UTAH GEOLOGICAL SURVEY

SURVEY NOTES

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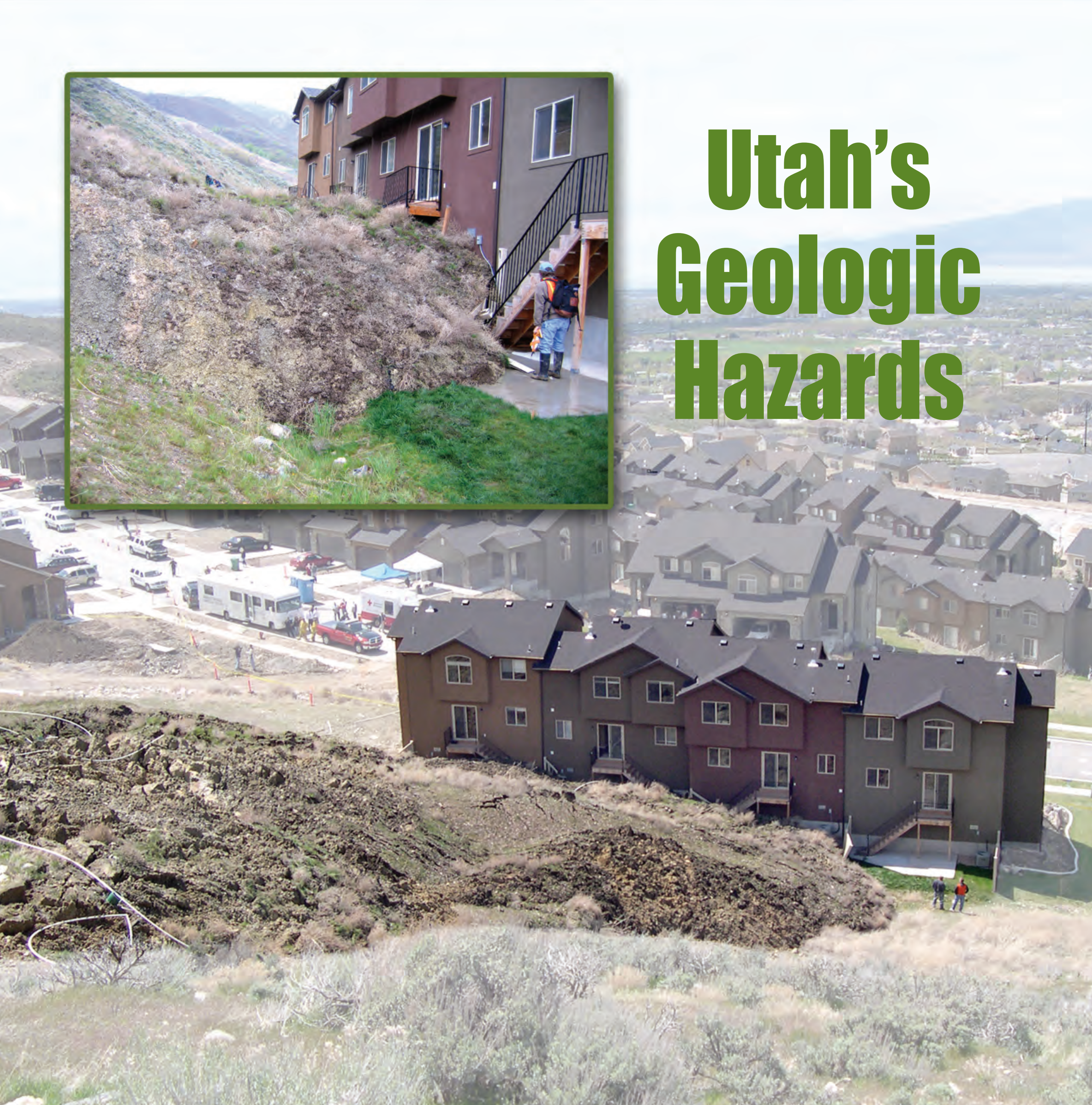

Utah's Geologic Hazards

contents

Design: Vicky Clarke

Cover: Townhouse damaged by a landslide in Cedar Hills, northern Utah County, April 28, 2005.

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the director's perspective

This issue of Survey Notes has a strong emphasis on geologic hazards. As last winter progressed, and the snow pack in most parts of Utah accumulated at an above-average rate, our Hazards Program became concerned about the increased risk of landslides once the spring snowmelt began. Warnings were sent out to city and county officials to be on the watch for evidence of ground movement, which could be a precursor to damaging landslides. The concerns were justified, because 85 landslides were documented this spring. This compares with only three during spring of 2003 following a winter with below-normal snow accumulation. In addition, several large debris flows and rock falls also occurred this spring. Some of the notable hazard events are reviewed in this issue. The total cost of the property damage and repair is difficult to estimate, but it probably exceeds $5 million, in addition to one fatality.

The Cedar Hills landslide (page 6) highlights a recurring challenge caused by the rapid urban growth in Utah and development pressure to build on more hazardous land. A townhouse was built on a portion of a landslide that reactivated during the very wet spring of 1983. This landslide was shown on geologic-hazard maps, but unfortunately this information was not adequately taken into account prior to construction. It is not uncommon for UGS concerns about slope instability to be downplayed by developers or even contested as not a relevant factor potentially limiting a proposed subdivision. It is during times like the recent spring that local government planning departments, and hopefully most developers, realize that the risk of geological hazards is real, requiring either avoidance or special mitigation measures.

On May 15, Utah's State Energy Program (SEP) formally joined the UGS (see page 10). This was the result of Governor Huntsman's initiative to restructure the Utah Energy Office, and to appoint an Energy Advisory position to help shape Utah's energy future. The focus of the SEP is to provide support and information for energy efficiency, energy conservation, and renewable energy initiatives in Utah. There are synergies with the activities of our Energy and Minerals Program. One immediate initiative is an enhanced energy and minerals information base on the UGS web site. This is an ongoing project, with the goal of having the latest production and consumption summaries, along with historical trends, immediately accessible through the UGS web site. With the recent climate of high energy and mineral prices, growing interest in expanded use of Utah's traditional and new energy resources such as oil shale and tar sands, and increasing interest in ways to save energy and use renewable energy resources, the SEP is rapidly become an important part of the UGS.

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The 2001 Heather Drive landslide in Layton damaged six homes; the damage to this home was so severe it was condemned and later demolished.

PROTECTING UTAH HOMES FROM GEOLOGIC HAZARDS

by Gary E. Christenson

Damage to homes in Utah this year from landslides, rock falls, and floods highlights the importance of considering geologic hazards in residential development. Land-use regulation to help ensure safe development is a responsibility granted to Utah's local governments (cities, towns, and counties) by the state. Some state agencies offer technical assistance to encourage responsible land use, and the Utah Geological Survey (UGS) is one such agency that provides geologic assistance to help local governments deal with geologic hazards. This technical assistance includes helping to write ordinances, preparing generalized geologic hazards maps, reviewing geologic reports by developers and their consultants, and responding to geologic-hazards-related emergencies and disasters.

Many of the geologic processes that have shaped Utah's rugged and scenic landscapes over the past few million years remain active today. Uplift of the Wasatch and other mountain ranges in central and western Utah is episodic and accompanied by large earthquakes. The resulting steep mountainsides and high elevations are prone to rapid erosion and landslides, and are a source of floodwaters. These are all natural geologic processes, but they are termed geologic hazards when they damage structures or threaten lives.

Earthquakes: Earthquakes have the potential to inflict a greater loss of life and property in a single event than all other hazards in Utah. Damaging geologic effects of earthquakes include ground shaking, surface faulting, soil liquefaction, and earthquake-induced landslides and flooding. Strong ground shaking represents the greatest hazard during an earthquake because it affects large areas, causes the most damage, and induces many of the secondary effects such as liquefaction, landsliding, and flooding. Estimated losses from a magnitude 7 earthquake in the Salt Lake City area could exceed 1500 lives lost and $15 billion in damages to buildings, including private residences.

