SURVEY NOTES

VOLUME 23, NUMBER 1 SPRING 1989
UTAH GEOLOGICAL & MINERAL SURVEY

Antelope Island State Park

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Survey Notes is published quarterly by **Utah Geological and Mineral Survey**, 606 Black Hawk Way, Salt Lake City, Utah 84108 (801) 581-6831. The UGMS inventories the geologic resources of the state, identifies its geologic hazards, disseminates information concerning Utah's geology, and advises policymakers on geologic issues. The UGMS is a division of the Department of Natural Resources. Single copies of Survey Notes are distributed free of charge to residents within the United States and Canada. Reproduction is encouraged with recognition of source.

FROM THE DIRECTOR'S CORNER

This issue of *Survey Notes* highlights the work of UGMS Geologic Mapping Program. The feature article celebrates the completion of a major mapping project which has resulted in a better understanding of Antelope Island's geology and recreational potential. Several publications about the island will be available later this year including a geology map and explanatory brochure, a thick volume containing several technical articles, and a number of publications especially designed for visitors to the island who want to better understand its geology.

Other articles in this issue ... describe how to use UGMS geologic mapping projects ... report the status of geologic mapping in Utah ... recognize the contributions of an earlier geologic mapper ... describe UGMS Mapping Program's information bases and solicit information for our stratigraphic data bases.

The geologic mapping of Antelope Island is an excellent example of UGMS multipurpose geologic maps. Geologists worldwide for over a hundred years have summarized their findings on geologic maps. Most geologists map an area for a specific purpose such as to find mineral resources or to understand one particular aspect of the earth's history. Often a geologist will map only "interesting" features in detail and omit information of less importance for his/her project. Thus one quadrangle may be mapped several times for different objectives and none of these maps will contain all the basic geologic information. Conversely, some "less interesting" areas may not be mapped at all.

Not so with the UGMS program. We take a multipurpose, statewide approach. UGMS generalized mission is to make the state richer, safer, and better understood geologically. Geologic mapping is one of the primary ways we accomplish these tasks. We intend to systematically map all areas of the state at a suitable scale for multiple users.

Multipurpose maps are designed for at least *three general uses.* This *first* is to help find energy, mineral and water resources. Energy resources and minerals are found in special geologic environments such as in faults and fissures, or in certain rock formations, or associated with certain rock types such as igneous rocks. The *second* major purpose of geologic maps is to assist in the evaluation of potential geologic hazards such as earthquakes, volcanic eruptions, and landslides. Less obvious but expensive hazards include expanding, shrinking and collapsible soils, high ground water, sand dunes, debris and mudflows and other types of ground failure. The *third* category of user is interested in understanding or appreciating some aspect of the earth such as its history or structure, or simply its scenic beauty.

Regional maps (1:100,000) are used extensively by land planners (such as for transportation routes) and by resource geologists (such as for petroleum exploration or for examining mineral trends). More detailed maps, 7.5′ quadrangle maps at a scale of 1:24,000, provide much more specific information. Geologists use them to avoid small and large landslides or fault zones, scientists use them to understand details of the earth's surface, and hikers and amateur geologists use them to enhance their enjoyment of their surroundings. UGMS conducts mapping at both these scales.

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ANTELOPE ISLAND STATE PARK
The History, The Geology, and Wise Planning For Future Development

by Hellmut Doelling

INTRODUCTION

Antelope Island, the largest of the Great Salt Lake islands, is 15 miles long, about 5 ½ miles wide, and has an approximate area of 40 square miles. It is noted for the largest buffalo herd in the state. The State of Utah acquired the island in 1981 and made it part of the state parks system, administered by the Division of Parks and Recreation (UPR). In August, 1987 the UPR and the Utah Geological and Mineral Survey (UGMS) Divisions of the Department of Natural Resources concluded that geological input would help in the development of the park master plan.

The UGMS organized a task force of geologists to study the island's geology, ground water, geologic hazards, and economic geology. Even a radon hazard study was conducted. Interesting geologic sites needed to be identified, the local geologic history needed to be better understood, geologic problems relating to the park's development needed to be recognized. The UPR agreed to provide logistical support, which proved to be the key to the success of the project: high water had destroyed all land access to the island, so it could only be reached by boat or plane.

The UGMS began field studies in the early part of October 1987 and finished most of the work by December. More than 20 scientists participated, including various types of geologists, geophysicists, and geographers. Professionals from the UGMS, the University of Utah, the U. S. Geological Survey, and even one visiting geologist from the People's Republic of China participated.

