

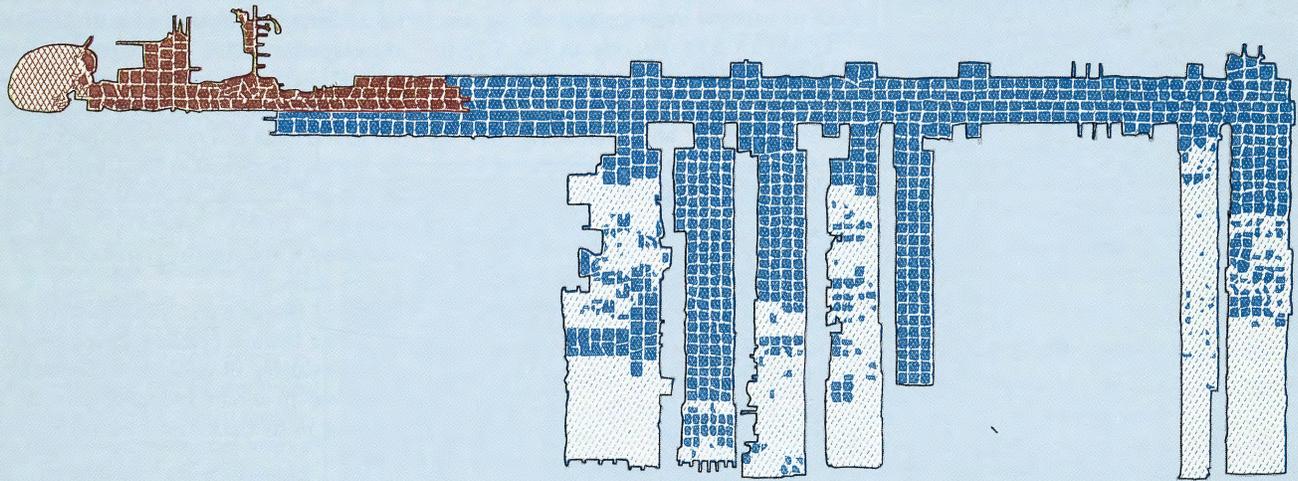
SURVEY NOTES

SERVICE TO THE
STATE OF UTAH

VOL. 19 NO. 2



SUMMER 1985



METHANE

METHANE & COAL MINING

By ARCHIE D. SMITH

METHANE is a gas that is both an energy resource and a hazard. It is associated, to some degree, with all coal deposits and the explosive constituent of the gas known to miners as "fire damp". A ubiquitous gas of one carbon atom and 4 hydrogen atoms (CH_4) found in a diverse range of environments, it is colorless, odorless, tasteless, and non-poisonous. With a specific gravity of 0.555 making it lighter than air, and with the ability to form an explosive mixture with air (in volume percentages of 5 to 15), methane concentrations must be kept below five percent in the mine and below one percent at the working face. Air circulation is the means of achieving these levels and preventing ignitable conditions.

Since it ignites, it is also a fuel source. Development of methane as an unconventional fuel can occur as part of the coal mining process because the coal seam contains the methane reservoir. Economic factors have not favored recovery from coal solely for the methane. Capital expenditure for placement and maintenance of pipelines, compressors and sundry equipment must at least equal the dollars returned to the company from the recovered gas although other benefits may accrue such as decreased cost of ventilation and increased productivity. Methane can be used at the mine site or pumped into a distribution pipeline if one is nearby. Utah is unusual in that some of the main pipelines for natural gas are located relatively nearby known methane-rich coal.

Draining methane with drill holes before and during coal mining is the present approach, both for methane production and mine safety. Holes drilled into the coal bed can drain the methane before and during coal mining. But a drainage program should be coupled with a thorough knowledge of mining and geology as well as economics if it is to succeed in increasing productivity and safety in the mine. Modern mining methods such as the long wall, which rapidly shears large amounts of coal from a seam, sometimes must control large volumes of methane. If ventilation cannot reduce methane emissions sufficiently, the shearing rate must be reduced. This reduction lowers productivity and the economics of the operation.

UGMS geologists recently collected 316 samples from seven of Utah's coal fields and measured their gas content using the Direct Method developed by the U.S. Bureau of Mines. A preponderance of the samples collected are from the Emery, Wasatch Plateau and Book Cliffs coal fields. The study indicates that the most favorable areas for methane content are in the northern half of the Book Cliffs Coal Field and the central part of the Emery Coal Field. It should be

emphasized that only seven coal fields have been sampled and much more work needs to be accomplished to determine the methane content of Utah's coal.

The microscopic constituents of coal and the coal's physical and chemical characteristics determine whether it will hold gas or release it. Normally, gas exists in voids or micropores between solid spaces, and migration of gas through the coal is governed by pressure gradients as described by Darcy's Law.

In an unpenetrated coal bed reservoir, very small amounts of gas are found in the cleat as unconstrained gas. The greatest volumes of gas are adsorbed on the coal surface in an extensive micropore structure. The movement of gas from the micropore system is initiated when a disruption to the pressure gradients lowers the pressure in the fracture system, and causes gas to flow from the micropore system into the fracture system until equilibrium is re-established. Coal rank, overburden, water saturation, roof and floor rock type, regional and local structure, geometry or areal extent and thickness also influence migration and emission of methane. Normally all but a minor fraction of residual gas drains from a coal core sample when it is removed from the coal bed reservoir.

COAL FIELD COMPARISONS

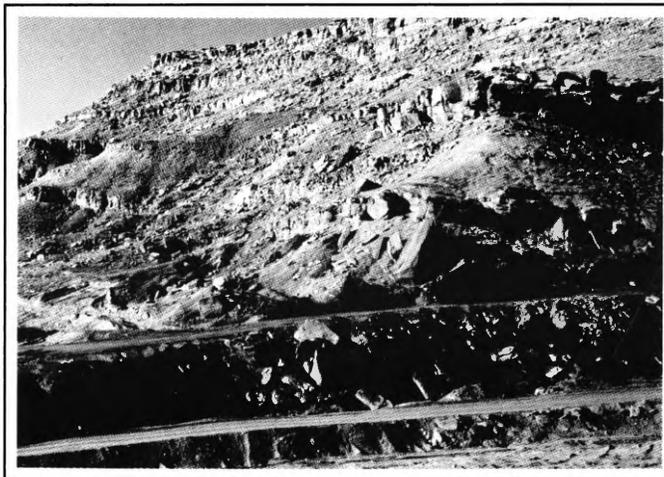
For our purposes, coal containing one to five cubic centimeters of gas per gram has been considered as moderately gassy coal, while coal with greater than five cubic centimeters has been considered as gassy coal. Although this working classification is admittedly

somewhat arbitrary, it serves the purpose of furnishing a relative comparison for Utah's coal fields.