Landslides: The landslide hazard in Utah was dramatically demonstrated in 1983 when the Thistle landslide blocked the Spanish Fork River, causing flooding that inundated the small town of Thistle and severed highway and rail connections between the Wasatch Front and areas to the south and east. Although the Thistle landslide was spectacular and cost the state over $200 million, many smaller landslides regularly damage homes. Damages have generally been greatest during periods of abnormally high precipitation such as in 1983, 1984, 1997, 1998, and 2005. Landslides occasionally cause injuries and deaths; the most recent death was in March of this year when a young boy was buried by a slide from a steep stream cut in Kanab. Utah experiences a wide variety of landslide types, from Thistle-type slides to debris flows (slurries of mud and rocks generated by cloudburst floods and rapid spring snowmelt), to rock slides and rock falls in areas of steep, barren rock outcrop. Snow avalanches also present hazards to homes built along mountain fronts.

This 2002 rock fall in Rockville occurred at night and barely missed the resident as the boulder came to rest in the bedroom.

Following a fire which burned the west side of Dry Mountain in 2001, a storm in 2002 generated ten separate debris flows, one of which caused extensive damage to this subdivision in Santaquin.

Problem Soil and Rock Conditions: Several types of naturally occurring materials may damage foundations and pose a threat to permanent structures. Two of the most damaging are expansive and collapsible soils. Expansive clayey soils can swell and generate forces sufficient to crack walls and foundations of relatively light residential structures. Collapsible soils undergo a volume decrease when wet, inducing subsidence that may cause structural damage. Subsidence may also result from decomposition of organic soil materials and collapse due to piping (subsurface erosion) and dissolution of gypsum, salt, and limestone causing sinkholes. Subsidence and ground cracks caused by ground-water withdrawal have recently been recognized in southwestern Utah (see accompanying article). Shifting wind-blown sands in the more arid parts of the state also present hazards, most recently in the Escalante Desert where shifting sands have encroached on residences and buried yards.

Flooding: Stream flooding is a widely distributed and frequently occurring geologic hazard in Utah, as demonstrated by the January 2005 floods in southwestern Utah. Spring snowmelt is responsible for much flooding along Utah's streams, and is to some extent predictable. Cloudburst storms generate more localized but often very destructive flooding and can occur with little warning. Cloudburst storms also cause alluvial-fan flooding, including debris flows, which may affect large areas and cause damage by sediment burial. Another type of flooding that has caused considerable damage in Utah is the rise of lake levels, particularly Great Salt Lake. Flooding may also result from a rise in the shallow water table in response to high stream and lake levels, heavy precipitation, and excess irrigation. Flooding of topographically low areas and subsurface structures such as basements and septic-tank soil-absorption fields is the major hazard to private residences from a rising water table.

ORDINANCES

For residential development, local governments in Utah address geologic hazards in geologic or natural-hazards, critical-environmental, sensitive-area, and/or hillside-protection ordinances. The purpose of these ordinances is to encourage prudent site development in areas of geologic hazards. The overall approach in addressing geologic hazards consists of requiring developers to perform geologic-hazards studies to assess hazards and recommend risk-reduction measures prior to subdivision approval. This approach is outlined in the UGS Public Information Series 75 brochure, *Using Geologic-Hazards Information to Reduce Risks and Losses - a Guide for Local Governments* (http://geology.utah.gov/online/pdf/pi-75.pdf).

Over 30 homes were damaged by the January 2005 floods in southern Utah. These homes are along the Santa Clara River in Santa Clara.

An important step in addressing geologic hazards in an ordinance is to identify hazard areas. Generalized maps typically delineate special-study areas where geologic hazards may exist. The ordinance then requires that developers and their consultants perform geologic hazards investigations to address site-specific hazards and recommend appropriate action prior to development in such areas. One outcome may be that no hazards are found at the site and no action is necessary. If hazards exist, detailed site investigations are performed to determine a prudent course of action. Recommended actions may include setbacks from faults and landslides, slope stabilization, placement of engineered structures such as debris basins, special foundation designs, and disclosure of hazards to potential buyers. In some cases, site abandonment is necessary where risks from geologic hazards cannot be adequately reduced or are too costly to reduce and are best avoided.

In the final step, reports of these investigations along with recommendations for action to reduce risks are submitted to the local government and reviewed by qualified engineering geologists, such as the UGS, and geotechnical engineers acting on behalf of the local government and future homebuyers. Reviewers then either determine that the investigations are sufficient and risk-reduction measures satisfactory, or recommend further work to resolve remaining issues.

AVAILABILITY OF GEOLOGIC HAZARDS INFORMATION

Generalized maps (1:24,000 scale or larger) are used in ordinances to delineate areas where geologic hazards should be considered and site-specific studies are needed. The UGS

Guidelines for evaluating geologic hazards for geologists

Guidelines for preparing engineering geologic reports in Utah, by Utah Section of the Association of Engineering Geologists; 2 p., 1986 . . . . . . FREE

Guidelines for evaluating surface-fault-rupture hazards in Utah, by Gary E. Christenson, L. Darlene Batatian, and Craig V Nelson, 14 p., 8/03, MP-03-6 . . . . . . $5.50

Guidelines for the geologic evaluation of debris-flow hazards on alluvial fans in Utah, by Richard E. Giraud, 16 p., 6/05, MP-05-6 . . . . . . $6.00

Guidelines for evaluating landslide hazards in Utah, edited by M.D. Hylland, 16 p., 1996, ISBN 1-55791-392-7 C-92 . . . . . . $5.50

Geologic hazards information for homeowners

Homebuyers guide to earthquake hazards in Utah, by S.N. Eldredge, 27 p., 11/96, PI-38 . . . . . . $3.00

The Wasatch fault, by S.N. Eldredge, 17 p. , 12/96 PI-40 . . . . . . $2.00

Earthquakes & Utah, by S.N. Eldredge, 6 p., 8/97 PI-48 . . . . . . Free

Homeowner's guide to recognizing and reducing landslide damage on their property, by GES staff, 4 p., 7/98 PI-58 . . . . . . Free

Rock-fall hazards, by W.F. Case, 2 p. color flyer, PI-69 . . Free

Debris-flow hazards, by W.F. Case, 2 p. color flyer, 10/00, PI-70 . . . . . . Free

Landslides: What they are, why they occur, by W. F. Case, color flyer, 11/01, PI-74 . . . . . . Free

For more information

UGS (http://ugs.utah.gov/, 801-537-3300, fax 801-537-3400; Geologic Information and Geologic Hazards Programs), DNR Map and Bookstore (http://mapstore.utah.gov/, 801-537-3320, fax 801-537-3995), and Utah Automated Geographic Reference Center (for digital map data) (http://agrc.its.state.ut.us/, 801-538-3665, fax 801-538-3317) produces such maps, and most of the urbanizing areas along the Wasatch Front now have generalized maps specifically prepared for use in local government ordinances. Maps are available to the public from county planning offices along the urbanized Wasatch Front portions of Salt Lake, Davis, Weber, and Utah Counties. Similar maps are available from the Department of Natural Resources (DNR) bookstore and library for western Wasatch County, Tooele Valley, Moab-Spanish Valley and Castle Valley in Grand County, and Monroe in Sevier County. Preparation of generalized geologic hazards maps is also underway by the UGS for the St. George basin, Cache Valley, and Ogden Valley.

