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

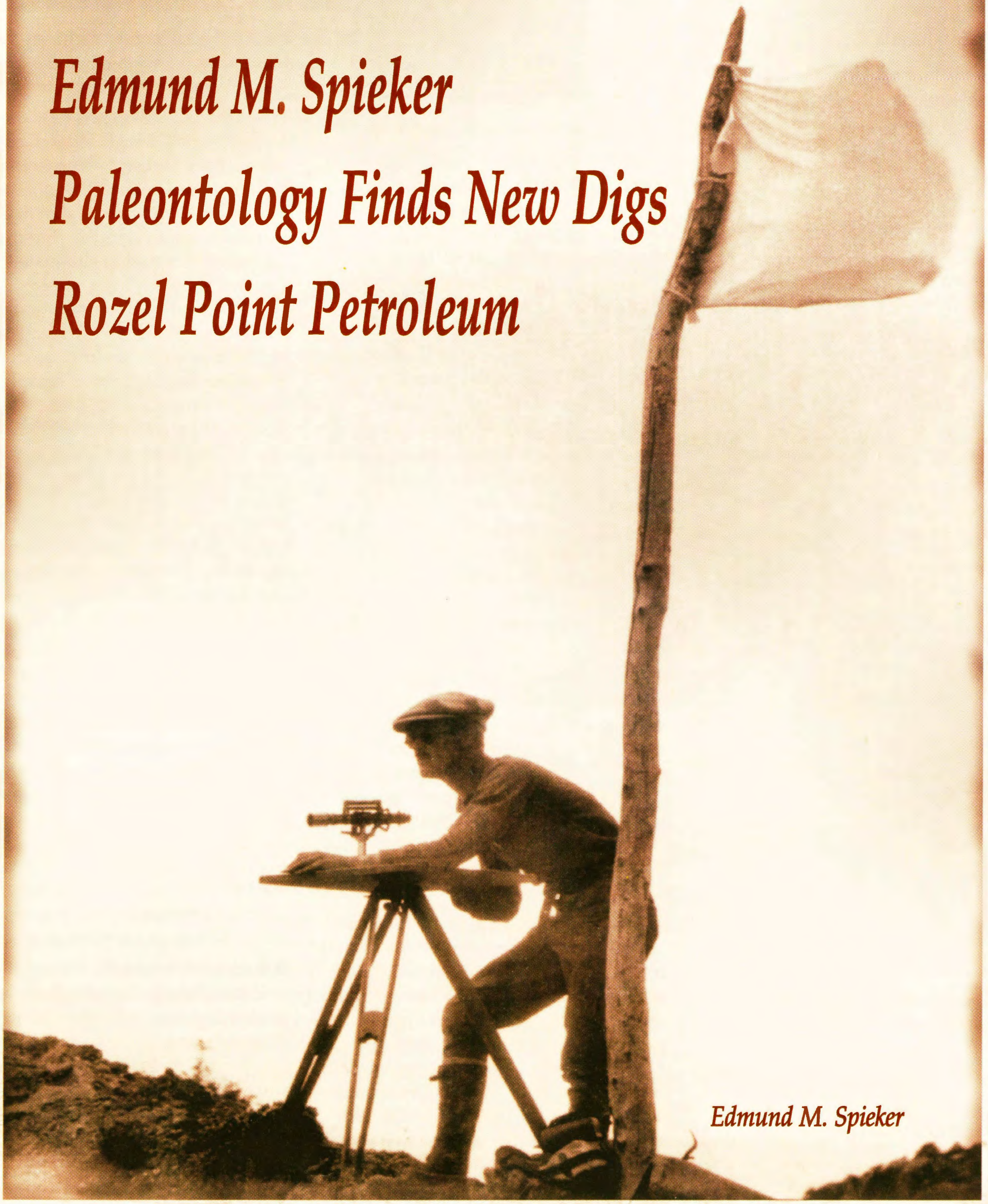
SURVEY NOTES

Volume 27, Number 3 August 1995

Edmund M. Spieker

Paleontology Finds New Digs

Rozel Point Petroleum



Edmund M. Spieker

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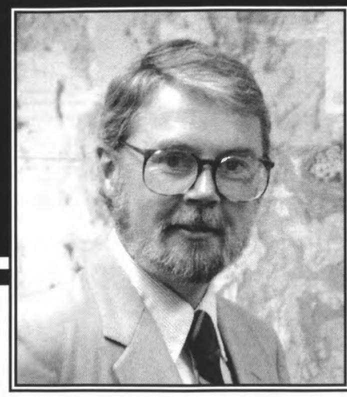

The Director's Perspective

by M. Lee Allison

Opportunities and Mandates

The UGS is entering a period that may best be reflected by Dickens' quote that "it was the best of times, it was the worst of times." During the past year the UGS expanded, entered new areas of investigation, and found new sources of funding. At the same time, we are preparing to digest some tasks previously handled by the federal government, most likely with reduced or no additional funding.

During the fiscal year that ended on June 30, the UGS staff grew by 18 percent and our budget expanded by 25 percent. For fiscal year 1996, we will see an unprecedented 40 percent budget increase, although almost all of that is money that simply passes through us to our partners involved in one of the four huge oil and gas projects we are undertaking.

State funds have not kept pace with increased costs for salaries and expenses such as rent. The persistent underfunding of salaries by the Legislature forces us to bring in an increasing portion of our budget from outside sources. We have been so successful at doing this that, over all, the UGS is one of the fastest, if not the fastest, growing state survey in the nation.

With this growth comes new responsibilities and challenges. With the formal transfer of the Paleontology and Paleoecology staff from the Division of State History to the UGS, we have for the first time assumed a minor regulatory function, permitting paleontological digs on behalf of the state Trust Lands Administration. With the passage of H.B. 54 in last year's legislative session, we also acquired certification authority for amateur paleontologists who pass a course we will develop and institute.

While the UGS broadens its duties and scope of work, we see federal agencies scaling back and retreating from some of their activities, either in response to threats of budget cuts or due to direct mandates from Congress. For example, the initial proposal to eliminate the U.S. Geological Survey was mitigated into an apparent overall 20 percent budget cut that will eliminate an estimated 600+ jobs by October, 1995. In addition, the U.S. House recently approved complete elimination from the federal budget all university and state-agency earthquake research funded by the USGS in their budget proposal. As we go to press, earthquake researchers around the country are urging the Senate to modify the House budget and spread the cut over the entire earthquake program rather than targeting one specific recipient group.

As part of its cost-cutting moves, the USGS is also scaling back its core library in Denver, which means it needs to dispose of huge quantities of well cores. These cores were collected mostly by industry and represent tens of millions of dollars worth of drilling. The core is largely irreplaceable. The UGS hopes to recover all of the Utah core and bring it to the Utah Sample Library. Already five tractor-trailer loads of core have been delivered. This almost completely fills up all of our remaining storage space.

It is difficult to predict where all of this will lead during the next year. We are attempting to take advantage of opportunities where and when they occur. We are also trying to be prepared to take on duties crucial to Utah's well-being that may be dropped by federal agencies. Stay tuned.

Survey Notes is published three times yearly by Utah Geological Survey, 2363 South Foothill Drive, Salt Lake City, Utah 84109-1491: (801) 467-7970. The UGS inventories the geologic resources of the state, identifies its geologic hazards, disseminates information concerning Utah's geology, and advises policymakers on geologic issues. The UGS is a division of the Department of Natural Resources. Single copies of *Survey Notes* are distributed free of charge to residents within the United States and Canada. Reproduction is encouraged with recognition of source.

Contributors to Geologic Mapping in Utah

Edmund Maute Spieker
1895 - 1978

by Malcom P. Weiss
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Santa Barbara, California 93106

Each year the UGS recognizes a geologist who made exceptional contributions to the geologic mapping of Utah. This year we recognize Edmund Spieker, who spent a career mapping and describing the geology of central Utah.

Edmund M. Spieker and his dog, 1920s

Background and Career

Edmund Maute Spieker was born February 25, 1895, in Baltimore, Maryland. His father was a philologist (scholar of literature and language) who taught Greek at Johns Hopkins University. His mother was the daughter of Andrew Maute, an immigrant from southwestern France who edited and published newspapers in several Nevada mining towns, and who went on to a distinguished career in the Nevada government. As a youth, Edmund spent many summers with his grandfather Maute in Nevada, where he developed enduring love and sympathy for the mountains and arid lands. On those visits he traveled by train and stagecoach within Nevada, experiences that he cherished. One of his principal regrets in later life was all the amethystine whiskey bottles (now cherished collector's items) that he and his cousin shot up with .22 caliber rifles at the dumps of mining camps!