BOOK CLIFFS COAL FIELD GEOLOGY

The field consists of 70 miles of Cretaceous coal-bearing outcrop extending easterly from the North Gordon fault zone to Sunnyside and then southeasterly to the Green River. The field is exposed along high cliffs at the south edge of the Uinta Basin. Although dips are gentle to moderate toward the basin, overburden builds rapidly behind the outcrop leaving only a

4- to 12-mile-wide strip available for relatively easy mining. Farther north or northeastward, the cover builds to more than 3,000 feet. The escarpment front is irregularly and deeply incised by perpendicular drainages so that the cover over the coal varies markedly between spurs and canyons. Locally the coal-bearing rocks are cut by high-angle faults. The geology indicates an eastward-regressing sea during the Cretaceous period so that the coal beds mined to the



west are slightly older than those mined to the east.

METHANE RESOURCES

The field was sampled over a geographic area of twelve (12) townships. Thirteen coal beds were sampled at a mean depth of 1,372.0 feet and had an average gas content of 3.2cm³/gm. This coal field has been classified as moderately gassy (1-5 cm³/gm), but at specific locations, it is classified as gassy (greater than 5 cm³/gm).

A comparison of the mean reflectance values of vitrinite from the samples of the three fields follows:

Book Cliffs	6.8
Wasatch Plateau	5.6
Emery	6.3

MACERAL ANALYSIS

A total of 69 samples were viewed for maceral content, measured

TABLE 1. Book Cliffs CH₄ collection data by coal bed.

BED	NO. OF SAMPLES	AVG. DPTH. (FT)	MIN/MAX (FT)	AVG. GAS*	MIN/MAX GAS*
Gilson	8	1,601.2	476 - 3,097	3.5	0.0-9.4
Sunnyside	9	1,105.5	396 - 2,720	1.8	0.1-5.3
Castlegate A	23	1,573.0	194 - 3,355	3.5	0.2-9.4
Castlegate B	9	736.4	316 - 1,234	2.1	0.9-7.2
Castlegate C	8	877.9	198 - 3,292	2.7	0.7-10.6
Castlegate D	9	785.7	149 - 1,431	2.3	0.7-5.6
Rock Canyon	9	1,629.6	404 - 2,867	3.1	0.3-7.5
Kenilworth	6	2,047.7	766 - 3,177	5.8	0.1-11.0
Subseam 1	4	1,951.1	1,395 - 2,821	6.9	2.2-9.4
Subseam 2	6	1,654.5	937 - 2,188	3.2	0.5-8.4
Subseam 3	4	1,624.9	963 - 2,222	1.3	0.4-2.3
Beckwith	1		653	0.1	0.1
Fish Creek	1		1,728	0.2	0.2
Unknown	6	1,039.9	284 - 2,081	3.8	1.2-8.1

*cm³/gm.

It is interesting that the working mines north of Horse Canyon ventilate approximately 3,461,300 cubic feet of methane to the atmosphere each 24 hours according to MSHA records (this figure can vary depending on the number of working sections in the mines) while the mine at Horse Canyon ventilates none, for all practical purposes (remember, methane is associated with all coal).

If a line is drawn east-west at the Sunnyside Mine, the northern half of the field is a moderately gassy field and locally can be gassy, whereas the southern half is low gassy. This is supported by mine ventilation readings from both sides of the line as well as the collected coal cores. It has been observed in UGMS Special Studies 49 that "Although the quality of the coal is the same south of the line (Carbon-Emery County line), it contains much less gas. There are no obvious explanations, but an interesting suggestion comes by superimposing aeromagnetic contours over the area. High magnetic readings coincide with Utah's area of gassy coals. The high magnetic areas may indicate that the emplacement of magnetic materials in the basement may have been responsible for increasing heat or pressure and thereby favor gas formation or the formation of coking coal . . ." An interesting suggestion which this article will not attempt to substantiate or disprove. However, reflectance analysis shows a difference in the overall degree of coalification between the fields. The Book Cliffs samples show the highest reflectance values, which is significant because the coals from both the Book Cliffs and the Wasatch Plateau are from the Blackhawk Formation whereas the Emery samples are from the older Ferron Member of the Mancos Shale. The speculation concerning the magnetic anomalies in the Book Cliffs and basement rock emplacement with resulting heat may have credence.

for vitrinite reflectance, and viewed for fluorescence and adjusted. The average maceral analysis by percent is:

Vitrinite.....	56.7
Pseudo Vitrinite.....	20.3
Resinite.....	3.8
Micrinite.....	3.1
Sporinite.....	2.7
Cutinite.....	0.8
Semifusinite.....	9.8
Sclerotinite.....	0.1
Fusinite.....	2.6
Macrinite.....	0.1

The average apparent porosity of 38 of the samples available for determination is 3.0 and the average density determined from 62 of the samples available is 1.3.

WASATCH PLATEAU COAL FIELD

The Wasatch Plateau coal field in central Utah has a nearly north-south-trending Cretaceous coal-bearing outcrop about 90 miles in length and 7 to 20 miles in width. The east margin consists of cliffs, with coal cropping out along the faces. Overlying units finally cover the coal-bearing unit, the Blackhawk Formation of the Mesaverde Group, with more than 2,500 feet of cover at the west margin. A structural feature known as the Wasatch monocline and faulting quickly drop the favorable unit to uneconomical depths farther to the west. To the north the coal plunges into the Uinta Basin and to

the south the coal is finally buried beneath volcanics. The field is contiguous with the Book Cliffs Coal Field at its northeast end but separated from it by the North Gordon fault zone. It is cut by several significant fault zones that trend not quite parallel to the long axis of the field. Dips are mostly gentle in a west-northwesterly direction while numerous canyons cut the cliff front and indent the coal outcrops to the west. The geology shows that the important coal beds are located in the lower 300 feet of the 700 to 1,500 foot Blackhawk Formation. Coal beds are not continuous north to south and there are areas with only thin coals present in the central and extreme southern parts of the field. Qualitatively, the coal improves in rank south to north and, to a lesser degree, west to east.

METHANE RESOURCE

The Wasatch Plateau Coal Field was sampled over a geographic area of 19 townships. Ten coal beds were sampled with samples collected at a mean depth of 856.1 feet. Relatively speaking, the upper O'Connor bed is the more gassy bed with a range 0.0 to 2.0 cm³/gm of coal, and the upper Hiawatha is the least gassy with an average gas content of 0.1 cm³/gm of coal. A summary of gas collection data by coal bed follows:

Semifusinite	2.9
Sclerotinite	0.8
Fusinite	0.1
Macrinite	0.1

The average apparent porosity of 49 of the samples available for determination is 3.6 and the average density determined from 62 of the samples available is 1.3.

