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SURVEY NOTES

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South Six Shooter Peak

Southeast Utah

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Design by Vicky Clarke
Cover photo: *North Six Shooter Peak with Triassic Moenkopi Formation in foreground. Photo by Michael Hylland*

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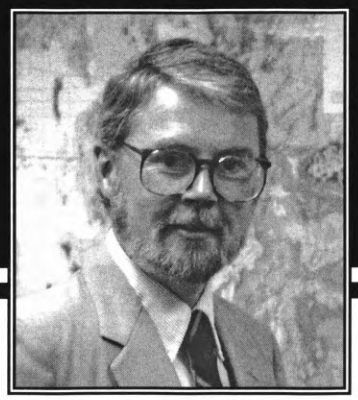


The Director's Perspective

by M. Lee Allison

UGS Activities Provide Basis for Historic Land Exchange

On May 8, 1998, Governor Mike Leavitt and Secretary of Interior Bruce Babbitt unveiled the largest state-federal land swap in the history of the nation. The state gave up slightly more than 441,000 surface and mineral-right-only acres from inside national monuments, parks, recreation areas, forests, and Indian reservations ("inholdings") in exchange for $63 million in cash and future earnings, large resources of coal (160 million tons) and coalbed methane (185 billion cubic feet), deposits of limestone, tar sands, and oil and gas, and 139,000 acres of land and mineral rights in nine counties from the Federal Government. Many of the resource assessments used to construct the exchange came from reports and studies done by the Utah Geological Survey during the previous few years.

The UGS played a pivotal role in helping to bring about that part of the exchange involving the Grand Staircase-Escalante National Monument. In the fall of 1996, just prior to the creation of the Monument, the UGS released the results of a recently completed U.S. Geological Survey study which revised greatly upward the coal resources of the Kaiparowits Plateau. This information probably created considerable pressure on the President to commit in his Monument proclamation speech to expedite a trade for school trust lands and compensate the school children of Utah for any possible lost revenue.

In January, 1997, the UGS released Circular 93, "Preliminary Assessment of Energy and Mineral Resources within the Grand Staircase-Escalante National Monument." This 47-page report provided the State of Utah material for a strong bargaining position to take to the negotiating table. Further, a series of papers presented by UGS staff at the "Learning from the Land" planning conference for the Monument held in Cedar City in the fall of 1997 helped debunk the claim that coal quality in the Kaiparowits Plateau was inferior to that of central Utah, and improved the understanding of the economic potential for titanium-bearing sands, and oil and gas deposits in the Monument.

The state negotiators also had access to a variety of published UGS reports outlining the coalbed methane potential in central Utah, coal quality and distribution in the Wasatch Plateau, and high-quality limestone and tar sands throughout the state.

As the state and federal negotiators hammered out the details of the exchange, representatives from the state's School and Institutional Trust Lands Administration (SITLA) and the Governor's office contacted UGS geologists for some quick assessments such as the coal volume and quality of a particular federal tract, or the mineral potential on some other parcel.

As spring sped by and it started to become clear that the long-awaited

Continued on page 9 . . .

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

Available Coal Resources for the Northern Wasatch Plateau Coalfield, Carbon and Emery Counties, Utah

by David E, Tabet, Jeffrey C. Quick, Brigitte P. Hucka, and John A. Hanson

Utah's most important coalfield

Coal is vital to Utah's economy since it fuels about 95 percent of the electricity generated in the state. In addition, coal is a major overseas export commodity for Utah, accounting for over $100 million in export sales in 1996. Demand for Utah coal has nearly doubled in the past 15 years.

County, state, and federal governing bodies involved with land management and economic planning rely on geological surveys to provide up-to-date estimates of the amount, type, and location of coal resources of the United States, and to describe the uncertainty of those resource estimates. The Utah Geological Survey (UGS) was funded by the U.S. Geological Survey (USGS) to conduct a new regional assessment of the amount of coal remaining for future development in the northern part of the Wasatch Plateau coalfield, which currently provides about 87 percent of the state's coal. Information used in this study was generously provided by the Utah State Office of the U.S. Bureau of Land Management, the Utah Division of Oil, Gas and Mining, the Utah Automated Geographic Reference Center, and the U.S. Mine Safety and Health Administration.

This new assessment includes calculating the amount of coal originally in the ground, as well as determining the magnitude of past mining and the potential restrictions to future mining. An important study objective was to determine how much minable coal remains and where it is located. The results of this new study will be incorporated into the current National Coal Assessment program of the USGS.

Geology and mining history

The coalbeds mined in the Wasatch Plateau coalfield occur in the 700 to 1,100 foot-thick Upper Cretaceous Blackhawk Formation (Doelling, 1972). These Cretaceous strata, as well as some younger Tertiary units, cap the highly dissected Wasatch Plateau.

The Wasatch Plateau lies along the gently inclined western flank of the San Rafael Swell in central Utah. Inclination of the strata is usually less than 6 degrees to the west or northwest. The strata of the Wasatch Plateau have been broken by a series of north-trending, down-dropped fault blocks, called grabens, which have dropped as much as 1,000 feet. The Joe's Valley and Pleasant Valley grabens cut the northern Wasatch Plateau study area.

There are 13 principal coalbeds in the Blackhawk Formation of the study area, only six of which have seen significant mining. Faulting and the lenticular nature of the coalbeds has caused some of them to be locally mis-identified or given a number of different local names. Our study attempts to clear up some past confusion regarding coalbed names. The coalbeds that have historically seen the most mining in that area are the Cottonwood, Blind Canyon, and Wattis, with lesser mining in the Axel Anderson, Bear Canyon, and Castlegate A beds.

Coal production records indicate that 351 million tons of coal had been removed from the northern Wasatch Plateau study area through the end of 1996 (Jahanbani, 1997). This amounts to 86 percent of past coal mining in the entire Wasatch Plateau coalfield.

Coal Reserves

Three types of information were used to calculate the amount of coal in the study area: the area underlain by coal, the coal thickness, and density of the coal in the ground. The UGS used a computerized Geographic Information System (GIS) to store data and to calculate and map the coal reserves. The GIS system has two great advantages: 1) when new information is added in the future, new coal reserve maps and calculations can be completed quickly; and 2) the coal reserve calculations and mapping can be rerun quickly using slightly different assumptions (for example how the remaining coal reserve picture changes when the minimum coalbed thickness is changed from 4 feet to 6 feet).