Edmund was a cultured man, an accomplished musician, and a linguist of skill (French and German). For example, he spoke and wrote only French with his son, Andrew, which made Andrew bilingual early and easily. Spieker earned a B.A. degree in chemistry in 1916, and a Ph.D. in geology in 1921, both at John Hopkins University. In his early graduate-school years, he was as much a chemist and geophysicist as a geologist, but his dissertation was in paleontology.

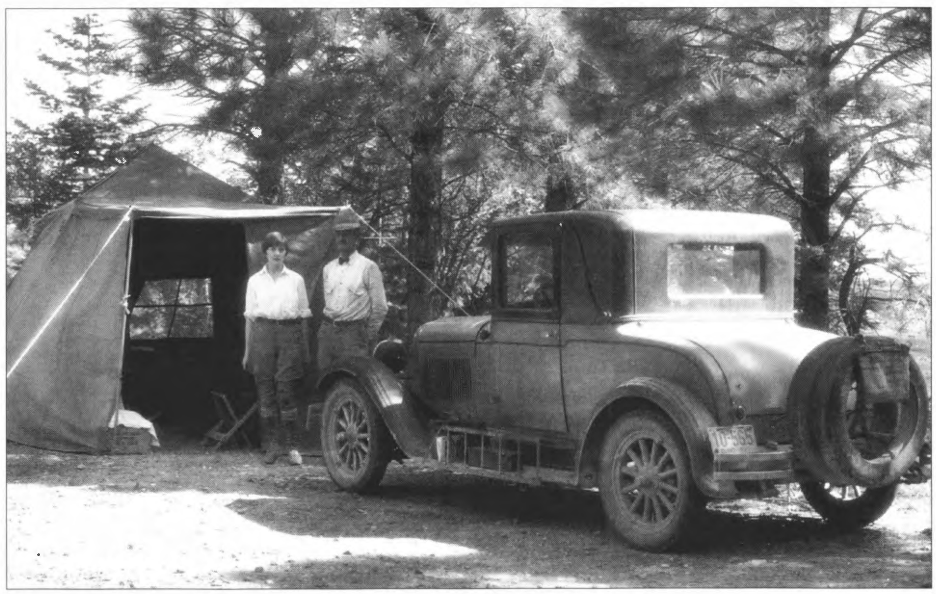
He started field work for the U.S. Geological Survey (USGS) in the Sunnyside area of Utah on June 1, 1921. He was delighted to be sent to Utah, for G.K. Gilbert (the geologist who studied and named Lake Bonneville) was Spieker's "geologic hero." His first large task after joining the USGS was to study the coal resources and related stratigraphy of the northern Book Cliffs, reported in USGS Bulletin 793 (Clark, 1928). Much of the field work and writing of this excellent work was by Spieker, although the USGS practice of those years denied him authorship.

Dr. Spieker left full-time work with the USGS in 1924 to join the faculty at The Ohio State University, but he continued part-time work in Utah for the USGS until World War II. His second and largest USGS project was mapping and estimating the reserves of the Wasatch Plateau coal fields, a study that included topographic mapping in addition to geologic work. He led field parties of geologists, topographers, cooks, packers, teamsters, and wranglers during this work. In the late 1920s and the 1930s those field parties usually included Mrs. Helen Spieker as an unpaid assistant. Helen was rodman for many square miles of plane-table work.

Spieker's detailed structure-contour maps of the coal beds in the Wasatch Plateau were later used by entrepreneurs from Salt Lake City to discover and develop the Clear Creek gas field and also made easier the development of area coal mines.

USGS Bulletin 819 (Spieker, 1931), on the Wasatch Plateau, has long been regarded as an outstanding geologic report and map. Years later, while preparing the 1:100,000-scale 30′ by 60′ geologic quadrangle maps of the Price 1° by 2° quadrangle, I.J. Witkind merely enlarged the scale of Spieker's original work and inked it down. Witkind learned very early that Spieker's work needed no revision (I.J. Witkind, personal communication, 1979).

Wasatch Plateau field party. Spieker seated at center with John B. Reeside, Jr. to his left, 1920s.

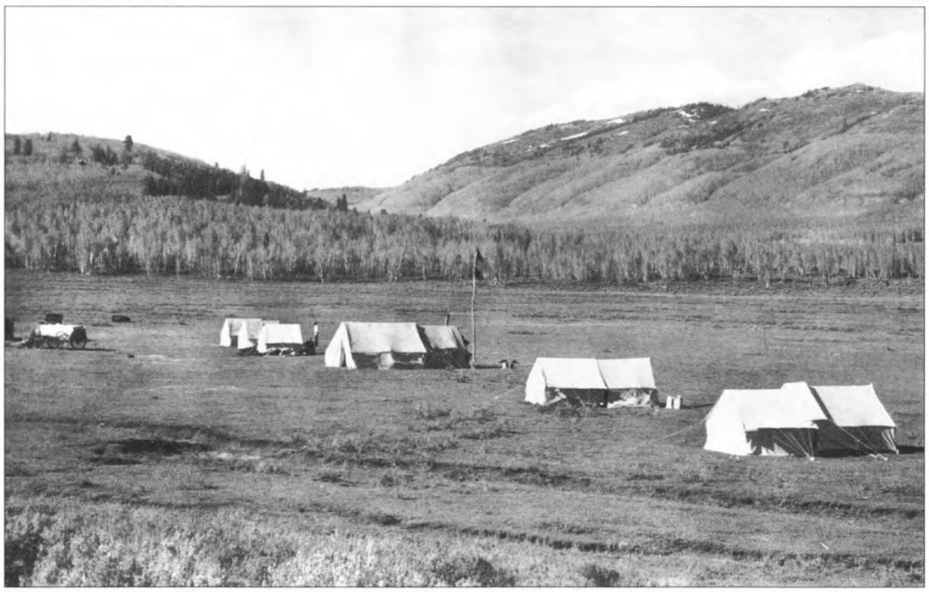


Helen and Edmund Spieker camped with their 1927 Pontiac, 1927.

The map accompanying Utah Geological Society Guidebook 4 on the geology of the Colorado Plateau-Basin and Range transition zone (Spieker, 1949a) was compiled by Charles H. Summerson directly from Spieker's maps (Spieker and Baker, 1928; Spieker, 1931) and additional plane-table sheets. The fact that this was possible is testimony to the high quality of Spieker's work, considering that no topographic base maps were available when Spieker completed the mapping. J.A.A. La Rocque (a skilled speed-typist) had agreed to type the manuscript for Guidebook 4. Dr. Spieker wrote the text with fountain pen on lined school paper (the published text is 106 pages long). La Rocque received page after holograph page, very few with corrections or other changes; the report flowed from Spieker's mind to his hand, fully formed and coherent (Aurèle La Rocque, personal communication, 1957).

Spieker developed many important insights into the stratigraphy and structure of central Utah and the history of the Cretaceous interior seaway (published in USGS Professional Paper 205-D; Spieker, 1946). He discovered that the Cretaceous-Tertiary boundary is not coincident with a great regional unconformity, but instead lies within a thick sequence of terrestrial deposits—the North Horn Formation. This formation contains many unconformities of local extent, but no regional discontinuity that might signify a geologic "revolution." This fact turned upside down the then-prevailing orthodoxy of worldwide orogenies and "layer-cake" stratification. (Spieker later called it "crazy fool luck" that he walked right into such evidence). Spieker had to overcome much professional antagonism to produce Professional Paper 205-D (Stokes, 1983); his view of the Cretaceous-Tertiary transition was nearly heretical 50 years ago. Later, he also propounded these "revolutionary" conclusions as a distinguished lecturer for the

Only a demonstration here! Often required, however.



USGS camp, probably in Joes Valley, with national and USGS flags on the staff.

American Association of Petroleum Geologists during two long trips in 1950 and 1952.

The complex structural geology of central Utah has been debated for many years and many contrasting views have developed. Recent work suggests that the major structures are the result of Sevier orogenic thrusting, duplexing, and back-thrusting, followed by Basin-and-Range extension, only partly similar to Spieker's original interpretation, of vertical motions of crustal blocks. In particular, Spieker should be remembered for his belief that the Wasatch monocline, with its numerous antithetic faults, is an extensional structure (in contrast to the then-current view of some structural geologists).

