleggers. Miners searched for precious metals (gold, silver), base metals (copper, lead, iron), and fluorite,

mica, and beryl. In the early 1900s, a spring near the north end of the mountain was an important water stop on the Lincoln Highway, the nation’s first transcontinental highway (New York to California). The onset of World War II led to the creation of Dugway Proving Ground in 1942 by President Franklin D. Roosevelt. Since then, national security has kept Granite Peak Mountain shrouded in geologic secrecy. There has been little study of the mountain’s geology, except for a 1920 report on area mining districts, a 1964 BYU student thesis, and some USGS reconnaissance work.

Rocks of Granite Peak Mountain

Most of Granite Peak Mountain is composed of two primary rock types—dark-colored layered granitic rock (foliated granodiorite) and light-colored granite (leucogranite). The upper part of the leucogranite appears to have been affected by high pressure and temperature, converting it to foliated granodiorite. The presence of these metamorphic and igneous rocks is interesting because such rocks are known from only a few areas in Utah. Magma was generated at great depth in the Earth and the Granite Peak pluton (igneous intrusion) was ultimately emplaced about 4 miles or less below the Earth’s surface. The overlying rocks have subsequently been eroded leaving the intrusion exposed.

At the south end of Granite Peak Mountain, the granodiorite intrudes a small area of metamorphosed sedimentary rocks. These rocks include schist, marble, and quartzite, which were transformed by increased pressure and temperature from the original shale, limestone, and sandstone parent rocks, respectively. These metamorphic rocks provide an important clue to the mountain’s geologic history.

A noteworthy and striking feature of Granite Peak Mountain is the presence of pegmatite dikes, the focus of the 1964 BYU study. A pegmatite is an unusually coarse-grained igneous rock, and a dike is an igneous intrusion that cuts across pre-existing rock. These pegmatite dikes are visible as bold white streaks that form intricate patterns (see cover photograph). The dikes cut across the granodiorite, leucogranite, and metasedimentary rocks, but are most obvious and voluminous within the granodiorite rock unit. Their emplacement may be related to a later phase of the leucogranite intrusion when the rare element beryllium was concentrated in the final liquids to crystallize.

Rhyolite and andesite dikes also cut the various rocks of Granite Peak Mountain. The rhyolite dikes may be related to a rhyolitic lava flow that forms Sapphire Mountain, a low ridge just south of

View to the west of Granite Peak Mountain and Sapphire Mountain (lower ridge at left), rising like a great battleship from the surrounding flats of the Great Salt Lake Desert.



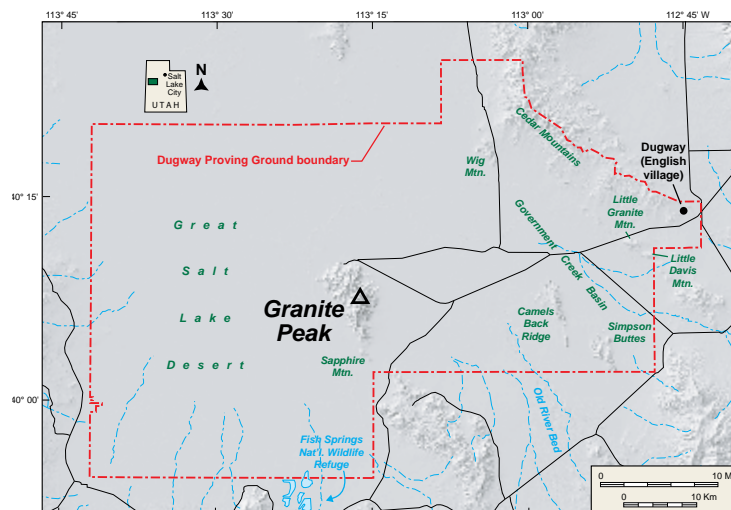
Northeast side of Granite Peak Mountain. Lighter-colored granite near the base of the range is overlain by darker-colored granodiorite with pegmatite dikes (white streaks). The mountain displays a stark beauty with its jagged cliffs and deep canyons.

Granite Peak Mountain. These two types of dikes cut across all other rock types and are not metamorphosed, thus providing an indication of their relatively young age.

Geologic History and Significance

Geologists have long wondered about the age of the granite and metamorphosed rocks that form Granite Peak Mountain. Prior estimates ranged widely from 1.6 billion years old (Precambrian) to 13 million years old (late Tertiary). We now have field relationships of the rocks, chemical comparisons, and sophisticated laboratory dating methods on minerals composing the rocks to help us answer the question of age. Preliminary work indicates that the metasedimentary rocks are likely the oldest exposed rocks. They are now tentatively considered to be roughly 540 to 245 million years old (Paleozoic), correlating to unmetamorphosed rock originally deposited in a shallow-marine environment and now exposed in mountain ranges to the west and south. The Paleozoic rocks of Granite Peak Mountain were subsequently intruded and metamorphosed by the leucogranite, granodiorite, and pegmatite approximately 150 million years ago (Late Jurassic). This age is comparable to other granitic intrusions in western Utah at Notch Peak of the House Range to the south, and at the Newfoundland Mountains, Silver Island Mountains, and northern Deep Creek Range in northwest Utah. The rhyolite and andesite dikes cutting these older rock units are not yet dated, but are likely 40 to 5 million years old (Tertiary).