**EMERY COAL FIELD
GEOLOGY**

The Emery Coal Field is located immediately east of the southern one-third of the Wasatch Plateau Field and its outcrops roughly parallel it. The field is split almost in half by the Emery-Sevier County line and it is approximately 35 miles long with a width that varies from 4 to 8 miles. The principal area of coal occurs along the southeast margin near the tops of sandstone cliffs indented at irregular intervals by transverse canyons which trend northwestward. The coal thins and disappears in outcrops to the north while to the south the coal beds are covered by volcanics. To the west and

TABLE 2. Wasatch Plateau CH₄ collection data by coal bed.

BED	NO. OF SAMPLES	AVG. DPTH. (FT)	MIN/MAX (FT)	AVG. GAS*	MIN/MAX GAS*
Bear Canyon	3	1,190.0	971.3 - 1,313.6	0.16	0.01-0.41
Blind Canyon	7	969.7	185.4 - 1,762.5	0.38	0.00-0.60
Ferron	5	270.5	85.0 - 584.2	0.10	0.00-0.50
Flat Canyon	2	1,484.4	1,368.2 - 1,600.2	0.08	0.00-0.16
Hiawatha	25	955.9	89.0 - 1,671.0	0.35	0.00-1.65
Hiawatha (u)	18	1,029.8	791.7 - 1,825.0	0.10	0.00-0.34
Ivie	3	721.7	595.0 - 813.2	0.00	0.00
Ivie (u)	2	179.2	81.8 - 276.6	0.12	0.11-0.13
Muddy	2	1,167.0	744.0	0.20	0.00-0.40
O'Connor	15	892.3	326.0 - 1,995.2	0.26	0.00-1.80
O'Connor (u)	9	901.1	605.1 - 1,384.3	0.44	0.00-2.00
Kinnon	2	475.1	200.2 - 750.0	0.45	0.10-0.80
Unknown	4	1,098.0	924.0 - 1,432.0	0.00	0.00

The data show that these coals have drained their gas content at the locations sampled since few had residual gas content. Statistical analysis of the residual gas content of the samples has proven the average residual gas content to be 0.006 cm³/gm. If USBM RI 8245, Estimating Methane Content From Bituminous Coalbeds From Adsorption Data by Ann G. Kim, is followed to determine the original methane capacity of these coal beds, a calculated estimate of adsorbed gas capacity of the coal in place is 8.9 cm³/gm.

MACERAL ANALYSIS

A total of 76 samples were analyzed for maceral content, measured for vitrinite reflectance, and inspected for fluorescence and adjusted. The average maceral analysis by percent is:

Vitrinite.....	61.4
Resinite.....	3.7
Micrinite.....	2.6
Sporinite.....	6.4
Cutinite.....	2.6

northwest the coalbeds have the overburden of the Wasatch Plateau covering them.

The coal is contained in the upper part of the Ferron Sandstone Member of the Mancos Shale. Consequently, the coal is older than that of the other two fields discussed. The overburden on most of the area ranges from zero to one thousand feet, but significant areas are covered by 500 feet or less. There are many coal beds within the coal-bearing portion of the Ferron Sandstone Member; that portion comprises approximately 400-500 feet with beds designated in ascending order alphabetically from A to M. These beds have also been grouped into the zones of lower, middle, and upper. The coal beds range in thickness to approximately 13 feet, but they are significantly lenticular and discontinuous. Also, the beds can fuse to a thickness of approximately 25 feet.

METHANE RESOURCE

The Emery Coal Field was sampled over a geographic area of three townships and show a mean gas content of 0.46 cm³/gm. The 51 gas samples from seven coal beds collected have a gas content

TABLE 3. Emery CH₄ collection data by coal bed.

BED	NO. OF SAMPLES	AVG. DPTH. (FT)	MIN/MAX (FT)	AVG. GAS*	MIN/MAX GAS*
A	14	656.3	323.0 - 859.0	0.19	0.00-1.10
C-D	12	564.8	259.0 - 815.0	0.30	0.00-2.00
G	11	370.8	247.0 - 755.2	1.13	0.00-4.70
I	4	588.7	143.2 - 601.3	0.13	0.00-0.30
I-J	6		465.5 - 680.0	0.52	0.00-2.60
J	1		642.5		0.40
K	1		664.5		0.00
A (rider)	1		514.0		0.00
Unknown	1		548.5		0.60

that ranges from 0.00 to 4.70 cm³/gm and indicate that the G bed is the most gassy while the A bed is the least. The samples were collected at an average depth of 581.3 feet .

The average gas content for the Emery Coal Field is 0.45 cm³/gm, therefore the field is classified for the purpose of this work as low-gassy (greater than 1 cm³/gm). Collections from the A bed and C-D bed support this classification, however, collections from the G bed do not. The G bed should be considered as moderately gassy (1-5 cm³/gm) until more sampling can be accomplished.

The data show that the coals in this field, in general, have also drained their gas content while the methane capacity of these coal beds can be shown through calculation to have been 9.4 cm³/gm; the average residual gas content of the samples from this field is 0.01 cm³/gm.

MACERAL ANALYSIS

A total of 32 samples were viewed for maceral content, measured for vitrinite reflectance, and viewed for fluorescence and adjusted.

The average maceral analysis by percent is:

Vitrinite.....	57.6
Pseudo Vitrinite.....	20.4
Resinite.....	1.9
Micrinite.....	2.4
Sporinite.....	2.5
Cutinite.....	0.9
Semifusinite.....	11.3
Sclerotinite.....	.0
Fusinite.....	2.9
Macrinite.....	0.1

The average apparent porosity of 9 of the samples available for determination is 3.3 and the average density determined from 28 of the samples available is 1.4. The slightly higher density observation is probably a result of the 14.03 average ash content. ■

UGMS STAFF CHANGES

The following staff changes have taken place since last issue:

Gary Arndt, an administrative assistant, completed an internship under the University of Utah's Masters Program and has been hired as a Personnel Analyst at the Department of Natural Resources Personnel Department.

Jessie Roy, senior cartographer, has resigned to accept employment working in computerized mapping for Analytical Surveys Inc. in Colorado Springs, Colorado. She joins her husband who has also accepted a new position with that company. **Kent Brown**, a 2-year UGMS cartographer, has been promoted to fill her position.

Carl Jacobs, accountant, transferred to the Division of Oil, Gas and Mining at the Triad Center. **Gwen Anderson** has recently been hired to fill his position. Gwen received

her accounting education at the L.D.S. Business College and has an extensive background in financial banking accounting. She is a valuable addition to the staff.

Don Mabey, who has been senior geologist for Applied Geology for the past 2½ years, has been appointed to the newly established position of deputy director. In this new position he will assist the director in managing the UGMS, act as director in her absence, and manage the UGMS support functions. Until a new senior geologist for Applied Geology is appointed, Don will also continue to manage the Applied Geology Program.