The first step was calculating the

State Paleontologist of Utah

The Utah Geological Survey (UGS) invites applications for the position of Senior Geologist (Paleontologist) of Utah (Senior Geologist). This position begins approximately November 1, 1998. Duties of the position include: (1) conducts field surveys, excavations, laboratory research, and curation, and publishes results in house and in outside publications; (2) pursues funding and prepares proposals for priority paleontology projects; (3) advises the Director of the Utah Geological Survey on paleontological issues of local, state, and national significance; (4) issues permits for paleontological excavations; and (5) promotes the paleontology of Utah through collaboration with other paleontologists, cooperation with Utah museums, support and guidance of amateur organizations, and supervision of volunteers. Preference will be given to individuals with an advanced degree in geology (paleontology specialty) or other earth science degree and experience in excavation and laboratory preparation of vertebrate fossil specimens. The UGS has just completed a new specimen preparation laboratory. Minimum starting salary $34,278 with an excellent benefit package. Submit a resume and Utah Skill Match cover sheet (which can be found at www.ugs.state.ut.us; or obtained from Cheryl Ostlund at 801-537-3300) to Department of Human Resource Management, 2120 State Office Building, Salt Lake City, UT 84114. On the top right hand corner of the Utah Skill Match cover sheet please enter 8NR9UG in the blank for the source code. In addition, applicants may contact the Department of Natural Resources Human Resources office at 801-538-7210 to ensure consideration for this position. The State of Utah is an equal opportunity employer.

amount of minable coal resources originally in the ground. Coalbed thickness data from scattered drill holes and measured sections were processed by computer to estimate the thickness and extent of each coalbed in all parts of the study area. Data distribution and spacing were used to establish various levels of reliability for the coal resource estimates. Areas underlain by the various coalbeds were measured by computer and multiplied by the thickness to calculate coal volumes. Finally, the calculated coal volumes were multiplied by the USGS's standard density factor for bituminous coal (Wood and others, 1983) to yield the tons of coal present. We calculate that the study area originally contained 5.4 billion tons of minable coal resources in beds greater than four feet thick. This new estimate is a 21 percent increase over the minable coal resources previously calculated by our agency (Doelling, 1972).

The coal resources available for future mining were calculated by subtracting the amount of coal disturbed by past mining and the amount of coal that most likely will not be mined due to engineering and land-use concerns. Areas disturbed by coal mining include abandoned and active mines as of the end of December 1996. Mining in the areas may disturb the coalbeds either directly, or by mining below higher beds and making them unminable by destroying their continuity. The amount of coal disturbed by past mining was estimated at about 1.0 billion tons.

Engineering concerns prohibit mining for various reasons including: where the coalbeds are covered by more than 3,000 feet of overlying rock; where the coalbeds thicker than 14 feet preclude the full bed height from being mined; where old mine workings require a barrier to avoid the danger of breaking through to old workings; where shallow cover has caused the coalbeds to be destroyed by oxidation or burning; or where vertically stacked coalbeds are not separated by enough intervening rock to be mined safely. Subtracting out the coal resources that have engineering restrictions on their ability to be mined eliminates approximately 0.5 billion tons of coal in the northern Wasatch Plateau study area.

Finally, the coal resources that are restricted from future mining by land-use factors were determined by applying regulatory guidelines that prohibit or restrict mining in such areas as under perennial streams, lakes, railroads, roads, pipelines, power lines, and municipalities. Land-use restrictions in the study area will likely preclude the mining of about 0.1 billion tons of coal.

Combining all the coal resource losses due to mining and due to the various engineering and land-use restrictions eliminates a total of 1.6 billion tons of coal from future mining consideration. This leaves the northern Wasatch Plateau coalfield with coal resources of 3.8 billion tons that are available for future mining. The final resource calculations and report for this study are still in the process of review for release in late 1998. The final report will present a detailed coal resources estimate for the study area, and give a further reserve breakdown by coalbed, by thickness category, by depth-of-cover category, and by resource reliability category.

References

Doelling, H.H., 1972, Central Utah coal fields: Sevier-Sanpete, Wasatch Plateau, Book Cliffs, and Emery: Utah Geological and Mineralogical Survey Monograph Series No. 3, 570 p.

Jahanbani, F.R., 1997, 1996 Annual review and forecast of Utah coal production and distribution: Utah Office of Energy and Resource Planning, 28 p., 1 appendix.

Wood, G.H., Jr., Kehn, T.M., Carter, M.D., and Culbertson, W.C., 1983, Coal Resource Classification System of the U.S. Geological Survey: U.S. Geological Survey Circular 891, 65 p.

Paradox Basin Project Yields Successful Horizontal Well

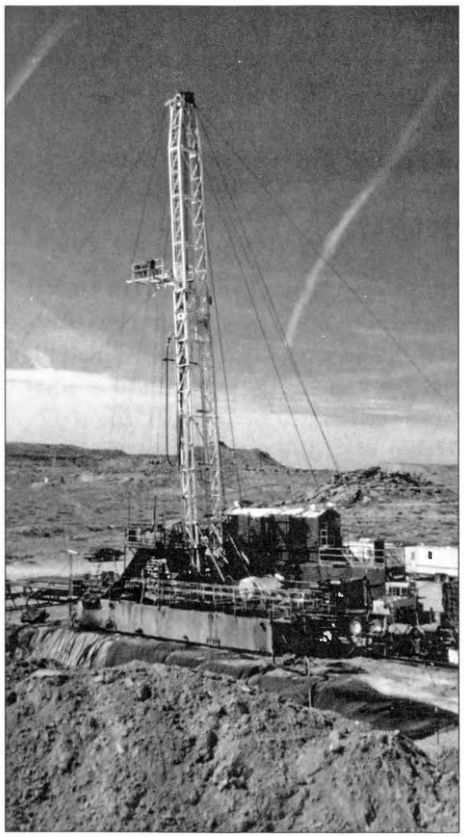
by Thomas C. Chidsey, Jr.

The successful completion of a horizontally drilled oil well in Mule field of the Paradox basin in the Navajo Nation, southeastern Utah, has geographically extended the productive area, increased the rate of oil production, and added to the recoverable reserves of the field without additional surface disturbance. The new well, the Mule No. 31-K-1, is part of a $5 million project funded by the U.S. Department of Energy with the Utah Geological Survey as prime contractor. The project is designed to increase oil reserves and production from small fields throughout the Paradox basin region using new techniques such as horizontal drilling. Harken Southwest Corporation of Irving, Texas, the Survey's industry partner, is the field operator.

Horizontal drilling technology has advanced tremendously over the past 10 years and is used widely throughout the country. In horizontal drilling, the drill bit is manipulated so that it turns to enter the reservoir (the oil-bearing rock) horizontally. Recent improvements in the driller's ability to measure and control both the direction and depth of the drill bit has greatly improved the success of this technique. One horizontal well can often drain oil and gas from a reservoir more efficiently than several vertical holes, especially in reservoirs having numerous vertical fractures containing oil.

In the Paradox basin most oil is trapped in small (1/2 to 2 square miles), reef-like mounds which formed from algae (in this case a leafy type of seaweed), rather than coral, in a shallow, warm sea 320 million years ago during the Pennsylvanian period. These mounds grew on a platform of marine muds and commonly surrounded quiet lagoons. Waves from the open sea eroded the outside part of the mounds, causing a mixture of sand and broken mound material to be deposited at the base of the mounds.