To date, the UGMS has produced a colorful, non-technical brochure describing the geologic story of the island. A geologic map at 1:24,000 scale has been open-filed and is presently being prepared for publication. Additionally, the UGMS will prepare a bulletin containing all available earth-science information about the island; several participants are preparing manuscripts at this time.

Figure 1. Numerous geologists participated in the geologic study and mapping of Antelope Island late in 1987. Although mostly conducted by UGMS geologists, University of Utah and U.S. Geological Survey professionals also participated.

HISTORY OF THE ISLAND

A few non-diagnostic artifacts have been found at four sites on the island, providing evidence that American Indians inhabited the island long before the white explorers arrived. It is thought that members of the early Fremont culture (8,000 to 2,000 years ago) either resided there or visited the island.

Jim Bridger "discovered" the Great Salt Lake during the winter of 1824-1825 (Bancroft, 1889). He floated into the lake (via the Bear River) near the present location of the Bear River Migratory Bird Refuge, west of Brigham City. He may have travelled on and discovered some of the islands, but there is no documentation that he did. He reportedly tasted the salty water and thought he had reached an arm of the Pacific Ocean.

The news spread, and William Sublette of the Rocky Mountain Fur Company dispatched an expedition of four men headed by James Clyman to explore the lake in skin boats during the summer of 1826. They followed the north and west shores to the south end of the lake. In 1833, Joseph R. Walker, chief scout and guide of Captain B. L. E. Bonneville, proved that the lake was truly an inland sea. John C. Fremont, "the Pathfinder," explored the lake in 1843 and 1845. In October, 1845, he visited Antelope Island in company with Kit Carson. In his memoirs he wrote,

> *There is at this southern end of the lake a large peninsular island which the Indians informed me could at this stage of the water be reached on horseback. Accordingly...I took with me Carson and a few men and rode... across the shallows.... On the island we found grass and water and several bands of antelope. Some of these were killed, and, in memory of the grateful supply of food they furnished, I gave their name to the island.*

Fremont encountered the son of Chief Wanship, a Shoshone who was living on the island with two of his wives. Wanship's son demanded payment for the antelope killed by Fremont because he claimed the island was his.

The Mormon pioneers entered Salt Lake Valley in the summer of 1847. In 1848 the level of Great Salt Lake is presumed to have been low and at least three horseback expeditions reached the island. The route followed that of Captain Fremont, across the delta of the Jordan River to the south tip of the island. The first expedition included Albert Carrington, Jedediah M. Grant, William A. Porter, a "Brother" Kimball and others. They only stayed a day, but reached the area of the present ranch house. The second expedition, reaching the island in April, noted several Indian ponies and saw three Indians. The third expedition arrived in late summer or early fall and included Fielding Garr. The first expeditions had reported the presence of water and lush grass, and the third one investigated the island for the purpose of establishing a ranch.

The first non-Indian resident on Antelope Island was Daddy Stump, Doc Stump, or Father Stump. No one knows where he came from, but he is referred to as a bear hunter and old mountaineer. He may have been allied with the early hunters and trappers, or may have attached himself to the Mormon settlers. Some think he was living on the island when the Mormons arrived on 24 July 1847. He is known to have helped Mormon cattlemen drive the first herd onto the island in the fall of 1848. He disappeared in Cache Valley in 1855 and was never heard from again; rumors indicated he may have been killed by Indians.

Fielding Garr, a Mormon convert from Virginia, was placed in charge of the cattle on the island. The ranch house, still standing on the island today, was built in the fall of 1848 or early in 1849 by Garr from adobe bricks made by mason Rodney Badger. Garr lived on the island with his family of seven children. In 1850 the cattle of the Mormon Perpetual Emigration Fund Company (PEF) were herded to the island along with those of the private cattlemen. The cattle and oxen were in high demand during the colonization of the west and brought needed cash for PEF purposes. Even though the island was set aside for the PEF herds, private ranchers, including Brigham Young and Heber C. Kimball, kept their herds there as well.