Cynthia Brandt recently joined the UGMS as a petroleum geologist. For the past four years Cynthia has worked as a petroleum geologist and geophysicist for Texaco in Houston, Texas.

Jack Oviatt, a UGMS mapping geologist since July, 1983, has relocated to Manhattan, Kansas where he is now employed as assistant professor of geology at the University of Kansas.

Debi Jenkins, cartographer and digitizer for the mapping department, has left the UGMS to attend the Colorado Aerotech Technical School in Denver, Colorado. She is planning to earn a pilot's license as well as learning airplane mechanics skills. ■

NOTICE OF MEETING

The Society of Mining Engineers Fall meeting will be held October 16-18 in Albuquerque, New Mexico. Geology of ore reserve estimation will be featured.

Contact SME-AIME, Caller No. D, Littleton, CO 80127 for more information.

ON THE LEVEL : THE GREAT SALT LAKE

By DON R. MABEY

IN SEPTEMBER 1982 more precipitation fell at the Salt Lake City International Airport than in any earlier month on record. Precipitation was above normal in 19 of the next 26 months and more than 200 percent of normal in five of these months (fig. 1). The geologic effects of this abnormal precipitation include disastrous landslides and debris flows, a rise in the shallow water table, extensive stream flooding, a major rise in the level of Utah Lake and a nearly ten-foot

rise in the level of the Great Salt Lake. Total damage from these events has been several hundred million dollars and Utah received the first two Major Disaster Declarations in history as declared by the President. Total precipitation for the past winter and spring was below normal and this past spring the geologic events were much less severe than in the previous two years.

While the cause of the unusual weather is uncertain, the weather and the sequence of geologic events it caused can be analyzed. An immediate effect of the record rainfall in September 1982 was to halt the seasonal decline of the Great Salt Lake earlier than normal (fig. 2). Thus the lake did not recede as much as in a normal year and began to rise about two months early. By the end of December the lake level had risen almost two feet and was higher than the June peak. The snowpack was near normal but the moisture content in the soil under the snow was much above normal because of the late summer and early fall rains (fig. 3).

Through the winter of 1983 the snowpack measure as percent of average increased slightly and a few landslides at low elevations warned of problems to come. The spring was wet and cold and the snowpack continued to increase. By late May the water content of the snow at the SNOTEL stations in the Great Salt Lake Basin averaged nearly 300 percent of normal. The Thistle landslide and several others began to move in mid-April and, with the delayed snow melt

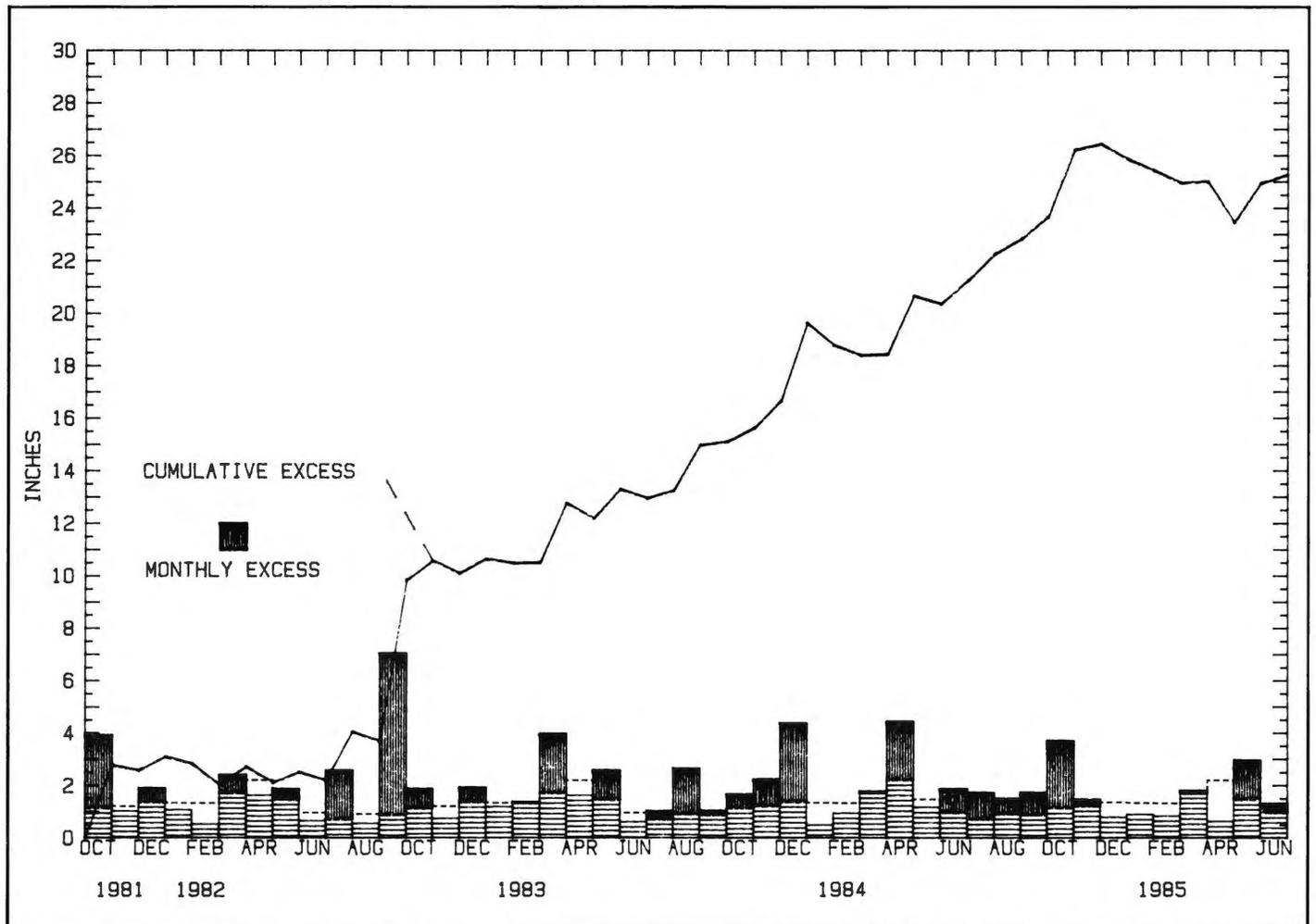


FIGURE 1. Precipitation at the Salt Lake City International Airport. Dashed line is 30-year monthly normal and cumulative excess is from October 1, 1981.

in May, destructive floods and debris flows hit the Wasatch Front and continued in June in Sanpete County. The Great Salt Lake continued to rise until July and peaked over five feet above the September level - a record rise for one season.

