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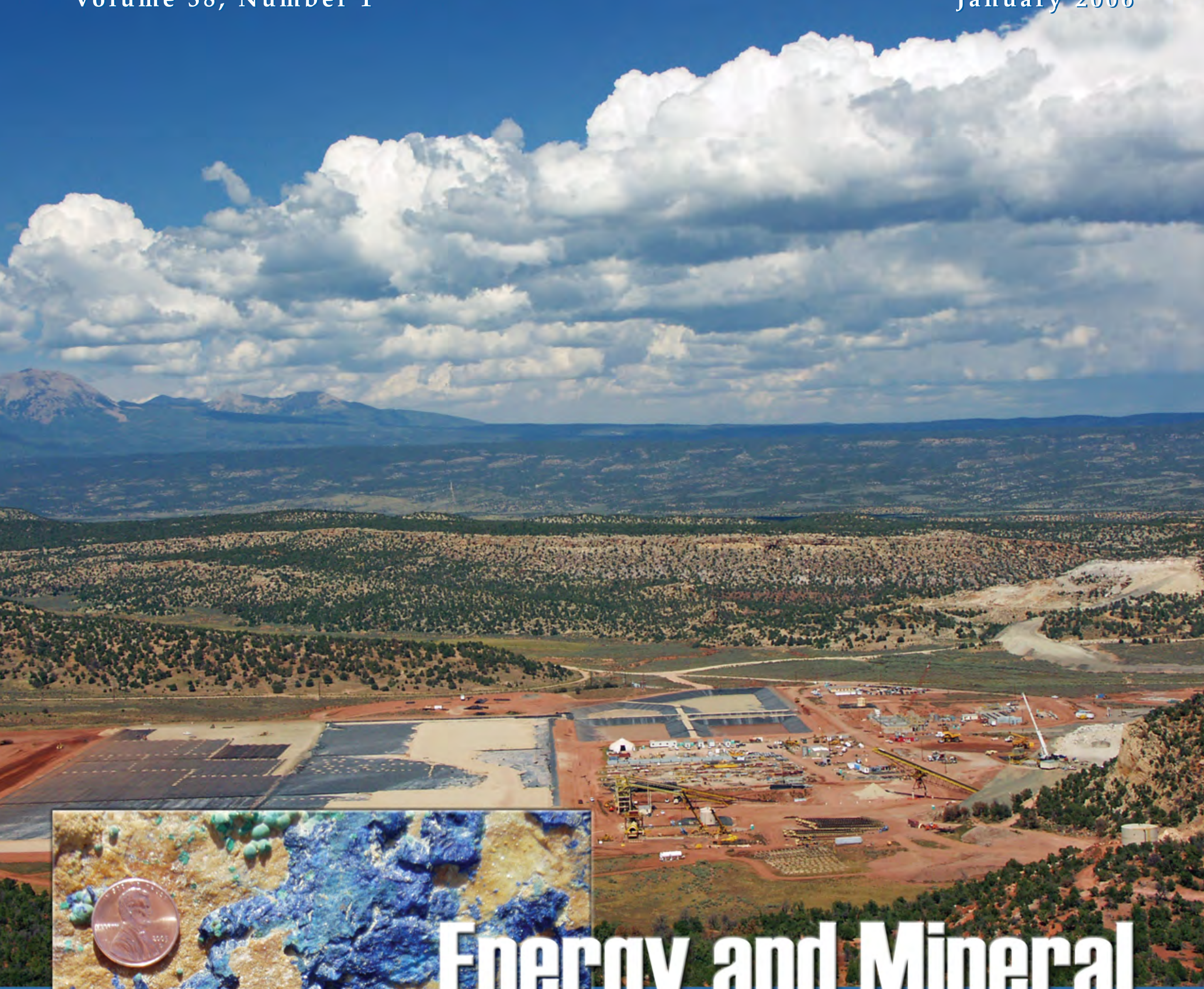

Energy and Mineral Production in Utah

contents

Design: Vicky Clarke

Cover: Copper ore is once again being mined in southeastern Utah at the new Lisbon Valley mine (see article on p. 1).

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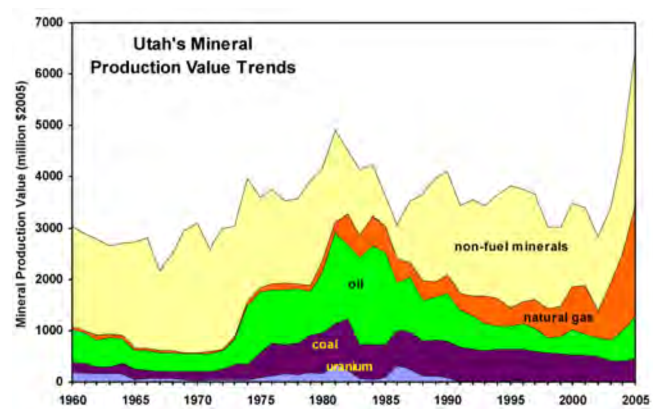
the director's perspective

This issue focuses on some of the energy and mineral activities in Utah that the UGS has recently been involved in. As we compile the final figures for 2005, it is clear that this year has been a spectacular one for energy and mineral production revenue. Many of the energy and mineral commodity prices have risen to near historic highs, and production volumes have also increased. The graph shows that the total energy and mineral production value (inflation-adjusted) greatly exceeds the previous peak of the early 1980s, and is likely to be an all-time record for the state. Production value is calculated from the annual commodity volume produced and the average annual price at the mine-mouth or wellhead. A large increase in the price for oil and natural gas is the dominant factor causing the upturn in these two commodities. In addition, oil production volume reversed the decline it began in the 1980s with increased production from the new Covenant field, and natural gas production reached a new record in 2005 due to increased drilling in the Uinta Basin. The increase in non-fuel mineral value was caused by increases in the price of copper (26% increase over 2004) and molybdenum (88%), and a substantial increase in molybdenum production from Kennecott's Bingham Canyon mine. The value of industrial minerals (e.g., salt, potash, magnesium chloride, sand, gravel, crushed stone, cement, and lime) also increased due to higher prices and increasing demand from Utah's strong economic growth. Coal production and the mine-mouth price increased significantly in 2005.

The UGS expects the current high levels of mineral and energy production activity in Utah to be sustained over the next few years. We are also seeing increasing interest in our oil shale, tar sands, and uranium deposits, driven largely by global pressure on energy and mineral supplies, and the resultant increase in commodity prices. It is possible that in a decade these commodities will also be contributing to Utah's economy. In recent years local economic pundits have said that the importance of the energy and mineral sector to Utah's economy peaked during the twentieth century and would diminish during the present century. The trends for 2005 suggest Utah's geologic wealth will continue to be an important part of our future economy.