In 1850, the U.S. Government's interest in the Great Salt Lake was again revived and Captain Howard Stansbury of the Topological Engineers was commissioned to survey the lake and make recommendations for a possible transcontinental railroad route. Stansbury and his crew made their survey from a boat known as the Salicornia, Flower of Salt Lake, or "Sally." Party member James Hall (1852) probably published the first specific geologic comments on the region:

> *The specimens collected in the islands and shores of the Great Salt Lake are sufficient to give one a very good idea of the general geologic features. The specimens are of metamorphic rocks, consisting of talcose and mica slates, hornblende rocks, and a few specimens of granitic or syenitic character.*
>
> *...The more elevated portions of the lake shore and the mountain ranges consist of carboniferous limestone. In some localities this limestone is partially altered, losing its granular character and becoming sub-crystalline, or threaded by numerous veins of calcareous spar. In most localities, however, the limestone abounds with fossils, particularly corals of the Cyathophillidae....*
>
> *Judging from the relative position of the limestone, and the metamorphic rocks of Antelope and Fremont's Islands, the former occupies the position of low synclinal basins, the valley between being produced to a large extent probably by erosion along the anticlinal axes, occasioned by the elevation of the metamorphic rocks....*

Stansbury made his camp on Antelope Island while surveying Great Salt Lake and got to know Fielding Garr. They became good friends and Garr provided invaluable assistance in logistics to the survey party. The lake experienced a gradual rise during the life of Fielding Garr, and in his later years cattle had to be barged to and from the island. In 1854 a grasshopper plague destroyed much of the forage and the cattle had to be moved to Cache Valley. Brigham Young built a boat that year to improve his access to the island. This boat was named the "Timely Gull." Four years later it ran aground on the island and was destroyed.

When Fielding Garr died in 1855, Briant Stringham and Garr's sons took over his duties. They lived on the island with their families during the summer and on the mainland in the winter. Life was so difficult that most families wanted to leave. Even Stringham tried to get a replacement for himself. Nevertheless, the herds prospered while Stringham was in charge and he stayed at the ranch house on the island until his death in 1871, at age 48. During his administration as many as 2000 to 3000 cattle grazed on the island. Horses were kept on the island in large numbers after 1854.

After Briant Stringham died the Church of Jesus Christ of Latter-day Saints (LDS) could find no responsible person to take care of the herds. Since no one wanted to live there because of the isolation, the island was considered empty and the Federal Government turned over some of the land to the Union Pacific Railroad as part of the alternate section land grant agreement. Other sections came under control of the Bureau of Land Management and a few miners and homesteaders.

Although the railroad now owned much of the island, it had no use for it, so for a while longer the LDS church maintained its cattle and horse herds there. After Stringham's death, Christopher Layton took the job to herd sheep for 5 years. In 1872 some 7000 sheep were taken to the island, and at one time it is thought that 10,000 sheep were there. One of his sons spent his honeymoon on Antelope Island, the first of several such connubial events. In 1875 the LDS church, beset with polygamy problems, abandoned the island. Most of their assets were retrieved, except for many blooded and registered horses. In an effort to retrieve them in 1875, a contract by the church offered half the horses as payment. It seems the horses were smarter than the contractors and few were retrieved.

In 1884 John E. Dooly Sr., a Salt Lake City banker and representative of the Wells Fargo Bank, and his partner, Frederick Myers, purchased most of the island for 1 million dollars. A few homesteads and mining properties not included were later absorbed by them. Myers and Company, the contractors previously hired to retrieve the horses, considered the wild horses a nuisance and had them exterminated.

In 1885 the island was leased to the White and Sons Company, which purchased Myers' shares and controlled the island until 1903. This company brought the first buffalo to the island; twelve from Texas arrived in 1893. Later, a larger variety of buffalo were added from the Yellowstone area. The company also placed mountain sheep, a number of deer, imported pheasants, and elk on the island. The elk did not survive; most were shot by trespassers. The White and Sons Company sought commercial remuneration from their buffalo and started buffalo hunts. They were hunted from horseback for meat, and for sale to taxidermists and clothiers. Each head brought about $300, a sizable sum in those days.

In 1903 Ernest Bamberger purchased the White's interest on the island. A report notes that there were 40 buffalo, 100 horses, and a cattalo named Teddy at the time on Antelope Island. The buffalo herd was expanded to 100 by 1911 and, because of the impending extinction of the bison, created so much interest nationally that the American Bison Society wanted to convert Antelope Island into a "national buffalo park." Such plans never came to fruition. In 1914 it was estimated that 1000 cattle and 125 buffalo roamed the island. In 1915 sheep were returned to the island and they remained there until 1955.