The oil fields which produce from these ancient algal mounds usually consist of from one to five vertical wells. Often, several dry holes are drilled in an attempt to determine the geographic limits of these algal mounds. Using horizontal drilling technology, wells can penetrate a greater section of rock thought to be the mound, thus increasing the chance of finding oil. In addition, a horizontal well may intersect small, isolated pockets of oil within the mound that would otherwise be missed with a vertical well. One horizontal well may produce as much as four conventional vertical wells, and the environmental impact to the surface area is significantly reduced, as are drilling costs. The Mule No. 31 K-1 well was the first horizontal well drilled in a small algal mound in the Paradox basin. The well initially

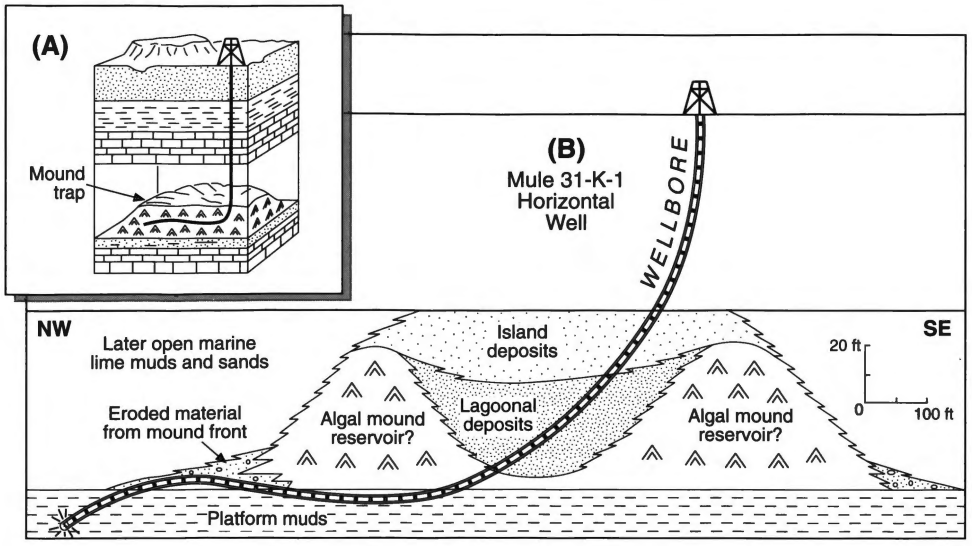


Drilling operations at the Mule No. 31-K-1 horizontal test well, Mule field, Navajo Nation, San Juan County, Utah. Photo by R.L. Bon, UGS.

flowed at a rate of 149 barrels of oil per day from the Desert Creek zone of the Paradox Formation, a good rate for successful vertical wells in the basin.

Mule field was discovered in 1991 and consists of two wells. Total pro-

duction for the field prior to the horizontal well was 382,241 barrels of oil. New seismic data (showing the depth and areal extent of potential petroleum traps by measuring the time it takes for shock waves, generated by exploding dynamite, to bounce off the various rock layers) acquired as part of the project, indicated that Mule field is a lenticular, north to northeast-trending, linear mound having additional reservoir potential to the northeast. Harken and the UGS determined the most economical way to penetrate a significant portion of this potential algal mound reservoir was to drill horizontally in a northwest direction.



(A) Schematic block diagram of a horizontal well penetrating a small algal-mound oil trap, and (B) a vertical cross section of the rocks below ground surface in the Mule mound penetrated by the Mule No. 31-K-1 horizontal well.

After drilling to a depth at 6,029 feet, the drill bit was turned and went a horizontal distance of 939 feet. At first the well encountered rocks that represent possible sandy islands that developed on top of the mound. Then the drill bit penetrated lagoonal rocks instead of the main algal mound. These deposits were followed by shale possibly representing the muddy platform upon which algal colonies grew. After drilling a horizontal distance of 142 feet, the drill string was directed upward in an attempt to find the mound but encountered only rocks representing material eroded off the front of the mound by waves. The drill was turned downward after penetrating an additional 500 horizontal feet of these "mound-front deposits," and the well returned to the muddy platform rocks where drilling operations were halted on March 26, 1997. Although the well never encountered the main algal mound reservoir, several zones having indications of good reservoir quality (such as pores, which are small holes in the rock capable of storing oil, and oil staining) led the operator to attempt a well completion. The Mule No. 31-K-1 horizontal well was completed open hole (without metal pipe [casing] in the hole) following treatment with acid used to clean the wellbore, and has produced 3,730 barrels of oil after 2 1/2 months.

The success of horizontal drilling at Mule field can provide the impetus for other operators to apply the technique to the 100-plus similar small fields in the Paradox basin of Utah and Colorado. The results could be field extensions and more complete reservoir development. Horizontal drilling could also be used to increase the success of exploring for new fields in the region. Ultimately, Paradox basin oil production and reserves may increase while drilling costs and environmental impact are reduced due in part to the success at Mule field.

The Ferron Dino Block

Two years ago State Paleontologist Dave Gillette began the excavation of an articulated Allosaurus skeleton from the upper Jurassic Morrison Formation in the San Rafael Swell of central Utah (see UGS *Survey Notes* v. 29, no. 11, December, 1996). The excavation was finally completed this spring when the 2,500 pound block containing the skeleton was brought back to the newly completed prep lab at the UGS Sample Library.

The photo shows the Ferron dinosaur block in its massive plaster cast being carried down the hill.

"Glad You Asked"

by Mark R. Milligan

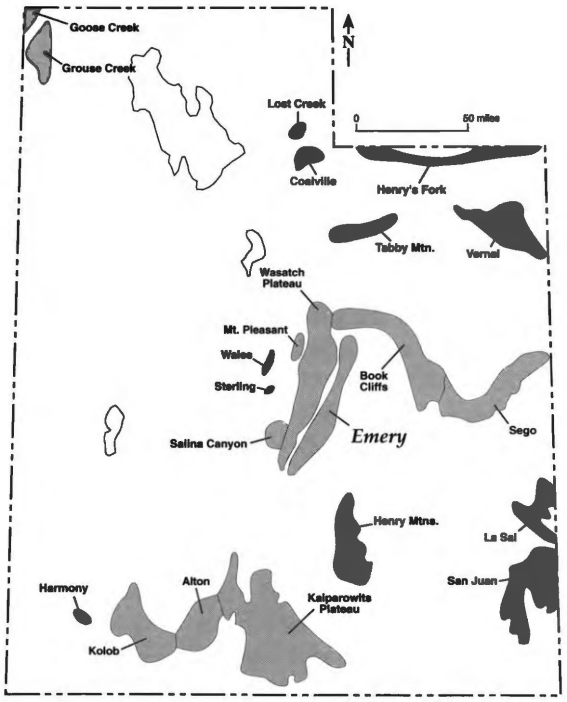
What are "colloidal mineral supplements" and where do they come from?