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Lisbon Valley Copper Project

Utah's Newest Copper Mine

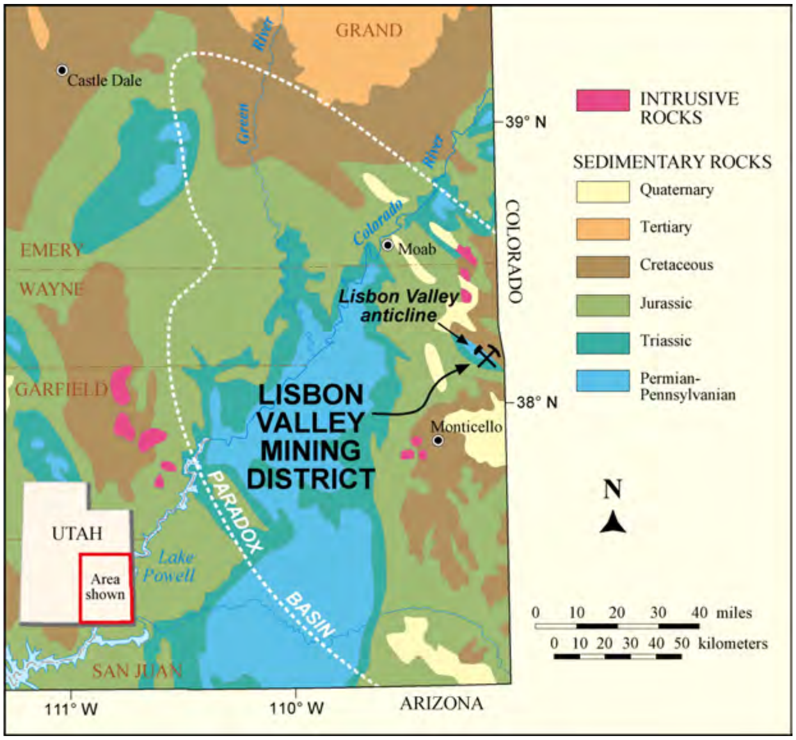
Lisbon Valley copper mine facilities (looking northeast) under construction in September 2005. Note pregnant solution ponds on the left, crusher under construction in foreground, and the old Sentinel pits (white areas) in the middle distance.

by Ken Krahulec

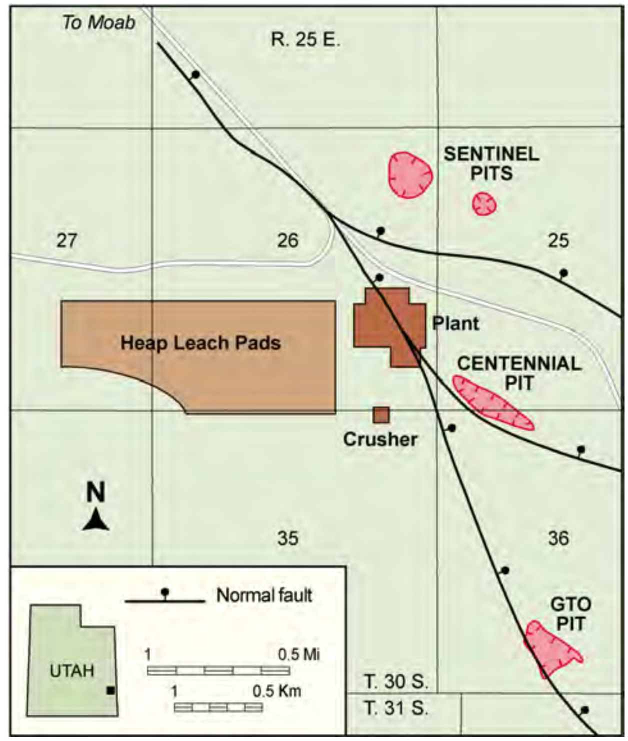
Utah's newest copper mine at Lisbon Valley lies in southeastern Utah, about 40 miles southeast of Moab. Historically, Utah has been an important copper-producing state. The century of copper mining at Bingham Canyon, for example, has had an enormous economic impact on Salt Lake County, as well as Utah as a whole. Similarly, copper mining at Eureka (Tintic district) and Park City also proved to be important elements in the state's economy through the mid-twentieth century. Now, the new Lisbon Valley copper mine is poised to give an economic boost to southeastern Utah.

History of the Lisbon Valley Mining District

The Lisbon Valley district is localized on a northwest-trending, doubly plunging anticline (arch-shaped fold). Copper mining began in the area in 1903 at the Big Indian mine at the northwest end of the anticline; however, production was sporadic and insignificant until a 300-ton-per-day acid leach mill was completed in June 1918. The Big Indian was initially mined by underground methods, but switched to open pit operations during World War II. The Big Indian mine produced about 150,000 tons of 1.5% copper ore during the war. The Blackbird copper mine, at the southeast end of the anticline, shipped several thousand tons of copper ore to the Kennecott smelter north of the Bingham mine at Magna in the 1950s. The old Blackbird copper mine returned to production in the 1960s with construction of a 200-ton-per-day acid leach plant. Intermittent production continued into the early 1970s when all copper production ceased. The discovery of beautiful azurite mineral specimens near the Big Indian mine in 1978 resulted in the commercial collection of crystal clusters there into the late 1980s.



Simplified geologic map of southeastern Utah showing the general location of the Paradox basin and the Lisbon Valley copper mine.



Sketch map of Lisbon Valley copper mine pits and facilities.

Modern copper exploration, including extensive drilling, began in the Lisbon Valley district in the 1960s and continued through the 1990s. This work delineated the Lisbon Valley copper deposits around the old Blackbird mine. New mine plans were drawn up by Lisbon Valley Mining Company LLC, a subsidiary of Constellation Copper Company, and permitting began. In 2004, the final mining permits were issued and mine construction began in early 2005.

Geologically, the northwest-trending, doubly plunging anticline dominates the Lisbon Valley area. A normal fault on the anticline's northeast flank has roughly 1000 feet of vertical offset, down to the northeast. This fault has acted as the primary hydrothermal channel way for the rising copper-bearing fluids that produced the deposits. Bleached sandstones of the Cretaceous Burro Canyon Formation host the typical Lisbon Valley copper ore body, with subsidiary mineralization in the overlying Dakota Sandstone. Copper minerals occur in pore spaces in the medium- to coarse-grained, bleached sandstones. The upper oxide zone contains the copper-bearing minerals malachite, azurite, and tenorite, while the lower sulfide-zone mineralization consists of chalcocite, bornite, chalcopyrite, and cuprite.

Current Mining Operations

In late 2004, Constellation began constructing their new open-pit, heap-leach, solvent extraction – electro-winning (SX-EW) operation. Several existing, small, open-pit mines (the Sentinel, Centennial, and GTO) from the old Blackbird operation will be incorporated into the new mine. The current reserves at these three mines are estimated at 36,700,000 tons averaging 0.51% copper. In addition, Constellation has additional copper resources just east of Lisbon Valley in Colorado and is exploring for mineralization along the Lisbon Valley trend to the southeast.