In much of the remainder of the state, however, appropriate-scale hazards maps for local government ordinances are generally not available. To determine the likelihood of hazards, generalized information is available for the entire state on small-scale statewide geologic hazards maps. These maps depict the following:

- Shallow ground water and related hazards (1:750,000 scale)
- Flood hazard from lakes and failure of dams (1:750,000 scale)
- Landslides (1:500,000 scale, also available for each 30 X 60 minute quadrangle at 1:100,000 scale)
- Soil and rock causing engineering geologic problems (1:500,000 scale)
- Quaternary faults and folds (1:500,000 scale)
- Radon (1:1,000,000 scale)

These maps are not suited for use in local government hazards ordinances except as preliminary guides to potential hazards in areas where more detailed maps are not yet available. The maps are available in hard copy at the DNR bookstore and library, and in digital form in the State Geographic Information Database from the Utah Automated Geographic Reference Center.

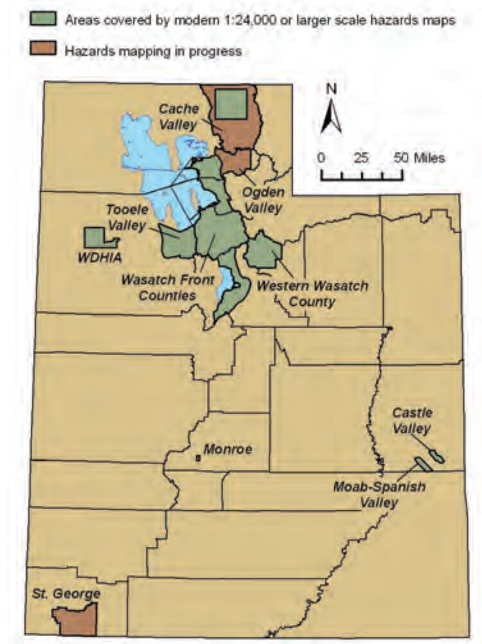
ROLE OF THE UGS

The UGS assists local governments by helping write ordinances and preparing generalized geologic hazards maps. To help local governments and developers' consultants ensure that adequate investigations are performed, the UGS has published guidelines for (1) the preparation and review of engineering geologic reports, (2) evaluating landslide hazards, (3) evaluating surface-fault-rupture hazards, and (4) evaluating debris-flow hazards.

Geologic hazards reports must be prepared and reviewed by qualified engineering geologists licensed in Utah, generally in conjunction with a licensed geotechnical engineer. To administer an ordinance, local governments should have access to qualified geologists and engineers to perform reviews and to represent their interest in contacts with developers and their consultants. The Salt Lake County geologist provides geologic review services for unincorporated Salt Lake County, and the UGS provides such services for other local governments in the state. Some local governments retain qualified engineering geologists and geotechnical engineers under contract to represent their interests, as is commonly done with the city/county engineer position.

ADVICE TO HOMEBUYERS

The extent to which local governments consider geologic hazards in residential development varies widely among jurisdictions, and has changed over time as well. Check with your local government planning department to find out what ordinances they have adopted and whether they were in force when your house was built. Also, ask how ordinances are enforced and the extent to which geologic hazards reports are reviewed prior to approval. In general, adoption and enforcement is improving with time, particularly in larger communities, as is the technology used in assessing hazards and reducing risks. New subdivisions typically undergo closer scrutiny than many of the older existing subdivisions did.



Areas where 1:24,000-scale geologic-hazards maps are either completed or in progress by the UGS (WDHIA-West Desert Hazardous Industries Area).

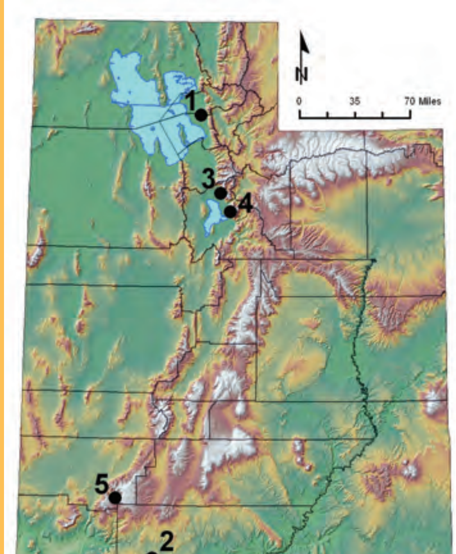
However, homebuyers should not assume that local government approval of a subdivision or building permit guarantees safety from geologic hazards. Also, losses due to geologic hazards are generally not covered by standard homeowners' insurance policies. A wise homebuyer should check generalized geologic hazards maps and ask the local government to see geologic hazards reports for a subdivision, particularly when contemplating purchase of a home in a hazardous hillside or mountain-front location, to aid in their decision making. If questions arise, homebuyers may wish to have a consulting geologist and/or engineer help evaluate the information and provide advice. The UGS publishes helpful guides for homebuyers and can also help find useful information to aid homebuyers in making a wise choice.

LANDSLIDES KEEP GEOLOGIC HAZARDS PROGRAM BUSY IN 2005

by Geologic Hazards Program Staff

Record precipitation throughout much of Utah beginning in October 2004, and record snow packs, particularly in southwestern Utah, brought us an active spring landslide season in 2005. The UGS has documented over 85 landslides in 2005, and this is probably only a small percentage of the total in the state. Most of the documented landsides were reactivations of existing landslides, both natural and human-caused. Landslide types included rock falls, debris flows, and both rapid and slow-moving slides. Here we discuss a few of the notable landslides of 2005 that the UGS investigated to assist local governments in emergency response; for more information on these landslides, visit the UGS Web site at http://ugs.utah.gov/utahgeo/hazards/landslide/index.htm#recent.

On February 20, a landslide in South Weber, Davis County, moved across and blocked South Weber Drive. The landslide destroyed a barn south of the highway and flowed into a field north of the highway. The landslide was just below the Davis-Weber Canal and likely started as a rotational slide in the canal embankment, but quickly



Locations of notable 2005 landslides in (1) South Weber, (2) Kanab, (3) Cedar Hills, (4) Provo, and (5) Cedar Canyon.

Stream cut along Kanab Creek similar to that which collapsed and killed a 10-year-old boy (note vertical cracks).

Damaged townhouse and disrupted toe and main scarp of the landslide in Cedar Hills.

transformed into a rapid earth flow about midway downslope and ran out 150 feet beyond the toe of the slope in a period of about a minute. The landslide occurred in one of the steeper parts of the slide-prone north-facing slope along the Weber River underlain by sand, silt, and clay of the Pleistocene Lake Bonneville Weber River delta. Other landslides occurred on February 20 and again on May 11 about 3 miles to the east in a similar slope above a subdivision in South Weber.

On March 12, a 10-year-old boy was killed when a vertical stream cut along Kanab Creek in Kanab, Kane County, collapsed in an earth-fall-type landslide, burying the boy and partially burying two girls. The girls, one covered by landslide material to her waist and the other to her knees, were able to free themselves and began searching for the boy, but were forced to flee when a second section of the stream cut collapsed. The landslide involved about a 100-foot-long portion of the approximately 60-foot-high vertical stream cut in Holocene-age sandy Kanab Creek alluvium. The landslide resulted in a pile of material at the base of the cut up to 20 feet thick. Workers using heavy equipment required 15 hours to recover the boy's body. Deep, vertical cracks parallel to the face of the cut served as the failure plane for the landslide as material detached and fell on the children.

On April 28, a landslide that had moved in 1983 reactivated above a Cedar Hills subdivision in Utah County and slid against the back wall of a four-unit townhouse. Residents of the townhouse evacuated as the slow-moving landslide crushed vinyl fencing, air conditioners, and deck supports at the back of the units and days later pushed through the back wall and foundation, destroying the structure. The landslide is on a southwest-facing slope and is part of a larger prehistoric landslide complex associated with the Manning Canyon Shale, a highly slide-prone geologic unit commonly found in the east bench of northern Utah County. The UGS placed stakes on and adjacent to the landslide, and the Utah County Surveyor's office, using high-resolution Global Positioning System (GPS) techniques, monitored movement by resurveying the stakes periodically. Movement rates increased immediately following significant rainstorms, and then slowed or suspended during subsequent dry periods. The landslide has largely stopped moving but remains unstable, and a smaller, new landslide forming above the head of the main slide may one day be incorporated into it.