Precipitation for each month in the last half of 1983 was above normal, ending with a new December record. During the summer the lake level declined only about half a foot and by the end of December was rising at a record rate. The snowpack was at near-record levels and the moisture content of the soils was high.

Precipitation for the first three months of 1984 was near normal or below, the snowpack declined but was still much above normal, and the rate of the lake level slowed but continued at a high rate. Heavy precipitation in the early spring increased the snowpack in a manner alarmingly similar to that of the previous year. However, when a warmer and drier trend developed in May, the melting snowpack caused flooding that was locally severe but less extensive than the previous year. Landslides and debris flows were common but single events did not produce the dramatic damage of the previous year; however, two fatalities resulted directly from slope failures. The Great Salt Lake continued to rise through June for the second largest seasonal rise, and the volume of water added to the lake was a record. On August 1, a 300-foot wide breach was opened in the Southern Pacific Railroad causeway and this, combined with the seasonal decline, lowered the elevation of the south arm of the Great Salt Lake about 1.5 feet from the July 1 peak.

JUNE 1984 was the first of six consecutive months of above-normal precipitation with October much above normal. At high elevations the snowpack began to build early in the fall over soils with a very high moisture content. The Great Salt Lake rose throughout the fall. In December a change in the pattern developed with precipitation for December, January and February well below normal, March near normal and April much below normal. The snowpack measured as percent of normal declined through January, held a little above normal for February, March and early April, and then declined rapidly as warm weather melted the snowpack. The Great Salt Lake responded quickly to the drier weather and peaked in late May after a seasonal rise of two feet compared with approximately five feet for the two previous years. Stream flooding was a minor problem and landslides and debris flows were much less common than in 1983 and 1984.

Although the current conditions are the driest in nearly three years, return to above-normal precipitation could quickly cause serious problems because the Great Salt Lake is at a high elevation, and in the foothills and mountains many slopes have been destabilized in the last two years. Total precipitation for the last eight months has been below normal, and if precipitation for the next year is near normal or below, the lake next year should peak below this year's peak. If near-normal weather persists, the lake will decline toward its historic average elevation of 4202 feet above sea level. However, about 15 years of normal precipitation will be required to reach this level. Precipitation about 125 percent of normal will be required to maintain the lake at the current level.

The last three years have provided a dramatic demonstration of Utah's vulnerability to the geologic effects of variations from the normally dry climate. The present respite has relieved some of the urgency for actions designed to control or minimize these effects, but the problems remain. We need a better understanding of the geological and meteorological phenomena involved. Bruce Kaliser

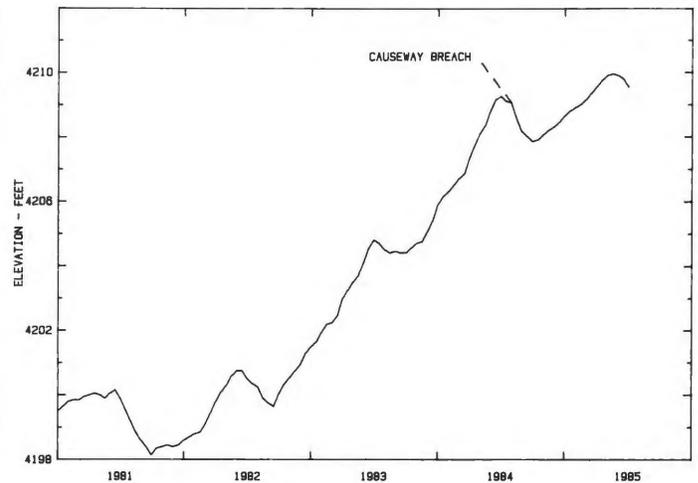


FIGURE 2. Elevation of the south arm of the Great Salt Lake based on measurements by the U.S. Geological Survey.

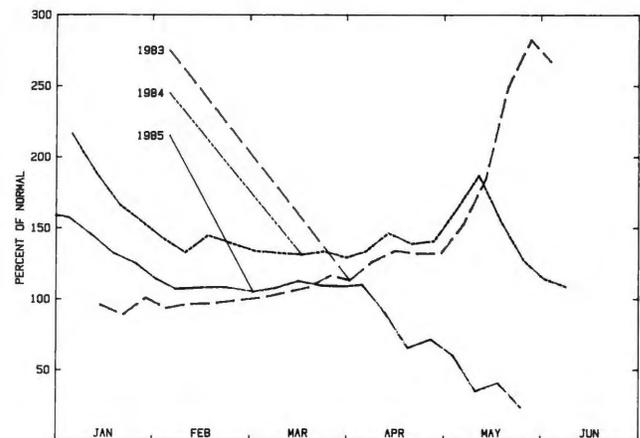


FIGURE 3. Percent of average snow water content at 25 U.S. Soil Conservation SNOTEL Stations. Value is the average for Bear River, Weber River-Ogden River, Utah Lake-Provo River-Vernon Creek basins.

and Fitzhugh Davis have documented the effects of the 1983 events and Bruce has continued a study of the 1984 and 1985 events. A new program of landslide research is being started in cooperation with the USGS and Bruce is the lead UGMS scientist in this effort. Other members of the UGMS are working on other geologic problems related to the wet cycle. Concern by the public and decision makers for geologic hazards has been high during the events of the past three years and many constructive actions have been taken to provide protection from these hazards. If the more normal weather pattern persists, an added effort will be required to maintain the support for the additional actions needed to make Utah less vulnerable to future weather cycles. ■

NEW PUBLICATIONS

Quaternary Geology

Special Studies 64, *Contributions to Quaternary Geology of the Colorado Plateau*, by G.E. Christenson, C.G. Oviatt, J.F. Shroder, and R.E. Sewell, 1985, 85 pages, maps and photos, \$5.00 over-the-counter, \$7.50 by mail, prepaid, please add \$0.29 for sales tax if purchased in Utah.

The practical importance of studying Quaternary glacial, mass wasting, and alluvial deposits in the Colorado Plateau is for assessing geologic hazards such as flooding, slope stability and avalanche potential for making long-term assessments of land stability for construction, especially of critical facilities.

The Colorado Plateau has been the site of continuous stream down-cutting, cliff retreat, and landscape denudation during much of the Quaternary period. Glacial, periglacial, and mass-wasting deposits are found in high plateau areas and mountain ranges rising above the plateau surfaces. Alluvial fans and piedmont gravels surround areas of higher elevation. Loess and wind-blown sands are found on the plateaus and alluvium along streams in canyons.

The two papers by Christenson and Oviatt show how detailed studies of alluvial stratigraphy can be used to distinguish the effects of local geomorphic factors and climate changes in the canyons of the Colorado Plateau. Shroder and Sewell discuss glacial and mass wasting deposits in the La Sal Mountains.