The preliminary results of our research have given us insight into the geologic context of Granite Peak Mountain. This mountain is one of several intrusions in western Utah, Nevada, and the Sierra Nevada mountains of California emplaced in Late Jurassic time. This regional mountain-building event may be attributed to the Nevadan orogeny from about 160 to 120 million years ago (Late Jurassic to Early Cretaceous), a precursor to the Sevier orogeny which significantly affected the western half of Utah from about 120 to 40 million years ago (Early Cretaceous to Eocene). The Ju-



Granite Peak Mountain is near the center of Dugway Proving Ground, which sprawls across the southern part of the Great Salt Lake Desert.

rassic igneous and metamorphic rocks were subsequently exposed through doming and/or extensional faulting. The extension or stretching of western Utah and the Great Basin began about 17 million years ago and continues today.

Further Work

Continued analysis of rock samples will further resolve the geology of this enigmatic mountain. Our work at Granite Peak Mountain has led to a longer-term project, beginning in July 2006, to map the geology of the entire Dugway Proving Ground at a regional scale (1:100,000). The UGS recently obtained partial funding for this additional mapping from the USGS through the STATEMAP component of the National Cooperative Geologic Mapping Program. This mapping is an important step as the UGS continues toward its goal of completing geologic mapping of the forty-six 30' x 60' quadrangles (1:100,000-scale maps) covering the state of Utah.



ABOUT THE AUTHOR

Don Clark is a geologist with the UGS Mapping Program, primarily involved with 1:24,000- and regional-scale geologic mapping projects in northwest Utah. His specialty is geologic mapping and stratigraphic studies of sedimentary and volcanic rocks. He has mapped all or parts of nine 7.5-minute quadrangles in Juab, Utah, and Tooele Counties, and also manages several mapping projects by non-UGS geologists in northwest and southeast Utah. Don and Jack Oviatt of Kansas State University are currently mapping Dugway Proving Ground and adjacent areas (parts of the Wildcat Mountain, Rush Valley, and Fish Springs 30' x 60' quadrangles). Prior to joining the UGS in 2004, Don worked as a UGS student and contract mapper, and also as a Chicago-based environmental geologist.

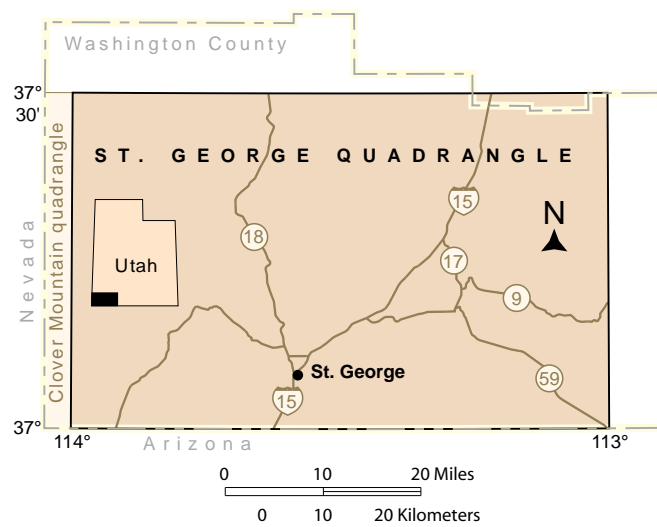
THE ST. GEORGE 30' x 60' QUADRANGLE

A New Regional-Scale Geologic Map of Southwest Utah

By Robert F. Bick

The Utah Geological Survey will soon release a preliminary geologic map of just over 2000 square miles in southwest Utah, comprising the St. George 30' x 60' quadrangle and the easternmost (Utah) part of the Clover Mountain 30' x 60' quadrangle. The geologic map is one of many in our 1:100,000-scale series, and is part of a larger effort to map the entire state at that scale (one inch on the map equals 1.6 miles on the ground). The map covers the area from

over the past 10 years) and significant new unpublished field mapping in the Bull Valley and Pine Valley Mountains. This regional-scale map is the culmination of a decade-long effort to geologically map areas of rapid population growth and high-use recreational and natural areas in the greater St. George area. Following technical review over the coming year, which will include extending the map to cover all of Washington County, the map will be published in full color as a poster-size map.



A new geologic map of the St. George 30' x 60' quadrangle (and the Utah part of the Clover Mountain quadrangle) will soon be available, culminating a decade-long effort to provide detailed geologic maps of the greater St. George-Zion National Park area.

The area covered by the new St. George map is one of amazing geologic diversity and importance. With its dry climate and colorful rock layers, southwest Utah is justly famous for its exceptional exposures of structures such as the Virgin anticline (an



View northwest across part of the St. George map area, showing the snow-capped Pine Valley Mountains (an important source of water for the region), layered sedimentary bed-rock, and the Crater Hill cinder cone (at right) and lava flow (center). The lava flow blocked the ancestral Virgin River about 300,000 years ago, creating Lake Grafton, which reached upstream to the lower part of Zion Canyon. The town of Rockville and State Highway 9 are in the foreground.

the Beaver Dam and Bull Valley Mountains on the west, eastward through the St. George area to Zion National Park, and from the Arizona border north through the Pine Valley Mountains.