On May 12, a large rock fall from a cliff high on "Y" Mountain above Provo spawned many individual falling rocks, some of which ran out nearly a mile from the source. One of the rocks impacted the southwest corner of a guest house on the east bench of Provo. No one was

The rock fall from "Y" Mountain in Provo clipped the corner of this guest house and came to rest at the base of the tree behind the trash can on the left.

Damage to State Route 14 in Cedar Canyon caused by the June 3 debris flow (photo by David Excel, Utah Highway Patrol).

home at the time; the structure is likely a total loss. The source of the rocks was a cliff in the Mississippian Deseret Limestone about 2600 vertical feet above the guest house. The rock that impacted the guest house measured approximately 7 x 5 x 4.5 feet and weighed about 13 tons. Many rocks from the rock fall left impact craters (bounce marks) and trails of flattened oak brush on slopes at the base of the cliff and on the slope just above the damaged house.

On June 3, following a period of rapid snowmelt and a day-long rainstorm, a large debris flow from Black Mountain above Cedar Canyon in Iron County inundated State Route 14 between Cedar City and Long Valley Junction, resulting in the highway being closed for a week. The source of the debris flow was a landslide from a cliff in Cretaceous sedimentary rocks at an elevation of about 9800 feet, just above the retreating snow line as the record southwestern Utah snow pack rapidly melted. The landslide material liquefied, transformed into a debris flow, and flowed 1.5 miles before emptying into Crow Creek, which flows along State Route 14 in Cedar Canyon. The debris flow dumped mud, rocks, and logs into Crow Creek, which then caused flooding, plugged culverts with debris, and both undercut and buried the highway for several miles downstream along Crow Creek. This was one of the few debris flows of the 2005 spring season, but was perhaps the largest since 1983.

The UGS continues to study these landslides to better understand their triggering mechanisms, movement characteristics, and implications for future development. We worked closely with each of the local governments affected by the landslides to assist them in responding to the emergency and subsequently to monitor movement and assess the longer-term hazard. Landslides are a relatively common occurrence in Utah, particularly during periods of increased precipitation and rapid snowmelt, and we must adequately plan for them as we develop our hillsides and canyons.

Recent Geologic Hazards Publications

The origin and extent of earth fissures in Escalante Valley, southern Escalante Desert, Iron County, Utah, by William R. Lund, Christopher B. DuRoss, Stefan M. Kirby, Greg N. McDonald, Gary Hunt, and Garrett S. Vice, CD (30 p., 37-photo appendix), 7/05, MP-05-7 .... $19.95

Consensus preferred recurrence-interval and vertical slip-rate estimates: review of Utah paleoseismic-trenching data by the Utah Quaternary Fault Parameters Working Group, by William R. Lund, CD (109 p.), 6/05, B-134 .... $19.95

Proceedings volume, Basin and Range Province Seismic-Hazards Summit II, edited by William R. Lund, CD (20 papers, 64 abstracts, 10 posters), 5/05, MP-05-2 .... $19.95

Reconnaissance investigation of ground cracks along the western margin of Parowan Valley, Iron County, Utah, by Christopher B. DuRoss and Stefan M. Kirby, CD (17 p.), 10/04 RI-253 ....$14.95

Liquefaction potential maps for Utah, CD in pdf format (463 p., 81 plates) (reprints of CR-94-1 to CR-94-10), Liquefaction potential maps for: northern Wasatch Front, central Utah, and for Davis, Salt Lake, and Utah Counties, 8/04 OFR-433 .... $14.95

Earthquake-hazards scenario for a M7 earthquake on the Salt Lake City segment of the Wasatch fault zone, Utah, by Barry J. Solomon, Neil Storey, Ivan Wong, Walter Silva, Nick Gregor, Douglas Wright, and Greg McDonald, CD-ROM (59 p., 6 pl. scale 1:250.000), 5/04, SS-111DM [CD contains GIS data] $24.95

Geologic hazards of Monroe City, Sevier County, Utah, by Richard E. Giraud, digital compilation by Justin P. Johnson, 51 p + CD-ROM [CD contains GIS data], 5/04, SS-110 .... $13.95

Ground-water-level fluctuations in Wasatch Front landslides and adjacent slopes, northern Utah, by Francis. X. Ashland, Richard E. Giraud, and Greg N. McDonald, 22 p., 5/05 OFR-448 .... $10.00

EARTH FISSURES

in Escalante Valley, Iron County, Utah

by William R. Lund, Christopher B. DuRoss, Stefan M. Kirby, Greg N. McDonald, Gary Hunt, and Garrett S. Vice

On January 8-12, 2005, a warm winter storm moved into southwestern Utah from southern California, causing widespread flooding and damage. The flooding extended northward into Escalante Valley in western Iron County about 35 miles west of Cedar City. Erosion by floodwaters revealed five earth fissures in western Escalante Valley. The fissures range in length from about 330 feet to more than 1300 feet, and form a discontinuous, nearly 6-mile long, generally north-trending zone roughly centered on the community of Beryl Junction. Locally the fissures show as much as 12 inches of down-to-the-east displacement. Where unaffected by flooding, the fissures were an inch or less wide, but were quickly enlarged as floodwater drained into them. In places, the floodwater eroded gullies along the fissures up to 10 feet wide and 7 feet deep. Local residents reported that floodwater flowed into the fissures for a period of a day or more during the peak of flooding, and that a vortex formed in the floodwater over at least one fissure.

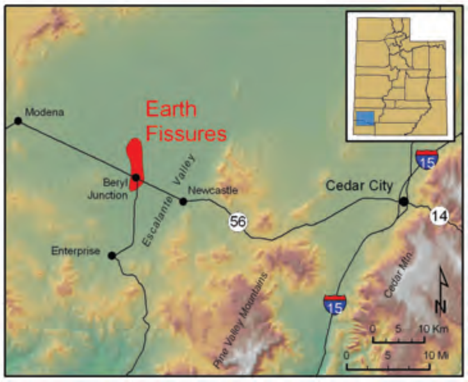
Escalante Valley is a sediment-filled basin, the deepest part of which lies between Beryl Junction and Newcastle. Escalante Valley is an agricultural area, and ground-water pumping from the basin-fill aquifer began in the 1920s. Measurements in wells indicate that ground-water levels have declined steadily since the late 1940s and show no recovery during periods of above-average precipitation. The area of greatest ground-water decline (95 to 105 feet) extends from near Beryl Junction to Enterprise.

Earth fissures are commonly associated with ground subsidence caused by aquifer compaction, which results from the permanent reduction in volume of fine-grained deposits (silt and clay) within the aquifer following ground-water withdrawal. Fissures up to 10 miles long have been reported in Arizona, and the Las Vegas Valley also has experienced earth fissuring as a result of ground-water pumping. Our investigation showed that the Escalante Valley earth fissures are similar to those that have formed in other western states as a result of ground-water pumping and water-level decline. The Escalante

Aerial view showing the January 2005 flooding north of Beryl Junction.

Valley earth fissures extend for considerable distances in a mostly linear fashion across a variety of material types, locally exhibit vertical displacement, and likely extend to considerable depths (perhaps to the ground-water table) based on the volume of floodwater that entered the fissures. Additionally, the fissures coincide with an area of measured ground subsidence (2 to 4 feet between 1941-1972 and 2005 based on Global Positioning System surveying) and significant ground-water-level decline near Beryl Junction. Other possible causes for the fissures (desiccation cracking, hydrocompaction, surface faulting) typically produce cracks having different characteristics, are limited to clay-rich deposits, or require a large (magnitude 6.5 or greater) earthquake to form.