Integral to Spieker's work in Utah, but of world-wide significance, was his understanding of sedimentary facies—both lithofacies and biofacies. Trained in the Ulrichian era of layer-cake stratigraphy, he very quickly saw that the traditional model would not serve in the Book Cliffs. Because of his language skill he was familiar with the French and German literature, which included stratigraphic concepts and ideas of structural and tectonic geology barely available in the North American literature. His understanding of those "quaint" foreign ideas, such as facies, showed through all his Utah work, and culminated in his report on sedimentary facies. His ideas are developed and expressed in USGS Professional Paper 205-D (Spieker, 1946), Utah Geological Society Guidebook 4 (Spieker, 1949a), and Geological Society of America Memoir 39 (Spieker, 1949b). The texts of these reports are distinguished for their clarity and elegance of expression, features that always characterized Spieker's discourse, written or oral.

Ohio State University Field Station

Prior to World War II, Ohio State had carried out its geologic field training in eastern Tennessee, a heavily vegetated area with much poison ivy. In 1945, faced with a horde of students, Spieker planned a new field training course. He wanted a course that would induce greater skill and competence than he had discovered in many young assistants in USGS field parties. He chose to teach students in Utah, where the rock exposures are almost limitless, where unusual features such as double unconformities abound, and where rapid facies changes are so easily seen and understood. He surveyed Sanpete County for a suitable site for a field station, before reducing the possibilities to two: (1) a ranch on Twelvemile Creek just east of Mayfield, which was for sale, or (2) dormitory apartments, converted from barracks of the Japanese internment camp near Topaz Mountain that had been moved to Snow College in Ephraim. He chose the Snow College site, and began a symbiosis between the town and Ohio State University that continues today. Spieker directed the Ohio State University Geology Field Station from 1947 through 1965 (except 1960), a span of 19 years. Five-hundred-five undergraduate students studied field geology in Utah under Spieker and his colleagues in that period, and the field course continues under succes-

Left: Spieker ready for work, under the camp flags, Wasatch Plateau.

Above: Early September snowfall at Forest Service cabin high in Ephraim Canyon. Left to right: Helen Spieker, Olga Spieker, Edmund Spieker, and Charles Spieker (a brother hired as assistant geologist).

Below: Edmund Spieker preparing a "studio shot" of a field class on the North Rim of the Grand Canyon, late 1940s. (Photo by G.E. Moore, Jr.)

sive directors. The class size in the Spieker years ranged from 9 to 50 students, a major economic boost to Snow College and Ephraim City.

Spieker made the plane-table the principal tool of his courses. (The plane-table is a portable platform that is carefully leveled and oriented in the field using floats and compasses. Geometric triangulation is then used to accurately plot the locations of features on a sheet attached to the table, creating a map.) He learned the method from Eugene Stebinger (skillful plane tabler and inventor of the Stebinger drum—an important plane-tabling improvement). His own plane table sheets are marvels of beauty and accuracy. He fancied 9H pencils made in Germany, but they were no longer available after World War I. So, students had to use 6H pencils, with a "mighty sharp point."

Spieker held two axioms to be essential to effective field training of young geologists. First, that just as Antaeus lost his strength when Hercules raised him from the ground, so geology loses its science and utility when work is not based on field phenomena and field relations (Spieker, 1972). Second, that the key to successful field education is to put the responsibility to see, to think, to relate, and to conclude onto the student, rather than have teachers point and tell. His staff was expected to advise by querying students until they saw their own path to answers.

Spieker was delighted to learn that the difficult geology of central Utah was no impediment to young students sent to work on their own. Ignorant of problems they faced, they studied out structures, sedimentary features and facies changes, and developed decent maps and coherent explanations of what their maps showed. Although methods have changed, Dr. Spieker's philosophy of requiring students to figure things out on their own still dominates field training at Ohio State University.

Summer Institute

In 1962 Spieker initiated a summer institute for secondary-school teachers at Snow College. It was on "Geology and the Nature of Science" and was based on a principle dear to his heart: geology is best taught on the rocks. He himself lectured regularly on the nature and development of science, a course he had taught since 1930 at Ohio State University. The institute offered class and laboratory work in geology and led numerous field excursions; morning trips studied particular topics and day-long trips integrated these studies over the region. Three-hundred-sixteen teachers attended the institute during the 12 years it was in operation.

Contributions

Spieker's enduring scientific contributions to geology include: (1) four decades of university teaching, (2) path-breaking analysis of the Cretaceous and Tertiary deposits in the Utah segment of the Cretaceous interior seaway, (3) elucidation of the facies changes therein, (4) the revelation that the Cretaceous/Tertiary transition had been peaceful and unobtrusive over large regions, and (5) the extension of his own work in central Utah by 30 masters and 12 doctoral students. Through his work and that of his students, Spieker also recognized a series of tectonic events that explain the sedimentary record of the later Mesozoic and early Tertiary in central Utah (Spieker, 1949a). He also named or shared in naming the following Utah rock units:

published in Spieker and Reeside, 1925
- Blackhawk Formation
- Emery Sandstone
- Flagstaff Limestone
- Garley Canyon Sandstone
- Price River Formation
- Star Point Sandstone

published in Spieker, 1946
- Allen Valley Shale
- Arapien Shale
- Colton Formation
- Funk Valley Formation
- Indianola Group
- North Horn Formation
- Sanpete Formation
- Sixmile Canyon Formation
- Twist Gulch Formation

published in Spieker, 1949a
- Axtell Formation
- Gray Gulch Formation

Many young geologists who studied under Spieker went on to become distinguished geologists. They invariably cite their tutelage under Spieker as one of the main reasons for their success. A generation of geologists and scores of high school teachers remember their studies in central Utah under Spieker with gratitude, pride, and affection.

On July 16, 1978, Spieker's son, Andrew and a dozen colleagues, friends, and former students scattered the ashes of Edmund M. Spieker on the Flagstaff Limestone at the highest prong of The Horseshoe on his beloved Wasatch Plateau, overlooking Spring City, Utah.

Acknowledgments

I was tempted to solicit comment from scores of old students and friends, but that is not practical. Several who have provided memories or material for this appreciation are: Charles E. Corbató, Clyde T. Hardy, George E. Moore, Jr., Siegfried J. Muessig, E. Frederick Pashley, Jr., Howard J. Pincus, Eleanora Iberall Robbins, Andrew M. Spieker, Richard L. Threet, and Howard D. Zeller. Corbató provided statistics on the classes in Ephraim. James W. Collinson's unpublished bibliography of scholarly products of the Field Station (Collinson, 1968) and his memorial to Spieker (Collinson, 1980) were used freely and extensively, but without references in this text to save space. Dr. Spieker's views of field training and his goals for the Field Station in Ephraim are extracted from two of his reports to the Ohio State University Geology Alumni Newsletter (1950, 1959). I am grateful also to Corbató, Moore, and Andrew Spieker for improvements and corrections to an early draft.

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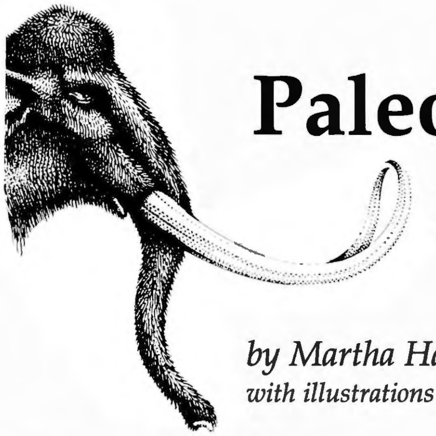


Paleontology Section Finds New Digs

by Martha Hayden
with illustrations by Brad Wolverton

The new Paleontology Section at the Utah Geological Survey was created with the recent passage of the Paleontology Transfer Act by the 1995 Utah State Legislature. This act transfers the responsibility for the preservation and protection of Utah's fossil resources from the Utah Division of State History (UDSH) to the Utah Geological Survey (UGS). Vertebrate fossils and other "critical paleontological resources" have been protected under the state's Antiquities laws since 1977. However, management of fossil resources under the same laws that govern cultural resources has been at best only partially successful. State laws apply only to state lands, and unlike cultural resources that have equivalent laws at the federal level, there are no directly comparable federal laws for fossils. Public outreach and education have been a major focus of the Paleontology Section as a strategy for preserving fossil resources, because the impact of education is far greater than the power of existing laws to protect fossils.

The primary responsibilities of the Paleontology Section include research, data management, and public outreach and education. Major research projects focus on the areas of expertise of the paleontology staff. Section Manager, Dr. David B. Madsen, was Utah's State Archaeologist from 1972 until this transfer was completed. The title of State Archaeologist, as well as the duties of that position involving the preservation of Utah's cultural resources, will remain at the UDSH. Madsen's position at the UGS will be as a Quaternary Paleoecologist, which involves analyzing the dynamics of past ecosystems, their changes through time, and their implications for managing modern ecosystems. Focusing on Utah's Great Basin, Madsen's research interests include Lake Bonneville stratigraphy and geomorphology, archaeology of the Archaic and Fremont cultures of the Great Basin, palynology, and ethnography (origins of Numic-speaking cultures). Current research involves a Department of Defense Legacy Project, a pilot study for ecosystem management. This multi-year study of environmental change in the Great Basin over the past 15,000 years employs two additional staff members, Monson Shaver and Jeff Hunt, as well as Madsen and Dr. David D. Gillette.

