SURVEY NOTES

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UTAH GEOLOGICAL AND MINERAL SURVEY

UGMS NEW SAMPLE LIBRARY

TABLE OF CONTENTS

The UGMS Sample Library 2
The Mineral Industry of Utah in 1987 4
Dead Horse Point Rockfall Recorded on Seismograph 5
Utah Earthquake Activity 6
Scandium-bearing Aluminum Phosphate Deposits in Utah 7
UGMS Staff Changes 7
Items of Interest 8
UGMS Publications 9
Past Survey Notes Publications 10

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FROM THE DIRECTOR'S CORNER

This issue of *Survey Notes* highlights the Sample Library. The expiration of our present lease in July 1988 and a reassessment of the priorities of the UGMS Economic Geology Program make this issue particularly timely.

Problem/Need: Every year in Utah tens of millions of dollars are spent by industry and government in drilling to obtain information on the subsurface geology of the state. Most of the drilling is done for specific objectives but the samples obtained can provide important fundamental data for a variety of uses. If the samples (in the form of cores and cuttings) obtained in this drilling are not archived in a way that they can be recovered and used in the future, much of the potential information on subsurface geology is lost. Because new geologic concerns and new analytical techniques are continually developing, it is not possible to do an analysis on the samples that will provide all the information for future studies. These materials are a direct aid to industry in exploration programs and often the availability of such material is a key factor in decisions to invest in exploration programs.

Present Status: The Utah Geological and Mineral Survey has maintained a Sample Library for many years. Core and cuttings from drill holes of particular interest (usually relating to economic geology) have been accepted and stored. However, limitations of space and funds have prevented the UGMS from accepting many important samples and from providing the facilities for the public and the state to make the most effective use of the material in the Sample Library.

Thanks to conscientious staff, the sample collection is now stored much like any well-run library. Samples are neatly shelved, although in relatively cramped facilities, cataloged, and made available for use. Compared to most state sample libraries, ours is a "bare bones" approach. The more aggressive ones actively search for new acquisitions. Some states even require, by law, that samples be deposited in the state's sample library. They see the sample library as the "backbone of the survey" ... "that's all you've got once you've drilled the well" ... "it's data ... if you throw it away, it's gone forever." They boast of attracting industry. One of Alaska's triumphs was having a sample library ready and waiting when petroleum companies began looking for geologic information to aid exploration efforts. Some libraries serve engineering geologists in other state agencies by storing critical core such as from the foundation studies at dam sites, or problem soils and core from construction projects. Many sample libraries attract students and university professors to study the evolution of sedimentary basins or engineering characteristics such as changes in porosity and permeability that affect enhanced petroleum recovery. State survey personnel sometimes are among the most active users of their own sample library. It appears that the more a sample library is used, the more likely industry will give samples to it and support others use of it, and the more useful it becomes.

Library: To many, a collection of Utah rock samples housed in a warehouse is far from the definition of a library, but in one sense of the word it is. The rocks contain information and geologic stories that can be "read" by those trained to do so. As technology improves and the science of geology develops, more and more information can be found and understood from the samples, enabling scientists and investigators to form theories and make predictions about earth history and the economic resources of Utah.

The UGMS provides a stability which benefits the State of Utah by housing valuable samples without regard to economic fluctuation. A public library of books does the same. Thus, the valuable and irreplaceable rock samples that might otherwise be thrown out by companies and universities during economic downturns are kept and made available when they are needed during economic boom times.

Continued on Page 11

The UGMS Sample Library

by Cynthia Brandt

The Utah Geological and Mineral Survey (UGMS) Sample Library offers to all, free of charge, the use of geological samples from diverse parts of Utah and from a few adjacent states. It is a collection of whole core, drill cuttings, and outcrop samples.

The Real Goal

The UGMS Sample Library exists to benefit the citizens of the State of Utah. It does so by providing geological samples to scientists and engineers interested in better understanding Utah's remarkable geological record. For it is through better understanding that Utah's vast natural resources can be wisely developed for the betterment of the citizens of Utah. When resources are developed, jobs are created and incomes rise. In addition, when there is resource development, be it oil, gas, gold, coal, or other commodities, the Land Grant Maintenance Fund and the Federal Mineral Lease Funds are enhanced and better able to fund education and other state programs.

History

The UGMS Sample Library, when established in 1951, was located in the Mines Building on the University of Utah campus. Over the years the collection has always grown faster than anticipated. Consequently, since its establishment, the UGMS Sample Library has moved several times to new and larger quarters in order to keep the Library viable.

Collection

Drill cuttings from approximately 1,700 wells in Utah and surrounding areas are part of the UGMS Sample Library collection as well as more than 400,000 feet of core. The core and drill cuttings represent approximately 17% of the petroleum wells drilled in Utah. Historically, samples from wells drilled for petroleum exploration and development have dominated the collection, but metallic mineral, coal, tar sand, and geothermal samples likewise comprise a significant part of the collection. Some outcrop samples, including oil-impregnated rocks from Utah localities, are also part of the collection. Samples have also come from water wells and stratigraphic test wells. Recently, Questar Corporation donated to the UGMS Sample Library drill cuttings from 102 petroleum wells and cores from 6 wells. This has certainly enriched the library, and the UGMS is most grateful to Questar for the generous donation.

Sample Library Clients

Geologists, geophysicists, geochemists, engineers, and other investigators from petroleum companies, mining companies, coal companies, engineering companies, federal agencies, universities, and other State of Utah agencies utilize the UGMS samples. Samples provide critical data points which enhance indirect subsurface evaluations and provide a more accurate subsurface picture. The rock samples which the UGMS Sample Library loans enables direct, key determinations about the subsurface and surface of Utah to be made. Without samples, only indirect methods of making determinations are possible; indirect methods are inferior and less reliable than the direct methods. Moreover, as geological theories become more sophisticated, rock examination becomes more and more necessary: subtle aspects can make the difference between an economic success and a failure, between good scientific constructs and poor ones.

Sample Library Usage

From November 1986 through March 1988, the UGMS Sample Library responded to 76 requests, received approximately 1,006 boxes of samples, and loaned samples to 28 people. If 1988 continues to be as busy as it has been so far, the Sample Library staff will answer 80 to 100 requests, will receive 300 to 500 boxes of samples, and will loan samples to 40 to 60 people.

Staff

A manager and a technician provide service to clients of the library as well as maintain and develop the collection. At the end of December, 1987, Carolyn Olsen became the Sample Library's full-time geotechnician after years of service to the UGMS in other capacities. Her talents and enthusiasm will be a great asset to the library and will provide the manager with great capability to coordinate this function with the responsibilities of a UGMS petroleum geologist.