Ground subsidence and earth fissuring may cause a variety of problems including (1) changes in elevation and slope of the ground surface, possibly affecting streams, canals, and drains, (2) damage to roads, buildings, railroads, and underground utilities, and (3) failure of well casings from forces generated by compaction of the valley-fill alluvium. Additionally, surface water diverted into earth fissures may reach the water table and cause ground-



Regional map of the Escalante Valley area showing the general location (red zone) of the earth fissures.

water contamination. The landowner at the southern end of the longest earth fissure, which extends into an alfalfa field at its south end, noticed that slopes in his field have changed recently, altering surface-water flow directions and causing water to pond in areas where it formerly drained.

He also reported that the casing in a well in the southwest corner of his field sheared and failed during the summer of 2004. Floodwater that infiltrated and enlarged one of the earth fissures flowed through a cattle feedlot prior to encountering the fissure, and contaminated surface water likely reached the water table in that area.

Based on current evidence, the best explanation for the formation of earth fissures in Escalante Valley is long-term ground-water withdrawal, which has caused a significant drop in the ground-water level, permanent compaction of fine-grained deposits in the Escalante Valley aquifer, and ground subsidence near Beryl Junction. We infer that the earth fissures are the surface expression of horizontal tension in the Escalante Valley aquifer formed in response to differential

Earth fissure enlarged by infiltrating floodwater adjacent to State Route 56 near Beryl Junction.

aquifer compaction and ground subsidence in Escalante Valley.

For more information on these earth fissures, visit the UGS Web site at http://ugs.utah.gov/utahgeo/hazards/pdf/ss-115.pdf.

Survey News

UGS Board

We had to cancel the Spring Board meeting because the UGS Board did not have a quorum. At the Special Legislative session, the Senate approved the four nominations from the Governor for the UGS Board:

> **Steve Church** (Sinclair Oil) reappointed for his second four-year term (Minerals-oil & gas); **Geoff Bedell** (Kennecott) reappointed for a second four-year term (Minerals – metals); **Dave Simon** (Simon-Bymaster Inc.) appointed for a four-year term (Engineering Geology); **Jack Hamilton** (U of U Engineering Expt. Research Station) appointed for a four-year term (Academia)

Terms also expired for **Craig Nelson** and **Ron Bruhn**. Both have served us well as members of the UGS Board and we thank them for their efforts.

UGS personnel are scanning approximately 30,000 well logs from Oil, Gas & Mining that are currently stored in the Natural Resources Library. This is part of a project to provide all Utah well logs on the internet. There are currently 15,779 logs on our web site, representing 5,923 wells. OG&M contracted with A2D, a private company, to scan all logs received since March 2005. A2D and UGS are continuing to scan logs. Access to the well-log files is available on the web at http://utstnrogmsql3.state.ut.us/UtahRBDMSWeb/main_menu.htm.

The Utah Automated Geographic Reference Center (AGRC) provided funding for the project and will provide an Internet Map Service link to the files in the near future.

PDF files of all the publications produced by the UGS are available through the Natural Resources Library online card catalog.

This represents over 1600 publications since the UGS began publishing. Plans are underway to make many of the U.S. Geological Survey publications and maps concerning Utah also available in pdf form. Stay tuned.

Welcome to **Kevin Thomas**, who is our latest addition (replacing Jake Umbriaco) to the Ground Water and Paleontology section. Kevin has an M.S. from the Geology Department at USU, specializing in structural geology and downhole geophysics.

Jennifer Cavin has recently joined us as a paleontologist. Jennifer has an M.S. from the South Dakota School of Mines and Technology.

Jenifer Baker is our new receptionist, while **Dallas Rippy** has left the Economic group. **Robert Ressetar** joins us part time as a technical reviewer. He has degrees in geology and law.

The Hazards Program bids farewell to **Mike Kirshbaum** who will be working across the valley with Kennecott. We wish you well in your new position, Mike.

Mark Hale, has begun working part-time with the Hazards Program.

Glade Sowards moved from head of our new SEP unit to the Department of Environmental Quality.

State Energy Program Comes to UGS

by SEP Staff

Introduction

There is another energy section in town at the Utah Geological Survey! The State Energy Program (SEP) was recently relocated to the Survey and, after a brief transition period, is ready to provide funding and support for energy efficiency, energy conservation, and renewable energy efforts in the state of Utah. We are excited to be a part of the Survey and to continue to promote clean and efficient energy options for Utahns.

History of SEP

During the 2005 General Session of the Utah State Legislature, S.B. 199 dissolved the Utah Energy Office and divided its functions across a handful of state agencies.

The legislation relocated the SEP and the Renewable Energy Tax Credit program to the Utah Geological Survey. S.B. 199 also transferred the Clean Fuel Vehicle Grant and Loan Program to the Division of Air Quality in the Department of Environmental Quality. In separate administrative actions, the State Building Energy Efficiency Program was moved to the Division of Facilities Construction and Management, and an energy policy position was established directly within the Governor's office.

SEP is the state interface with the U.S. Department of Energy (U.S. DOE) State Energy Program and provides a funding opportunity for energy efficiency, energy conservation, and renewable energy initiatives in Utah. The SEP typically receives between $425,000 and $450,000 in formula grant funding annually. This amount is determined by the level of SEP funding that U.S. DOE receives from Congress, and by the population and energy consumption of each participating state. To qualify for federal support, the SEP also receives matching funds from the State of Utah. Some of this funding is made available to energy conservation- and renewable energy-related organizations through a competitive bid process at the beginning of each calendar year. In addition, SEP serves as the point of contact for businesses and organizations to receive funding for a variety of special energy projects that are selected and supported by U.S. DOE each year.

A new 665 kilowatt turbine is installed next to the original 225 kilowatt turbine at Camp Williams. Photo by Mike Vanden Berg.

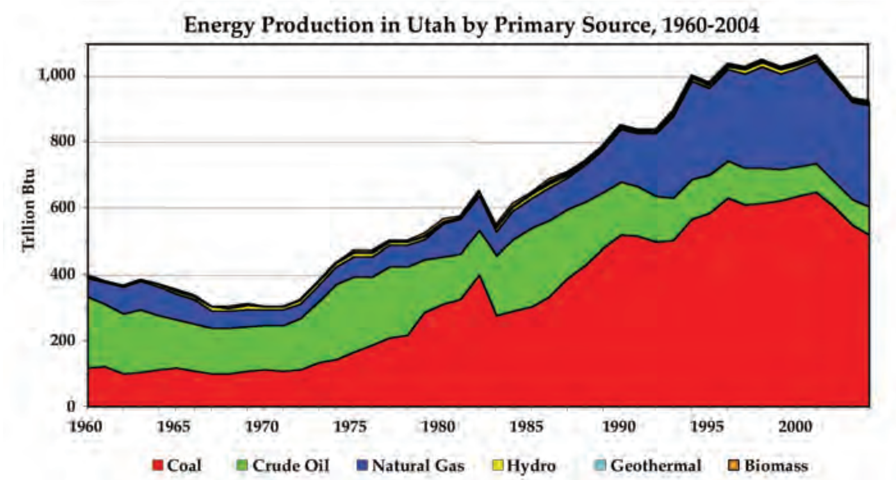
Mission and Programs

The mission of the SEP is to provide direct support and access to federal funding for energy efficiency, energy conservation, and renewable energy programs and projects in the state of Utah. To accomplish this mission, SEP administers several programs either directly or with the assistance of its valued community partners.

Renewable Energy Program

In 2004, renewable sources constituted only 1.6 percent of energy production

A solar photovoltaic (PV) system located at Goblin Valley State Park. Additional PV work is anticipated at the park over the coming year. Photo by Dave Lochtefeld.



An example of energy trends compiled by SEP and made available on the UGS Web site. (Source: UGS Web site.) Geothermal and biomass are too small to show on this graph.

in Utah. The SEP works through a variety of programs to help diversify Utah's energy resource mix and to encourage the development of renewable energy in the state.