Dave Gillette came to Utah in 1988 to join the staff of the UDSH Antiquities Section as Utah's State Paleontologist. Although he had not worked in Utah before 1988, his areas of expertise were well suited to Utah paleontology. Gillette came to Utah from the New Mexico Museum of Natural History in Albuquerque, where he was involved in the study of sauropod dinosaurs from the Upper Jurassic Morrison Formation. His studies of *Seismosaurus* began with the excavation of this new supergiant dinosaur in 1985 and are ongoing. *Seismosaurus, The Earth Shaker*, a popular book illustrated by dinosaur artist Mark Hallett, was published in 1994 and is available at the UGS bookstore. Gillette has continued his studies of Utah sauropods, at some new sites, as well as at the site of Utah's first dinosaur discovery. *Dystrophaeus viamaelae* was discovered in southeastern Utah by the Macomb expedition of 1857. It was the first sauropod discovered in North America and only the second dinosaur discovered in the western United States. A re-examination of the local stratigraphy places this site in the lowermost part of the Morrison Formation, the Tidwell Member. This indicates that *Dystrophaeus* may be one of the earliest sauropods in the New World. Further studies of this historically and scientifically significant find are planned.

Within six months of Gillette's arrival in Utah, the discovery of a columbian mammoth at Huntington Reservoir on the Wasatch Plateau (elevation 9,000 feet) created the first opportunity for Madsen and Gillette to work together, and brought Gillette back to his original area of expertise, Pleistocene, or Ice-Age animals. Gillette received his Ph.D. from Southern Methodist University, specializing in the study of Pleistocene vertebrates, and in particular, glyptodonts (Volkswagen-sized, Ice-Age relatives of the armadillo).

Gillette is currently involved in the

study of Pleistocene faunas from a number of sites in Utah, including the Little Dell Dam site in Parley's Canyon, a site owned by Kennecott Copper Corporation, and a site at the University of Utah's Research Park that was described in a recent issue of *Survey Notes*. These discoveries commonly yield new taxa, such as the 1991 excavation of a giant ground sloth from Orem. This partially articulated skeleton of *Megalonyx jeffersoni* was the first ground sloth found in Lake Bonneville sediments.

The bones of Ice-Age mammals are frequently found in Lake Bonneville deposits along the Wasatch Front, during construction activities and in sand and gravel quarries. Important scientific information may be lost when these finds are not reported, often due to the common misconception that paleontological excavations will halt or delay construction activities. Paleontology Section staff are making an effort to inform quarry operators and construction crew chiefs that vertebrate fossils can be retrieved without affecting construction timetables.

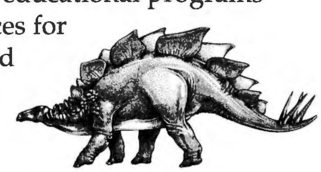
Management of a database on Utah paleontology is an important function of the Paleontology Section that has received little attention in the past. With the move to the UGS, the Paleontology Section plans to emphasize data management. The database encompasses all lands in Utah and includes a locality catalog, map files, and a bibliography of Utah paleontology. Through the acquisition of the Paleontology Section, the UGS is now the permitting agency for paleontological investigations on state lands in Utah.

Most of the public-outreach functions of the Paleontology Section have been conducted through the Utah Friends of Paleontology (UFOP), a statewide non-profit organization dedicated to the preservation of Utah's fossil record through public education and volunteer support of sponsoring institutions. State Paleontologist Dave Gillette is the advisor for the group as well a sponsor for the local Great Basin Chapter. A Paleontology Certification Program to train volunteers has been in the works for the last few years. A $2,500 grant from the Utah Division of State History for the current fiscal year, and a $9,500 appropriation from the State Legislature for the upcoming year have provided the funds needed to formalize this program.

This wanted poster is distributed to gravel quarry operators and construction crews to encourage the reporting of vertebrate discoveries. Free copies are available at UGS.

Utah Prehistory Week, an annual celebration of Utah's cultural and fossil resources and Native American heritage, is a major activity that utilizes education to promote the preservation of fossil and cultural resources. The sponsors of Utah Prehistory Week, including other state as well as federal agencies, are pleased to welcome the UGS as a new sponsor for this year's event, which was held May 6-13, 1995.

Other outreach functions include responding to public inquiries, investigating reported fossil localities, and developing educational programs and resources for students and the general public.



"Glad You Asked"

by Rebecca Hylland

Topographic Map Scales and the General Land Office Grid System

Maps. We all have used them at one time or another. They are sometimes stuffed into glove compartments, backpacks, and pockets. Maps get folded, crumpled, torn, and written on. I have even heard of maps going through the laundry. These used and abused sheets of paper are fairly important. Sometimes the only way we know how to "get there" is when we have a map as our guide. Maps, however, are only useful to us when we understand their language.

Since the Utah Geological Survey (UGS) began selling topographic maps in January 1994, map-related questions are a daily occurrence. Some people are curious about various map symbols and others need help with map orientation. Most of the questions we receive regarding topographic maps are about the difference in map scales, and what are "township, range, and section", technically referred to as the Government Land Office Grid System.

Map Scale

Map scale is the relationship between distance on a map and the corresponding distance on the ground. Scale is expressed as a ratio, such as 1:24,000, and shown graphically by bar scales marked in feet and miles, or in meters and kilometers. The table below shows the various scales of topographic maps available at the UGS Bookstore.

Maps with a small bar scale, for example 7.5-minute maps, are often called large-scale maps because they show more detail (by covering less area) than a large bar-scale (30 x 60 minute) map. To explain it another way, the smaller the ratio (1:24,000) the larger the scale, and *vice versa.*

7.5-minute Map Series

The 7.5-minute map series is the most detailed available at the UGS. This series is useful because topographic features are easy to identify, which allows for accurately determining location. Also, the clarity of topographic features makes route-finding easier. For these reasons, the 7.5-minute series is very popular and is typically used for hiking, hunting, geologic prospecting, locating real estate - the number of uses is endless. The main drawback of this map series is that several maps may be needed to provide coverage for a large area. One map covers approximately nine miles in a north-south direction and approximately 6.5 miles east-west.

15-minute Map Series

Also suitable for recreational and other activities is the 15-minute map series, which provides enough detail to determine location with good accuracy. These maps cover about four times the area of one 7.5-minute map. The U.S. Geological Survey has discontinued publishing and distributing this map series, but the UGS Bookstore stocks over 100 different 15-minute map titles.

30- x 60-minute Map Series

The 30- x 60-minute map series is useful for four wheeling, hunting, and other activities for which coverage of a large area, rather than detail, is required. Approximately 42 7.5-minute maps cover the area of one 30- x 60-minute map. This is a multi-purpose map series which shows most of the same features (for example, railroads, powerlines, unimproved roads, and highways)

Map Series	Scale	1 inch represents approximately	1 centimeter approximately	Size (latitude x longitude)	Minimum area covered (square miles)
7.5 minute*	1:24,000	2,000 feet (exact)	240 meters	7.5 x 7.5 minutes	49
15 minute	1:62,500	1 mile	625 meters	15 x 15 minutes	197
30 x 60 minute	1:100,000	1.6 miles	1 kilometer	30 x 60 minutes	1,568
U. S. 1:250,000	1:250,000	4 miles	2.5 kilometers	1 x 2 degrees	4,580

*(*Minute refers to one minute of latitude and longitude. A 7.5-minute map covers 7.5 minutes of latitude and 7.5 minutes of longitude)*

on larger scale maps, but with much less detail.