The Lisbon Valley project anticipates mining about 18,000 tons-per-day ore with a general process flow path of crushing the ore, stacking it on the leach pads, spraying the top of the heaps with a solution to dissolve the copper from the rock, and piping the resulting mineral-rich, "pregnant" solution from the base of the pads to the SX-EW facility where the copper is recovered. The SX-EW process leaches copper directly from the coarsely crushed ore and electrically plates out copper metal from the pregnant solution, without the usual concentrating and smelting processes. The product is 99.99% pure cathode copper. Constellation anticipates that production will begin in early 2006.

Capital costs for the Lisbon Valley mine and plant are projected at about $55 million. Constellation will have an annual operation cost of $18 million in goods and services, $10 million in taxes, and $9 million in wages to the 146 staff. The Utah portion of the copper project has a seven-year mine life. The Lisbon Valley copper project should be an important economic benefit to the people of southeastern Utah.

Utah Geological Survey Funding Encourages a Wide Spectrum of Research on Utah's Hydrocarbon Resources

by Craig D. Morgan

Cross-bedding in the Jurassic Entrada Sandstone. The eolian dune deposits of the Entrada are an important gas reservoir in the southern Uinta Basin. Photo by Thomas Morris, Brigham Young University.

The Utah Geological Survey (UGS) started a new program in 2004, titled "Characterization of Utah's Hydrocarbon Reservoirs and Potential New Reserves." This program uses mineral lease funds to support geologic research to help improve the characterization of Utah's hydrocarbon reservoirs primarily at the play level, but also at larger scales (for example, field, basin, or province). The goal of this research is to fulfill one or more of the following: (1) improve the state's assessment of its hydrocarbon reserves and future hydrocarbon resource potential, (2) identify reservoir features, untapped compartments, or recovery techniques to encourage more effective exploitation of proven reserves, and (3) improve the understanding of the play's depositional history, trapping mechanism, source rocks, and generation/migration of hydrocarbons to encourage exploration for new or untapped hydrocarbon reserves. The final reports of the research become public domain and will be released as UGS Open-File Reports.

The U.S. Energy Information Administration projects that the U.S. demand for natural gas will grow at an average rate of 2 percent per year for the next 20 years. Utah will play a vital role, along with other Rocky Mountain states, in meeting that demand. The Rocky Mountain region now provides 20 percent of our nation's natural gas according to the University of Utah, Bureau of Economic and Business Research.

Utah has produced natural gas since 1891, but low prices, a lack of a national market for Rocky Mountain gas, and expensive drilling have resulted in slow development of the state's natural gas resource. The 21st Century, however, has brought dramatic changes to Utah and other Rocky Mountain gas-producing states. A major shift to cleaner burning natural gas has occurred in industrial and manufacturing use, and generation of electricity. As a result, there has been a significant increase in demand for natural gas and an associated increase in price. New pipelines have been constructed to transport Rocky Mountain gas out of the region, bringing more competitive national pricing to Utah's natural gas. Drilling and production from under-developed gas plays and exploration for new plays, both conventional and unconventional, will result in a significant financial contribution to Utah's economy for many decades to come. The

University of Utah, David Eccles School of Business, Bureau of Economic and Business Research reported that nearly $140 million in royalties and severance tax was paid on Utah's natural gas production in 2001.

Utah's total petroleum consumption is at an all-time high, but crude oil production in the state is at a 45-year low. In 2004, the state produced less than 15 million barrels of oil, down from a high in 1985 of more than 40 million barrels. Even with the decline in production, however, oil continues to be a vital part of the economy of the state and many of the counties, especially with oil selling for around $60 per barrel. Many of the oil fields in the Uinta Basin are beginning water-flood operations that will help maintain production for many years. Also, the newly discovered Covenant field in Sevier County has spurred additional wildcat drilling in the central Utah area which could lead to many new discoveries (see related article in Survey Notes, 2005, v. 37, no. 2)

During fiscal year 2005 (July 1, 2004, through June 30, 2005) the UGS funded four hydrocarbon research projects. The final report for each project is available as a UGS Open-File Report on CD-ROM. The four projects are:

1. *Mesaverde Gas of Southeastern Uinta Basin*, by Paul B. Anderson, consulting geologist, Salt Lake City, Utah. Open-File Report 460.
2. *Defining and Characterizing Mesaverde and Mancos Sandstone Reservoirs Based on Interpretation of Formation MicroImager (FMI) Logs, Eastern Uinta Basin, Utah*, by Mark W. Longman, consulting geologist, Lakewood, Colorado, and Randolph J. Koepsell, Schlumberger Oilfield Services, Greenwood Village, Colorado. EOG Resources, Kerr-McGee, Questar, and Schlumberger Corporations (Colorado) contributed to the project. Open-File Report 458.
3. *A Multidisciplinary Approach to Reservoir Characterization of the Entrada Erg-Margin Gas Play, Utah*, by Thomas H. Morris, John H. McBride, and Willl D. Monn, Brigham Young University, Provo, Utah. Open-File Report 459.
4. *Shale-Gas Reservoirs of Utah: Survey of an Unexploited Potential Energy Resource*, by Steven Schamel, GeoX Consulting Inc., Salt Lake City, Utah. Open-File Report 461.

In fiscal year 2006 (July 1, 2005, through June 30, 2006) the UGS is funding three research projects:

1. *Reservoir Characterization in the Jurassic Navajo Sandstone, Snow Canyon State Park, Utah*, by Marjorie Chan and Gregory Nielsen, University of Utah, Salt Lake City, Utah.
2. *Integrated Sequence Stratigraphy and Geochemical Resource Characterization of the Lower Mancos Shale, Uinta Basin, Utah*, by Donna Anderson and Nicholas Harris, Colorado School of Mines, Golden, Colorado.
3. *Reservoir Characterization of the Cretaceous Cedar Mountain and Dakota Formations, Southern Uinta Basin*, by Brian Currie, University of Miami, Oxford, Ohio, and Mary McPherson, McPherson Geologic Consulting, Vernal, Utah.

To learn more about this and other UGS energy research programs visit http://geology.utah.gov/utahgeo/energy/index.htm.

New Publications

The origin and extent of earth fissures in Escalante Valley, southern Escalante Desert, Iron County, Utah, by William R. Lund, Christopher B. DuRoss, Stefan M. Kirby, Greg N. McDonald, Gary Hunt, and Garrett S. Vice, CD (30 p., 37-photo appendix), ISBN 1-55791-730-2, 8/05, SS-115 (on-demand print $11.95) **$19.95**

Interim geologic map of the Beaver 30' x 60' quadrangle, Beaver, Piute, Iron, and Garfield Counties, Utah, by Peter D. Rowley, Garrett S. Vice, Robert E. McDonald, John J. Anderson, Michael N. Machette, David J. Maxwell, E. Bart Ekren, Charles G. Cunningham, Thomas A. Steven, and Bruce R. Wardlaw, 27 p., 1 pl., 1:100,000, 9/05, OFR-454 . . . . **$10.95**

Interim geologic map of the Plain City quadrangle, Weber County, Utah, by Kimm M. Harty and Mike Lowe, 2 pl., 1:24,000, 9/05, OFR-451 . . . . **$9.95**