The SEP works with Utah Clean Energy to sponsor the Wind, Geothermal, and Solar Working Groups. These groups provide forums for parties interested in the advancement of renewable energy resources in Utah and focus on ways to eliminate or reduce regulatory, institutional, and market barriers to renewable energy development in the state.

The SEP also administers the Utah Anemometer Loan Program, which provides interested land owners with 20- and 50-meter meteorological towers with which to assess the wind resource on their land. The anemometer data can be compared with the projected wind resource information used to develop the Utah Wind Resource Map. This comparison establishes a better understanding of Utah's wind energy potential and, ultimately, can help encourage wind power development in the state.

Energy Efficiency and Energy Conservation Program

Energy efficiency and conservation measures have been identified by Utah Power and others as one of the most cost-effective sources of "new" power for the state of Utah. The SEP works with several partners to encourage the adoption of energy efficiency and conservation strategies in all sectors of Utah's economy.

In the spring of 2005, the SEP - in conjunction with partner Utah Clean Energy - initiated the Utah Energy Efficiency Working Group (EEWG) to serve as a focal point for energy efficiency and conservation efforts in the state. The EEWG includes representatives from utilities, large energy users, non-profit organizations, and other entities interested in "doing more with less" energy in Utah.

The SEP partners with the National Energy Foundation to sponsor the Utah Energy Smart program, which provides K-12 teachers and their students with energy education materials. The program goals also focus on building strong alliances and partnerships, conducting and participating in events for teachers and their students, maintaining strong implementation programs in school districts with energy management action plans in place, and conducting large-scale energy awareness activities and energy education efforts for the general public.

According to U.S. DOE's Energy Information Administration, the transportation sector consumes over 29 percent of all energy used in Utah. The SEP works with its partners, including the Utah Transit Authority and the Utah Clean Cities Coalition, to provide ride sharing, alternative fuel vehicles, advanced vehicle technology, idle reduction, and energy efficiency programs in Utah. These options can help reduce the amount of energy used in transportation and can help reduce the impacts of increasing fuel prices on Utah's citizens and businesses.

Energy and Mineral Data

The SEP also maintains an energy and minerals trends Web site, which provides detailed information on reserves, production, consumption, and prices for Utah's citizens and policy-makers. The data are available for easy viewing and download on the Internet using common file formats at www.energy.utah.gov. This information helps SEP understand the need for and impacts of various energy efficiency, energy conservation, and renewable energy initiatives.

Contacts

The SEP staff consists of Denise Beaudoin, Partner Coordinator; Nykole Littleboy, Renewable Energy Specialist; Michael Vanden Berg, Geologist/Energy Data Specialist; and Kim Mellin, Web and database specialist. For more information on the UGS SEP and its programs, please contact us at 801-538-4798 .

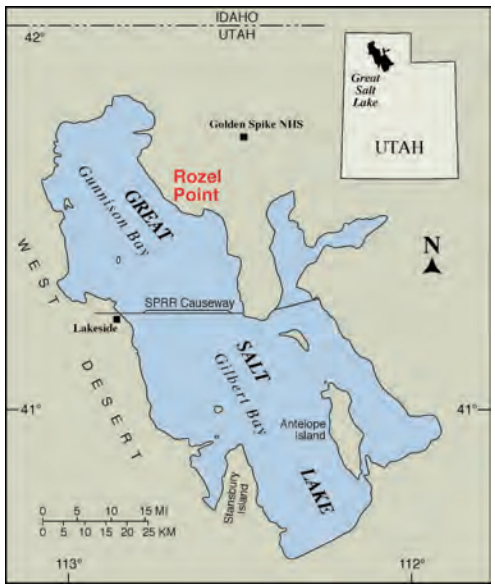
GeoSights

"Bubblin' Crude" at Rozel Point, Box Elder County, Utah

by Mark Milligan

Geologic Information: "An' up through the ground came a bubblin' crude. Oil that is, black gold, Texas tea." A crude oil-seep made Jed Clampett of the 1960s TV sitcom The Beverly Hillbillies a millionaire. In Utah you can see, smell, and feel natural crude oil-seeps at Rozel Point when Great Salt Lake levels are low.

Miocene to Pliocene (24 to 1.8 million years old) organic-rich lake sediments probably generated the oil at Rozel Point. From these source beds, the oil migrated upward along faults and fractures to an 80-foot-deep, 2- to 3-foot-thick porous basalt layer that comprises the main reservoir. Some of the oil in this basalt reservoir leaks to the surface through faults and fractures, emerging as thick, sticky, tar-like oil. Rozel Point is one of the oldest (if not the oldest) fields to produce oil in Utah. The seeps have been known since the late 1800s and production attempts began in 1904. The field produced an estimated 10,000 barrels of oil from 30 to 50 wells, but has been inactive since the mid-1980s due to extremely difficult production, very high refining costs, and rising lake levels.



Location map for Rozel Point.

Rozel Point in May of 2005. North arm of Great Salt Lake is about 4196 feet above sea level.

Rozel Point may not be the place to take a first date. In the August 1995 issue of Survey Notes, Thomas Chidsey writes of "crude oil dripping from abandoned wellheads, tar on rocks and beach sands, and dead pelicans along the beach…" The wellheads have since been capped, but rusting industrial debris remains. The sweet perfume or retched stench of crude fills your nose. And, you can occasionally see, hear, and feel the U.S. Air Force test weapons in the Lakeside Mountains across Gunnison Bay to the west. On the other hand, graceful flocks of pelicans flying by and distal views of the lake and mountains can inspire awe and wonder. The red brine, white salt, and black basalt impart an otherworldly feel. And the economic potential seeping from the ground creates an air of excitement. Perhaps it is because of, not in spite of, these dichotomies that artist Robert Smithson chose to locate his Spiral Jetty earthwork in this area, just a few hundred yards to the northwest of Rozel Point.

The oil seeps at Rozel Point appear when the lake level drops below an elevation of

A crude oil seep flowing over salt (key for scale).

Crude oil floating on Great Salt Lake.

approximately 4198 feet, roughly the elevation at which the Spiral Jetty emerges. The U.S. Geological Survey Web site (http://ut.water.usgs.gov/infores/gsl.intro.html) provides current lake-level information.

How to get there: Drive to the Golden Spike National Historic Site (GSNHS), 30 miles west of Brigham City, Utah by following signs on Utah State Route 83 through Corinne. From the GSNHS Visitor Center follow the small white signs toward the Spiral Jetty, about 16 miles. When you see a rusted military amphibious vehicle, you are almost to Rozel Point. The oil seeps can best be seen from the long linear jetty found a few hundred yards southeast of the Spiral Jetty. Detailed directions can be found in the January 2003 edition of Survey Notes (http://ugs.utah.gov/surveynotes/geosights/spiraljetty.htm).

For more information see the article on the Rozel Point oil field in *Great Salt Lake, an Overview of Change* (2002) edited by J. Wallace Gwynn.

Capped and abandoned oil well.

The U.S. Air Force testing weapons across Gunnison Bay. Westward view of the Lakeside Mountains, which rise more than 2000 feet above the lake.