UGMS History

Circular 77, *Utah Geological and Mineral Survey: An Historical Sketch - 1984*, compiled by Martha Ryder Smith, 7 pages (no charge), add \$1.00 for postage if requested by mail.

Circular 78, *Utah Geological and Mineral Survey Annual Report 1983-1984*, compiled by Martha Ryder Smith, 10 pages (no charge), add \$1.00 for postage if requested by mail.

The two publications are designed to present the history and explain the purpose and activity of the Utah Geological and Mineral Survey through 1984.

Maps

Map 53-A, *Geology of the Northern Wasatch Front, Utah*, compiled by Fitzhugh D. Davis, 1985. Two sheets in full color on plastic coated paper, 26" x 30", scale 1:100,000 (one inch equals 1.5 miles). Price \$5.00 over-the-counter, \$7.00 by mail, prepaid. If purchased in Utah, add \$.29 for state sales tax.

This map is one of a series showing the geology, water and mineral resources of rugged mountains of the Wasatch Front and the flat, sediment-filled valleys to the west. Map 53 covers the area between Ogden and Weber Canyon on the south and Logan and Tremonton on the north. Logan and Pineview Reservoir are shown on the east and a portion of Great Salt Lake on the west. The rocks range in age from Precambrian to Recent. The map also shows the known faults and geologic hazards in the area.

A second sheet includes a summary of the geologic history of the area and a key to the ages and kinds of rocks shown on the map.

Map 77, *Geologic Map of Tecoma Quadrangle, Box Elder County, Utah and Elko County, Nevada*, by David M. Miller and Joel D. Schneyer, U.S. Geological Survey, 1985, Utah Geological and

Mineral Survey Map 77, full color, scale 1:24,000, includes 8 page report. Price \$5.00 over-the-counter (\$7.50 by mail, prepaid). Please add \$0.29 for sales tax if purchased in Utah.

The Tecoma quadrangle is located along the Utah-Nevada border about 40 miles south of the Idaho-Utah border and includes the northern portion of the Pilot Range, typical of the fault-bounded north-trending ranges of the Basin-Range Province. The range is composed of Late Proterozoic and Paleozoic sediments and was subject to igneous intrusion, metamorphism, folding and low angle faulting during Mesozoic time. In Tertiary time additional faulting, igneous activity and local metamorphism modified the older structures. The area to the west includes lowlands underlain by a Tertiary pediment and contains surficial Lake Bonneville deposits.

Map 86, *Geologic Thesis Map Index of Utah*, compiled by Russell Knight, 1985, scale 1:1,000,000, 20" x 26½", multi-color on Utah base showing townships and ranges, drainages, and names of topographic features. Includes references to 369 geologic theses completed in Utah through 1984. Price \$3.50, \$5.00 by mail; add \$.20 sales tax if purchased in Utah.

Map 54-D, *Mineral Resources of the Central Wasatch Front, Utah*, compiled by Fitzhugh D. Davis, 1985. Two sheets, full color, 26" x 30", scale 1:100,000; 24 p. booklet; \$6.00 over-the-counter and \$7.00 by mail, prepaid. Add \$.29 for Utah state sales tax.

Another of the Wasatch Front series, this is essentially a lithologic map covering Ogden and Weber Canyon in the north to Lone Peak - Draper - Bingham Canyon in the south. The second sheet is explanation for the map and a petroleum map and short explanation. An extensive booklet of mineral resources complements the maps.

Reports of Investigations

Report of Investigation 190, *Technical Letters and Memoranda for 1983, Site Investigation Section*, edited by William R. Lund, 1985. 220 pages.

Report of Investigation 194: *Reconnaissance Study of the Black Dragon Tar Sand Deposit, San Rafael Swell, Emery County, Utah*, by Bryce Tripp, 1985, 45 pages, 4 plates, tables. Price is \$8.00 by mail, prepaid. Please add \$.29 for sales tax if purchased in Utah.

Report of Investigation 195: *Causes of Basement Flooding along 11800 South near 3800 West, South Jordan and Riverton, Salt Lake County*, by Gary E. Christenson, 1985, 29 pages, illustrations, tables. Price is \$7.00 by mail, prepaid. Please add \$.23 for sales tax if purchased in Utah.

Report of Investigation 196, *Economic Potential of State-owned Lands in the Sunnyside Special Tar Sand Area, Carbon County, Utah*, by Keith Clem, 1985, UGMS Report of Investigation 196, 12 pages, map, figures, appendices. Price \$5.00 (includes postage); add \$0.23 for sales tax if purchased in Utah.

Report of Investigation 197, *Dam Failure Inundation Study for Deer Creek Dam and Utah County*, by William F. Case, 1985, 37 pages, 2 plates, many figures. Price is \$8.00 by mail, prepaid; please add \$.29 for sales tax if purchased in Utah.

Report of Investigation 198, *Technical reports for 1984, Site Investigation Section*, compiled by Kimm M. Harty, 1985. 291 pages.

Continued on next Page

WASATCH FRONT COUNTY HAZARDS GEOLOGISTS

By GARY E. CHRISTENSON

In 1983, the U.S. Geological Survey (USGS) expanded the National Earthquake Hazards Reduction Program to include an Urban and Regional Hazards element and identified the Wasatch Front as the highest priority area under this element for funding during the following 3 years. Much valuable hazards information will be collected under the Urban and Regional Hazards program, and this information must be made available to those in a position to use it to reduce risks to life and property. One of the five components of the Urban and Regional Hazards element is termed implementation, and the goal of this component is to facilitate the effective use of scientific information to reduce loss of life and damage to property caused by major geologic hazards. At present, the responsibility for implementation of geologic hazards data lies principally with local government where a majority of planning and zoning decisions are made. A critical need exists for a means of translating geologic information to make it understandable to local government and other non-technical users. One means of achieving this goal that was proposed to the USGS by the Utah Geological and Mineral Survey (UGMS) was for local government to employ full-time staff geologists to collect and translate technical hazards information for use by planners and local government officials. The USGS supported this approach and in 1985 the UGMS and USGS entered into a cooperative 3-year program to provide funding and technical assistance to hire three geologists to work on hazards in the five most populous Wasatch Front counties (Weber, Davis, Salt Lake, Utah, and eastern Juab counties). The county geologists will pull together in a single location all the hazard-related information already completed in each county, and use this and additional data collected during the program to produce maps and reports describing geologic hazards in the counties. In addition to providing a comprehensive library of data and hazard maps for each county, it is hoped that the program will demonstrate the usefulness of maintaining a

geologist on the county staff as well as establish effective working relationships between various levels of government concerning implementation of hazards information. The final products of this program will be published by the UGMS.