U.S. 1:250,000 Map Series

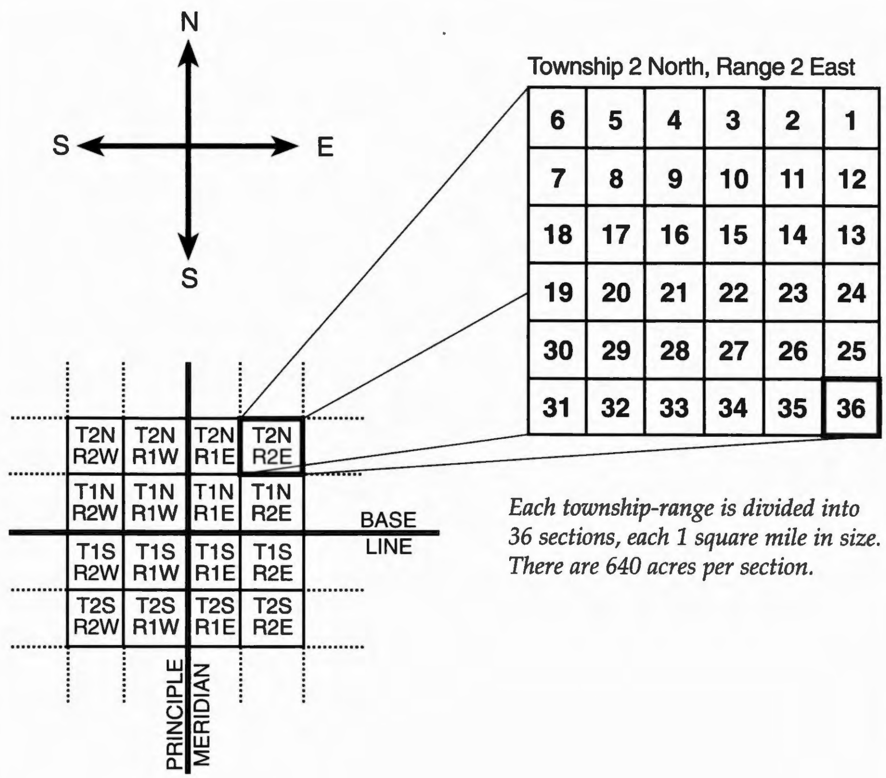
This map series is the smallest scale available at the UGS. These maps show a large area; only 13 1:250,000 maps are needed to cover the state of Utah (full state coverage using 7.5-minute maps requires 1,512 maps). The 1:250,000 map series is useful for an overall view of an area but is not recommended for back-country use because of the lack of topographic detail.

Township, Range, and Section

In 1812, the U.S. Government formed the General Land Office (renamed the Bureau of Land Management in 1946) to create a standardized system to more accurately define a given U.S. location. This system was initiated in response to the acquisition of large tracts of land, like the Lousiana Purchase, during the early 1800s. The system developed by the General Land Office is called the *Government Land Office Grid System* and is used in states west of Ohio. This system divides land into 36 square mile units called *townships*. Each township has a *township* and *range* designation to define its 36-square-mile area. Township is numbered north or south from a selected parallel of latitude called a *base line*, and range is numbered west or east of a selected meridian of longitude called a *principle meridian.*

Townships are sub-divided into 36 1-by-1-mile parcels called *sections*. Sections are numbered from 1 to 36 for identification. Sections are broken into quarters, which are further quartered to describe a property location. The figure below shows the numbering systems for township-range, sections, and quarter sections.

The office grid system is used for legal land descriptions. As an example, the legal description for the Utah Geological Survey's office on Foothill Drive is written: SE1/4NW1/4 section 23, T.1 S., R.1 E., of the Salt Lake Base Line.

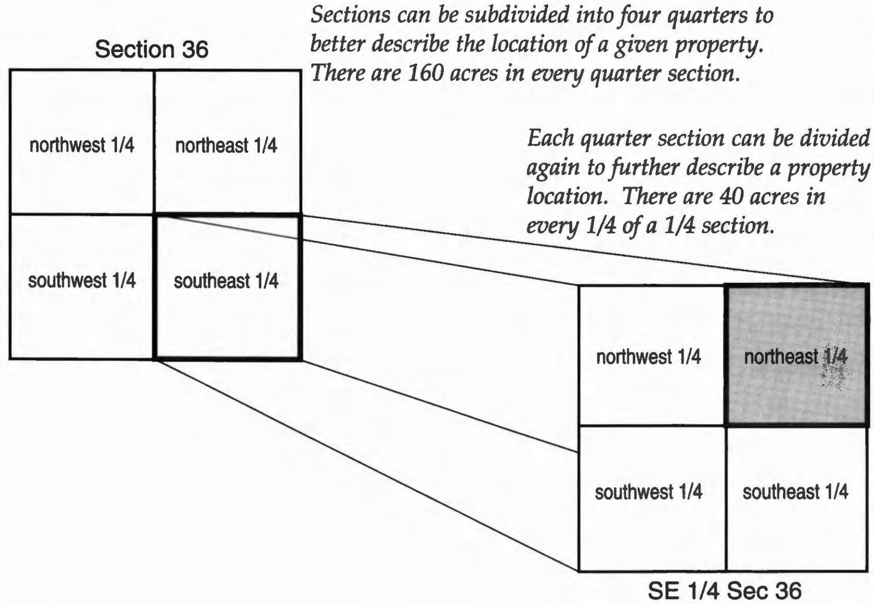


Each township-range is divided into 36 sections, each 1 square mile in size. There are 640 acres per section.

Government land office grid system defined as Township and Range. Each Township is 6 square miles in size.

Sections can be subdivided into four quarters to better describe the location of a given property. There are 160 acres in every quarter section.

Each quarter section can be divided again to further describe a property location. There are 40 acres in every 1/4 of a 1/4 section.



This complete legal description for the shaded area above is: NE 1/4, SE 1/4, section 36, T. 2 N., R. 2 E.

Energy News

Rozel Point: Harbinger of Petroleum Potential

by Thomas C. Chidsey, Jr.

Crude oil dripping from abandoned wellheads, tar on rocks and beach sands, and dead pelicans along the beach have brought the abandoned Rozel Point oil field and associated natural oil seeps, located along the north shore of the Great Salt Lake in Box Elder County, to the attention of state officials and the U.S. Environmental Protection Agency (EPA). There is no doubt that leaking wells need to be capped and that abandoned tanks and other oil-field equipment from nearly 100 years of on-again-off-again drilling must be removed. Discovered in 1904, Rozel Point is one of, if not the oldest, oil field in Utah. This fact is a significant part of Utah's petroleum-exploration history. But should that be the end of Rozel Point oil field? Recent inquires by the petroleum industry and investigations by the Utah Geological Survey suggest that major economic potential may still exist at Rozel Point and other areas beneath the Great Salt Lake.

Oil Seeps

Naturally occurring oil seeps are found throughout the world. Oil seeps in the Rozel Point area have been known since the late 1800s. Thick, black, tar-like or asphaltic oil has flowed from these seeps for hundreds, if not thousands of years. The seeps have attracted petroleum-exploration companies to Rozel Point and other areas in the Great Salt Lake since the turn of the century. Four natural seeps have been documented beneath Great Salt Lake in the direct vicinity of Rozel Point oil field; others likely exist now or did sometime in the geologic past. The oil issues from craterlets whose cones are 12 to 18 inches high and 20 to 40 feet in diameter. The seeps were observed during the low-lake level years of 1901, 1934, and 1963. The submerged seeps are irregularly distributed from the shore in an east-southeasterly direction for about a half mile.

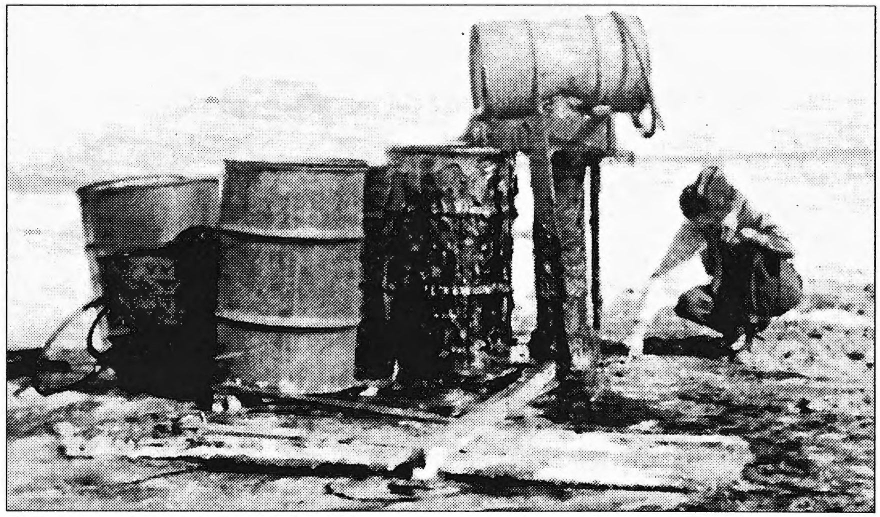
Oil migrates upward along faults and fractures in the bedrock beneath the lake before emerging from the seeps. There are no estimates of rates at which the oil flows from the seeps. When the area is covered by water, the oil issues as small, worm-like stringers. Oil also appears as numerous globules 1/4 to 1/2 inch in diameter over patches several square feet in area. The oil is very low in volatiles (gaseous constituents), resulting in a dense, semi-solid material that commonly sinks to the bottom of the lake. The oil is carried away from the seeps by waves and deposited along the shoreline around Rozel Point. In the heat of the summer, the shoreline deposits of oil warm up and slowly flow, covering the rocks, beach sands, and abandoned oil-field equipment. Most of the rocks in the Rozel Point area are boulders of black basalt (a volcanic rock formed from lava flows), which can give viewers the false impression of being completely covered with oil.