Recharge and discharge areas for the principal basin-fill aquifer, Curlew Valley, Box Elder County, Utah, by Stefan M. Kirby, Jason L. Kneedy, and Mike Lowe, CD (17 pg., 1 pl., 1:100,000), 11/05, M-218 . . . . **$19.95**

Geologic guide to the central Wasatch Front canyons, Salt Lake County, Utah, by Sandra Eldredge, 28 p., ISBN 1-55791-722-1, 9/05, PI-87 . . . . **$3.95**

Uranium publications of the UGS (reprints of 14 out-of-print items concerning uranium/vanadium), CD (1418 p., 14 pl.), 10/05, OFR-462 . . . . **$14.95**

High-calcium limestone resources of Utah, by Bryce T. Tripp, 84 p. (includes 1 pl., 1:750,000 and CD [contains GIS data]), 10/05, ISBN 1-55791-736-1, SS-116 . . . . **$15.95**

Water-Resource Bulletins of the Utah Geological Survey, 1962 to 1987, CD (1065 p., 26 pl.), 11/05, OFR-465 . . . . **$14.95**

Progress report, geologic map of the east half of the Loa 30' x 60' quadrangle, Emery, Garfield, and Wayne Counties, Utah (year 1 of 2), by Hellmut H. Doelling and Paul A. Kuehne, 11 p., 1 pl., 1:62,500, 11/05, OFR-453 . . . . **$7.25**

Interim geologic map of the West Mountain Peak quadrangle, Washington County, Utah, by Janice M. Hayden, Lehi F. Hintze, and J. Buck Ehler, 19 p., 1 pl., 1:24,000, 12/05, OFR-456 . . . . **$7.25**

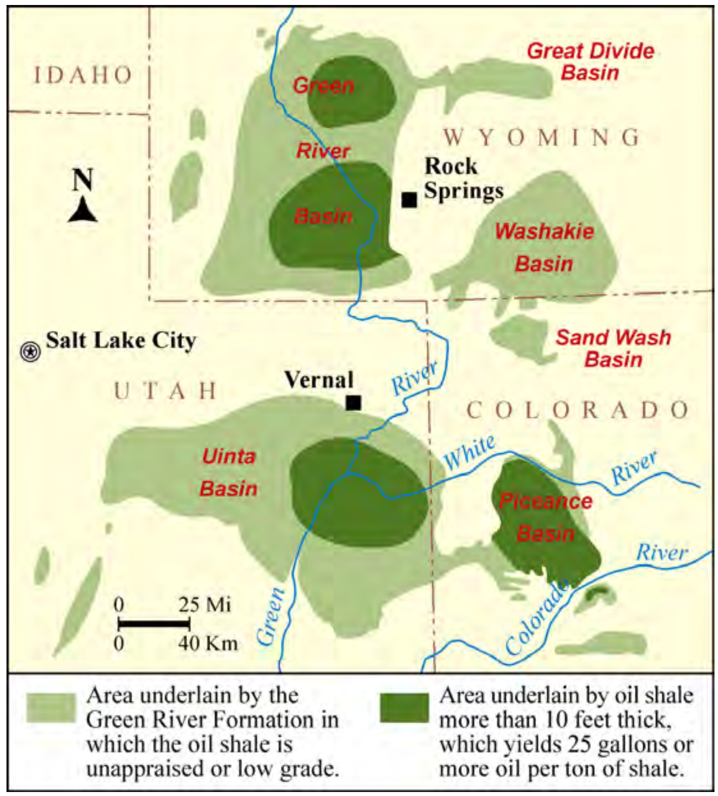
continued on page 9 . . .

Utah likely to be a key player in future oil shale development

by David E. Tabet

The recent increase in energy prices has spurred renewed interest in the development of liquid hydrocarbons from oil shale deposits, including those in Utah. In addition to significant deposits in the United States, over 20 major deposits of oil shale are known from various countries around the globe. Beginning as early as the 1830s, some limited development of oil shale has taken place in Australia, Brazil, Canada, China, Estonia, France, Scotland, South Africa, Spain, Sweden, and Switzerland. Past efforts to recover oil from these shale deposits have generally been economic only when less expensive conventional oil deposits were not available. However, the interest in non-conventional oil sources like oil shale has grown with the increasing demand for oil in Asia and the rest of the world, and as questions have arisen whether the world's conventional oil supply is headed into a long-term decline in productive capacity. So where does Utah fit into the energy picture with regard to oil shale?

The distribution of oil shale deposits in the world is not uniform: the Green River Formation of the western U.S. contains more than half of the world's oil shale resources. The Green River oil shale deposits are some the thickest and highest grade in the world, and the oil-bearing intervals can be over 130 feet thick and yield more than 25 gallons per ton of rock. Northeastern Utah, northwestern Colorado, and southwestern Wyoming are estimated to contain about 1.5 trillion barrels of oil in the Green River Formation (see map and table), about 72 percent of which underlies land owned by the federal government. The Utah portion of the Green River oil shale resource is estimated at 499 billion barrels of oil, while Colorado holds 700 billion barrels, and Wyoming has about 300 billion barrels. Thus, some future tests of new oil shale technology will probably occur in Utah, and if oil shale should become economic to develop, Utah will likely be one of the first places to see development, too.



Oil shale resource areas of Utah, Colorado, and Wyoming.

The oil shale deposits of Utah accumulated about 50 million years ago in a lake (called Lake Uintah) that covered an area larger than the present-day Uinta Basin. Organic- and lime-rich mud deposited in the center of the lake forms the present-day oil shale. The organic material preserved in the oil shale is not oil, but a substance called kerogen that can be heated in a process called "retorting" to produce oil and gas. To date, no technology for producing oil from oil shale has proven commercially successful in Utah or elsewhere, but testing has occurred on two basic types of oil shale processing technology. One involves mining the oil shale first and then heating it in a surface retort to produce the oil; the second involves heating the oil shale in the ground and extracting the produced oil through wells. Shallow oil shale deposits around the margin of Utah's Uinta Basin are probably best suited to mining and surface-retort production of oil, while the deeper oil shale deposits are better suited for in-ground heating and oil production. Several companies are presently taking another look at the economics of extracting oil from the shales of the Green River Formation, but great uncertainty exists over the long-term oil price forecast, and whether the forecast includes a sustained period of high prices needed to promote oil shale technology development. In addition to pricing issues, other questions about oil shale leasing and environmental regulatory issues need to be resolved before large-scale oil shale development could take place. Thus, large-scale development of oil shale deposits in Utah is at least 5 to 10 years into the future.

The UGS is putting together an oil shale information database for the state of Utah that will be available on the UGS Web site in February 2006. This database will include Fischer Assay data, formation tops information, and geophysical logs. For more information contact David Tabet (801-537-3373; davidtabet@utah.gov) or Mike Vanden Berg (801-537-5419; michaelvandenberg@utah.gov).