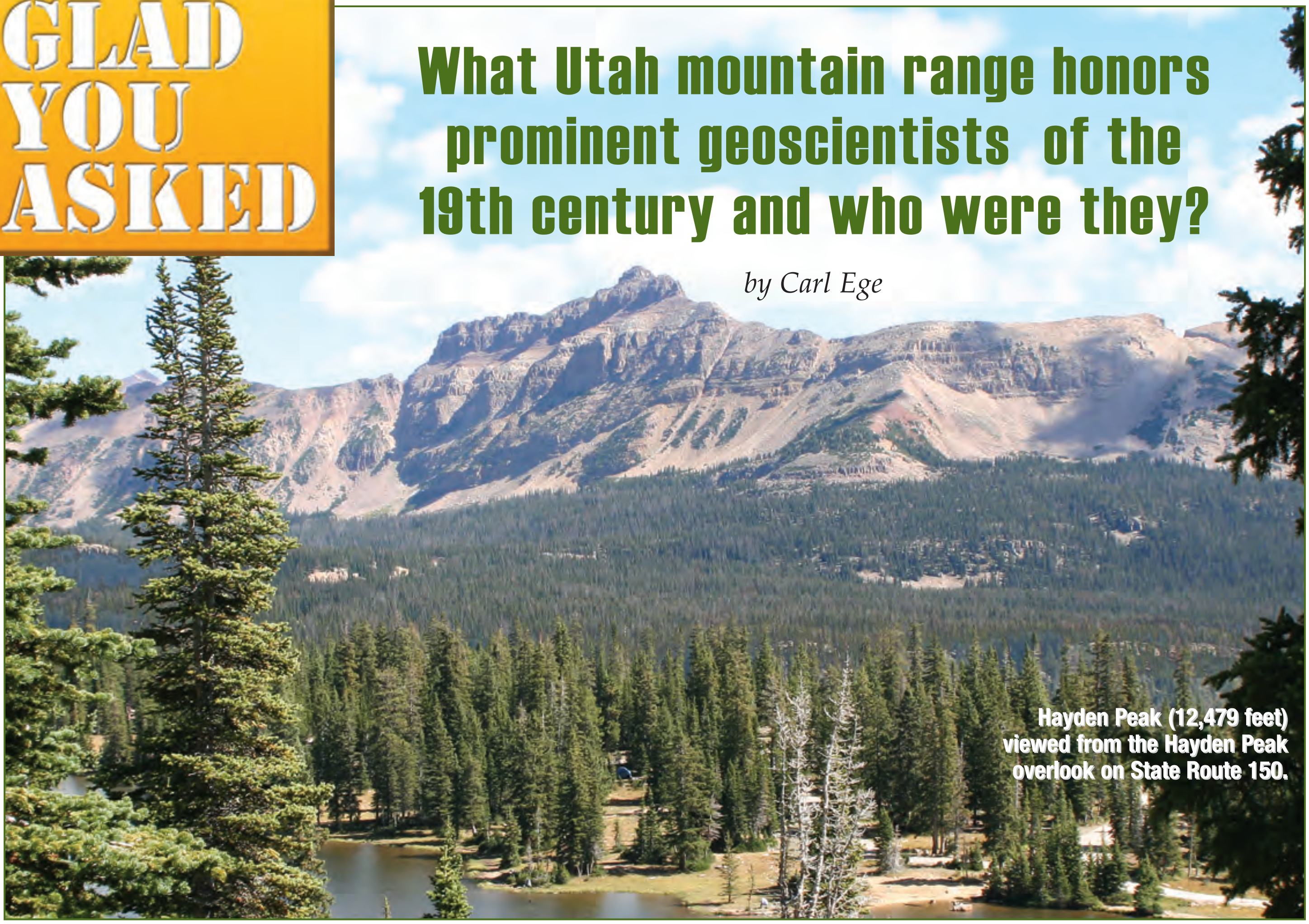
A miniature La Brea Tar Pits in the making; thick and sticky crude oil is slowly encrusting ladybugs and other debris.

Desolation, rusted industrial debris, and stinking crude oil seeps. This may not be a site for the faint of heart.

GLAD YOU ASKED

What Utah mountain range honors prominent geoscientists of the 19th century and who were they?

by Carl Ege



Hayden Peak (12,479 feet) viewed from the Hayden Peak overlook on State Route 150.

Many geographic features in Utah are named in honor of explorers, trappers, ranchers, and pioneers who were important to the state's history. However, there is one mountain range that commemorates early 19th century geologists and topographers who were influential figures in the geoscience field: the Uinta Mountains. More than 20 major geographic features in this mountain range (lakes, streams, and mountain summits and passes) bear the names of these important geoscientists.

Many of these early geoscientists developed the basic framework of the current understanding of geologic concepts we now study and practice. Some of these geoscientists were also responsible for organizing and/or participating in the first scientific surveys for the United States government, exploring regions of Utah and throughout the American West. Known as the four "Great Surveys," the main objectives were to investigate, map, and study the natural resources and geology of the American West. The first was the Geological Survey of the 40th Parallel led by Clarence King from 1867 to 1878. The survey was successful in mapping the topography and geology in the Sierra Nevada, Great Basin, Uinta Mountains, and Rocky Mountains along the latitude of 40 degrees north. This was closely followed by Ferdinand Hayden's survey (known as the Geological and Geographical Survey of the Territories) of Nebraska, Utah, Wyoming (Yellowstone area and Teton Range), Colorado, and Idaho from 1867 to 1879; John Wesley Powell's survey (known as the Geographical and Geological Survey of the Rocky Mountain Region) of the Green and Colorado Rivers and through the Grand Canyon from 1869 to 1879; and George Wheeler's survey of the U.S. territory west of the 100th meridian (Nevada, Utah, California, Arizona, Idaho, and New Mexico) from 1871 to 1879. (Just across Utah's border, the second-highest peak in Nevada is named after Wheeler.) All these government surveys were important in providing geologic information that helped "open up" the American West to frontier settlement and led to preserving geological areas, such as Yellowstone National Park, for future generations.

Three of the four "Great Surveys" (King's, Hayden's, and Powell's) investigated the Uinta Mountains region, and these geoscientists were responsible for naming the newly discovered geographic features in the Uinta Mountains.

Listed on the following page are the Uinta Mountains' geographic features named for geoscientists.

Geologic Feature	Geoscientist feature is named after	Who were these geoscientists?
Atwood Creek and Atwood Lake	Wallace Atwood	Geologist who studied glaciation in Uinta Mountains.
Gatman Lake	Gatman	Geologist and naturalist
Gilbert Peak, Gilbert Creek, and Gilbert Lake	Grove K. Gilbert	Geologist who did pioneering research on Lake Bonneville, Great Salt Lake, and the Henry Mountains.
Hayden Peak, Hayden Pass, Hayden Fork, and Hayden Lake	Ferdinand Hayden	Geologist for early government surveys. Visited Uinta Mountains in 1870.
Hyatt Lake	Alpheus Hyatt	Naturalist, zoologist, and paleontologist.
Kings Peak, Kings Lake, and South Kings Peak	Clarence King	Conducted Geological Survey of the 40th Parallel. First director of the U.S. Geological Survey.
Leconte Lake	Joseph Leconte	Geologist and educator who worked with John Muir.
Leidy Peak	Joseph Leidy	Paleontologist who studied the Bridger and Uinta Formations. Considered father of vertebrate paleontology.
Marsh Lake and Marsh Peak	Othniel Marsh	Paleontologist who studied the Bridger Formation.
Mount Agassiz	Louis Agassiz	Professor of Zoology and Geology at Harvard University.
Mount Emmons	Samuel Emmons	Geologist for the Geological Survey of the 40th Parallel.
Mount Powell and Powell Lake	John Wesley Powell	Led surveys down the Colorado and Green Rivers. Second director of the U.S. Geological Survey.
Packard Lake	Alpheus Packard	Professor of Biology and Geology at Bowdoin College.
Scudder Lake	Samuel Scudder	Paleontologist who is considered the father of insect paleontology.
Shaler Lake	Nathaniel Shaler	Professor of Paleontology and Geology at Harvard University.
Walcott Lake	Charles Walcott	Geologist and paleontologist who studied the Burgess Shale. Third director of the U.S. Geological Survey.
Wilson Peak	A.D. Wilson	Head topographer for the Geological Survey of the 40th Parallel.
Verrill Lake	Addison Verill	Geologist and zoologist

New Publications

Geologic map of the Delta 30' x 60' quadrangle and part of the Lynndyl 30' x 60' quadrangle, northeast Millard County and parts of Juab, Sanpete, and Sevier Counties, Utah, by Lehi F. Hintze and Fitzhugh D. Davis, CD (1:100,000), 6/05, M-206DM [CD contains GIS data] $19.95