Federal, state, and county governments will cooperate in the program. Funding of all salaries and benefits will be paid by a grant from the USGS to the UGMS. The UGMS will provide technical assistance and supervision as well as specialized equipment and publications. Counties will provide office space, transportation, and secretarial assistance to the geologist as a regular full-time member of the county planning staff. Three geologists have now been hired to cover the five Wasatch Front Counties. Michael Lowe was hired by Weber and Davis Counties and will maintain offices in both county planning departments. Craig Nelson will cover Salt Lake County, and Robert Robison will work in Utah and eastern Juab Counties. All three geologists are completing graduate degrees with emphasis on engineering and surficial geology at Utah State University and bring to the jobs a variety of academic and industry experience. ■

For more information on this program, contact Gary Christenson at the Utah Geological and Mineral Survey (801-581-6831) or:

Michael Lowe Weber County Planning / 801-399-8795
Davis County Planning / 801-451-3261

Craig Nelson Salt Lake County Planning / 801-488-5073

Robert Robison Utah County Planning / 801-373-5510
ext. 346
Juab County / 801-623-0275

Report of Investigation 199, Preliminary Geologic Hazard and Resource Inventory for State Lands in Washington County, Utah, by Gary E. Christenson and Charles Bishop, 1985, 15 pages, map and table, reference list.

New UGA Guidebooks

Utah Geological Association Guidebook No. 12, Geology and Energy Resources, Uinta Basin of Utah, 1985, by M. Dane Picard, Ed., 338 pages. \$50.00 over-the-counter; \$62.00 by mail, prepaid. Add \$2.88 state sales tax if purchased in Utah.

A new guide book published by the Utah Geological Association expands the available information on the history, stratigraphy, structure, economic geology and hydrology of the Uinta Basin. The thirty-three papers also include archeological and historical background of the Basin. Eight short essays give personal impressions of geologists travelling, exploring, and working in the area.

Stratigraphic studies include the Mesozoic rocks and depositional setting of the Current Creek and saline facies of the Green River Formation. Three papers give geologic features of lakes, identification of lacustrine rocks, and sedimentology of Great Salt Lake. Structural papers discuss the history of the Uinta Mountains, the interpretation of gravity anomalies in northeastern Utah, and Quaternary faulting.

Twelve papers on the mineral resources of the Basin cover oil and gas, oil shale, tar sand, gilsonite and phosphate. Eight papers discuss ground water and surface water resources and aspects of the Central Utah Project to bring water from the Uinta Mountains to central Utah.

Utah Geological Association Guidebook No. 13, Geology of Northwest Utah, Southern Idaho and Northeast Nevada, 1985, by Gloria J. Kerns and Raymond L. Kerns, Jr., editors, 290 pages, including road logs. \$40.00 over-the-counter, \$48.00 by mail, prepaid. Add \$2.30 for state sales tax if purchased in Utah.

The 1984 UGA Field Conference Trip started near Albion, Idaho, and followed the Utah-Idaho state line to look at Proterozoic and Paleozoic stratigraphy, Mesozoic deformation and metamorphism, and Tertiary volcanics and mineral deposits in southern Idaho, northeast Nevada and northwest Utah.

The guidebook contains six papers on the structure and stratigraphy of northwest Utah, two papers on the petroleum potential of northeast Nevada, and five papers on metallic deposits at Tallman, Idaho; Tecoma, the Deep Creek Mountains, Spor Mountain, and Mercur in Utah. Three papers discuss the hydrology of northwestern Utah, and a final paper describes the vegetation zones in the Bonneville basin. ■

UTAH EARTHQUAKE ACTIVITY

January through March 1985

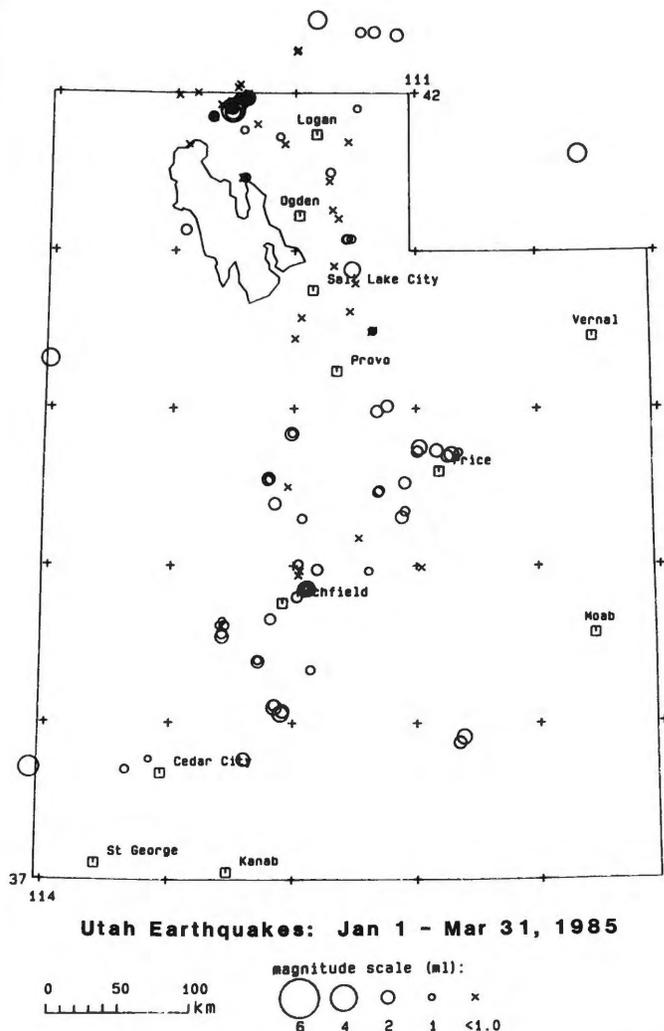
By JAMES C. PECHMANN

UNIVERSITY OF UTAH SEISMOGRAPH STATIONS
DEPARTMENT OF GEOLOGY AND GEOPHYSICS

THE University of Utah Seismograph Stations records a 77-station seismic network designed for local earthquake monitoring within Utah, southeast Idaho, and western Wyoming. During January 1 to March 31, 1985, 140 earthquakes were located within the Utah region (fig. 1). The largest earthquake during this time period occurred on January 26, 1985 in the Utah-Idaho border area north of the Great Salt Lake and had a local magnitude (M_L) of 3.6. It was followed one day later by an M_L 3.3 event with nearly the same epicenter. Both events were felt locally. The only other earthquake of magnitude 3 or greater to occur in the Utah region during this three-month period was an M_L 3.1 event on January 18, 1985 near the Utah-Nevada border west of Cedar City, Utah.