"Colloidal mineral supplements" are cloudy liquids marketed as dietary supplements under many product names. Suppliers claim they provide minerals not available from today's foods. To a believer in alternative medicine, these items are touted to have the power to greatly improve your health by providing numerous essential minerals. To a skeptic, they are nothing more than snake oil sold to unwary fools. As a geologist, not a doctor, I am unsuited to comment on positive, negative, or non-existent potential health effects. What I can address is the geology of the rocks used to produce these products in Utah.

Soaking specific types of pulverized shale in water allows some of the shale's organic matter to dissolve, creating a liquid that is termed a shale leachate. "Colloidal mineral supplements" are nothing more than shale leachates. Fine particles, which do not dissolve, are also suspended in these leachates. At least some, if not all, of these elixirs are water-leached from carbonaceous shales mined from the Emery coalfield of Emery County in central Utah (more specifically the "G" bed / middle coal zone of the Ferron Sandstone Member of the Mancos Shale). The Ferron Sandstone was deposited approximately 90 million years ago during the Late Cretaceous, near the close of the age of dinosaurs.

Within a coalfield, individual zones and beds vary in their ratio of carbonaceous material (altered plant mater- ial) to sediment (clay, silt, and sand). Carbonaceous shales are interbedded with purer coal, but contain much more inorganic silt than coal and are thus not useful as a fuel. However, the organic matter in these shales is essentially the same as the organic matter that composes purer coal.

The organic matter in the shales and coals originated as plant material that accumulated in wetlands and bogs. The organic matter began to change to peat when bacteria broke down the plant material. The peat was then buried by sediment and more plant material, which raised the temperature and pressure. As the peat was compressed, water, carbon dioxide, and methane gas were forced out. With increasing heat and pressure the peat was converted to the types of organic matter found in coals and carbonaceous shales. After a great length of time, uplift and erosion have exposed the coalfields so they can be mined at or near the surface.



Index map of Utah coalfields.

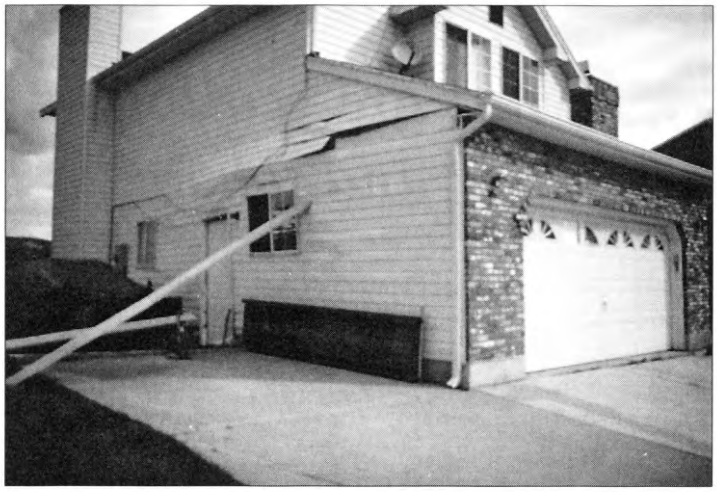
At the surface, weathering further alters the carbonaceous shales before they are mined. After being mined, the carbonaceous shale is crushed and then soaked in water. After a period of time, perhaps 3 to 4 weeks, the water (leachate) is filtered off, bottled, and marketed as a "colloidal mineral supplement."

(Some of the information in this article was taken from the Society of Organic Petrology Newsletter, March 1997, Volume 14, Number 1.)

Spring Landslides Keep UGS Busy

by Gary E. Christenson

Following two years of above-average precipitation, this spring was northern Utah's most active landslide season since the early 1980s. The northern Wasatch Front was particularly hard-hit as a result of snowmelt from last winter's lake-effect storms and well-above-average winter and spring precipitation. Luckily, damage was not extensive, although many of the landslides retain the potential to produce significantly more damage in coming years. One of the most damaging landslides was in Layton, where one house was condemned and two others were damaged. Landsliding along the Davis-Weber Canal in South Weber threatened to block the canal, forcing canal operators to post heavy equipment along the canal to remove debris and keep it open. Other landslides occurred elsewhere in South Weber and Layton, as well as in Ogden and Salt Lake City. Some of these landslides disrupted backyard landscaping and may eventually damage houses. Over the summer, an area of slow ground movement and suspected landsliding became evident in North Salt Lake. One house has been condemned, several others were severely damaged, and an entire neighborhood remains potentially at risk, making this the most damaging of the year's earth movements.



Condemned house damaged by the Sunset Drive landslide in Layton.

Another area hard-hit this spring by wet conditions and resulting landslides was Spanish Fork Canyon, where both the Shurtz Lake and Thistle landslides were reactivated. Last year's Shurtz Lake landslide moved another 50 feet, and reactivated a large mass of prehistorical landslide debris between the 1997 Shurtz Lake landslide and the Spanish Fork River, essentially doubling the volume of material involved. Also, nearly the entire Thistle landslide, except for the old landslide "dam" across Spanish Fork Canyon, moved in late May and early June. The landslide actually increased in size at the head as a large area about the size of several football fields rotated and slid downslope. In addition, a debris flow occurred in Joes Canyon, a tributary to Spanish Fork Canyon about 3 miles downstream from the Thistle landslide. Although the debris flow didn't damage any buildings, it further

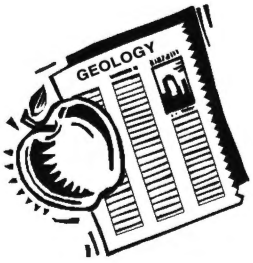
Landsliding into the Davis-Weber Canal, South Weber.

Landslides above the Cedar Bench subdivision, South Weber.

Debris-flow levees along Joes Canyon, Spanish Fork Canyon.

highlighted the unusual conditions this spring in Spanish Fork Canyon.

Most of the 1998 landslides were on steep slopes characterized by older historical and prehistorical landslides. They highlight the dangers inherent in hillside development, particularly on or near old landslides, and the need to consider landslide hazards prior to development. Because of the threat to life and property, and the fact that homeowners insurance does not cover landslide damage, developers and local governments must share a responsibility to ensure that hillside development is safe from landslides.



Teacher's Corner

by Sandy Eldredge

New and Improved Rock, Mineral, and Fossil Kits!

During the past school year, the Geologic Extension Service (GES) loaned out approximately 25 rock, mineral, and fossil kits to teachers and several boy scout leaders. With an increasing demand for this item, we have decided to upgrade the kits to further aid teachers. By October, each box will contain additional minerals, a magnifier, a streak plate, and oolitic sand. In addition, GES staff are working on "suggested activities" that will be included in the kits, and are continually upgrading the quality of rock and mineral samples when possible.