Rozel Point Oil Field

The first attempts to produce oil in the Rozel Point area began around 1904. Fifteen to 20 wells had been drilled by the end of 1956. About 31 wells were drilled on one-acre-spacing in the field between 1964 and 1969. The depths of these wells range from 125 to 300 feet. The deepest well in the field is a 3,500-foot dry hole drilled by Gulf Oil Company in 1964. The latest well, a 263-foot dry hole, was drilled in 1982 by Kenneth Pixley. The main oil reservoir is a 2- to 3-foot-thick layer of porous basalt located 80 feet below the surface of the lake. Other productive zones have been encountered between 125 and 300 feet. Oil stains on drilling samples have also been encountered in several other zones below the basalt.

It is estimated that the field has produced over 10,000 barrels of oil. The reservoir is under very low pressure, but has a reservoir temperature up to 115°F which allows the oil to flow. Wells had to be pumped and only sustained production for short periods of time (a few days or weeks) at 5 to 10 barrels of oil per day before abandonment. Some oil was produced from pipes driven a few feet into the oil seeps. All attempts to enhance production were unsuccessful including the use of down-hole electric heaters and steam injection. Unplugged wells continue to flow small amounts of oil in warm weather.

The oil produced at Rozel Point has some unusual characteristics. It contains up to 12 percent sulfur, has anomalously high nitrogen concentrations, and is highly asphaltic. The high percentages of these constituents result in an oil having a very low gravity (5° API), which makes it denser than water. Oil from Rozel Point is extremely difficult to produce and costly to refine. It is chemically similar to ichtyol, a rare substance used for medicinal purposes and thus has the potential to be an extremely valuable commodity. Higher fractions of the asphalt, when added to motor oil, are known to increase the lubricity of the oil thus making it more useful. The oil from Rozel Point has been used in the past to resurface roads and was marketed to tire companies for impregnating the cords of the tire fabric prior to the introduction of latex.



Oil seeps at Rozel Point, photograph circa 1937.

Conclusions

Plugging or capping the leaking wells at Rozel Point field is necessary. However, this activity will have little, if any, effect on the flow from nearby oil seeps beneath the Great Salt Lake, primarily because of the low-pressure nature of the oil reservoir (the higher the reservoir pressure, the higher the flow of oil). Remediation efforts on the Rozel Point oil seeps could disrupt the natural network of oil-flow pathways and might create new seeps in the area. Any remediation attempts at the site will likely be extremely expensive with little likelihood of success. Tar and oil seeps are naturally occurring phenomena found worldwide and have existed through most of geologic history. For example, the La Brea tar pits of Los Angeles are similar natural seeps that have existed for over 12,000 years. The oil seeps at Rozel Point will likely continue to flow for hundreds, perhaps thousands of years to come.

The Utah Geological Survey believes there is still a potential hydrocarbon resource at Rozel Point which can be prudently developed. The unique chemical components of the oil at Rozel Point offer several possible commercial products. Recently, several companies have been pursuing methods to economically remove the sulfur from the oil, which would result in a lighter, more easily refined oil and therefore a more marketable product. If these efforts are successful, other areas within the lake also known to contain high-sulfur oil may be developed.

UGS Paradox Basin Oil Recovery Demonstration Program Begins

On February 9, 1995 the U.S. Department of Energy (DOE) signed the contract for a major Utah Geological Survey (UGS) project entitled "Increased Oil Production And Reserves Utilizing Secondary/Tertiary Recovery Techniques On Small Reservoirs In The Paradox Basin, Utah." This five-year, $5-million-project is funded by $2.5 million from the DOE Class II Oil Recovery Demonstration Program - Shallow Shelf Carbonate Reservoirs, and through cost shares by the UGS and Harken Southwest Corporation. The UGS is the prime contractor, with Harken as its industry partner. The Utah Office of Energy and Resource Planning is also a partner on the project. Work has begun to characterize the geology and reservoirs of five small oil fields located within the Navajo Nation in San Juan County. These fields produce oil from marine, shallow-shelf carbonate reservoirs composed of algal mounds (reef-like buildups of porous limestone from ancient growths of algae). The project goal is to increase oil recovery by up to 175 percent in a selected field through geological and engineering characterization, and a field demonstration using either a water or carbon dioxide flooding technique. The resulting data and methods developed then can be used on similar reservoirs by other operators in the Paradox basin and throughout the U.S.

UGS Sample Library Participates in Pre-history Week

The Utah Geological Survey (UGS) Sample Library was pleased to participate in Pre-History Week (May 8-12) for the first time. Utah's extraordinary natural and cultural heritage is celebrated each year during this week. In addition to the paleontological activities usually associate with this event, the UGS Sample Library presented a look back in time regarding geologic processes and demonstrated how we are preserving their historical record for the benefit of the citizens of Utah. The Sample Library hosted an open house which was attended by school classes, scouts, families, and individuals. The open house included:

• An explanation of the purpose of the library followed by a tour showing examples of cores, core chips, cuttings, and oil samples. The slabbed Ferron Sandstone core from Ivie Creek showed UGS "work in progress".

• An explanation about the formation of certain rocks and minerals with free samples of each.

• A display of fossils, volcanic rock samples, and a variety of excellent mineral specimens. Guests were encouraged to pick up specimens for close examination and density comparisons.

• Supervised "hands on" activities including:

- Moh's hardness test.
- Hydrochloric acid test on several items containing calcium carbonate.
- Magnetite with magnets available.
- A "sensory corner" with: (1) a binocular microscope (sight) with an assortment of sands including oolitic sand from the Great Salt Lake and white sand from New Mexico. Some people chose to also examine things such as hair, wood, geodes, and some of the rocks and minerals, (2) molybdenite (touch) with its greasy feel, (3) sulphur (smell), and (4) salt crystals (taste).

• Gold panning was especially popular. Pyrite was used to simulate gold and participants kept whatever they found in their pans. A few took pans of the "placer ore" home to continue the search.

• A selection of earth-science and maps and publications, suitable for all age groups, which were available art no charge.

The UGS would like to thank the National Energy Foundation for maps and booklets, Akzo Nobel for salt crystals, Ed Wanless for gypsum crystals, and Kennecott Utah Copper for pyrite. Kennecott has supplied the UGS with pyrite and other minerals for education purposes for many years. We appreciate the generosity of all these people in contributing to the success of Pre-history Week at the UGS Sample Library.

. . . *continued from page 5*

———1949a, The transition between the Colorado Plateaus and the Great Basin in central Utah: Utah Geological Society Guidebook no. 4, 106 p., approximate scale 1:125,000.

———1949b, Sedimentary facies and associated diastrophism in the Upper Cretaceous of central and eastern Utah, *in* Longwell, C.R., Chairman, Sedimentary facies in geologic history: Geological Society of America Memoir 39, p. 55-81.

———1954, Structural history [of central and south-central Utah]:Intermountain Association of Petroleum Geologists Fifth Annual Field Conference, p. 9-14.

———1956, Mountain-building chronology and nature of the geologic time scale: American Association of Petroleum Geologists Bulletin, v. 40, p. 1769-1815.

———1960, The Cretaceous-Tertiary boundary in Utah: Copenhagen, Denmark, Twenty-first International Geological Congress Report, part 5, p. 14-24.

———1968, Course background (Ohio State University field work in Utah): Utah Geological and Mineralogical Survey Supplement to Quarterly Review, v. 2, no. 2, p. 1-2.

Fatal Big Cottonwood Canyon Rock Fall Prompts UGS Emergency Response

by Michael D. Hylland

About 4:00 p.m. on January 13, 1995, a rock fall occurred at milepost 8 on State Route 152 in Big Cottonwood Canyon, Salt Lake County, about 1.7 miles above the S-curve and just east of the Mineral Fork turnout. The rock fall provided a grim reminder of the potential dangers of travel in Big Cottonwood Canyon by crushing a car, fatally injuring one occupant and seriously injuring the other. Utah Geological Survey geologists investigated the site the following morning to determine the source and probable cause of the rock fall and evaluate possible imminent risk to life safety from future rock falls.