Catalog

The UGMS Sample Library staff has updated the listing of the holdings of the library. In the past year, the catalog information was transferred into a computer format, allowing the information on the Sample Library collection to be manipulated by database management software. As a result, the computer has helped the Sample Library staff respond more quickly and more accurately to requests for samples. The staff can search for a particular request while the client is still on the phone and answer yes, we do have that sample, or no, we do not. Because the computerized catalog is updated continually as new samples come in, the staff is also responding to clients with the best information possible. If the Sample Library has the particular sample requested, the information in the computer tells the staff member exactly where to find it in the Sample Library and if there is supplementary data on that sample in the Library files.

A new catalog should be forthcoming as soon as the needed additions and revisions can be made to the database of sample information. When published, the catalog will be available in a hard copy format and in a computer ready format, such as on floppy disks. The aim is to make the UGMS Sample Library catalog convenient to use and up-to-date. If the catalog information is bought in disk form, frequent updates will be inexpensive and easy.

Current Facilities

The collection of UGMS samples is currently housed in a warehouse at 2150 South 300 West in Salt Lake City. Adequate space is a major concern. At present the collection occupies about 4,500 sq. ft. with little room for expansion. Under current conditions, the UGMS's ability to accept new geological samples is severely limited: it can only continue to take key geological samples into its collection for one or perhaps two more years. After that, the collection must remain a static collection, and key samples must be refused, until larger

quarters can be arranged.However, there is an outside chance that the UGMS may be able to acquire better and more space for less cost per square foot. This option is currently being explored.

Acquisition Policy

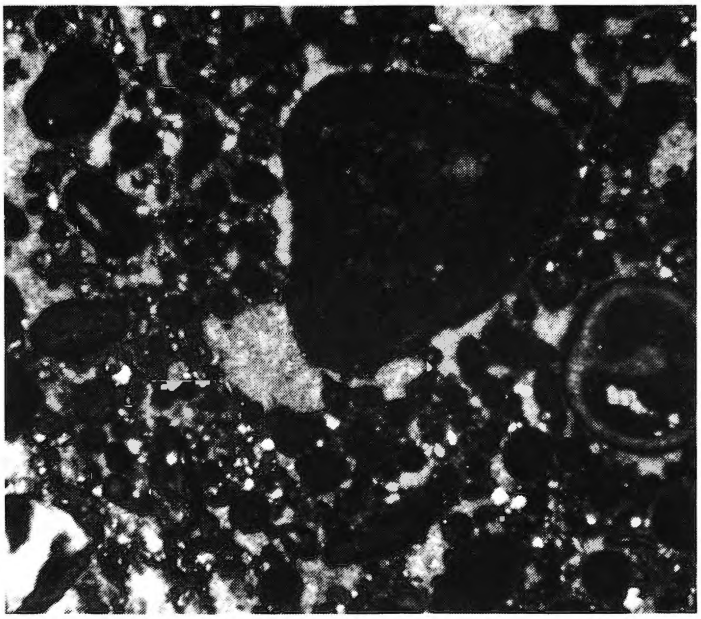
Emphasis has been on increasing the diversity and the richness of the Sample Library collection. However, the decision as to what to accept and what to decline is a difficult one. To help with the decision-making, a committee of both UGMS geologists and outside scientists has been formed. Thus, individual committee members with expertise in one or more areas of geology or geography can be consulted when a question arises as to the value of a particular group of rock samples offered to the UGMS. We believe that the best acquisition decisions can be made when advice is sought from those who are expert in the pertinent fields of geology and geography which relate to the samples.

Lending Policy

The lending policy of the UGMS Sample Library is simple. Samples can be borrowed for a period of two to six months, depending on need, but special arrangements can be made for longer use. Samples can be picked up from our warehouse or the UGMS office; they can also be shipped by the Sample Library staff as long as the two-way shipping costs are covered by the person or organization requesting the samples.In return for this service we ask for any analyses, lithologic logs, or determinations which are derived from the samples. All information is kept in a file and the sample catalog is flagged so that scientists and investigators can benefit from previous work on rock samples.

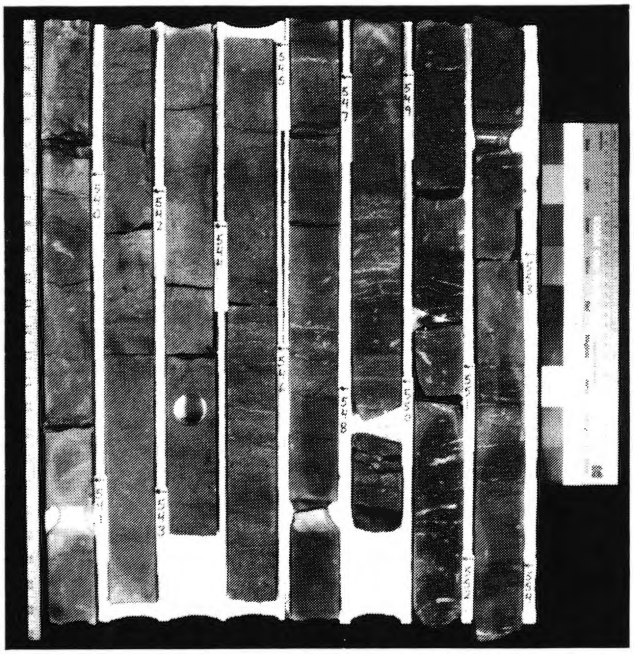
Destructive Sampling

Age dating, source rock analysis, scanning electron microscopy, and other analyses often require destruction of a sample through grinding, burning, or dissolution. After a sample is destroyed, no future investigations can be made. The UGMS allows destructive sampling if the information is in the best interest of the State and the information derived from the destructive process is made part of the Sample Library's permanent store of data and information. In this way, scientists can at least look at the information although the sample can no longer be viewed or analyzed.



Microphotograph (X20) of fossils and carbonate sand grains.

For example, in December 1987 and January 1988, the Texaco Geochemical Research Section in Houston borrowed cuttings from three petroleum wells in Duchesne County, Utah, and asked for permission to do destructive analyses on parts of samples from key intervals. The UGMS decided that the type of data and information which would result from Texaco's analyses would be valuable to Utah. Permission was granted. In March 1987, the UGMS Sample Library received geochemical analyses for the three wells and those reports are now available to the public. The geochemical reports include organic carbon analyses, thermal maturation indices, kerogen identifications, gas chromotography results, and many more determinations.



Drill cuttings, well no. 3B Federal, Virgin oil field, Washington County, Utah.