The kits, which contain over 40 identified specimens, are available for a one-month loan with a $15.00 refundable deposit.

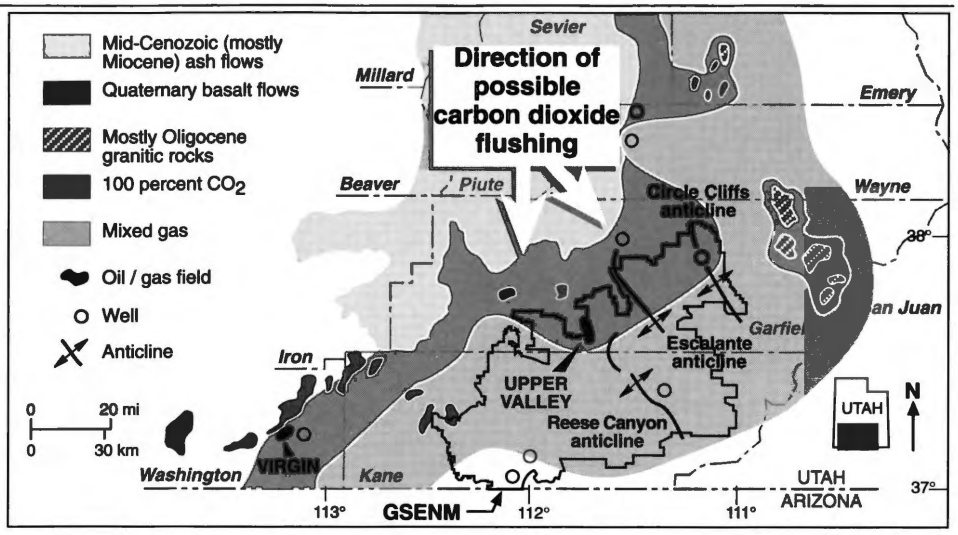
Dinosaur Teaching Kits are also available that contain authentic and cast specimens, slides, publications, and other teaching aids. These kits are available for a two-week loan with a $25.00 refundable deposit.

All kits must be picked up and returned to the UGS offices (Suite 3110) in the Department of Natural Resources Building, 1594 West North Temple, Salt Lake City.

You may call ahead to reserve kits: contact the GES staff at 801-537-3300 for the rock kit or Martha Hayden at 801-537-3311 to reserve the Dinosaur Teaching Kit.

Energy News

New Study Suggests Oil, Gas Deposits in Grand Staircase May Have Been Moved by CO_2



The search for oil is as much a determination of where it isn't as an exploration of where it is. Economic geologists with the UGS, analyzing data from numerous wells in the Grand Staircase-Escalante National Monument, have come up with an interpretation that could narrow the search for oil in that region.

The new theory is that igneous activity north of the region some 30 million years ago generated carbon dioxide (CO_2) and other non-hydrocarbon gases. These gases, together with deep ground-water flow through the region, may have moved oil and gas to the flanks of geologic folds, called anticlines, away from where such deposits could expect to be found – in the process creating several stacked drilling targets. The effect of this natural CO_2 flood could have been so dramatic as to have flushed oil deposits completely out of the region and into northern Arizona.

Recent drilling by oil exploration companies has targeted the 570 million-year-old Cambrian Tapeats Sandstone on the crests, or highest points, of anticlines. In light of the new theory, geologists may want to look for oil on the flanks of the anticlines that are south of the presumed source of the CO_2 and other non-hydrocarbon gases.

The theory is authored by Thomas C. Chidsey, senior scientist and head of UGS's petroleum section; Douglas A. Sprinkel, senior geologist in the section; and Lee Allison, UGS director and State Geologist. Chidsey presented the theory at the American Association of Petroleum Geologists annual meeting in Salt Lake City in May.

AAPG Convention '98 a Grand Success

For four days in May, Salt Lake City, the Utah Geological Association, and the Utah Geological Survey hosted the world of oil exploration.

The American Association of Petroleum Geologists, the largest geoscience association in the world with a membership of over 30,000 people in 115 countries, had its annual convention in Salt Lake City from May 17 to 20. Nearly 6,300 people from 83 countries attended, adding approximately $10 million to the local economy. The main hall of the Salt Palace was filled with 201 commercial exhibitors, 57 educational presentations, and 45 international pavilions.

The UGA was the host society for the meeting, and Lee Allison, director of the UGS, served as general chair for the event. Several UGS staff conducted workshops, led field trips around the region, or presented scholarly papers or poster sessions. In addition, Sandy Eldredge, program manager of the UGS's Geologic Extension Service, coordinated workshops and field trips for more than 100 elementary- and secondary-school science teachers.

In promoting the event, the May issue of AAPG Explorer, an industry magazine that goes to the organization's worldwide membership, recounted the history of oil exploration and production in Utah. The cover featured a panoramic photo of Waterpocket Fold in Capitol Reef National Park. A later edition featured an extensive interview with the authors of the study on Grand Staircase-Escalante National Monument oil and gas deposits.

Because of the success of the 1998 convention, the AAPG has expressed interest in returning to Salt Lake City in 2006.

UGS Board, AAPG Encourage Resource Development in GSENM

The UGS Board and the AAPG, in separate actions, have called for continued development of energy resources in the GSENM.

The actions came in the wake of a final agreement between Utah and the U.S. Department of Interior on trading out state trust lands in the Monument. The UGS Board, at its regular quarterly meeting in June, passed a resolution urging the BLM to "allow and encourage prudent and responsible access to and exploration and development of mineral resources" in the Monument. The Board further resolved that the director of the UGS "utilize whatever resources and facilities at hand to accomplish this goal."

The AAPG issued a position paper a week later supporting "continued access to the [Monument] for petroleum and mineral exploration and development activities." The AAPG statement suggested that royalties from production "be paid into a trust fund to be used to maintain and improve the national park system, making the Monument a 'working asset' for the benefit of all citizens of the nation."

"At a minimum," the statement concluded, "the prospective areas of the Monument should be designated 'National Strategic Energy Reserves' for use in time of national emergency as determined by the President of the United States."

Director's Perspective continued . . .

exchange might become reality, the UGS also advised the State Office of Education (SOE). SOE is the recipient of interest from the trust funds managed by SITLA for the school children of Utah. They rightly worried whether the proposed deal was the best possible, or whether additional drilling, sampling, and testing might increase the recognized value of the state's resources. Without endorsing the draft exchange proposal, a UGS team provided extensive briefings on the cost of additional exploration and the nature of exploration risk. Finally, as part of a review for SITLA, the UGS concluded that the proposed coal and coalbed methane resources to be exchanged were approximately equal in value.