Estimated in-ground oil shale resources
(data from U.S. Geological Survey)

State/Country	Resource (billions of barrels)
Colorado	700.0
Utah	*499.0*
Wyoming	300.0
Other U.S.	619.2
Russia	447.3
Zaire	100.0
Italy	73.0
Morocco	53.3
Jordan	34.2
Estonia	16.3
France	7.0
Thailand	6.4
Sweden	6.1
Israel	4.0
Scotland	3.5
Kazakhstan	2.8
Germany	2.0
Turkey	2.0
Other	1.5

Survey News

Two long-term permanent staff left us during December. **Dan Kelly**, our Fiscal Analyst, resigned after 15 years with the UGS and took a position with the U.S. Army at Dugway. **Jim Stringfellow**, in charge of our Editorial Section, retired after 20 years with the UGS. Vicky Clarke is currently Acting Manager of the Editorial Section.

Dr. Philip Powlick has been appointed as the new program manager of the State Energy Program. Philip was director of the Energy Office in Indiana until early 2005.

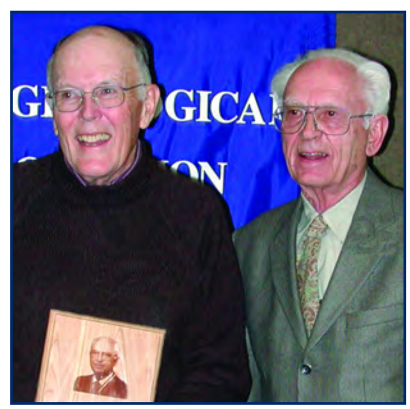
Jenifer Baker, our receptionist, left us in mid-December. The open position has been filled by **Valerie Davis**, who transferred from another state agency.

Neil Burk announced his resignation in mid-December after working with the Ground Water and Paleontology Program for about two years. He has accepted a position with a local environmental consulting company.

Darryl Greer, GIS analyst for the Geologic Mapping Program, moved to Seattle.

2005 Lehi Hintze Award

The Utah Geological Association and the UGS presented Dr. William T. Parry the 2005 Lehi Hintze Award for Outstanding Contributions to the Geology of Utah. Dr. Parry is currently professor emeritus at the University of Utah. Dr. Parry has published over 100 professional papers, the overwhelming majority of which have elucidated the geology of Utah from the Wasatch Front to the Colorado Plateau. He wrote a recently published book about the geology along hiking trails in the Wasatch Range. In addition, he continues to educate the public about Utah's geologic history.



Dr. William T. Parry and Dr. Lehi Hintze

Named for the first recipient, Dr. Lehi F. Hintze of Brigham Young University, the Lehi Hintze Award was established in 2003 by the Utah Geological Association and Utah Geological Survey to recognize outstanding contributions to the understanding of Utah geology. Recipients can be from academia, government, the private sector, or the general public.

Utah's Limestone – Like Money in the Ground

by Bryce T. Tripp

Question: Why is the paper on which this article is printed a bright white color? Because the wood fiber in the paper is filled and coated with white geologic materials like talc, clay, and limestone — a little known fact. This is only one example of how limestone, a basic constituent of our material world, is underappreciated; limestone is very important to the economies of Utah and the world.

Limestone is a common sedimentary rock composed mostly of calcium carbonate. It constitutes about 15% of the earth's sedimentary rocks by volume. Most limestone formed from the accumulation and cementation of skeletal and shell fragments from plants and animals that lived in shallow waters of oceans and lakes. Calcium carbonate can also precipitate directly in caves, in hot springs, and in hydrothermal veins. An interesting example of direct precipitation of calcium carbonate in Utah is oolite formation in Great Salt Lake. Oolites are the small, egg-shaped, white sand grains that form many of the white sand beaches along the shores of the lake.

Pit in Mississippian Great Blue Limestone near Tenmile Pass, Tooele County, that produces crushed stone. This pit has also been prospected as a source of limestone for Portland cement production.

Limestone's major industrial uses are as crushed stone, in lime manufacture, and in cement manufacture. Crushed stone is used for a variety of construction purposes like road base and concrete aggregate. In 2003, companies in the United States produced 1.08 billion tons of crushed limestone with a value of $5.46 billion. High-calcium limestone can be heated in kilns and converted to lime (calcium oxide) that is used for metallurgical, environmental, chemical and industrial, and construction purposes. In 2004, U.S. companies produced 18.2 million tons of high-calcium lime worth about $1.3 billion. Cement is limestone that is processed at high temperature with shale, sandstone, and iron. (Cement when mixed with water and crushed rock or sand and gravel becomes concrete.) In 2004, U.S. companies produced 105 million tons of cement worth about $8 billion and the concrete made from the cement was worth about $45 billion.

The value of the limestone in many of these uses depends on chemical purity that is commonly expressed in percentage of contained calcium carbonate. Limestone containing 95% or more calcium carbonate is termed high-calcium limestone. Only a small amount of the limestone exposed on the earth's surface is this pure, so it is economically important to know where this material occurs. To answer that question for Utah, the Utah Geological Survey has recently completed a preliminary study of high-calcium limestone resources of the state, published as UGS Special Study 116, "High-Calcium Limestone Resources of Utah."

Special Study 116 reports that Utah's most important deposits are in Paleozoic-age (Cambrian, Devonian, and Mississippian) shallow-marine rocks, primarily in the western half of the state. Tertiary-age lacustrine rocks of central and northeast Utah contain large volumes of limestone but they are generally less pure than the Paleozoic limestone. There are some Mesozoic-age formations that probably contain small amounts of high-calcium limestone. Quaternary-age cave travertine, hot springs tufa, and Great Salt Lake oolite deposits in Utah have been used as local sources of high-calcium limestone. The report identifies 84 high-calcium limestone workings in Utah, ranging from small pits to large quarries. Although not all carbonate rocks in Utah were systematically evaluated, the report includes 387 available chemical analyses from 46 stratigraphic formations. Furthermore, Special Study 116 predicts that Utah's high-calcium limestone production should increase at a rate comparable to the state's population growth, because of high-calcium limestone's importance to residential and commercial construction; the Utah Governor's Office of Planning and Budget has projected the state's population to increase 60% between 2003 and 2030.

UGS geologists are collecting and analyzing additional limestone samples to add more detail to the general picture presented in Special Study 116; these results will be made available on the UGS Web site.

In addition to Special Study 116, information on high-calcium limestone is available from (1) http://minerals.usgs.gov/minerals/, (2) Carr, D.D., senior editor, 1994, Industrial rocks and minerals: Littleton, Society for Mining, Metallurgy, and Exploration, Inc., 6th edition, 1196 p., and (3) Boynton, R.S., 1980, Chemistry and technology of lime and limestone: New York, John Wiley & Sons, Inc., 2nd edition, 579 p.

Geothermal Development in Utah – New Incentives and New Projects

by Robert Blackett and Nykole Littleboy

Utah Geothermal Working Group

Utah possesses an abundance of untapped geothermal resources. Encouraging development of these resources is the main goal of the Utah Geothermal Working Group (Working Group). The Working Group, organized in 2003 as part of the U.S. Department of Energy's (DOE) GeoPowering The West initiative, combines people from federal, state, and local governments; utilities; renewable energy advocates; geothermal industry; environmental organizations; landowners; and others interested in using Utah's geothermal resources. Meetings are held two to three times annually at the Department of Natural Resources in Salt Lake City with the Utah Geological Survey serving as the coordinator. Membership is open to anyone.