Current Laboratory Capabilities

The UGMS has microscopes, a light to check fluorescence, hydrochloric acid, carbonate stains, and various tools for doing quick analyses and descriptions of samples. All cores or samples housed at the UGMS Sample Library can be viewed under the research microscope because of the special attachments. In fact, a small boulder or a thin section can be viewed with equal ease. In addition, the research microscope has a photographic set-up which will enable a Sample Library client to take photomicrographs of samples. At this time the laboratory facility is at UGMS in Research Park, not in the Sample Library warehouse building, although some equipment can be brought down to the warehouse when clients request that assistance.

The Future

If the UGMS Sample Library is to continue to enhance economic development of Utah's resources, it will need to incorporate important geological samples into its collection. Current and future scientists and investigators can then use the samples to unravel the geologic history of Utah so its vast resources may be developed.

The Mineral Industry of Utah in 1987

Preliminary annual report, prepared by Lorraine B. Burgin, U.S. Bureau of Mines

THE VALUE OF nonfuel mineral production in Utah in 1987 was estimated at $728 million, a 95% increase over that of 1985, according to the Bureau of Mines, U.S. Department of the Interior. Leading commodities included copper, gold, portland cement, magnesium metal, construction sand and gravel, salt, silver, crushed stone, and phosphate rock. Metals accounted for about one-third of the total value of the 1987 nonfuel minerals output, a substantial gain over the one-fifth recorded for 1986.

The principal factor in the rise in value of Utah's nonfuel mineral output was the return to production of Kennecott's Utah Copper Division, shut down in 1985. The Bingham Canyon Mine had been the State's major producer of copper and byproduct gold, molybdenum, and silver. In 1987, British Petroleum Co. p.l.c., London, acquired control of The Standard Oil Co., Kennecott's parent company, and in September, merged its BPB affiliate Amselco Minerals Inc. and Kennecott into a new company called BP Minerals America Inc., based in Salt Lake City. BP Gold Co. was formed out of producing and prospective gold-producing properties of BP Minerals and registered as a public company; this new firm includes byproduct gold production from the Bingham Mine and other Kennecott and Amselco gold properties. The $400 million modernization plan of the Utah Copper Division operation continued.

Magnesium metal production declined as AMAX Magnesium Corp. at Rowley had to purchase brine salts for its primary magnesium plant after a mid-1986 storm destroyed its solar evaporation ponds on Great Salt Lake. In the fall of 1988, brines are expected to be recovered from replacement ponds being constructed adjacent to the newly created ponds of the State's West Desert pumping project. The pumping project built during the year and less precipitation lowered great Salt Lake's record-breaking water level from an elevation of 4,211.85 feet in the spring to 4,209.45 feet by December, thus protecting shoreline industries from flooding.

Basic Manufacturing & Technologies of Utah Inc., a group of private investors, purchased the USX Corp. Geneva steel plant near Provo on August 31. Closed since August 1986, the operation was renamed Geneva Steel of Utah and production started in mid-September with shipments of 12,000 tons of steel coil moving to market on October 3.

Although several uranium operations reopened in late 1987, the continued depressed conditions of the uranium industry led Atlas Corp. to announce the permanent closure of its uranium-vanadium mines and mill near Moab.

The total value of industrial minerals rose one-fifth as increases were posted for all nonmetals except native asphalt (gilsonite) and masonry cement.

TABLE 1. Nonfuel mineral production in Utah[1]

Minerals	1985 Quantity	1985 Value (thousands)	1986 Quantity (thousands)	1986 Value	1987 p/ Quantity	1987 p/ Value (thousands)
Beryllium concentrates ..... short tons	5,738	$6	6,533	$7	7,000	$7
Cement:						
Masonry ..... thousand short tons	W	W	W	W	1	55
Portland ..... do	W	W	1,014	58,431	1,100	63,400
Clays ..... do	332	2,509	305	2,048	326	2,088
Gem stones	NA	e/ 80	NA	96	NA	105
Gold (recoverable content of ores, etc.) ..... troy ounces	135,489	43,039	W	W	W	W
Gypsum ..... thousand short tons	413	4,033	470	3,671	473	3,695
Lime ..... do	225	11,912	232	13,079	318	17,927
Salt ..... do	1,057	30,013	1,112	31,830	1,086	31,869
Sand and gravel:						
Construction ..... do	e/ 14,000	e/ 36,400	16,452	39,763	e/ 18,000	e/ 48,600
Industrial ..... do	W	W	6	123	7	140
Stone (crushed) ..... do	4,657	14,180	e/ 4,500	e/ 14,100	4,900	19,500
Vermiculite ..... do	--	--	W	153	--	--
Combined value of asphalt (native), copper, iron ore (usable, 1986), magnesium compounds, magnesium metal (1986-87), molybdenum (1985, 1987), phosphate rock, potassium salts, silver, sodium sulfate (natural), stone (dimension), vanadium (1986-87), and values indicated by symbol W	XX	171,792	XX	210,755	XX	540,142
TOTAL	**XX**	**313,964**	**XX**	**374,056**	**XX**	**727,528**

e/ Estimated. p/ Preliminary. NA Not available. W Withheld to avoid disclosing company proprietary data, value included with "Combined value" figure. XX Not applicable.