The agreement between the state and the U.S. government was inked a few weeks later at a public ceremony at the Governor's Mansion. All sides in the land debate have endorsed the exchange and it now only requires Congressional and Presidential approval, which is expected to occur in the near future.

Utah Schools & Federal Land Exchange

May 8, 1998

On May 8, 1998 Governor Mike Leavitt and Secretary of the Interior Bruce Babbitt unveiled a historic land swap between the state and the federal government. The agreement includes a $50 million cash payment for the school children of Utah, plus additional land, coal and other mineral resources. The epic agreement also ensures protection for critical land in national parks, forests, Indian reservations and the Grand Staircase-Escalante National Monument. The agreement will implement the largest public land exchange identified anywhere in the continental United States.

The agreement is the culmination of weeks of delicate negotiations after decades of disagreement. It benefits both parties, who have struggled for decades over issues of land ownership patterns, energy development and environmental protection.

THE AGREEMENT

The Federal Government Receives:

- All state inholdings in the Grand Staircase-Escalante National Monument: 176,699 acres
- All state land inholdings in Utah's National Parks/National Recreation Areas: 80,000 acres
  Arches National Park, Capitol Reef National Park, Dinosaur National Monument, Glen Canyon National Recreation Area, Flaming Gorge National Recreation Area
- All state inholdings in the Navajo and Goshute Indian Reservations: 47,480 acres
- Nearly all state inholdings within the National Forests: 70,000 acres
  Wasatch-Cache National Forest, Sawtooth National Forest, Ashley National Forest, Caribou National Forest, Uinta National Forest, Manti-La Sal National Forest, Fishlake National Forest, Dixie National Forest, Desert Range Experimental Station
- Alton Coal Field tracts previously designated unsuitable for mining: 2,560 acres
- Total Surface Acreage to be Received by the Federal Government: 376,739 acres
- Additional Mineral-Rights-Only Acreage: 65,852 acres

The State of Utah Receives:

- $50,000,000 in cash upon completion
- $13,000,000 additional to be generated from the sale of unleased coal, for the benefit of the Utah Permanent School Fund
- More than 160 million tons of coal
- 185 billion cubic feet of coal bed methane resources
- Approximately 139,000 acres of land and minerals in nine counties
- Other minerals including limestone, tar sands, and oil and gas.

Survey News

Personnel Moves

Carl Ege, who recently earned his bachelor's degree in geology and environmental earth science, is the new Information Specialist in the Geologic Extension Service Program. Carl had been a revenue technician in the Natural Resources Map & Bookstore. He will continue his responsibilities there and in addition will now work with DNR divisions to assess and create materials to accommodate customer needs.

Mike Hylland has returned as UGS's technical reviewer. Although his prime duties are in the Mapping Program, Mike will continue with projects there while reacquiring the duties and responsibilities of chief judge and arbiter of all matters relating to technical review.

Bea Mayes, an institution at UGS for 13 years, has retired. She joined the Survey in 1985 after a career in teaching. Initially a geotechnician with the Economic Geology section, she transferred to the Applied Geology Program in 1991 and in 1996 took over editorship of Fault Line Forum, a publication of the Utah Seismic Safety Commission. Following her retirement on May 27, she headed for the Greek Isles, but indications are that she hasn't slowed down one bit.

Trent McNair has taken his skills to the private sector. A former revenue technician in the Natural Resources Map & Bookstore, Trent is finishing his degree work in computer sciences and received an offer from a private concern that he just couldn't refuse.

Welcome to new employees **Cory Bird** , **Christopher Ditton** and **Vanonda Kern**. Cory is the new Associate Director, replacing Garth Blanchard, who took a position in private industry. Cory worked as a division finance manager for the Utah Department of Environmental Quality. He has an accounting degree from Utah State and has experience in contract management, risk assessment, appropriation requests, and government finance and budgeting functions.

Christopher and Vanonda are the new revenue technicians in the Natural Resources Map & Bookstore. Christopher majored in geography at the University of Utah, specializing in geographic information systems, and plans on pursuing a career in wildlife management and conservation. Vanonda has an associate's degree from Mountain West Junior College. She worked for the Department of Health prior to joining the UGS staff.

Outside Publication

Mike Lowe co-authored the article, "Evaluating Debris-Flow Hazards in Davis County, Utah -- Engineering versus Geological Approaches," in Welby, C.W., and Gowan, M.E., editors, A Paradox of Power -- Voices of Warning and Reason in the Geosciences: Geological Society of America, Reviews in Engineering Geology.

Bill Lund co-authored "Preliminary Results, Paleoseismicity and Seismic-Hazard Investigation of the Hurricane Fault, Southwestern Utah and Northwestern Arizona" for Seismological Research Letters and "Quaternary History and Rupture Characterization of the Hurricane Fault, Southwestern Utah and Northwestern Arizona" for the Geological Society of America Abstracts with Programs.

Mark Milligan co-authored the abstract "A Sequence Stratigraphic Overview of Sandy and Gravelly Lacustrine Deltas Deposited along the Eastern Margin of Late Pleistocene Lake Bonneville, Northern Utah and Southern Idaho," which was part of the Utah Geological Association Guidebook 26: Modern and Ancient Lake Systems.

Craig Morgan co-authored "Secondary Oil Recovery (Water Flood) from the Lower Green River Formation, Central Uinta Basin, Utah" for UGA Guidebook 26: Modern & Ancient Lake Systems, and the article, "Bluebell Field, Uinta Basin: Reservoir Characterization for Improved Well Completion and Oil Recovery," in the June, 1998, edition of AAPG Bulletin.

Presentations

At the American Association of Petroleum Geologists annual convention in Salt Lake City from May 17-20: **Tom Chidsey** presented the poster session "Reservoir Characterization of a Heterolithic Carbonate Mound, Runway Field, Paradox Basin, Utah"; **Craig Morgan** presented the poster session "Second Field Demonstration of Completion Techniques in a DOE Class 1 Fluvial-Dominated Deltaic Lacustrine Reservoir, Uinta Basin, Utah"; **Doug Sprinkel** presented the poster session "Optimization of Heavy-Oil Production by Steamflood from a Shallow Sandstone Reservoir, Midway-Sunset Field, Southern San Joaquin Basin, California"; and **Dave Tabet** presented "Migration as a Process to Create Abnormally High Gas Contents in the Ferron Sandstone Coal Beds, Central Utah" in a technical session.

Francis Ashland presented "Investi-

gation and Mitigation of a Piping-Induced Slope Failure, Spanish Fork, Utah" to the 33rd Symposium on Engineering Geology & Geotechnical Engineering in Reno, Nevada, on March 27.

At the Seismological Society of America 93rd annual meeting in Boulder, Colorado, on March 16, **Bill Black** presented "Surficial Geologic Mapping and Paleoseismic Investigations on the West Cache Fault Zone, Cache County, Utah"; and Bill Lund presented "Preliminary Results, Paleoseismicity and Seismic-Hazard Investigation of the Hurricane Fault, Southwestern Utah and Northwestern Arizona."