John W. Thornley, a state politician, and later mayor of Kaysville, leased the island in 1920. He wanted to change the name of the island to "Buffalo Island." Other names the island has had include "Porpoise Island" and "Church Island,"names more popular in the early pioneer times. Through Thornley's influence a silent movie, "The Covered Wagon," was filmed on the island in 1922. At this time there were about 450 head of buffalo.

In 1941 a land trade with the Bureau of Land Management brought the island to complete private control except for a few small parcels. In 1951 the south causeway was constructed. Soon thereafter Davis County officials looked upon the island as a potential park and recreation area that would draw tourists to the area. In negotiations with the owners, the state agreed to purchase the northern 2,000 acres of the island in 1967. They built the northern causeway, but soon found out that the lake had other ideas, as it washed out on several occasions. Nevertheless, many improvements were made, and the park opened in 1969. In 1972 Anschutz Ranch and Livestock Company acquired the remainder of Antelope Island.

In 1981, the state purchased the rest of the island for 4 million dollars. Soon thereafter, the Great Salt Lake began to rise, flooding and destroying both causeways to the island. The park has therefore been closed since 1984, and the island has returned to its isolated state. In 1987 the buffalo herd numbered more than 600 animals and the UPR organized a great roundup to inoculate and improve the condition of the herd. Hunting was reinstated on a limited basis.

GEOLOGIC MAPPING OF ANTELOPE ISLAND

PREVIOUS GEOLOGIC MAPPING

The first geological study of Antelope Island began with the expedition of Howard Stansbury, who camped on the island in 1850. Someone from this expedition, probably Professor James Hall, noted that the rocks "...consisted of granite, or perhaps an altered sedimentary quartz or siliceous sandstone," but no geologic map was prepared. The first geologic map to include Antelope Island was made by Clarence King, S.F. Emmons, and Arnold Hague, who performed the geological exploration of the fortieth parallel for the U.S. Army. This was a regional map (1 inch = 4 miles), and shows Antelope Island as Archaean rocks surrounded by Quaternary deposits (King, 1878). This expedition visited Antelope Island, climbed to the top of the highest peak, and briefly described the Archaean rocks as "...mostly gneisses, with some quartzites and mica-slates" (King, 1877).

The first detailed geologic map of Antelope Island was produced by George G. Bywater and Joseph A. Barlow (1909) as part of their Engineering Bachelor of Science degree require-