[1]/ Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

Dead Horse Point Rock Fall Recorded on Seismograph

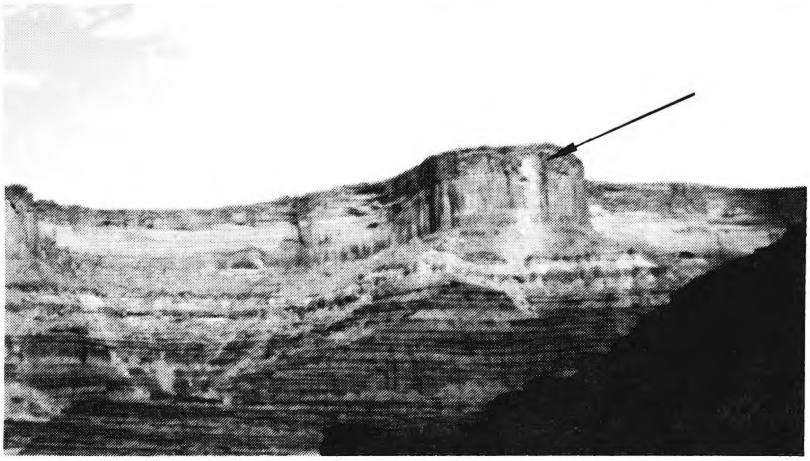
by William F. Case

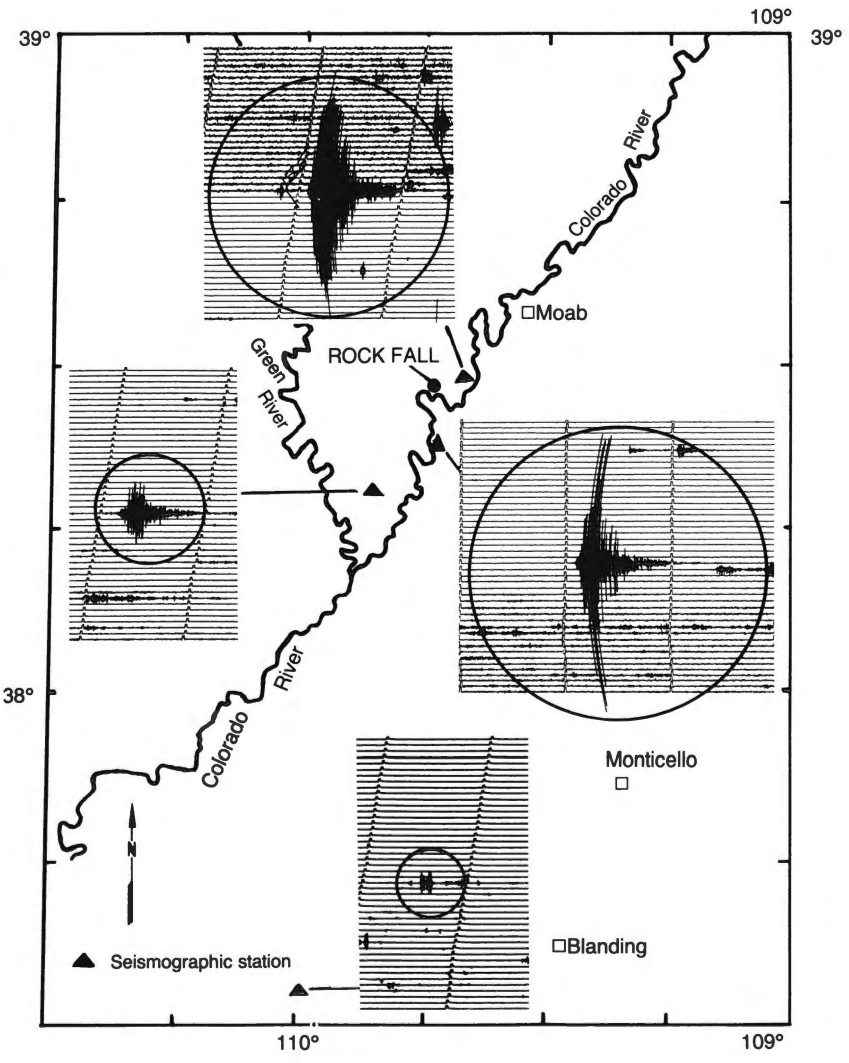
What may be the first location and identification of a rock fall in Utah from seismograph records was recently reported by Dr. Ivan G. Wong, Woodward-Clyde Consultants (personal communication, November, 1987). Rock falls were first identified on seismograms by scientists during investigations at Mt. St. Helens in the early 1980s, and Wong believes that the Utah records are probably the second reported instance. The calculation of the time and location of the rock fall is substantiated by eyewitness acounts. The rock mass fell at 9:05, in the morning of 3 July 1984, from a cliff face between the Dead Horse Point campground and visitor's center in Grand County. Wong noticed rock-fall "signatures" on seismograms recorded in a seismograph network established to monitor earthquakes in the Paradox Basin area of SE Utah. The network was part of the Department of Energy's evaluation of the suitability of the Paradox Basin as a repository site for nuclear waste. The rock-fall signature is similar to an earthquake except for a small "impulse" before the larger amplitude waves arrive. The signal energy of the rock fall is low compared to an earthquake, and decreases dramatically with distance from the source as shown by seismograms at various distances from the rock fall.

Gordon Topham, Supervisor of Dead Horse State Park, said that a pilot reported "smoke" at 9:22 am on the 3rd of July, 1984. The smoke was confirmed by park personnel as dust from the rock fall. The rock-fall trigger mechanism is not known, but Topham indicated that no earthquake was felt and the last rain in the area was on the 30th of June when 0.13 inches were reported.

The cliff consists of approximately 480 feet of Triassic Wingate Sandstone capped by Triassic Kayenta Formation rocks (Huntoon and others, 1982). About 8800 cubic yards of mostly Wingate Sandstone with a small amount of Kayenta Formation Sandstone fell from the cliff face leaving a fresh scar about 410 feet high and 95 feet wide.

The Utah Geological and Mineral Survey (UGMS) is mandated to identify and evaluate geologic hazards in Utah, and will be doing further work on rock falls as part of a larger Survey project to map and inventory resources and hazards in Grand County. Seismograph records may provide important data on rock fall location and timing.





Location of rock fall, seismograph stations, and seismograms with rock-fall record.

REFERENCE

Huntoon, P.W., Billingsley, G.H., Jr., and Breed, W.J., 1982, Geologic map of Canyonlands National Park and vicinity, Utah: The Canyonlands Natural History Association, Moab, Utah, scale 1:62,500.