Since organizing in 2003 the Working Group has met five times and co-sponsored two workshops focusing on geothermal direct-use applications and geothermal electric power development. Summaries of the meetings and workshops, as well as a position paper on geothermal energy development in Utah, are available on the Utah Geothermal Working Group Web site at http://geology.utah.gov/emp/geothermal/ugwg.htm.

Geothermal power plant at the Cove Fort-Sulphurdale geothermal area near the I-70 – I-15 junction, Millard and Beaver Counties, Utah. Amp Resources is proceeding with exploratory and development drilling in anticipation of reconstructing the plant into a 37 MW Kalina-cycle facility.

Geothermal Development and the New National Energy Bill

On July 29, 2005, The Energy Policy Act of 2005 (H.R. 6) was passed by Congress and signed into law on August 8 (Public Law 109-58). Among many sweeping energy initiatives, the act includes provisions to promote continued expansion of geothermal energy use. With respect to geothermal energy, the act establishes the following:

- Extends the 1.9-cent per kilowatt-hour production tax credit (PTC) for geothermal plants from five years to ten. New geothermal power plants placed in-service by January 1, 2008, will qualify for the PTC.
- Authorizes Clean Renewable Energy Bonds (CREB) issued by municipal power authorities, rural electric cooperatives and other units of government, tribal authorities or non-profits for financing renewable power projects, including geothermal. CREB purchasers will receive federal tax credits in lieu of interest payments from the issuer.
- The Bureau of Land Management will offer federal geothermal leases every two years through competitive bidding. New regulations will base royalties on percent of total income. County governments will receive 25 percent of royalty income from federal leases.
- Geothermal direct use is encouraged by simpler leasing procedures, establishing a fee schedule instead of royalty payments, and allowing state and local governments to use geothermal resources for public purposes at a nominal charge.

Geothermal well testing at Milgro Nurseries commercial greenhouse facility at the Newcastle geothermal area, Iron County, Utah. Since 1992, Milgro's operation has grown to include nearly 1.1 million square feet of greenhouses, heated directly from a geothermal reservoir, that produce 13 million potted plants and cut flowers annually.

New Geothermal Projects in Utah

Future Power Plant at Cove Fort — Amp Resources began redevelopment of a geothermal power project at the Cove Fort-Sulphurdale geothermal area, southeast of the Interstate 15 - Interstate 70 junction near the Millard County-Beaver County line. Amp is in the process of exploratory-production drilling, and plans to dismantle the existing plant, formerly operated by Utah Municipal Power Agency. Amp's objective is to build a 37 megawatt (MW) Kalina-cycle geothermal power plant at the site.

Future Expansion at Blundell Geothermal Plant — Utah Power, a subsidiary of PacifiCorp, is considering expanding power production at their existing Blundell geothermal flash plant near Milford by constructing an 11 MW "bottoming cycle" binary power unit "downstream" from the flash unit. The addition of the bottoming cycle would bring the total capacity of the plant to 37 MW.

Space and Water Heating at Utah State Prison — In January 2004, the Utah Department of Corrections in cooperation with Johnson Controls completed phase I of a geothermal space and water heating system for a 39,000-square-foot dormitory complex at the Utah State Prison near Bluffdale. Johnson Controls recently reported completion of phase II of the project, which includes space heat and domestic hot water to several other buildings, yielding a total area of about 250,000 square feet. The investment for both phases is $2,042,672 with a guaranteed annual savings in utility costs of $196,687.

More information about the Utah Geothermal Working Group and Utah's geothermal resources can be found through the Utah Geological Survey's geothermal Web page at http://geology.utah.gov/emp/geothermal/. To join the Working Group contact Robert Blackett at robertblackett@utah.gov, (435) 865-9035, or Nykole Littleboy at nykolelittleboy@utah.gov, (801) 538-5413.

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Geologic map of the Tickville Spring quadrangle, Salt Lake and Utah Counties, Utah, by Robert F. Biek, Barry J. Solomon, Jeffrey D. Keith, and Tracy W. Smith, 2 pl., 1:24,000, 11/05, ISBN 1-55791-735-3, 12/05, M-214 . . . **$12.00**

Wetlands in Tooele Valley, Utah - An evaluation of threats posed by ground-water development and drought, by Neil Burk, Charles Bishop, and Mike Lowe, CD (37 p., 1 pl., 1:40,000), ISBN 1-55791-743-4, 12/05, SS-117 . . . . **$19.95**

Large mines in Utah 2005, compiled by Roger L. Bon and Sharon Wakefield, 4 p., 1 pl., 1:700,000, 12/05, OFR-468 . . . . **$4.50**

Interim geologic map of the Vernal 30' x 60' quadrangle, Uintah and Duchesne Counties, Utah, and Moffat and Rio Blanco Counties, Colorado, by Douglas A. Sprinkel, 2 pl., 1:100,000, 1/06, OFR-470 . . . . **$9.95**

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Interim geologic maps of the Castle Cliff quadrangle and the east half of the Terry Benches quadrangle, Washington County, Utah and Mohave County, Arizona, by Janice M. Hayden, Lehi F. Hintze, and J. Buck Ehler, 15 p., 2 pl., 1:24,000, 12/05, OFR-457 & 464 . . . . **$9.00**

Defining and characterizing Mesaverde and Mancos Sandstone reservoirs based on interpretation of image logs, eastern Uinta Basin, by Mark W. Longman and Randy J. Koepsell, DVD (115 p., 1500+ images), 9/05, OFR-458 . . **$14.95**

Shale gas reservoirs of Utah: Survey of an unexploited potential energy resource, by Steven Schamel, CD (114 p., appendix of core photos and databases), 9/05, OFR-461 . . . **$14.95**