The map was compiled from existing geologic maps of 36 individual 7.5' quadrangles (most mapped by UGS geologists

Funding for this new map, and many of the previously published 7.5' quadrangles on which it is based, was through a cooperative agreement between the UGS and the U.S. Geological Survey under the National Cooperative Geologic Mapping Program. The Washington County Water Conservancy District also contributed funding.

upward of the Earth's crust that marks the eastern limit of folding associated with an ancient mountain-building episode) and Hurricane fault (an active fault capable of generating large earthquakes). The Pine Valley Mountains that tower over the St. George basin may be the world's largest laccolith. This laccolith, a shallow intrusion
(continued on page 11)

How old is that basalt flow? It seems that almost every visitor to Snow Canyon State Park in southwest Utah asks that question about the spectacular black lava flow that cascades over the red and white sandstone of the park, and which now forms the landscape of so many homes in the Santa Clara-St. George area.

Until recently, the answer has always been, “We don’t know, but it is young,” followed by a plethora of estimates ranging from a few hundred to several thousand years. Our estimate, based on indirect evidence including amount of weathering of the surface of the flow, erosion around the edges, and degree of soil development, was a vague “10,000 to 20,000 years” (UGS Open-File Report 339). Finally, we may have a more satisfying answer.

Igneous rocks yield the most tightly constrained ages of any rock type because they contain radioactive isotopes that decay at uniform rates. Unfortunately, very young volcanic rocks (less than a few tens of thousands of years old) generally have not had enough time to produce a significant amount of

the “daughter” isotope, and thus cannot be directly dated using the standard methods (except under ideal circumstances). When we mapped most of the St. George basin in the 1990s, we were able to obtain well-constrained argon-40 – argon-39 ages on nearly all basalt flows in the area, but never on the Santa Clara flow. Since the basalt itself could not be dated, we concluded that the best chance of obtaining an accurate age was to find a piece of charcoal from plant material buried by the flow that could be radiocarbon dated (carbon-14 dating of charcoal is useful back to about 60,000 years ago).

In the fall of 2005, we finally found the charcoal we had been looking for – a short woody branch preserved in loose sand just below the lava flow that



NEW AGE FOR THE SANTA CLARA (SNOW CANYON STATE PARK) BASALT FLOW

by Grant C. Willis, Robert F. Biek, and Janice M. Hayden



This wood fragment sampled for radiocarbon dating is probably from a small shrub burned by the advancing basalt flow.

Black basalt overlying loose orange sand containing burned branch that is just left of the knife.

appeared to have been burned by the advancing lava. The lab (Beta Analytic, Inc.) struggled with the sample, probably because of the high temperature to which it had been subjected, but finally obtained an age of $27,270 \pm 250$ radiocarbon years before present. We feel confident that this age is reliable, but we hope we can someday confirm or refute the results by finding another sample and using another dating method.

Is the Santa Clara flow the youngest lava flow in Utah, as some have suggested? No – not even close. Though other young flows are poorly dated for similar reasons, we are confident that some flows in the Fillmore-Black Rock Desert area in central Utah, and on the Markagunt Plateau north of Zion National Park, are much younger. The Ice Springs flow near Fillmore may be less than 1000 years old (C.G. Oviatt, UGS Special Studies 73).

Radioisotopic Methods Commonly Used to Date Igneous Rocks

DECAY SERIES	HALF-LIFE
Potassium-40–Argon-40 (K-Ar)	1.25 billion years
Argon-40–Argon-39	(improved variation of K-Ar method that uses ratio rather than direct half-life)
Uranium-238–Lead-206	4.5 billion years
Uranium-235–Lead-207	700 million years
Thorium-232–Lead-208	14 billion years
Samarium-147–Neodymium-143	106 billion years
Rubidium-87–Strontium-87	50 billion years
Carbon-14	5,730 years (indirect dating of associated carbonaceous material)

Mineral and isotope content, weathering, and burial history can increase or decrease effective ranges, but these commonly used radioisotopic dating methods are best suited for igneous rocks older than several hundred thousand years. Carbon-14 dating is one of the few methods that can date very young rocks, but it relies on the presence of associated organic materials. Many other direct and indirect methods are also attempted with varying degrees of success.

Opposite page: View southwestward across Snow Canyon State Park. The Santa Clara lava flow erupted from vents at cinder cones near the north end of the park (about a mile to right of photograph) and cascaded over red and white Navajo Sandstone in Snow Canyon. The extensive sand and vegetation cover, and weathering of the basalt surface, support the 27,270-year-old radiocarbon age. The basalt flow in the foreground is about 1.2 million years old and now caps an inverted valley that was once the floor of an earlier Snow Canyon.

SPECTACULAR TOWERING CLIFFS

at Castle Rock Campground, Sevier County

by Christine Wilkerson

Castle Rock Campground is nestled within the canyon of Joe Lott Creek in central Utah, adjacent to towering and intricately carved cliffs weathered out of the Sevier River Formation. The campground is located within Fishlake National Forest and is managed by Utah State Parks and Recreation. The campground road ends in a large loop with Joe Lott Creek flowing through the middle. Campsites on the west side of the loop lie next to the majestic castle-like cliffs and are the best places to view the

Tuff erupted as a large avalanche of volcanic ash, rock, and gas. The Joe Lott Tuff is a light tan to pink-brown rock primarily composed of welded ash with quartz and feldspar crystals, glass fragments, and larger fragments of gray pumice and darker volcanic rocks. So much material was ejected during the eruption that the roof of the magma chamber collapsed due to the loss of interior support, creating the Mount Belknap caldera, located about 10 miles to the southwest.



The two white layers within the Sevier River Formation, near the bottom and the top, are airfall volcanic ash deposits.

Sevier River Formation up close. Farther up the canyon are outcrops of the light-colored Joe Lott Tuff Member of the Mount Belknap Volcanics which underlies the Sevier River Formation.