UTAH EARTHQUAKE ACTIVITY

by Ethan D. Brown

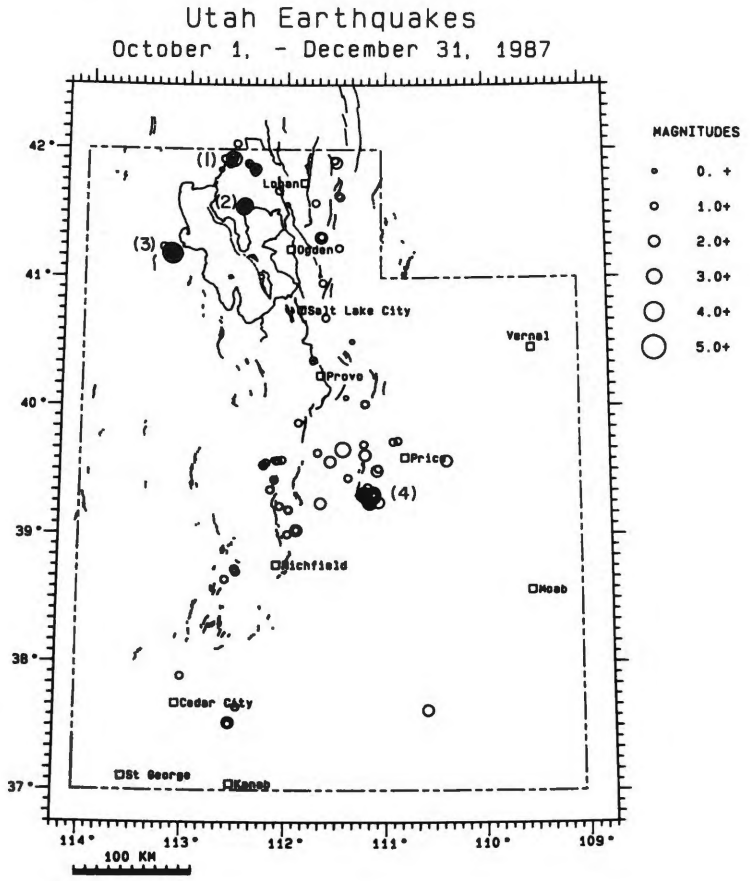
UNIVERSITY OF UTAH SEISMOGRAPH STATIONS, DEPARTMENT OF GEOLOGY AND GEOPHYSICS

October through December 1987

The University of Utah Seismograph Stations records an 85-station seismic network designed for local earthquake monitoring within Utah, southeast Idaho, and western Wyoming. During October 1 to December 31, 1987, 248 earthquakes were located within the Utah region, including 69 greater than or equal to magnitude 2.0. The epicenters in Figure 1 show earthquake activity extending from south-central Utah northward through Utah's main seismic region to the Utah-Idaho border. Clusters of events are shown north and west of the Great Salt Lake and 40 km southwest of Price, Utah. The largest earthquake during this time period, M_L 4.7, occurred on October 26 and was located 100 km west of Ogden, just west of the Great Salt Lake. This earthquake was reported felt from Wendover (on the Utah-Nevada border) to the Salt Lake Valley, and is part of an earthquake sequence that included an M_L 4.8 event on September 25, 1987. An M_L 4.3 event in the same area on October 23 was felt strongly by workers close to the epicenter. Other felt earthquakes during the report period include: an M_L 3.5 event on October 2, located 50 km southwest of Logan and felt at the Golden Spike National Historic Site; an M_L 3.8 shock on October 19, located 50 km west of Price and felt in northern Sanpete Valley; an M_L 3.2 event on December 11, located about 11 miles NW of Tremonton and felt at Morton Thiokol.

Spatial clusters of earthquakes occurred: (1) near the Utah-Idaho border, (2) north of the Great Salt Lake, (3) west of the Great Salt Lake, and (4) 40 km southwest of Price. Cluster (1) contains 18 events of $M_L \leq 3.2$. These earthquakes are located in the same area as a sequence active between October 1986 and April 1987 that included seven events greater than magnitude 3.5. Cluster (2) includes 21 events of $M_L \leq 3.3$, which occurred mainly in early October and late November. Cluster (3), containing 125 events of $M_L \leq 4.7$, is part of an ongoing sequence of earthquakes that began in September 1987. Cluster (4) was active through November and early December and contains 27 earthquakes of M_L 3.3.

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



GREAT SALT LAKE LEVEL

Date (1988)	Boat Harbor South Arm (in feet)	Saline North Arm (in feet)
Dec 1 '87	4209.45	4208.65
Dec 15	4209.45	4208.50
Jan 1 '88	4209.40	4208.65
Jan 15	4209.50	4208.80
Feb 1	4209.50	4208.85
Feb 15	4209.55	4208.85
Mar 1	4209.55	4208.75
Mar 15	4209.55	4208.65
April 1	4209.55	4208.65
April 15	4209.40	4208.55

Source: USGS provisional records.

Scandium-bearing Aluminum Phosphate Deposits in Utah

by Michael A. Shubat

Research and development of high-efficiency lasers that use gadolinium-scandium-gallium garnet (GSGG) crystals is creating an increased demand for scandium. Laser-grade scandium oxide (99.999% pure) currently sells for $15,000 per kilogram, roughly equivalent to today's price of gold. Scandium is critical in the growth of these laser crystals because it allows incorporation of chromium into the crystal structure with a very uniform distribution. Potential uses of the new crystal include surgical lasers (laser-welding of tissue to replace suturing), lasers used for the generation of fusion reactions, and military applications. Compounds used to make GSGG lasers include the oxides of gadolinium (a rare-earth element), scandium, gallium, chromium, aluminum, and silicon. All of these compounds, except scandium, are widely available in the United States. Domestic sources of scandium, however, are nearly non-existent and the majority of the world's supply comes from Russia and China.

Scandium enrichment occurs in several geologic environments. Late-stage pegmatite dikes and greisen zones with associated deposits of lithophile elements such as tin and tungsten commonly contain scandium. Small amounts of scandium also occur in association with uranium and thorium deposits of the Colorado Plateau. Some heavy mineral sands and placer deposits may contain scandium, particularly if composed of monazite, euxenite, or zircon. Phosphatic shales in western Utah represent a tremendous low-grade reserve of scandium. The Phosphoria Formation contains only about 10 ppm Sc but other phosphatic shales contain as much as 500 ppm Sc. Topaz Mountain Rhyolite of the Thomas Range contains lithophysae minerals highly enriched in scandium. The last geologic environment where scandium occurs is unique to western Utah and Nevada and consists of a class of hydrothermal scandium-bearing aluminum phosphate deposits containing variscite, crandallite, and related minerals.

The best-known scandium-bearing aluminum phosphate deposit in Utah is the Fairfield deposit (also known as the Little Green Monster or Clay Canyon deposit) located in the southern Oquirrh Mountains. Dark limestone and black shale of the Upper Mississippian Great Blue Limestone host the variscite deposits. Variscite nodules replace limestone along a north-trending, vertical fracture zone and the nodules lie within pipe-like bodies that plunge to the north. Scandium is present in the minerals crandallite, variscite, and a variety of rare minerals. Crandallite contains scandium oxide over a range of 100 to 8000 ppm, and wardite, deltaite, and goyazite contain as much as 5000 ppm Sc_2O_3. Bulk samples of crandallite ore from the Little Green Monster deposit contained over 1000 ppm scandium oxide. Trace elements associated with scandium mineralization include strontium, yttrium, gallium, vanadium, and gold.

A preliminary investigation of the Little Green Monster deposit and other occurrences in Utah suggests that these scandium-bearing deposits may be genetically related to epithermal disseminated gold deposits (such as the Mercur deposit), where the epithermal systems penetrate a stratigraphic section containing phosphatic shales. Additional information on these deposits can be found in the Utah Geological and Mineral Survey Report of Investigation 209.

UGMS Staff Changes

Andy King, went from a geotech in Applied to crew chief for Sorex doing aeromagnetic surveys in Texas and the western United States.