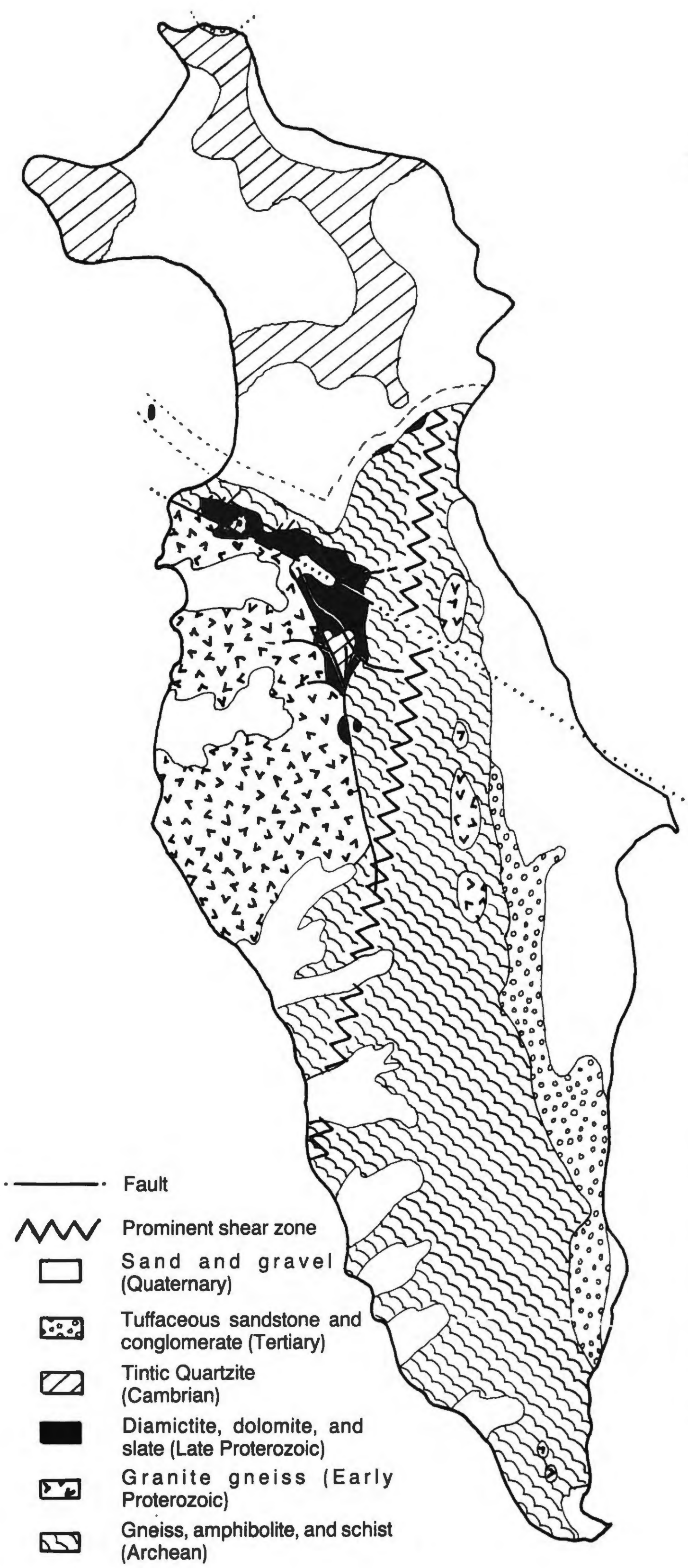


Figure 2. Geologic map of Antelope Island greatly simplified from the map prepared by the UGMS in 1987 (Doelling, et al., 1988).