Geologic Information: The campground is located within the Marysvale volcanic field, an area that underwent intense volcanic activity between 27 and 19 million years ago. Lava flows, debris flows, and volcanic ash falls that accumulated during this time are more than a mile thick. Near the end of this volcanic interval, the Joe Lott

Tuff erupted as a large avalanche of volcanic ash, rock, and gas. Not long after this eruption (geologically speaking, 1 or 2 million years), the Earth's crust here and to the west began to be stretched westward. During this initial phase of basin-range extension, sediments were eroded off higher areas and deposited in river channels, flood plains, and lakes, eventually filling in valleys and canyons with layers of siltstone, mudstone, sandstone, and conglomerate. This deposition occurred between 14 and 5 million years ago and produced what is now called the Sevier River Formation.

If you look closely at the cliff face behind campsite #23 (on the west side of the loop road), you can see the many different sediment sizes in the Sevier River Formation, including relatively large rock fragments. Most sediment carried by a stream is relatively fine-grained material such as silt, clay, sand, and small pebbles. But when the velocity of the flow increases, perhaps during storm floods, a stream has the power to transport large rocks. Most of the larger rocks here are volcanic, eroded from volcanic highlands to the south. You will also notice that the cliff has two white layers, one near the bottom and one near the top. These are airfall ash (tuff) deposits, indicating that there was still some volcanic activity during the deposition of the Sevier River Formation.

Hiking up the canyon trail south of the loop road, you can see the contact between the Sevier River Formation and lighter colored Joe Lott Tuff. The contact here is a normal fault, along which the Sevier River Formation has moved downward relative to the Joe Lott Tuff. The rock layers are tilted due to folding and movement along this and other faults in the area.

Before you leave the area, be sure to visit Fremont Indian State Park to see the many interesting artifacts uncovered during the construction of Interstate 70. The park also has an extensive rock art collection.

How to get there

Castle Rock Campground is on the south side of I-70 near Fremont Indian State Park. From the I-15/I-70 interchange south of Cove Fort in Millard County, head east on I-70 to exit 17 (this is the same exit for Fremont Indian State Park). Turn right at the end of the off-ramp onto the campground road and travel up the road about 1 mile to the campground. Rock outcrops will be visible on both sides of the road. Exit 17 can also be reached by traveling about 20 miles west on I-70 from Richfield in Sevier County. For camping reservations, contact Utah State Parks and Recreation, 801-322-3770 or toll-free 800-322-3770, from 8 a.m. to 5 p.m., Monday through Friday.



PHOTOS FROM TOP (Photos by Carl Ege)

1. There are many layers within the Sevier River Formation that contain large rock fragments, deposited during periods of increased river flow.

2. Farther up the canyon from Castle Rock Campground, a normal fault separates the Joe Lott Tuff on left and the Sevier River Formation on right.

3. The towering and intricately weathered cliffs at Castle Rock Campground.

4. The Joe Lott Tuff contains fragments of gray pumice and other darker volcanic rocks.

5. The light-colored Joe Lott Tuff erupted 19 million years ago within the Marysville volcanic field.



Teacher's Corner

Integrating Survey Notes Articles in the Classroom

by Nancy Carruthers

In the second of our continuing series illustrating how relevant geologic information in *Survey Notes* articles can be used in the classroom, this "Teacher's Corner" highlights articles in this issue that discuss aspects of the igneous and metamorphic geology of Utah. Utah's igneous activity has produced rocks and landforms of many shapes, sizes, and compositions, from the basaltic lava flows of southwestern Utah to the granitic intrusions found at Granite Peak Mountain. In the article "New Age for the Santa Clara (Snow Canyon State Park) Basalt Flow," learn how geologists unravel clues to Utah's volcanic past by studying evidence found in the present, and explore the complex processes associated with studying and dating igneous rocks. In the article "Granite Peak Mountain - A Geologic Mystery Revealed," learn how geologists collaborate

with other research scientists to produce a geologic map of the mountain range and gain knowledge about the geologic history of the area, which includes igneous intrusions, mountain-building events, and regional metamorphism (that often accompanies massive intrusions). In the GeoSights' article "Spectacular Towering Cliffs at Castle Rock Campground, Sevier County," learn about the geologic history that includes volcanic eruptions, ash and lava flows, and collapsing calderas.

This issue of *Survey Notes* provides a variety of discussion topics that can be incorporated into the 8th-grade Integrated Science and 9th-grade Earth Systems curricula.

For more information on basalt flows and dating rocks, see the following publications:

- The Geology of Snow Canyon State Park, Washington County, Utah, Public Information Series 13 at <http://geology.utah.gov/online/pdf/pi-13.pdf>
- How Do Geologists Know How Old a Rock Is? <http://www.ugs.state.ut.us/surveynotes/gladasked/gladage.htm>

You can also read about inverted topography in the St. George area in the September 2002 *Survey Notes* (v. 34, no. 3), at <http://geology.utah.gov/surveynotes/snt34-3.pdf>. Use the information in this article to discuss erosion and landform development and why basaltic lava flows ended up on the top of bluffs and mesas, creating some of Utah's most interesting geologic features.