Other significant aspects of earthquake activity during the report period shown in figure 1 include (from north to south):

- 1) an M_L 2.7 earthquake on February 24 in southeastern Idaho;
- 2) a large number of small-magnitude earthquakes in the Utah-Idaho border area north of the Great Salt Lake;
- 3) a magnitude 2.9 seismic event, possibly a blast, in southwestern Wyoming;
- 4) an M_L 2.4 earthquake on February 6 located 30 km northeast of Salt Lake City;
- 5) an M_L 2.7 event on February 8 along the Utah-Nevada border west of Provo;
- 6) small-magnitude ($M = 2.3$) earthquakes in the vicinity of active underground coal mining southwest and north of Price, Utah; and
- 7) clusters of earthquakes in southern Utah located 20 km northeast of Richfield, 50 km southwest of Richfield, and 100 km northeast of Cedar City.



Utah Earthquakes: Jan 1 - Mar 31, 1985



Additional information on earthquakes within Utah is available from the University of Utah Seismograph Stations, Salt Lake City, Utah 84112 (telephone 801-581-6274).

FROM THE DIRECTOR'S DESK

Continued from Page 2

its of limestone perhaps could be used for making cement or lime in areas of high population growth such as Utah's Dixie.

Gypsum — Georgia Pacific (located in Sigurd) wants to increase their gypsum reserve to meet present needs and to respond to a healthy market which appears to be growing at a 6% annual rate.

Abrasives — Bon Ami asked about abrasive mineral resources, specifically with a hardness of 6 on Mohs' scale.

Silica — Southwestern Portland Cement inquired about a softer form of silica than they now use; the Cambrian Tintic Quartzite is hard on their crushers.

Specialty sands — Specialty sands for sand blasting, waste water filtering, etc. have been inquired about. A source of clean, rounded quartz grains could be used locally

in sandblasting or air carving of headstones. Carefully sized sand is also used locally in waste water treatment plants.

Clay — Utah Portland Cement asked about a new source of clay for their Salt Lake cement plant. Also Western Clay inquired about a new market for their fuller's earth.

Lime — Utah Marblehead Lime inquired about new geologically derived products that might be produced with its excess rotary kiln capacity. The closing of the steel plant at Fontana California cut half its market for dead-burned dolomite.

Zeolites — The filter industry is interested in zeolites and other clay materials for pollutant control and clean-up. Utah State University's Water Lab is a leader in this type of research.

Other industrial minerals — Vermiculite, perlite, and barite are all imported into Utah and processed. If local deposits of these commodities were found, they would proba-

bly be developed and save transportation costs.

Salts — There may be potential for the development of sodium chloride, magnesium, and potassium from Sevier Lake as well as more extensive development of the brines of the Great Salt Lake. In addition to present lake industries, there is further potential for magnesium carbonate and oxide extraction, for development of a lithium industry, for new uses of the Great Salt Lake oolites as a relatively clean source of pre-crushed, well-sorted calcium carbonate (with silica impurity), and for production of high purity or pharmaceutical quality compounds.

ENERGY RESOURCES CONTINUE TO SUSTAIN UTAH'S ECONOMY

Petroleum resources — Oil and gas are produced from four major petroleum provinces in Utah. However, from "shows" and favorable geology in other unexplored

and untested regions, geologists are encouraged that there is even greater undiscovered potential in regions such as the Great Basin.

Coal — Utah's high-quality coal is expensive to mine but has properties that are very attractive for many users, both foreign and domestic.

Coal methane — The local coal mines in the Book Cliff area alone vent approximately 3 million cubic feet of methane (natural gas) per day while mining is in progress. In 1983, UGMS studies were utilized in the exploration of methane gas in the Soldier Canyon Mine where methane is presently being recovered.

Humate — Utah's low-grade humate resources near Westwater have been investigated as a possible source of fertilizer material.

Carbon dioxide — New uses of carbon dioxide have made it an economically important resource for secondary recovery of petroleum and as a transport medium in slurry pipelines. Recent drilling in the Kaiparowits Basin of Utah has resulted in the discovery of a very large CO₂ reservoir.

Helium — Commercial quantities of helium have been identified in the eastern part of the state and might be developed for medical and chemical purposes.

METALLIC RESOURCES SHOULD NOT BE IGNORED

Gold and silver — Even with today's economy gold and silver are being mined profitably in the state and there is industry interest in locating and developing additional resources. Recent successes include the gold-producing Mercur mine in Utah County, discovery of the Tecoma gold-silver deposit in Box Elder County, and the continued success of the Escalante Mine in Garfield County.

Copper and other metallic minerals — Utah's geologic environment is encouraging for the discovery of additional significant deposits of copper, lead, zinc, uranium, molybdenum, iron and others. Although these metals are not currently in demand, changes in economic conditions may again make them attractive exploration targets.

Sulfur — Sulfur resources of Utah have been the object of inquiries and could receive more attention in light of two recent occurrences. First, the shut-down of Kenne-cott eliminates one of the largest sources of sulfuric acid in the state (thereby affecting the local phosphate industry) and, second, the development of sulfur-asphalt paving and sulfur concrete may create new demands for sulfur.

Uranium and vanadium — Utah has the world's best known uranium-vanadium occurrences. Some day these will again be attractive as an energy resource.

Zirconium — Sources of zirconium within the state, if developed, could be used as a feedstock for the Western Zirconium Plant west of Ogden.

Beryllium, gallium, and germanium — Beryllium minerals and rare earths are not common in the United States in mineable deposits. Presently, Utah produces virtually all of the free world's beryllium and is the world's first primary producer of gallium and germanium.

And the list goes on.

UGMS ROLE

For decades the UGMS has collected and disseminated information that directly contributes to the development of Utah's mining industry. Our publications assist in the exploration for deposits and the definition of the resource.

Unfortunately, the UGMS during the 1970s substituted federal dollars for state funding of its economic geology program. As a result, most UGMS economic geology programs respond to problems of joint interest to federal and state government and are not necessarily encouraging economic development of Utah's resources.

Suddenly there is genuine interest being demonstrated by the legislature, local governments, and several departments of state government to stimulate diversified economic growth. We are delighted if this interest in a diversified economy includes renewed emphasis on the importance of mining to Utah's economy. It is clear to us that the potential for small and large developments is great. We look forward to redirecting UGMS economic geology programs to play an increasingly helpful role in encouraging the development of Utah's geologic resources. ■

Bonnie Atwood

GREAT SALT LAKE LEVEL

Date (1985)	Boat Harbor South Arm (in feet)	Saline North Arm (in feet)
March 1*	4209.15	4208.30
March 15*	4209.35	4208.50
April 1	4209.55	4208.65
April 15	4209.75	4208.85
May 1	4209.90	4209.00
May 15	4209.90	4209.05
June 1	4209.90	4209.05
June 15	4209.80	4209.00

Source: USGS provisional records.

*March levels incorrect in Spring issue.



UTAH NATURAL RESOURCES
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