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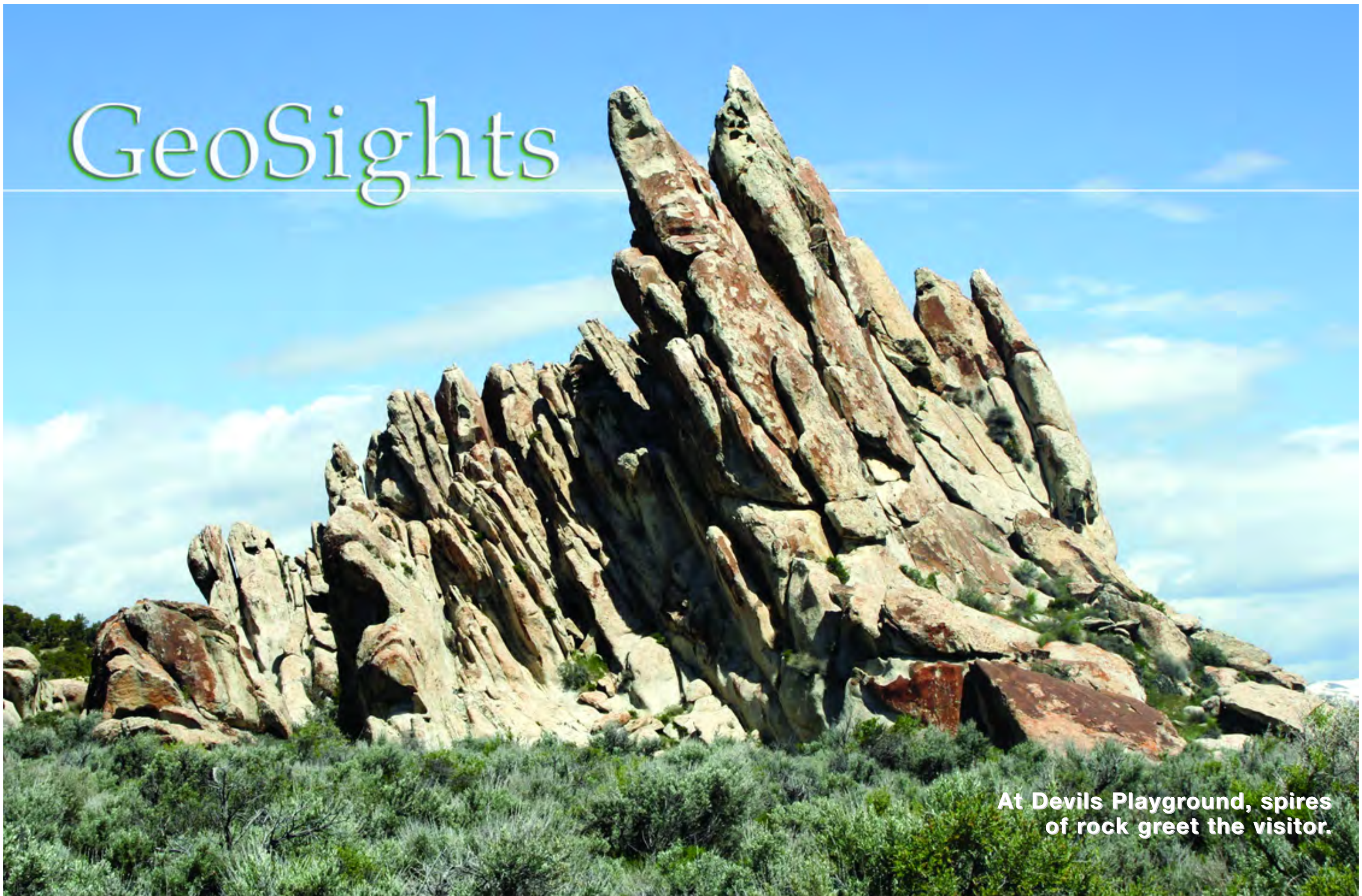
Landslide investigation of Timber Lakes Estates, Wasatch County, Utah: Landslide inventory and preliminary geotechnical-engineering slope stability analysis, by Daniel P. Neuffer and Ronald L. Bruhn, CD (65 p., 4 pl., 1:2400), 11/05, ISBN 1-55791-742-6, MP-05-9 . . . . **$19.95**

GeoSights



At Devils Playground, spires of rock greet the visitor.

Devils Playground, Box Elder County, Utah

by Carl Ege

Introduction: Why take your kids to the neighborhood playground, when you can visit a playground that can inspire your sense of geologic adventure? Devils Playground is not your typical playground at the park, but a playground of granitic rock weathered into fantastic forms and eerie shapes. Located on Bureau of Land Management and state land, Devils Playground is a relatively unknown geologic curiosity found in a remote region of northwestern Utah.

Geologic Background: Devils Playground consists of Tertiary-age (approximately 38 million years old) granitic rock formed from a cooling magma body that intruded overlying Paleozoic (400 to 300 million years old) sedimentary rocks. Known as the Emigrant Pass pluton, this intrusion covers an area of approximately 10 square miles in the southern part of the Grouse Creek Mountains. Later, small magma bodies intruded into the granitic rock forming pegmatites (coarse-grained igneous rocks with interlocking quartz crystals, usually found as irregular dikes or veins). The pegmatites are fairly common, several inches in thickness, and extend hundreds of feet. They represent the last and most hydrous (water-rich) portion of magma to crystallize. The pegmatites are easy to locate because they are more resistant than the surrounding rock, thus they resemble ribs and bones sticking out in relief.

Basin and Range faulting and uplift of the Grouse Creek Mountains (approximately 13 million years ago) subjected the region to extensive physical weathering (surface water runoff and

freeze-thaw), which over millions of years slowly peeled off the overlying sediments and sedimentary rocks. A thickness of roughly 3 to 6 miles of rock and sediment was removed before exposing the granitic rocks of the Emigrant Pass pluton. Once the rocks were uncovered, physical and chemical weathering (a variety called spheroidal or onion-skin) began attacking the rocks. In spheroidal weathering, joints or fractures create initial openings allowing surface

A small arch or a scene from a bad horror film. Arm for scale.

Granitic rock weathered into bizarre shapes and forms.

Weathered pegmatite dike in granitic rock resembles a backbone.

Granitic rock can also weather into large alcoves.

water to access the rock from all sides. Water seeping along these fractures slowly decomposes or alters the mineral composition of the granitic rock, causing the rock to weather inward. As a result, rounded shells of decomposed rock are repeatedly loosened and peeled off the unweathered core like the skin of an onion. The rate of weathering is greatest along the corners and edges where fractures and joints intersect because they have a greater surface-area-to-volume ratio than the rock faces. All of the "devils," alcoves, spires, arches, and small caves found at Devils Playground can be attributed to these physical and chemical weathering processes.

Eventually, physical and chemical weathering will destroy all of these artistic forms of nature. However, these processes will continue to sculpt new features as long as physical and chemical weathering expose granitic rock at Devils Playground.

How to get there:

North Route: From the northern I-15/I-80 interchange in Salt Lake City, head north on I-15 for 69 miles to Tremonton (exit 382). At exit 382 the freeway splits; I-84 continues to the northwest, and I-15 forks off and goes north. Travel northwest on I-84 for 37 miles to exit 5. Turn left (west) on Highway 30 and travel 16 miles to Curlew Junction (a junction with Highway 42). Turn left (southwest) and proceed 74.5 miles to the Emigrant Pass road. Turn right (north) and drive approximately 8.5 miles to the Devils Playground sign. Turn right (east) and proceed 0.2 miles to first granitic outcrops of Devils Playground on the right (south) side of the road. If you proceed on this road for several miles, the road will end up in the heart of Devils Playground.

West Route: From the northern I-15/I-80 interchange in Salt Lake City, head west on I-80 153 miles to Oasis, Nevada (exit 378). Turn right (northeast) on Nevada State Highway 233 (also Utah State Highway 30) for 57 miles to Emigrant Pass road. Turn left (north) and travel approximately 8.5 miles to the Devils Playground sign. Turn right (east) and proceed 0.2 miles to first granitic outcrops of Devils Playground.