Applied section promoted *Bill Mulvey* from geotech to Geologist II - he still has to do trench work however - and has temporarily added *Bill Black* and *Mike Laine* as geotechs. Bill served time as receptionist while Mike has been Sample Librarian on half-time basis.

Returning to the Survey are *Sandy Eldredge* as a Research Analyst and *Miriam Bugden* as the Information Specialist. Besides their regular duties, they'll be working together to delineate the economic resources of 29 counties in Utah.

Carolyn Olsen, long the mainstay of Editorial, assumed her new position as Librarian of the recognized and thriving Sample Library. Core blimey!

Michael L. Ross joins us as the newest Mapping Geologist.

Troy Thompson is going to work for Exxon Petroleum in Houston. He has been a Geotech in Economics.

Patti Frampton-Carter has accepted the position of Typesetter. She is beginning to realize what she has done!

Geologist *Bill Case* will assist the Earthquake Scientist when that position is filled.

Long-time UGMS personnel *Bruce Kaliser* (Hazards Geologist) and *Hasan Mohammed* (Energy Minerals Geologist) have gone to the private sector to continue their careers.

Two senior geologist research positions have been filled by *Archie Smith,* formerly Senior Geologist for the Economic section, and *Bill Lund,* Chief of the Site investigation group in the Applied section. They now occupy, respectively, the positions of Special Assistant for Energy and Mineral, and Special Assistant for Hazards Research.

Gary Christenson, most recently the Chief of the Hazards compilation team, has accepted the position of Geological Manager over the Applied Program.

Charlie Bishop has gone from Economic to Mapping back to Economic as Geotech extraordinaire.

ITEMS OF INTEREST

Call For Papers

A call for papers for U.S. Geological Survey Professional Paper *Assessing Regional Earthquake Hazards and Risks Along the Wasatch Front, Utah, Part B* was issued in early December, 1987. Manuscripts will be accepted until January 1, 1988. Persons interested in submitting papers, and who seek information regarding style and peer review should contact:

Paula Gori
U.S. Geological Survey
905 National Center
Reston, VA 22092
(703) 648-6707

Those wishing to present papers at the *World Gold '89 — Gold Forum Technology & Practices* meeting to be held October 22-25, 1989 are invited to submit a 200-word abstract. Held at Bally's Hotel, Reno, Nevada, the meeting is sponsored by Society of Mining Engineers and The Australasian Institute of Mining and Metallurgy. Submit abstracts to:

Meetings Department — World Gold '89
Society of Mining Engineers
P.O. Box 625002
Littleton, CO 80162
(303) 973-9550

A call for papers has been issued for the Ninth Rapid Excavation and Tunneling Conference (RETC), June 11-15, 1989, Los Angeles, California. The deadline for submissions is June 15, 1988.

The RETC is jointly sponsored by the American Institute of Mining, Metallurgical, and Petroleum Engineers (AIME) and the American Society of Civil Engineers (ASCE). The Society of Mining Engineers of AIME is coordinating the technical program.

Books and Papers

SUMMARIES OF TECHNICAL REPORTS, VOLUME XXV — National Earthquake Hazards Reduction Program. Compiled by M.L. Jacobson and T.R. Rodriguez, U.S. Geological Survey Open-File Report 88-16; includes several excellent articles dealing with hazards along the Wasatch Front.

GEOLOGY OF UTAH by William Lee Stokes. A complete summary of geologic history in Utah from a personal viewpoint. Profusely illustrated with photographs and drawings, it is written for laypeople as well as geologists. Published jointly by Utah Museum of Natural History and the Utah Geological and Mineral Survey, 1987.

The Colorado River Survey

by Robert B. Stanton and the Denver, Colorado Canyon and Pacific Railroad

This 305-page tome edited by Dwight L. Smith and C. Gregory Crampton is the journal of a fascinating dream — to build a low-grade railroad from Grand Junction, Colorado to San Diego, California. The survey, 1889-1890, followed Powell's and added another dimension by having a railroad engineer's orientation. Published by Howe Brothers, Salt Lake City, 1987.

Meetings

July 27-30 Earthquake Engineering and Soil Dynamics II "Recent Advances in Ground Motion Evaluation." An ASCE specialty conference sponsored by ASCE Geotechnical Engineering Division, Earthquake Engineering Research Institute, Seismological Society of America, Structural Engineers Association of Utah, and Utah Section of American Society of Civil Engineers. Prospector Square Hotel, Park City, Utah. Contact Dr. T. Leslie Youd, Department of Civil Engineering, Brigham Young University, Provo, UT 84602 (801) 378-6327.

August 17-19, 1988 Annual Highway Geology Symposium "Construction to Minimize Environmental Impact" sponsored by Brigham Young University, Utah Department of Transportation and Utah Geological and Mineral Survey held at Genesis Resort, Park City, Utah. Session topics include rock slopes; slope stability; retaining walls, expansive soils, and a field trip to view Thistle landslide, Jordanelle Dam site, Great Salt Lake dikes, and Provo River Canyon. For more information contact Dr. T. Leslie Youd, Department of Civil Engineering, 368 Clyde Building, Brigham Young University, Provo, Utah 84602, (801) 378-6327.

September 9-10 Utah Mining Association Convention, Park City, UT.

September 15-16, 1988 Utah Disaster Planning Workshop. Brigham Young University Conference Center in Provo, Utah, sponsored by the Utah Preservation Consortium. For more information contact Randy Silverman, 6216 HBLL, Brigham Young University, Provo, Utah 84602, (801) 378-2512.

September 23-25 Ore Estimation & Mine Planning, Golden, CO.

September 25-28 American Mining Congress Convention, Denver, CO.

October 14-15 Friends of the Pleistocene, Rocky Mountain Call, will hold a field trip in the Tonto Basin of central Arizona. Contact Larry Anderson or Lucy Piety, U.S. Bureau of Reclamation, D-1632, Box 25007, Federal Center, Denver, CO. 80225 (303) 236-4195.

October 16-21, 1988 Association of Engineering Geologists Annual Meeting, Kansas City, Missouri. For information contact Thomas J. McClain, Technical Program Chairman, Kansas Geological Survey, 1930 Constant Avenue, Lawrence, Kansas 66046, (913) 864-3965.

October 31-November 3, 1988 Geological Society of America Annual Meeting, Centennial Celebration held in Denver, Colorado. For information contact Jean Kinney, GSA, Box 9140, Boulder, Colorado 80301, (303) 447-2020.

December 7-11, 1988 American Geophysical Union Fall Meeting, San Francisco, California. For information contact AGU, 2000 Florida Avenue, N.W., Washington, DC 20009, (202) 462-6903.