Geologic map of the Jordan Narrows quadrangle, Salt Lake and Utah Counties, Utah, by Robert F. Biek, 2 pl. 1:24,000, 6/05, M-208 .... $10.00

Geologic map of the Lehi quadrangle and part of the Timpanogos Cave quadrangle, Salt Lake and Utah Counties, Utah, by Robert F. Biek, 2 pl. 1:24,000, 6/05 M-210 .... $10.00

Geologic map of the Lynndyl 30' x 60' quadrangle, west-central Utah. 2005, digitized from USGS Miscellaneous Investigations Map I-1830 by E.H. Pampeyan, 1:100,000, 1989, CD [CD contains GIS data], 6/05 M-211DM $19.95

Uranium and vanadium map of Utah, by Robert W. Gloyn, Roger L. Bon, Sharon Wakefield, and Ken Krahulec, CD (1 plate 1:750,000), 7/05,[CD contains GIS data] M-215DM $24.95

Geologic map of the Roy 7.5' quadrangle, Weber and Davis Counties, Utah, by Dorothy Sack, 22 p., 2 pl., 1:24,000, 6/05, MP-05-3 .... $10.00

Geologic map of the Clearfield 7.5' quadrangle, Davis County, Utah, by Dorothy Sack, 14 p., 2 pl., 1:24,000, 6/05 MP-05-4 .... $10.00

Selected mining districts of Utah, by Carl L. Ege, 59 p., 6/05, MP-05-5 .... $11.49

Guidelines for the geologic evaluation of debris-flow hazards on alluvial fans in Utah, by Richard E. Giraud, 16 p., 6/05, MP-05-6 .... $6.00

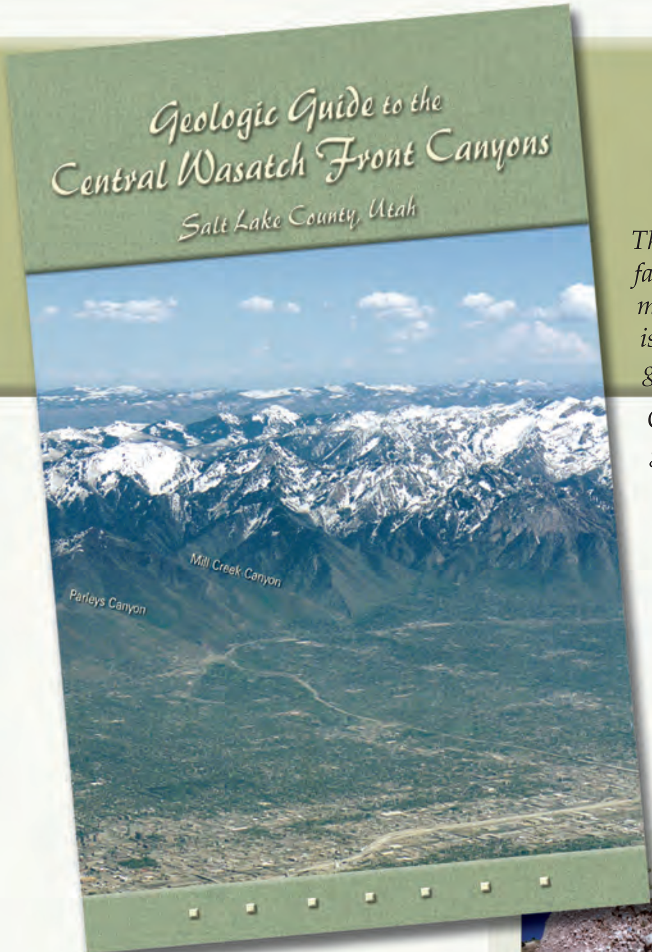
Ground-water sensitivity and vulnerability to pesticides, Salt Lake Valley, Salt Lake County, Utah, by Mike Lowe, Janae Wallace, Neil Burk, Justin Johnson, Anne Johnson, and Rich Riding, CD (24 p., 2 pl., 1:120,000), 7/05 MP-05-7 .... $19.95

The available coal resource for nine 7.5-minute quadrangles in the southern Wasatch Plateau Coalfield, Emery, Sanpete, and Sevier Counties, Utah, by Jeffrey C. Quick, David E. Tabet, Brigitte P. Hucka, and Sharon I. Wakefield, CD (41 p.), 8/05, SS-114 .... $19.95

Water resources of Millard County, Utah, by Fitzhugh D. Davis, 27 p., 5/05, OFR-447 .... $10.00

North Horn Mountain area coal drill-hole data: Wasatch Plateau coalfield, Emery County, Utah, CD, 6/05, OFR-449 .... $14.95

Provisional geologic map of the Deseret Peak East quadrangle, Tooele County, Utah, by Torrey J. Copfer and James P. Evans, CD (31 p., 3 pl., 1:24,000), 9/05, OFR-450 . $14.95



Geologic Guide to the Central Wasatch Front Canyons

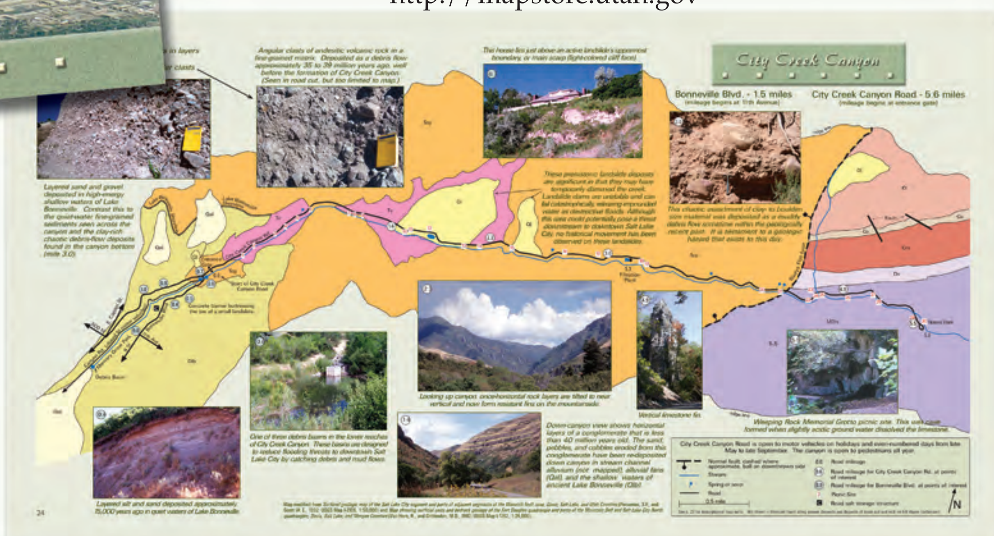
The Wasatch Range, grandly overlooking the Salt Lake Valley, is a product of fascinating geologic activity. Now a new comprehensive geologic guide to six major Wasatch Range canyons is available. This 5" x 8" fold-out publication is fun and informative for people interested in geology, for tourists, and for geologists as well.

Colorful paleoscenes and a generalized stratigraphic column accompany background information on the regional geologic history. Good illustrations and descriptions interpret local geologic features and processes, such as Lake Bonneville, glaciers, faults, landslides, and mining history.

The Utah Geological Survey is pleased to make this colorful and informative booklet available through the Natural Resources Bookstore at a Pretty Good Price. Please contact them:

Natural Resources Map & Bookstore

1594 W. North Temple
Salt Lake City, UT 84106
801-537-3320 or 1-800-UTAHMAP
http://mapstore.utah.gov



There are geologic maps for:

- City Creek Canyon
- Emigration Canyon
- Lower Parleys Canyon
- Mill Creek Canyon
- Big Cottonwood Canyon
- Little Cottonwood Canyon

Each includes mileage at points of interest, photos, and illustrations.

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