POSSIBLE DISCUSSION POINTS

- Why does magma solidify underground in some places (like at Granite Peak Mountain) but rise to the surface to emerge as lava in other places (like at Snow Canyon State Park)? Explain the difference between intrusive and extrusive igneous rocks.
- Geologic studies constantly reveal new data. What were the original age ranges estimated to be for the granite and metamorphic rocks at Granite Peak Mountain? What are the ages of these rocks now thought to be, and what scientific methods were used to help narrow in on the ages?
- How are metamorphic rocks formed?
- What type of volcanoes produced the lava flows in the Snow Canyon State Park area? (mostly cinder cones).
- What type of volcano produced the volcanic tuff at Castle Rock? (composite, or stratovolcano).

8TH-GRADE INTEGRATED SCIENCE

Standard 3, Objective 2 - describe the nature of the changes that rocks undergo over long periods of time.

Standard 3, Objective 4 - compare rapid and gradual changes to Earth's surface.

9TH-GRADE EARTH SYSTEMS

Standard 3, Objective 2 - describe the processes within the Earth that result in plate motion and relate it to changes in other Earth systems.

Utah's Anemometer Loan Program

By Philip Powlick

One of the occupational hazards of working in the renewable energy field is taking calls from landowners who say they want to build a wind farm. Some are practical business people and some are dreamers, but one thing they typically have in common is a lack of hard data about the wind in their area. Since 2001, the State Energy Program (SEP) has managed the Anemometer Loan Program to help Utahns measure and assess their wind resources. The program also helps the state to develop a better picture of where we can use the wind to generate emission-free and renewable electricity.

SEP owns thirteen 20-meter-tall guy-wired towers that are used to mount anemometers and other instruments for measuring wind speed and direction. Twenty-meter towers are lent to landowners at no cost and are intended as a first-cut assessment of wind data at a particular site. Landowners apply to SEP and are selected based upon criteria that include local topography, elevation, and wind model projections. Data are collected from each site for at least one year to determine not only average wind speed, but also daily and seasonal wind patterns. These data can then be used to assess a site's suitability for a small wind turbine for personal or local use. They can also suggest whether additional assessment is warranted.

SEP also owns eight 50-meter towers that can be used to determine whether truly large-scale wind power development in an area is possible. SEP lends several of these towers each year; however, recipients are responsible for the cost of commissioning and decommissioning. SEP also places a limited number of 50-meter towers on state-owned lands that show promise for wind development. In addition to other factors, siting of SEP's larger towers is based on proximity to electrical transmission lines. Some of the best potential winds in Utah are found far from transmission lines (e.g., in the Uinta Mountains), making the feasibility of developing wind farms in such areas cost-prohibitive.

In 2003, SEP's wind development efforts were aided by the commissioning of a new

To date, Utah has no large wind farms, though estimates suggest that over 1,000 megawatts of wind capacity (equivalent to a large coal power plant) is feasible.



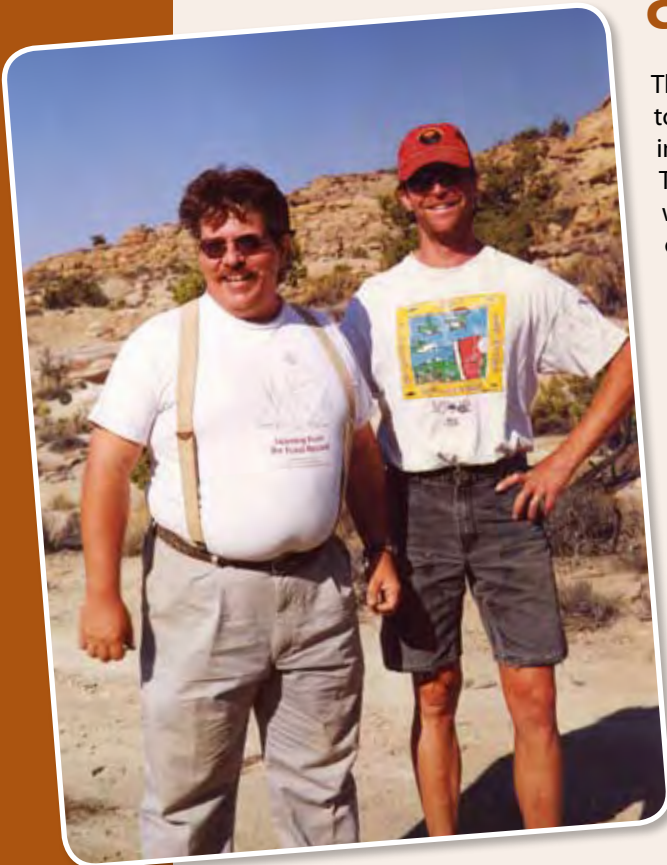
State Energy Program staff members Jason Berry and Bo White completing a 20-meter tower installation in Torrey, Utah, near Capitol Reef National Park.

wind resource map based upon meteorological and computer modeling. This map assists both SEP and prospective wind developers in targeting areas of likely strong wind. Since it is impossible to obtain anemometer data for all points in the state, this map provides useful "best estimates" of wind resources for all areas of Utah. Based on this and the availability of transmission, SEP has recently sited 50-meter towers near the Cricket and Raft River Mountains. Two 50-meter and two 20-meter towers are also currently assessing wind resources in Tooele County, where the wind resource map suggests a viable wind resource near both transmission lines and electrical load centers.

Sometimes, however, good wind resource guidance comes from local residents who are sure that the wind blows through their valley faster than through others. Data from SEP 20-meter towers indicate a potential wind development area near Monticello in San Juan County, an area that is not highlighted on the computer-generated wind resource map. With or without computer projections, hard data from anemometer towers are needed to verify the accuracy of a model's estimates or the observations of a wind-blown rancher.