July 9-19, 1989 28th International Geological Congress, Washington, D.C. For information contact Bruce B. Hanshaw, Box 1001, Herndon, VA 22070-1001, (703) 648-6053.

New Publications of the UGMS

Map 94 *Geologic map of the Pigeon Mountain quadrangle, Box Elder County, Utah,* by Linda L. Glick and David M. Miller, 1:24,000, 9 pages, 2 plates, 1987. The area in northwest Utah has lowlands of the Great Salt Lake Desert mountains underlain by Permian sedimentary rocks of the Cordilleran Miogeocline, and surficial deposits from Pleistocene Lake Bonneville.

Map 95 *Geologic map of the Jackson quadrangle, Box Elder County, Utah,* by David M. Miller and Linda L. Glick, 1:24,000, 7 pages, 2 plates, 1987. One of 6 published UGMS maps by U.S. Geological Survey personnel mapping in SW Box Elder County. The area has Devonian and Permian sedimentary rocks of the Cordilleran Miogeocline and surficial deposits from Pleistocene Lake Bonneville. Structural features mostly resulted from episodes of crustal extension in Neogene time.

Map 103 *Geologic map of the Panguitch NW quadrangle, Iron and Garfield Counties, Utah,* by John J. Anderson and Peter D. Rowley, 1:24,000, 8 pages, 2 plates, 1987. Lying just north of Panguitch, the area is dominated by the Marysvale volcanic field deposits. These USGS authors and others have been trying to define the complex volcanics in this part of Utah. This map is one of a series of UGMS and USGS publications resulting from their studies.

Map 104 *Geologic map of the Little Creek Peak quadrangle, Garfield and Iron Counties, Utah,* by John J. Anderson, Thomas A. Iivari, and Peter D. Rowley, 1:24,000, 11 pages, 2 plates, 1987. A companion piece to Map 103.

Map 105 *Geologic map of the Marysvale quadrangle, Piute County, Utah,* by P.D. Rowley, C.G. Cunningham, T.A. Steven, H.H. Mehnert, and C.W. Naeser, 1:24,000, 15 pages, 2 plates, 1988. The Marysvale quadrangle is in south-central Utah and features complex Tertiary volcanic lithologies, the Marysvale mining district, and the Monroe Peak Caldera.

Map 106 *Geologic map of the Antelope Range quadrangle, Sevier and Piute Counties, Utah,* by P.D. Rowley, C.G. Cunningham, T.A. Steven, H.H. Mehnert, and C.W. Naeser, 1:24,000, 14 pages, 2 plates, 1988. This quadrangle in south-central Utah is near the center of one of the largest Tertiary eruptive piles in the western U.S. The map and its adjoining one, Map 105, feature a wide range of volcanic and volcaniclastic lithologies as well as multiple Miocene through Pliocene rhombic-pattern faults and part of the Central mining district.

Map 108 *Geologic map of the Silver Peak quadrangle, Iron County, Utah,* by M.A. Shubat and M.A. Siders. 1:24,000, 13 pages, 2 plates. Tertiary volcanics dominate this area to the west of Cedar City. Structural events range from mid-Miocene intrusions to Neogene extensional tectonism. The 13-page text discusses base and precious metal epithermal mineralization of the Antelope Range mining district. An upcoming UGMS Bulletin on the district incorporates this data and the map.

Map 110 *Shallow ground water and related hazards in Utah,* compiled by Suzanne Hecker and K.M. Harty. 17 p., 1 plate , scale 1:750,000, 1988. The map delineates locations in Utah that are most likely to experience problems related to shallow ground water: basement flooding, liquefaction during earthquakes, flooded septic-tank fields, etc. Areas outlined as 1) less than 10 feet to ground water and 2) less than 30 feet to ground water.

Open-File Releases

OFR-115 *Earthquake response strategies for Utah Geological and Mineral Survey and the earth-science community,* 33 pages, 1988. Three papers helping define possible responses of UGMS and other personnel in the event of an earthquake.

OFR-117 *Great Salt Lake brine sampling program 1985-1987,* by J. Wallace Gwynn, 30 pages, 1988. This report provides an update of data collected from March 1985 to June 1987 to add to OFR-87. The chemistry of the lake has been continuously sampled since 1966 to provide information for users.

OFR-127 *Maximum extent of potential flooding due to simultaneous failure of dams in Salt Lake County, Utah,* by William F. Case, approximately 1" = 1¼ miles, 28 pages, 1 plate, 1988. A study to determine probable maximum flooding areas if all Salt Lake County dams failed simultaneously, a possibility during a major earthquake.

The following are informational releases of material in the review and publishing process. They are available for public inspection at the UGMS Library:

OFR-114 *Provisional bedrock geologic map of Northern Keg Mountain, Juab County, Utah,* by Michael A. Shubat, scale 1" = 1000', 2 pages, 2 plates, 1987.

OFR-116 *Geology of the Boulder Mountain quadrangle, Cache County, Utah,* by A.R. Mork, 1:24,000, 29 pages, 2 plates, 1988.

OFR-118 *Geology of the Gold Hill quadrangle, Tooele County, Utah,* by Jamie Robinson, 1:24,000, 33 pages, 1 plate, 1988.

OFR-119 *Geology of the Geyser Peak quadrangle, Sevier County, Utah,* by S.T. Nelson, 1:24,000, 37 pages, 2 plates, 1988.

OFR-120 *Geology of the Levan quadrangle, Juab County, Utah,* by W.L. Auby. 1:24,000, 56 pages, 2 plates, 1988.

OFR-121 *Geology of the Calf Creek quadrangle, Garfield County, Utah,* by G.W. Weir and L.S. Beard, 1:24,000, 21 pages, 2 plates, 1988.

OFR-122 *Geology of the Juab quadrangle, Juab County, Utah,* by D.L. Clark, 1:24,000, 54 pages, 2 plates, 1988.

OFR-123 *Geology of the King Bench quadrangle, Garfield County, Utah, by G.W. Weir and L.S. Beard, 1:24,000, 14 pages, 1 plate, 1988.*

OFR-124 *Geology of the Tenmile Flat quadrangle, Garfield County, Utah,* by G.W. Weir and L.S. Beard, 1:24,000, 18 pages, 2 plates, 1988.

OFR-125 *Geology of the Red Breaks quadrangle, Garfield County, Utah,* by G.W. Weir and L.S. Beard, 1:24,000, 15 pages, 2 plates, 1988.

OFR-126 *Geology of the Fountain Green North quadrangle, Sanpete and Juab Counties, Utah,* by R.L. Banks, 1:24,000, 78 pages, 3 plates, 1988.