The rock fall consisted of numerous cobble- to boulder-sized rocks comprising approximately 50 to 60 cubic yards of material. The three largest boulders, one of which landed on the car and caused the fatality, measured approximately 12 x 8 x 6 feet and weighed approximately 45 tons each. The source of the rock fall was an outcrop of Precambrian Mutual Formation quartzite about 200 feet above the highway on the north slope of the canyon. The outcrop displays an intersecting pattern of natural planar fractures, some of which were open approximately 1 to 2 inches wide and were penetrated by tree roots.

The rock fall originated when part of the outcrop detached along pre-existing fracture planes as a result of weathering. Rock falls caused by weathering and erosion are common, especially during fall, winter, and spring months. Pressure from root and ice growth in bedding planes, joints, and other fractures can widen existing fractures and eventually break the rock apart.

The conditions at the site did not indicate that additional rock falls presented an immediate threat to life safety. However, continued weathering will likely cause additional rock to detach from the outcrop in the future, and the fracture spacing indicates that large rock-fall boulders can be expected. A significant long-term hazard therefore remains from future rock falls.

The rock-fall hazard is relatively widespread in Big Cottonwood Canyon. Rock falls have occurred elsewhere in the canyon in the past and can be expected in the future. The extent of exposed, fractured rock and the steepness and height of the canyon walls put severe practical limitations on reducing the rock-fall hazard in the canyon. People traveling through the canyon must keep in mind the rock-fall hazard and be alert to possible danger.

Site of Big Cottonwood Canyon rock fall. Source of rock fall shown by arrow.

Source outcrop of rock fall showing intersecting fractures. Rock-fall material detached from dark area at upper left corner of outcrop. Outcrop is approximately 15 feet high.

UGS geologist surveys rock-fall boulders that had been cleared from the highway.

The Rockhounder

Obsidian in the Black Rock Desert, Millard County

By Christine M. Wilkerson

Geologic information: Approximately 2.5 million years ago (late Tertiary Period), volcanic eruptions in the Black Spring area of the Black Rock Desert in western Utah spewed out the volcanic rocks rhyolite, pumice, and obsidian. Obsidian is a dark-colored volcanic glass formed when molten lava cools quickly. It is usually black but colored varieties range from brown to red. Snowflake obsidian, a black obsidian with whitish-gray spots (spherulites) of radiating needle-shaped cristobalite (high-temperature quartz) crystals, is also found in the Black Rock Desert. Obsidian has been used for arrowheads and primitive cutting tools, and is presently used for jewelry.

How to get there: From the west edge of Delta, Utah, travel west on U.S. Highway 6/50 about 4.3 miles to the State Highway 257 junction. Turn south on highway 257 and travel approximately 43 miles to a BLM sign displaying "Kanosh 26" and a dirt road heading east. Turn east onto the dirt road and travel about 6 miles to the sign for Black Spring. Turn right onto the Black Spring dirt road and park in the open area across from the watering trough.

Where to collect: Walk in any direction and obsidian can be found on the ground. Most pieces are black and range from 1/2 to 6 inches in diameter, but some reddish-brown and snowflake obsidian can be found.

Useful maps: Richfield 1:100,000-scale topographic map, Cruz 7.5-minute topographic map, Bureau of Land Management (BLM) Recreation and Vehicle Guide to Warm Springs Resource Area map, and Utah highway map. Topographic maps can be obtained from the Utah Geological Survey, 2363 South Foothill Drive, Salt Lake City, (801) 467-0401. BLM maps are available from the BLM Utah Office at 324 South State, Salt Lake City, (801) 539-4001.

Land ownership: Black Spring is on BLM public lands but school trust land and private land are nearby; School Trust Land (state land): section 36 of Township (T.) 23 S., Range (R.) 9 W. and section 2 of T. 24 S., R. 9 W.; private land: most of section 3 of T. 24 S., R. 9 W. (Cudahy Mine).

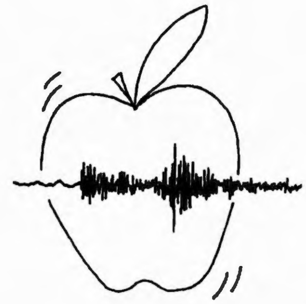
Precautions, miscellaneous: A four-wheel-drive vehicle is recommended but not required for travel on unimproved roads. Do not collect on marked claims. Bring a rock hammer and protective eyewear if you intend to break pieces of rock. A hat and water are recommended. Watch for rattlesnakes and cattle. Please carry out your trash. Have fun collecting!

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

School Trust Land collecting rules: State-owned properties are managed by the School and Institutional Trust Lands Administration and a rockhounding permit is required to collect on these lands. The annual permit costs $5.00 for individuals or a family, and $200.00 for an association/organization. With the permit, rockhounds may collect up to 25 pounds plus one piece per person per day, up to a maximum of 250 pounds per year. Commercial collectors must apply to the Trust Lands Administration for mineral leases. To obtain a rockhounding permit, please contact Teresa Wilhelmsen, School and Institutional Trust Lands Administration, 355 West North Temple, 3 Triad Center, Suite 400, Salt Lake City, (801) 538-5508.

Obsidian collected from the Black Spring area of Black Rock Desert.

Teacher's Corner



By Sandy Eldredge

Attention third- and fifth-grade teachers!

The Partnership for Earthquake Education Resources* is working to enhance earthquake education in the elementary grades. An "Earthquakes in the Science Core" project meets teachers' needs for hands-on activities and materials at the 3rd and 5th levels, addressing the topics Geological Features and Physical Features of Earth in Utah's new Elementary State Science Core Curriculum. For this project, the Earthquake Education Services (EES) of the University of Utah Seismograph Stations (UUSS) received funding from the Federal Emergency Management Agency to pay a team of teachers and to provide materials. Then, coordinating with the Utah State Office of Education and utilizing agency members of the Partnership, the project began in early 1995.

The 3rd-grade team presented its first workshop in May, 1995 to 20 teachers for field testing. This project team is comprised of three 3rd-grade teachers (Janice Flannigan, Orchard Elementary, West Valley City: Tins Fox, Dee Elementary, Ogden; and Kathy Heller, Parley's Park Elementary, Park City); Deedee O'Brien, EES Coordinator, UUSS; and Sandy Eldredge, Geologist, Utah Geological Survey. In June, the team provided the curriculum materials and instruction to 40 teachers in state-funded "train-the-trainer" workshops as part of Phase II Implementation of the Elementary Science Core Curriculum directed by Dr. Marvin Tolman of Brigham Young University.

The 3rd-grade Geological Features packet includes 26 activities and a set of slides. Currently, the packet is being revised based on teacher feedback. The trainers/facilitators in your school district will receive the revised packet this summer. We hope that the packet will help you implement the new science core. The project team is available for future workshops. For further information, contact Deedee O'Brien at the UUSS (705 W. C. Browning Building, Salt Lake City, UT 84112, telephone 801-581-6274).

The 5th-grade field-test workshop is scheduled for August. We will keep you posted on the project progress.

**The Partnership is composed of the University of Utah's College of Mines and Earth Sciences, Department of Geology, and Seismograph Stations, the Utah Division of Comprehensive Emergency Management, the Utah Geological Survey, and the Utah Chapter of the American Red Cross.*

New Utah Minerals

By Rebecca L. Hylland

Mcalpineite, $Cu_3TeO_6 \bullet H_20$.

Mcalpineite is a copper-tellurium hydrate found in the Centennial Eureka mine of the Tintic Mining District in Juab County. However, it was first identified in the McAlpine mine (the type locality), in Tuolumne County, California. Mcalpineite was named for this California mine.

At the Centennial Eureka mine, Mcalpineite was found as a coating in pore spaces in decalcified, brecciated brown-grey limestone boulders located in the mine dump. Mcalpineite was also found as cryptocrystalline nodules lining drusy quartz vugs in these same limestone boulders. Nodule sizes are small, about 1 millimeter in diameter. At the Centennial Eureka, mine Mcalpineite's color ranges from olive-green to dark green-black. It has a light-green streak and an adamantine lustre and is physically similar to a mineral called choloalite. Choloalite, however, has a vitreous lustre. Mcalpineite is nonfluorescent under all wave lengths of ultraviolet light and is brittle with an uneven fracture. Hardness and density have not been determined because the specimens of Mcalpineite that have been found are 1 mm or less in size.

Reference

Roberts, A.C., Ercit, T.S., Criddle, A.J., Jones, G.C., Williams, S.R., Cureton II, F.F., and Martin, C.J., 1994, Mcalpineite, $Cu_3TeO_6 \bullet H_2O$, a new mineral from the McAlpine mine, Tuolumne County, California, and from the Centennial Eureka mine, Juab County, Utah; Mineralogical Magazine, v. 58, no. 3, p. 414-424.