To date, Utah has no large wind farms, though estimates suggest that over 1,000 megawatts of wind capacity (equivalent to a large coal power plant) is feasible. Through SEP's efforts to gather and publish wind data from throughout the state, the UGS is helping Utah to move forward to the day when several large wind farms will provide electricity to its residents.

The most up-to-date picture of Utah's wind resources – including wind resource maps, a summary map of the anemometer loan program, and data from each anemometer site – can be found at <http://geology.utah.gov/sep/wind/index.htm>.



CRAWFORD AWARD RECIPIENTS

The Utah Geological Survey awarded its prestigious Crawford Award to geologists/paleontologists James Kirkland and Donald DeBlieux, in recognition of the outstanding geologic publication, "A Primitive Therizinosaurid Dinosaur from the Early Cretaceous of Utah," which was published in the scientific journal, *Nature*, during 2005. Non-UGS co-authors were Lindsay E. Zanno, Scott D. Sampson, and James M. Clark. The presentation was made at the annual UGS awards picnic on June 29th.

In publishing the results of their discovery of *Falcarius utahensis*, Kirkland, DeBlieux, and their co-authors provide insight into how an animal derived from meat-eating relatives evolved into a form that was primarily a vegetarian, perhaps in response to new environmental niches created by the emergence of flowering plants at the beginning of the Cretaceous Period. This milestone achievement brought worldwide recognition to the authors, the Utah Department of Natural Resources, and the State of Utah.

The Crawford Award was established in 1999 to commemorate the 50-year anniversary of the Utah Geological Survey. The award recognizes outstanding achievement, accomplishments, or contributions by a current UGS scientist to the understanding of some aspect of Utah geology or earth science. The award is named in honor of Arthur L. Crawford, first director of the UGS.

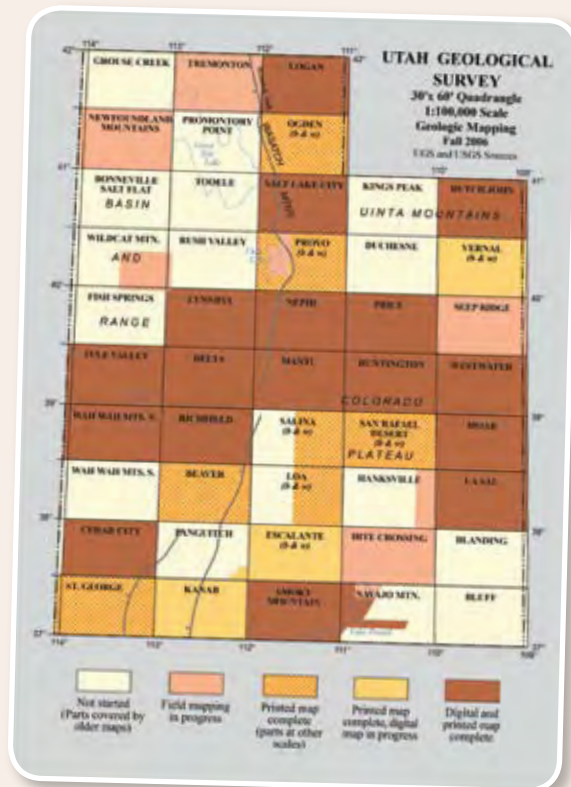
GEOLOGIC-MAP GIS DATA AVAILABLE ONLINE

by Grant C. Willis

The demand for digital geologic-map Geographic Information System (GIS) data has increased greatly in the past few years. To make GIS data easier to obtain, the same databases that are available on CD-ROMs in the DNR Map and Bookstore (primarily 30'x60' quadrangle geologic maps) will soon be available online. More than a dozen map databases will be posted to the UGS Web site over the next several months. These online files will include the primary GIS and supporting files, and will require specialized GIS software to open. If you want the complete map package in a user-friendly menu-driven format, the CD is still the way to go.

Status of 30'x60' geologic mapping

The UGS Mapping Program focuses its GIS production efforts on the 1:100,000-scale 30'x60' quadrangle series, though parts of some quadrangles are sometimes released as interim maps at different scales. GIS data for most completed maps (shown in brown) will soon be available on the UGS Web site. Several additional large- and intermediate-scale maps (not shown here) will also be posted to the Web site.



NEW PUBLICATIONS

Lead and zinc publications for

Utah: a collection of reprints,
compiled by Ken Krahulec, CD
(750 p., 14 pl.), 11/05,
OFR-466 \$14.95

Holocene earthquake history of the northern Weber segment of the Wasatch fault zone, Utah,

by Alan R. Nelson, Mike Lowe,
Stephen Personius, Lee-Ann
Bradley, Steven L. Forman, Robert
Klauck, and John Garr, CD (39 p., 2
pl.), ISBN 1-55791-741-8,
MP-05-8 \$14.95

Geologic map of the Jordan Nar- rows quadrangle, Salt Lake and Utah Counties, Utah, by Robert

F. Biek, CD (2 pl., 1:24,000 [con-
tains GIS data]), ISBN 1-55791-
746-9, M-208DM \$19.95

Interim geologic map of the Cedar City 30' x 60' quadrangle, Iron and Washington Counties,

Utah, by Peter D. Rowley, Van S.
Williams, Garrett S. Vice, David
J. Maxwell, David B. Hacker,

Lawrence W. Snee, and J. Hoover
Mackin, CD (2 pl., 1:100,000, CD
[contains GIS data]),
OFR-476DM \$19.95

Geologic Map of the La Sal 30' x 60' Quadrangle, San Juan, Wayne, and Garfield Counties, Utah, and Montrose and San

Miguel Counties, Colorado,
Utah, by H.H. Doelling, (2 pl.,
1:100,000, CD [contains GIS
data]), ISBN 1-55791-752-3,
M-205DM \$24.95

Utah Oil Shale Information Data- base, compiled by Michael D.