Report of Investigation 209 *Scandium-bearing aluminum phosphate deposits of Utah,* by M.A. Shubat, 26 pages, 1988. Scandium use by industry is increasing. This report examines the mineral, its uses, and occurrences in Utah (see article on page 7).

Report of Investigation 216 *Technical Reports for 1987 — Site Investigation Section, compiled by B.D. Black, 115 pages, 1988. A collection of on-site investigation reports done by UGMS personnel during 1987.*

Past *Survey Notes* Publications

Index of Lead and Main Articles

Year	Volume/Issue	Title of Article	Author
1984	18/1 SPRING	*The Great Salt Lake Incremental Sampling Program*	J.W. Gwynn
		Fluctuations of the Level of Great Salt Lake	Don R. Mabey and Genevieve Atwood
	18/2 SUMMER	*The Tintic Mining District*	Laurence P. James
		Early Uranium-Vanadium Mining in Monument Valley, San Juan County, Utah	William L. Chenoweth
	18/3 AUTUMN	*Petroleum Activities in Utah 1972-82*	K. W. Brown
		THE ALTA CONFERENCE:	
		Structure and Composition of the Crust	Ronald L. Bruhn
		Dating Geological Materials in Utah	Donald R. Currey
		Geologic Hazards	Robert W. Fleming
	18/4 WINTER	*Earthquake Hazards in Utah*	D.R. Mabey
		Looking Backward	Wm. Lee Stokes
1985	19/1 SPRING	*Utah's Geologic Mapping Program*	H.H. Doelling
		Geologic Projects in Utah Conducted in Summer 1984	
	19/2 SUMMER	*Methane and Coal Mining*	A.D. Smith
		Wasatch Front County Hazards Geologists	Gary E. Christenson
	19/3 AUTUMN	*Industrial Commodities in Utah*	Bryce T. Tripp
		Volcanic Hazards	Don R. Mabey
	19/4 WINTER	*Information Program at the UGMS*	M.R. Smith
		Utah Geological and Mineral Survey Excavation Inspection Program	Harold E. Gill
1986	20/1 SPRING	*Utah's Geologic Hazards*	Gary E. Christenson
		UGMS Workshop on Landslide Inventories	Sandra N. Eldredge
	20/2 SUMMER	*Kane County Geology*	H.H. Doelling, F.D. Davis, and C. Brandt
		Notes on the Historic High Level of Great Salt Lake	Don R. Mabey
	20/3 FALL	*Mining District Studies*	Michael A. Shubat
	20/4 WINTER	*Cusmap-Minerals Appraisal*	L.F. Hintze
		Utah Quadrangle Mapping	Hellmut H. Doelling
1987	21/1 SPRING	*Geologic Hazards and Land-Use Planning, Wasatch Front*	Gary E. Christenson, Mike V. Lowe, Craig V. Nelson Robert M. Robinson
		Big Cottonwood Canyon Flume Damaged by Rockfall Due to Cloudburst	William F. Case
	21/2,3 SUMMER/FALL	*Cooperative Geological Mapping*	Charles G. (Jack) Oviatt and Fitzhugh D. Davis
		End of the Wet Cycle	Don R. Mabey
	21/4 WINTER	*The UGMS Sample Library*	Cynthia Brandt
		Scandium-bearing Aluminum Phosphate	Michael A. Shubat

The following list represents Earth Science Annual Awards for 1987 for projects in Utah, as awarded by the **National Science Foundation.** Proposed title is followed by P.I. and associated institution.

Dynamics of the Yellowstone Volcanic Tectonic System from GPS, Precision Gravity and Earthquake Data
Robert Smith University of Utah

A High Resolution Heat Flow Study: Jordanelle Dam Site, Utah
D.S. Chapman University of Utah

Replacement of Electron Microprobe
William P. Nash University of Utah

Jurassic and Lower Cretaceous Stratigraphy: An Integrated Boreal and Tethyan Time Scale
Peter Roth University of Utah

Subaqueous and Eolian Facies Relationships, Permian of Northwestern Colorado Plateau, Utah
Marjorie Chan University of Utah

Geomechanical and Geochemical Analyses of Basin and Range: Normal Faulting — Dixie Valley Faults, NV
Ronald Bruhn University of Utah

Thermochemical Evolution of the Stratified Oligocene; Needles Range Magma System, Nevada and Utah
Eric Christiansen Brigham Young University

Tertiary Structural and Volcanic Evolution of the Ranges Surrounding Dry Lake Valley, Lincoln County, Nevada
John Bartley University of Utah

Paleontological Study of Hemphillian (Late Miocene to Early Pliocene) Vertebrate Localities in Central Mexico
Wade Miller Brigham Young University

Isotopic Helium as an Indicator of the Terestrial Exposure Age of Minerals and Implications for Surface Processes
Thure Cerling University of Utah

Mineralogy, Magnetism and Geologic Origin of Fine-Grained Fe-Ti Oxides in Glassy and Devitrified Rhyolitic Rocks
Charles Schlinger University of Utah

Structure and Mechanics of Seismogenic Fault Zones; A Comparative Study of Transtensional Faulting in Yunnan Province, China and Western Cordillera, United States
Ronald Bruhn University of Utah

Physico-Chemical Characteristics of Hydrothermal Alteration Associated with Massive Sulfide Genesis: Manitouwadge District, Ontario
Erich Petersen University of Utah

1988 INVENTORY REDUCTION SALE

The Utah Geological Association is having a 1988 inventory reduction sale on publications March 21st through July 31st. Most books are reduced 50% or more. Also, get a set of 3 Uinta Basin and Uinta Mountains publications for $17.00, a set of 4 Overthrust publications for $30.00, or a set of all 15 UGA books (except the 1987 Guidebook) for only $100! But don't forget about the latest — the 1987 Guidebook, ***"Cenozoic Geology of Western Utah,"*** *which is available for $65 plus 10% postage and handling.* Contact the Publication Desk of the Utah Geological and Mineral Survey for details and for orders.

FROM THE DIRECTOR'S CORNER

Continued from Page 2

I believe a sample library is one of the most valuable contributions a state survey can provide to industry, to other state agencies, and to the advancement of the science of geology. The level of effort we invest in it is a question of balance. Core is a precious commodity that companies can give to the state, but the state can't afford to buy. The sample library is a service that many companies can't justify when projects are completed but is one that state geological surveys can justify for the benefit of the citizens and the state's economy. UGMS is committed to these goals and will strive to give Utah a Sample Library which works for the betterment of Utah.

UTAH DEPARTMENT OF NATURAL RESOURCES
Utah Geological and Mineral Survey
606 Black Hawk Way
Salt Lake City, Utah 84108-1280

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