Bob Blackett presented "Geology, Resources, and Planning Efforts for the Grand Staircase-Escalante National Monument" to the Society of Mining Engineers in Salt Lake City on February 19; to the Dixie Geological Society in St. George on May 21; and to the Rocky Mountain Regional GSA meeting in Flagstaff, Arizona, on May 25.

J. Wallace Gwynn presented "Mineral Production from Great Salt Lake, Utah" to the American Institute of Chemical Engineers meeting on April 9.

Barry Solomon presented the poster session "Surficial Geologic Mapping on the West Cache Fault Zone, Cache County, Utah," which was co-authored by Bill Black, to the Rocky Mountain Regional GSA meeting in Flagstaff, Arizona, on May 26.

Bryce Tripp presented a slide show on "Plans for the 35th Forum in Utah" to the 34th Forum on the Geology of Industrial Minerals in Norman, Oklahoma, on May 4.

Field Reviews, Field Trips,& Short Courses

Bob Biek and **Janice Higgins** led field reviews of new geologic mapping in Washington County, Utah, Bob in the Hurricane quadrangle on April 29 and Janice in the Washing-

Architect of Change in UGS
Bill Hewitt

William P. Hewitt, Ph.D., the second director and the architect of fundamental changes in the Utah Geological Survey, died Saturday, April 11, 1998, in Austin, Texas He was 89.

Born in Manila, The Philippines, in 1909, Hewitt earned his doctorate in geology at Columbia University. He was named director of what was then called the Utah Geological and Mineralogical Survey in 1961 by the University of Utah administration, succeeding Arthur L. Crawford. He also served as a professor of geology at the school.

As director, Hewitt was responsible for refocusing the Survey on economic rather than scientific geology, bringing it in line with the intentions of the State Legislature. In 1963, Hewitt succeeded in convincing the state to set aside a portion of mineral income to help fund the agency. With a strengthened budget assured, Hewitt instituted mineral appraisals of state-owned lands and detailed geologic studies of mining districts, coal deposits, oil-impregnated sandstone deposits, and oil and gas fields. In addition, he increased the agency's participation in a study of the brine chemistry of Great Salt Lake, which led to the continuing development of mineral extraction industries.

While focusing on economic geology, Hewitt also began to place more emphasis on the hazards that characterize Utah's unique geologic makeup. He created the Urban and Engineering Geology section to study foundation conditions, slope stability, landslide and flood hazards, and seismic phenomena such as earthquakes and surface fault rupture. In addition, environmental issues were addressed, with the agency acting as a consultant to the state Division of Environmental Health. The Survey concentrated on new residential subdivisions, hazardous waste sites, and sewage lagoons.

Under Hewitt's leadership, the Survey's publications grew to include 30 bulletins, three coal monographs, 48 special studies, nearly 100 reports of investigations, 19 water resources bulletins, 13 oil and gas field studies, an earth science series, and a quarterly newsletter. He also helped secure federal grants and contracts to fund further coal and oil studies.

Work by the Survey under Hewitt's direction helped Utah secure ownership of Great Salt Lake, including its water, bed, shoreline, and relict lands. The Survey continues to play a strong role as advocate for the state's interest in boundaries of national parks, monuments, recreation areas, proposed wilderness areas, and particularly the assessment of mineral value of state lands.

In 1973, the State Legislature transferred the administration of the Survey from the University to the Department of Natural Resources, and Hewitt became the official State Geologist of Utah. Hewitt retired from his post in 1974.

Kudos

David B. Madsen, Ph.D., who for 25 years has successfully integrated public service with scientific research, was awarded the 1997 Governor's Medal for Science and Technology at a luncheon at the Governor's Mansion on May 27. Madsen is the third UGS recipient of this medal; the others are Lehi Hintze and Hellmut Doelling.

Now a senior scientist with the Utah Geological Survey, Madsen served the Utah Division of State History as State Archaeologist from 1973 to 1994. He is an internationally recognized authority on the archaeology of Utah and western North America, and is the world's leading expert on the Fremont, a prehistoric culture unique to Utah and surrounding states.

A native of Utah, Madsen is the author or co-author of 13 books and monographs and more than 70 scholarly papers. He was instrumental in creating and stimulating the growth of the State Paleontology Program, the Utah Professional Archaeological Council, and the Utah Statewide Archaeological Society, which now has nine chapters. His recent projects - assessing environmental change in western Utah, anthropological archaeology in the Bonneville Basin, and archaeological settlement patterns and adaptive strategies in the western U.S. and northern China - are landmark studies that have been supported by a series of research grants from the National Science Foundation, the National Geographic Society, and the U.S. Department of Defense.

Many of Madsen's research projects have been cooperative ventures with academic institutions in China, Mongolia, and the U.S. He is currently an adjunct professor of geography at the University of Utah and a visiting research professor at Ningxia Institute of Archaeology in China. His 1989 book, "Exploring the Fremont," remains a staple at Utah park and museum bookstores.

ton Dome quadrangle on April 28.

Co-leaders for field trips at the AAPG convention included **Bill Case** and **J. Wallace Gwynn** for "Geology of the Great Salt Lake and Antelope Island, Utah" (Bill combined the field trip with a teacher workshop); **Tom Chidsey** for the UGS-sponsored "Stratigraphic Framework for Reservoir Modeling in Fluvial-Deltaic Deposits: A Parasequence Level Analysis and Reservoir Characterization of the Ferron Sandstone, Utah" (he also hosted the companion short course, "Core and Reservoir Modeling Workshop: Fluvial-Deltaic Nearshore Sands of the Ferron Sandstone"); **Hellmut Doelling** and **Doug Sprinkel** for "Classic Geology of Zion and Bryce Canyon National Parks and the Grand Staircase-Escalante National Monument, Utah"; and Doug again for "Stratigraphy and Structure of the Sevier Thrust Belt and Proximal Foreland-Basin System in Utah: A Transect from the Sevier Desert to the Wasatch Plateau"; **David Gillette** for "Jurassic Morrison Dinosaurs of Utah and Colorado"; and **Mark Milligan** for "Modern Lacustrine Environments, Lake Bonneville-Great Salt Lake, Northern Utah."

Bill Lund was a field-trip co-leader for the fourth annual Utah Ground-Water Conference in St. George on May 22.

Utah will celebrate Earth Science Week, October 11-17, 1998, joining 16 other states in recognizing the importance of earth science in our lives. Visit our web page for activities at http://www.ugs.state.ut.us. The next issue of Survey Notes will have more information, including the proclamation signing by Governor Leavitt.

UGS to Host International Meeting of Paleontologists

For only the second time this century, Utah's extensive paleontological treasures will be showcased at a meeting of the Society of Vertebrate Paleontology. The group will gather from September 30 to October 3 at the Snowbird Ski and Summer Resort.