Vanden Berg, John R. Dyni, and
David E. Tabet, CD,
OFR-469 \$24.95

Basin and range province earth- quake working group seismic- hazard recommendations to the U. S. Geological Survey National Seismic Hazard Map- ping Program, edited by William

R. Lund, print on demand, 5/06,
OFR-477 \$4.00

NEW EMPLOYEES

Welcome to **Stephanie Carney**, our
new petroleum geologist. Step-
hanie did undergraduate work at Mis-
sissippi State and received her M.S.
from Utah State University.

Liz Paton is our new graphic de-
signer. She recently moved to Utah
from Virginia and has a Bachelor of
Fine Arts in Communication Arts
and Design from Virginia Common-
wealth University.

Jason Berry has joined the State
Energy Program as the Renewable
Energy Coordinator. He has a B.S. in
Environmental Studies from the Uni-
versity of Utah, and in December will
complete his M.S. in Public Adminis-

tration with an emphasis in Environ-
mental Policy and Management.

Starr Soliz is our new receptionist/
secretary at the front desk. Wel-
come!



(continued from page 5)

of magma, was emplaced so rapidly just below the Earth's surface that it domed up the rocks above, causing catastrophic gravity slides many square miles in size that literally uncorked the magma, which then erupted lava flows and tuffs (see *Survey Notes*, September 2002). The St. George area is known worldwide for its examples of inverted topography – lava flows that originally covered valley floors but that now form elevated, sinuous ridges (see *Survey Notes*, September 2002). In the past, petroleum and mineral occurrences in the area played important roles in the development of Utah's natural resources. The first oil produced in Utah came from the Virgin field, where oil seeps can still be found, and the Silver Reef mining district, near Leeds, is centered on an unusual silver chloride ore deposit that occasionally still interests prospective mining companies. Today, ground water is the hot commodity, and this map shows the location of the Navajo Sandstone, the region's principal aquifer. Residents of the area, and hundreds of thousands of visitors each year, are drawn to Zion National Park, at the east edge of the St. George map; to Snow Canyon, Quail Creek, Sand Hollow, and Gunlock State Parks, each with their unique geologic story; and to the St. George Dinosaur Discovery Site at Johnson Farm (see *Survey Notes*, October 2000) and a multitude of dinosaur track sites across the region.

There is no better way to get a sense of how the landscape has evolved than through the use of a regional-scale geologic map, and the new St. George-area map shows the geology of southwest Utah in unprecedented detail.

Soon to be available: *The interim map will be released as a print-on-demand color version: Interim Geologic Map of the St. George 30' x 60' quadrangle, and the east part of the Clover Mountain 30' x 60' quadrangle, Washington and Iron Counties, Utah, by Robert F. Biek, Peter D. Rowley, David B. Hacker, Janice M. Hayden, Grant C. Willis, Lehi F. Hintze, R. Ernest Anderson, and Kent D. Brown, Utah Geological Survey Open-File Report 478, available at the Department of Natural Resources Map & Bookstore. The final version, including GIS files, should be available in about a year.*

GLAD YOU ASKED

by Mark Milligan, illustrations by Liz Paton

Stump a Geologist.

Questions and other inquiries we have NOT been able to answer!



"Where can I get DNA testing done for my bleeding rocks?"

"In order to cure Salt Lake Valley's winter inversion, I want to mount jet turbines to the top of Lone Peak to blow away the pollution.... What permits will I need?"

"I heard we are going to have an earthquake.... Can you tell me which direction the earthquake waves will travel so that I can bolt my bookshelves the correct way?"

"As many as 13 black helicopters land, become bright, and then fly away.... They have stolen most of a 350-foot cliff called the Lace Curtain (a black basalt volcanic feature).... What would be the best way of stopping them?"

"Do you have a map to the Lost Rhodes gold mine?" (The Lost Rhodes gold mine is a mythical Spanish gold mine allegedly located somewhere in the Uinta Mountains.)

Asked while holding a quartz crystal, "Is this a happy crystal?"

"Can you help me? I was told that your Outreach Program will reimburse me for the landslide damage to my house...."

"I was walking in the desert and I found a rock. It was alone with no other rocks nearby. Can you confirm that it is a meteorite?"

"My horse found a gold nugget but now I can't find the location. Is it possible the Green River has moved its course several miles in the last decade?"

"Is this a Smithsonian-quality specimen?" (Asked about 10 different rocks.)

"What two states have capital cities that have never reached 100°F?" (geology/geography?)