Survey News

Jo Brandt Retires from UGS Board

Utah Geological Survey Board member, Jo Brandt, completed her two terms of service to the UGS this past March. She was appointed to the UGS Board in May of 1987 by then Governor Norman H. Bangerter. Her commitment to public service began years earlier, however.

In the early 1950s, while still raising four small children, Jo began sharing her time and energy with the Salt Lake Chapter of the League of Women Voters where she served in various capacities, including one term as president, and as Executive Director from 1970 - 1979. Jo has owned a small business, been project manager for several U.S. Department of Energy grants, and served as business manager of a National Science Foundation grant.

Besides serving on the UGS Board, Jo has been a member of the Salt Lake County Zoo Advisory Board, the Community Action Board of Trustees, the Salt Lake County Community Services Block Grant Board, the nominating committee for the YWCA Board of Directors, and the President's 50 State Project on Laws That Discriminate Against Women. From 1980 to 1982, she served in the Utah House of Representatives and was an unsuccessful candidate for the State Senate.

Jo is currently employed by the State of Utah, Attorney General's Office, Division of Consumer Affairs. In that capacity, Jo continues her nearly half century of service to the local community and the State of Utah. The members of the UGS Board and the UGS staff extend their appreciation and thanks to Jo and wish her success in her future endeavors.

New UGS Board Member: Deedee O'Brien

Deedee (Edith) O'Brien was appointed by Goveror Leavitt to the Utah Geological Survey Board in March, 1995 to fill the vacancy left by Jo Brandt. Deedee, representing the "public-at-large" on the Board, brings valuable experiences in public service and education. For over 15 years, Deedee has served the public; from being a docent at the Utah Museum of Natural History, to working with refugee resettlement projects, to providing educational services to rural communities. Deedee also belongs to other boards and committees, including the Public Awareness Committee of Utah Earthquake Advisory Board and various national and local education-advisory committees.

Deedee received a Masters of Education degree from the University of Utah in 1991. Geologic-hazards education is one forté of Deedee's that has made her a recognized face at the UGS. She has been a viable force in bringing earthquake awareness to Utahns. Her continued endeavors are gratefully appreciated by the UGS.

Currently, Deedee is employed as the Earthquake Education Services Coordinator at the University of Utah Seismograph Stations and as the Community Outreach Coordinator at the University of Utah College of Mines and Earth Sciences. In both roles, Deedee continues her service to communities in the State of Utah.

A Winner

"Geologic Hazards of the Ogden Area, Utah" by a cast of thousands, but including our own Mike Lowe, Bill Black, Kimm Harty, and Bill Mulvey, and published in UGS Miscellaneous Publication 92-3 Field Guide Excursions in Utah and Adjacent Areas of Nevada, Idaho, and Wyoming, has been selected as the recipient of this year's Geology Society of America John C. Frye Environmental Geology Award. This prestigious national award will be presented during the GSA annual meeting in New Orleans in October. Congratulations.

Hunt Receives Award

In June, Governor Mike Leavitt cited seven scientists and engineers for distinguished service to the state by naming them winners of the 1995 Governor's Medal for Science and Technology. One of the recipients was **Charles B. Hunt**.

Hunt is a field geologist, writer and inspirational teacher who joined the U.S. Geological Survey in 1927. He helped map geology along the Colorado River and studied the Henry Mountains and ancient Lake Bonneville;. He served as USGS regional geologist for Utah during 1946-48.

After decades at John Hopkins University, Baltimore, and New Mexico State University, Hunt retired to Utah in 1976, continuing to produce scientific reports and advocate appreciation for the state's scenic and wild places.

Linda Bennett is our new receptionist at the Utah Geological Survey. She is a long-time resident of Utah, currently residing in West Jordan. Prior to coming to the UGS, Linda worked as a loan processor for a mortgage company for two years.

New Publications of the UGS

Resistivities and chemical analyses of selected oil and gas field, water well, and spring waters,Utah, by J.W. Gwynn, 142 p. Circular 87 .... $9.50

UGS mission flyer by C.M. Wilkerson, 2 p. PI-30. . **FREE**

Oil and gas in Summit County, Utah, compiled by R.L. Bon, information brochure, 1995 PI-31 .... **$1.00**

Thermal springs in Utah, compiled by R.E. Blackett, 1995, 1: 1,000,000 PI-32 .... **$4.00**

Characteristics of Utah coals in the University of Utah's Coal Sample Bank, by S.N. Sommer, D.M. Bodily, and E.M. Whitney, 53 p., Mar 95 RI-226 .... **$5.00**

Energy and mineral resource evaluation of School and Institutional Trust Lands in the southern Deep Creek Range, Juab County, Utah, by R.W. Gloyn, D.A. Sprinkel, B.T. Tripp, and R.E. Blackett, 36 p, May 1995 RI-227 .... **$3.00**

Resistivities and chemical analyses of selected oil and gas field, water well, and spring waters, Utah, by J.W. Gwynn, 1 diskette OFR-316DF **$5.00**

Ferron Sandstone drill-hole database, Ferron Creek to Last Chance Creek, Emery and Sevier Counties, Utah, by B.P. Hucka, S.N. Sommer, D.A. Sprinkel, and D.E. Tabet, 9 p. + 1130 p. appendix, bound in 3 volumes, May 95 OFR-317 .... **$45.00**

Ferron Sandstone drill-hole database, Ferron Creek to Last Chance Creek, Emery and Sevier Counties, Utah, by B.P. Hucka, S.N. Sommer, D.A. Sprinkel, and D.E. Tabet, 5 p., 2 diskettes, June 95 OFR-317DF **$8.00**

Engineering geologic map folio, western Wasatch County, Utah by M.D. Hylland, M. Lowe, and C.E. Bishop, 12 plates, 1:24,000 *Landslide hazards, by MD. Hylland and Mike Lowe; Flood hazards, earthquake hazards, and problem soils, by M.D. Hylland and C.E. Bishop; Suitability for wastewater disposal in septic-tank soil-absorption systems, by M.D. Hylland.* OFR-319 .... **$24.00**

Dry holes and hydrocarbon shows in Summit County, Utah by C.D. Morgan, 9 p., 1 pl., 1″=6.25 miles, May 95 OFR-320 .... **$3.00**

Petroleum plays in Summit County, Utah by T.C. Chidsey, Jr., 25 p., 10 pl., 1″=6.25 miles, May 95 OFR-321 .... **$5.00**

Mines and prospects in and around the Farmington Canyon complex, northern Utah, by R.W. Gloyn, M.A. Shubat, and Bea Mayes, 30 p. + 66 p. appendix, 6 pl., 1:100,000, June 95 OFR-325 .... **$25.00**

Petroleum production and well data, Summit County, Utah by D.A. Sprinkel, 12 p., 2 diskettes, June 95 OFR-326DF **$10.00**

Mail or Fax order to:
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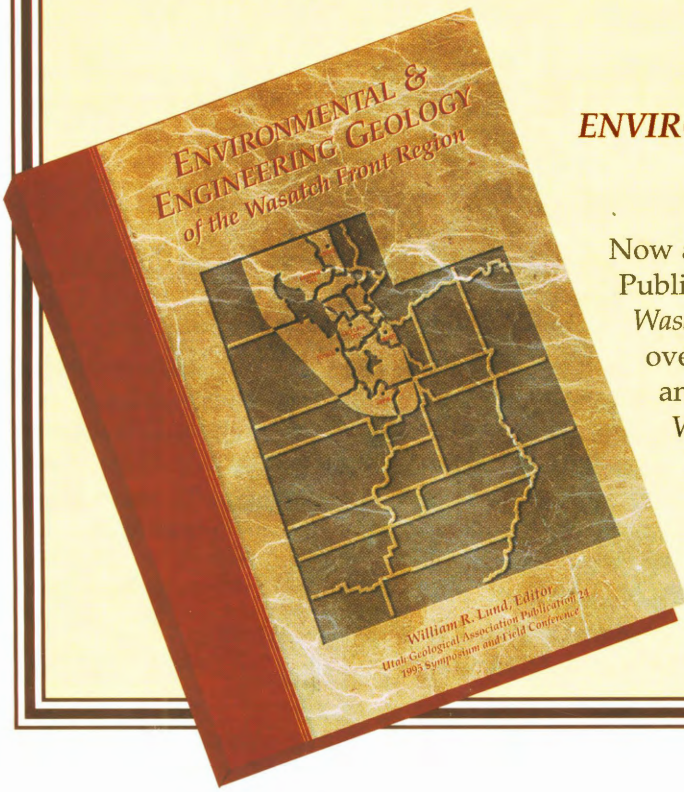

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