Teacher's Corner

by Sandy Eldredge and Mark Milligan

Poster Contest for Utah's 4th-grade Students Earth Science Week 2005

During the week of October 11-14, the UGS held its 6th annual Earth Science Week activities. The American Geological Institute initiated this international event in 1998 to increase public understanding and appreciation of Earth sciences. The UGS, with a group of esteemed volunteers, celebrates this week by hosting activities for hundreds of 4th-grade students. Activities include panning for "gold," identifying rocks and minerals, observing erosion and deposition on a stream table, and touring the paleontology lab. This year, an additional activity was viewing a wonderful model of Mars supplied by UGS geologist Mike Laine.

Earth Science Week at the UGS had become so popular that we were accepting reservations a year in advance and then turning other schools away. So, this year the UGS and the Utah Geological Association (UGA) sponsored a poster contest whereby the winners' classrooms were awarded reservations to attend the activities. In addition, the UGA paid bus expenses for the classes of the top three winning posters. Students were asked to illustrate "What Geoscientists Really Do." The following top six winning posters show what Utah's 4th-graders think geoscientists really do.

Paleontologists in southern Utah

1st place, by Courtney Bangerter, Granite Elementary School

Paleontologists working in Africa and a geomorphologist studying a fault in Utah

2nd place, by Ben Isaac Tresco, Granite Elementary School

Mineralogist in a cave

3rd place, by Bahaar Rokhva, Granite Elementary School

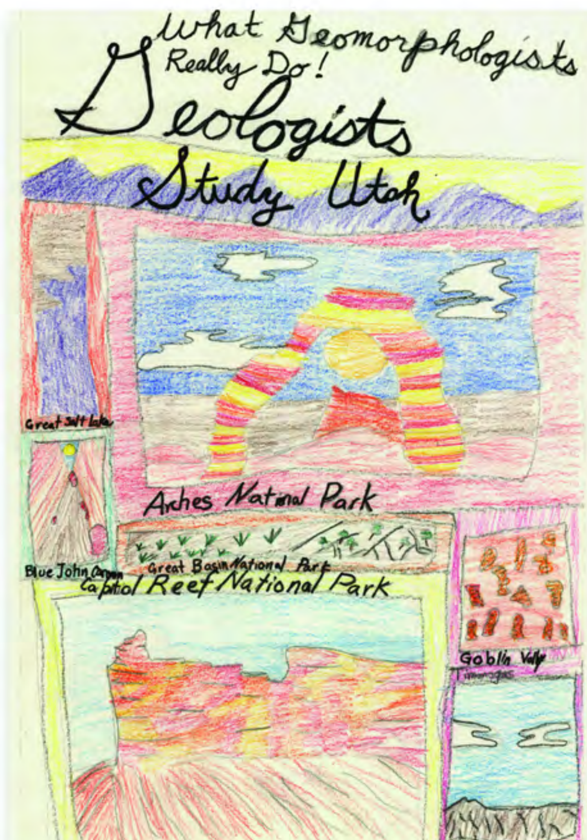
Geomorphologists and volcanoes, water, and landforms

Tied for 5th place, by Chloe Bruderer and Alyssa Fox, Butler Elementary School

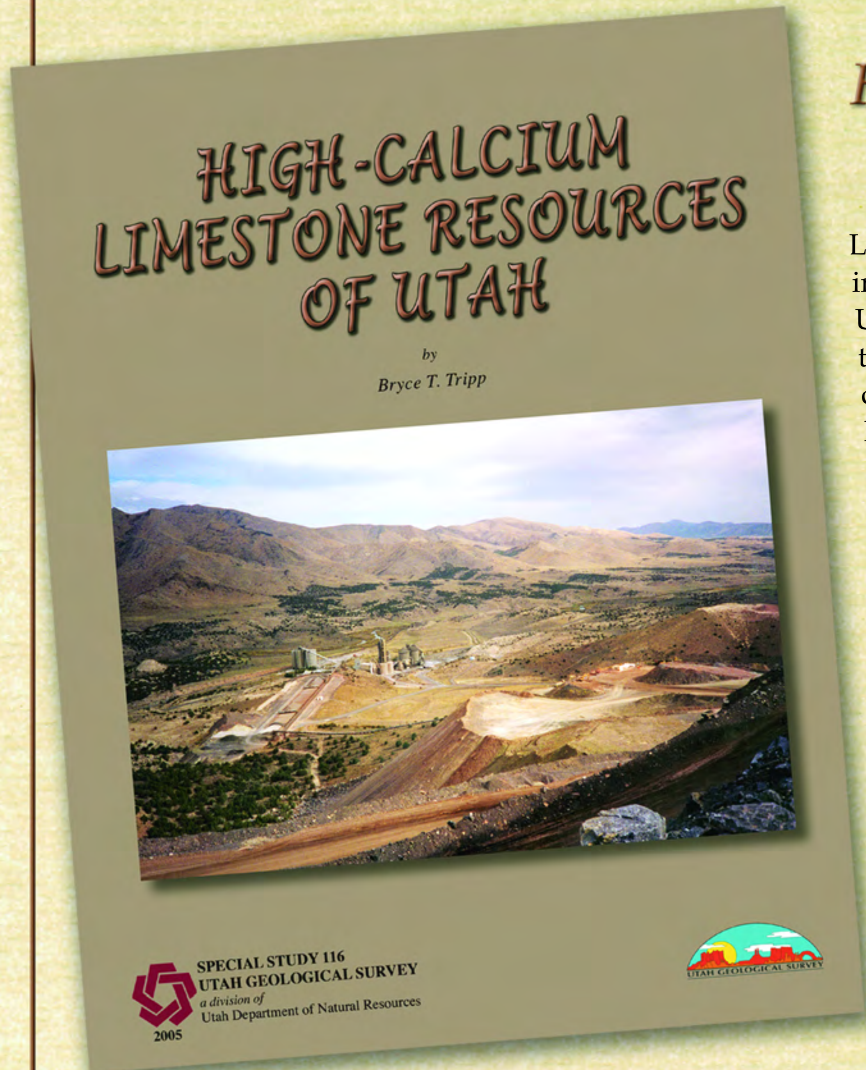
Paleontologist's work

4th place, by Nicole Cox, Foothills Elementary School

Geomorphologists and Utah landforms



Tied for 5th place, by Catesby Carman, Butler Elementary School



High-Calcium Limestone Resources of Utah

Limestone, mined for industrial uses, is very important to the economies of Utah and the U.S. Each year U.S. companies mine limestone to produce more than a billion tons of lime, crushed rock, and cement worth almost $15 billion, so it is important to know where the best limestone resources are located. Utah's most important limestone deposits are in Cambrian, Devonian, and Mississippian-age shallow-marine rocks, preliminary in the western half of the state.

The UGS has mapped these resources and has recently published a preliminary study and map titled *High-Calcium Limestone Resources of Utah* (UGS Special Study 116) available for $15.95. The publication contains text, data, a map and a CD. Information includes limestone uses and specifications, limestone pits and prospects, and other limestone publications.

Natural Resources Map & Bookstore

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