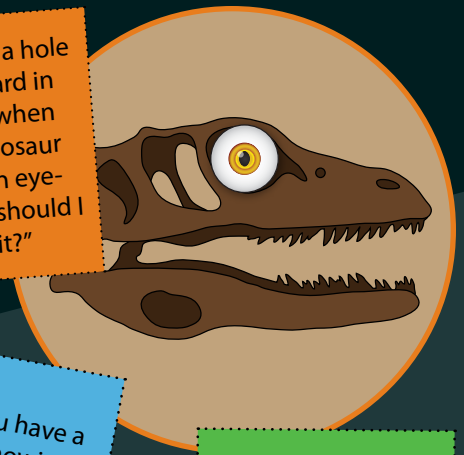
"I am looking for some very, very remote land.... I want it so remote that I will have to walk for three days to get to it. Will you please send me the information I need? The gentleman in Washington told me that the states would have this information...."



"I found a carving from Spanish explorers (who were in Utah over 200 years ago) on an aspen tree (individual trunks have an average lifespan of less than 100 years).... Can you help me find the Lost Rhodes gold mine?"

Regarding the rubber "alien" kept in a jar in our Map and Bookstore, "Is it real?" (A cute question from a 4-year-old. A peculiar question from an adult.)

"I was digging a hole in my backyard in West Valley when I found a dinosaur head with an eyeball.... What should I do with it?"



"I'm doing a recon of a colony of Sasquatch living southeast of Duchesne. Do you have a map of the area?"

"Do you have a map showing every house in Salt Lake Valley?"

"Guys in black suits ran me off of Lightning Ridge near Soapstone Basin. Is it a secret military installation?"

"I was talking to this guy the other day.... He said that everyone knows that the whole Salt Lake Valley sits above a large cavern and that downtown is going to fall about a quarter mile during an earthquake. When I heard this I just laughed. Then, the next day I was reading some stuff on the Internet about very large caverns, occupied by colonies of lizard people, that extend deep beneath the Western Rockies as well as beneath the Bonneville basin.... Can you give me more information?"

"I found Confederate gold bars in the west desert.... Can I keep them?"

"I know my house is on a landslide.... But if the landslide moves will it damage my house?"

"I found a petrified dinosaur heart.... Will you please come to my press conference and verify its authenticity...."

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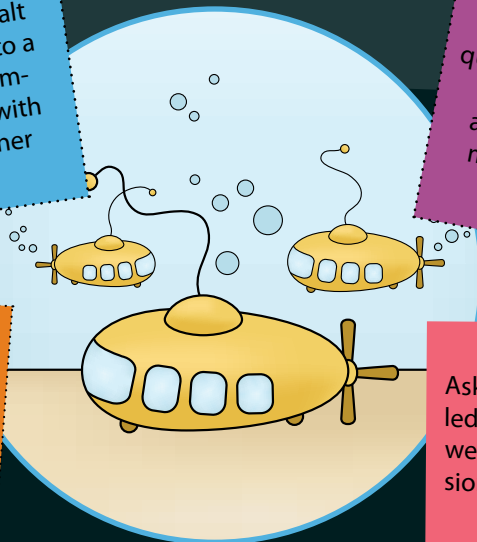
"Are you aware of a submarine village under the Great Salt Lake? It belongs to a fine American family that shares it with hundreds of other Utahns...."

"I am very happy to declare that there is an exact relationship between launching of satellites and natural disasters like volcanic eruptions, earthquakes, El Niños, and hurricanes.... Would you like to know more? I am very excited and happy to discuss this data with you because our southern region is in danger of earthquakes after launching from Cape Canaveral...."

"I have been quarrying Cambrian-age quartzite dinosaurs.... Can you verify the authenticity of my many astounding discoveries?"

"Can you help me research my family history?" (geology/genealogy?)

Asked on a UGS-led field trip, "Do we have permission to be here?"



We strive to answer all questions and truly believe there is no such thing as a stupid question. We treat all inquirers with dignity and respect. Even inquiries that leave us scratching our heads get us thinking outside the box and brighten our workdays.

UTAH OIL SHALE DATABASE

The Utah Oil Shale Database, UGS Open-File Report 469, was put together to archive and preserve historical oil shale data from exploration and research conducted on Utah's oil shale deposits. With the cooperation of the U.S. Geological Survey and the U.S. Bureau of Land Management, the Utah Geological Survey has gathered and organized into a usable electronic format, hundreds of important oil shale-related documents, reports, and geophysical logs, all of which should be an invaluable resource as new oil shale research projects are developed.



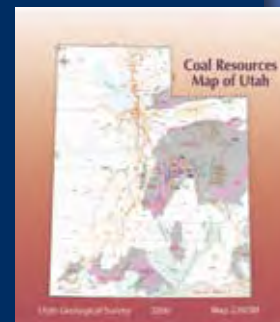
Files in the database include: Fischer assays for 581 wells made from drill cores and cuttings, scanned geophysical logs for 173 different wells, along with an inventory of paper logs for an additional 290 wells available in the UGS library, detailed well location information, lithologic descriptions for 168 wells, depths to the top of particular horizons within the Eocene Green River Formation, an extensive Utah oil

shale bibliography, and an overview Utah oil shale resource map.

Open-File Report 469 \$24.95

COAL RESOURCES MAP OF UTAH

The Utah Geological Survey has produced a new map at 1:750,000-scale showing the location of Utah's coal resource areas. The Coal Resources Map of Utah highlights the state's coal-bearing basins and areas within the basins that contain potentially economic deposits (those with individual beds greater than 4 feet thick and lying under less than 3000 feet of soil/rock cover).



The map will be useful to the coal industry, power industry, government planners, educators, and general public to identify where current mining and use of Utah coal is occurring, and where future development might take place.

Map 226 DM..... \$24.95

Natural Resources Map & Bookstore

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