The last time this international organization came to Utah was in 1952, when it met in the Field House of Natural History in Vernal. A much smaller group then, the Society expects to bring more than 800 vertebrate paleontologists to Utah for its 58th annual meeting.

The Utah Geological Survey and the Utah Friends of Paleontology, a statewide volunteer group sponsored by UGS, are the local hosts. State Paleontologist David Gillette is the host committee chair and UGS staffer Martha Hayden serves on the committee.

The meeting will feature symposia on Gondwana dinosaurs, three-dimensional scanning and computer modeling of vertebrate fossils, and research on government lands. In addition, for the first time, there will be a teacher's workshop on learning from the fossil record. Field trips are scheduled to include visits to vertebrate-rich sites in Utah, Idaho, Wyoming, and Colorado.

The Rockhounder

. . . takes a trip to the beach - clams, oysters, scallops, and snails - 180 million years old, near Mt. Carmel Junction, Kane County

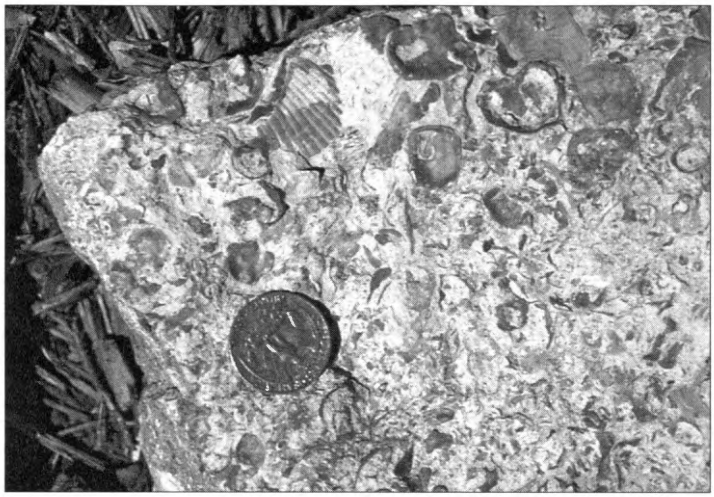
by William F. Case

Geologic Information: During the middle of the Jurassic Period, between about 180 and 170 million years ago, a narrow, shallow sea extended into Utah from the north. Sediments which formed the Carmel Formation were deposited during this time; they are thin to relatively thick, brown coastal sand bars and beach sandstones, limestones, dark reddish-brown and yellowish shales, and beds of alabaster. In many places the Carmel Formation rocks are colorful and appear "banded" because of alternating dark-red beds and light-colored beds. The Co-op Creek Limestone Member of the Carmel Formation is found at this fossil collecting locality at Mount Carmel Junction. The Co-op Creek Limestone Member is a light-gray to tan limestone and limestone shale in thin to medium-thick beds, in which fossil clams, oysters, scallops, snails, and tiny star-shaped columnar fragments of a sea-lily are found. According to the fossils and rock types, the Co-op Creek sea was probably warm and shallow with lagoons, sometimes almost completely drying up. The presence of wind-blown silt and sand from the land to the west and surf-fractured shells attest to occasional strong storms.

How to get there: Mount Carmel Junction is in southwestern Utah at the intersection of Utah Highway 9, which leads to Zion National Park, and U.S. Highway 89, which extends north from Kanab and the Utah-Arizona state line. The fossil collecting area is just south of the town of Mount Carmel Junction at milepost 81 on U.S. Highway 89. Turn east onto a gravel road which leads to a Utah Department of Transportation (UDOT) building just off of Highway 89. Fossils are found in the low rock cliffs north of the UDOT building along the remnants of the old highway.

Where to collect: Look at the float (pieces of rock that have fallen on slopes at the base of cliffs) lying on the soft slopes below the cliffs to find rocks with fossils. The fossil-bearing rock is a light-brown sandy limestone about 2 to 6 inches thick. Once the rock with fossils is found, look for the same rock when you explore the cliffs.

Useful maps: A Utah state highway map will show how to get to Mount Carmel Junction and U.S. Highway 89. The Mount Carmel Junction 1:24,000-scale U.S. Geological Survey topographic map may also be useful.



Fossil shellfish including oysters and scallops in the Co-op Creek Limestone Member of the Carmel Formation.

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

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

Miscellaneous: The usual geological exploring stuff is recommended - hammer, small chisels, newspaper to wrap rock specimens, bags to carry wrapped rocks, 10x hand lens, and 3-5x magnifier. Take clothing to suit the time of the year. Also, if you want to learn more about the geology of the area, obtain one or more of the following books (in order of relevance): The Geology of Kane County - Geology, Mineral Resources, Geologic Hazards by Hellmut H. Doelling, Fitzhugh D. Davis, and Cynthia J. Brandt; Geology of Utah by William Lee Stokes; and/or Geologic History of Utah by Lehi F. Hintze. All books and topographic maps are available at the Natural Resources Map & Bookstore, 1594 West North Temple, Salt Lake City, Utah, 84116, 801-537-3320 (or 1-888-UTAH-MAP).

New Publications of the UGS

Map of recharge areas for the principal valley-fill aquifer, Ogden Valley, Weber County, Utah, by Noah P. Snyder and Mike Lowe, 16 p., 1 pl., 1:75,000, 8/98, Map 176 ..... $5.00

The geology of the central Virgin River basin, southwestern Utah, and its relation to ground-water conditions, by Hugh A. Hurlow, 53 p., 7 pl., 1:48,000 and 1:100,000, 5/98, WRB-26 ..... $14.95

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

Characteristics, timing, and hazard potential of liquefaction-induced landsliding in the Farmington Siding landslide complex, Davis County, Utah, by Michael D. Hylland and Mike Lowe, 38 p., 8/98, SS-95 ..... $7.45

Radon-hazard potential of Beaver basin area, Beaver County, Utah, by Charles E. Bishop, 39 p., 8/98, SS-94 ..... $7.45

Guidelines for preparing hydrogeologic reports addressing suitability for alternative waste-water disposal systems in rock in Duchesne County, Utah by Mike Lowe, 11 p., 5/98, RI-238 ..... $2.50

The potential impact of septic tank soil-absorption systems on water quality in the principal valley-fill aquifer, Ogden Valley, Weber County, Utah by Janae Wallace and Mike Lowe, 11 p., 5/98, RI-237 ..... $2.50

The potential impact of septic tank soil-absorption systems on water quality in the principal valley-fill aquifer, Cedar Valley, Iron County, Utah - assessment and guidelines, by Janae Wallace and Mike Lowe, 11 p., 5/98 RI-239 ..... $2.50

Utah minerals, 20 x 22" color poster, 8/98, PI-59 ..... $1.75

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