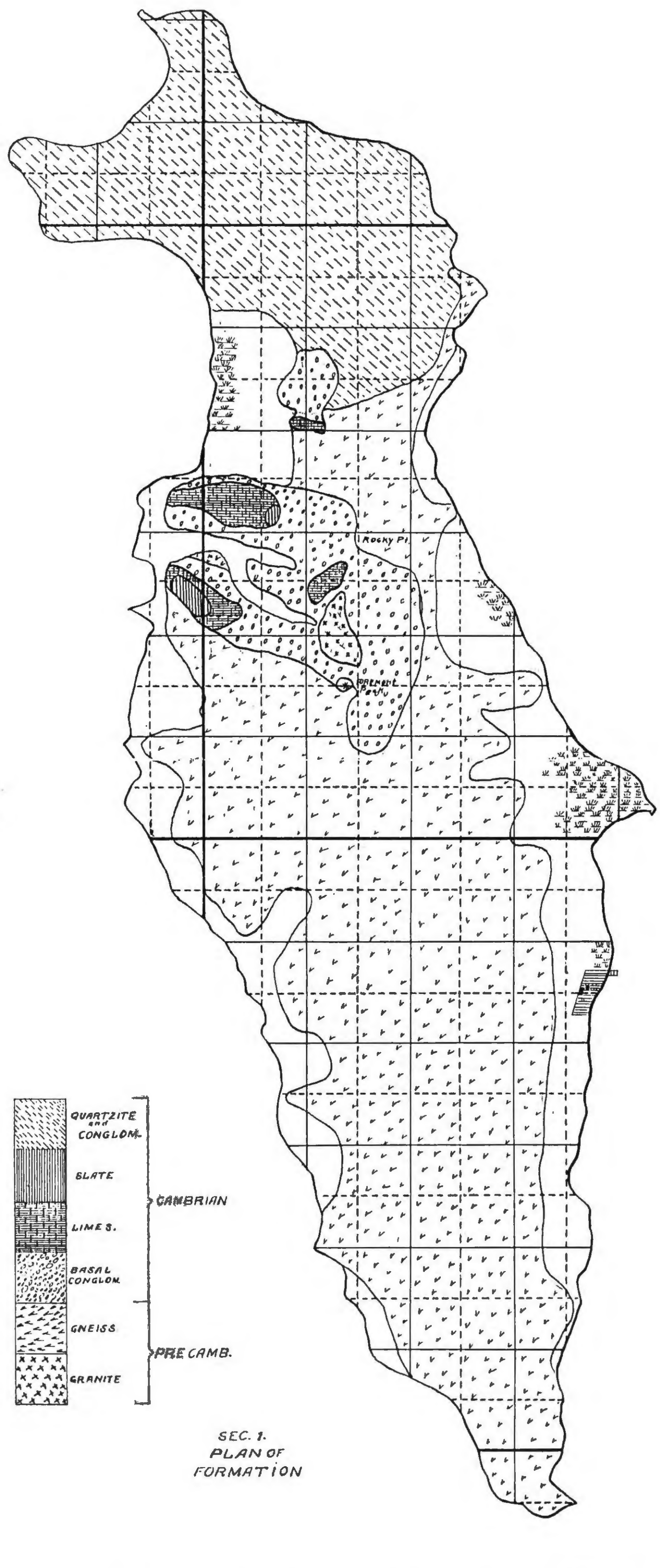


Figure 3. The first geologic map of Antelope Island called a 'Plan of Formation' was completed by Bywater and Barlow (1909). Original scale was 1 inch = 1 mile. Only rocks of Cambrian age and older were mapped and described.

ments at the University of Utah. This early geological map (figure 3) was prepared at a scale of 1 inch = 1 mile and included six bedrock units. The Precambrian crystalline rocks were divided into two units, gneiss and granite, and the three units that now make up the formation of Perry Canyon were recognized. In describing the three units they stated:

> *South and west of Monument Peak [the highest peak], and capping the peak itself, can be found a blue conglomerate or pudding stone. This at one time marked the shore line of an ancient ocean and constituted the deposit of gravel and sand which accumulated upon the weathered surface of the gneisses as they were submerged. The sinking land allowed the great western ocean, which then covered the greater part of our American continent, to creep upon the land and convert it into an ocean bottom. In the deeper water the deposition of a limestone followed on top of the pudding stone. Muds and silts followed the lime and many other sediments came above until the area again became subjected to regional metamorphism and the limestone was altered to marble, the siliceous silts to slates, and the later rocks to quartzites.*

They also noted the presence of Paleozoic boulders reworked by Lake Bonneville, but did not identify the Wasatch Formation, the source of the boulders.

Eardley and Hatch (1940a and 1940b) reconnoitered the island and divided the Precambrian crystalline rocks into three lithologic units, identifying them with the Farmington Canyon Complex. They also discussed the overlying metasedimentary rocks, and correlated the quartzite at the north end of Antelope Island with the Brigham Quartzite.

Willard Larsen (1957), produced a 1:24,000 scale geologic map as part of his study of the petrology and structure of Antelope Island. Larsen divided the crystalline rocks of the Farmington Canyon Complex of Antelope Island into 3 lithologic units and treated them as stratigraphic units. Larsen's "Lower unit" included the rocks on the west part of the island.

His "Middle unit" included an area that the UGMS later mapped as a major shear zone through the central part of the island. Larsen's "Upper unit" covered all of the southern and most of the eastern part of Antelope Island. He correlated overlying tillite with the Mineral Fork Tillite exposed east of Salt Lake City, and dolomite, slate, and quartzite with the Mutal (?) Formation.

Bryant and Graff (1980) determined that most of Larsen's "Lower unit" and parts of the other two units were metaigneous in orgin rather than metasedimentary. Several other studies that include Antelope Island have also been completed in recent years.

PRESENT GEOLOGIC MAPPING

In 1987, the Utah Geological and Mineral Survey started a multi-purpose mapping project of Antelope Island, producing a 1:24,000 scale geologic map. The Farmington Canyon Complex was divided into 11 lithologic units, the Precambrian metasedimentary rocks (diamictite, dolomite, and slate) were correlated with the formation of Perry Canyon (Sorensen and Crittenden, 1976), and the Tertiary sediments on the east side of the island were divided into two Wasatch Formation units and the Salt Lake Group. The Quaternary deposits of the island were mapped in greater detail, and the geologic hazards and geological engineering aspects were assessed. The faults north of Monument Peak have been mapped and interpreted differently, and the Stump Ridge fault, directly west of Monument Peak, has now been interpreted as a probable minor backthrust (see figure 2).

The geological mapping staff had many adventures reminiscent of some of the adventures of the early survey parties and ranchers. Both the north and south causeways to the island were covered by high lake water, so the only access to the island was by boat or airplane. The staff mostly traveled to the island by boat and worked four-day periods. From the east side of Antelope Island one can easily see civilization on the mainland — just a taste of what it must have been like for early ranchers on the island when the water rose and the only way to Salt Lake City was by boat or barge.

Although many springs are on the island, none are safe for drinking, so all drinking water had to be carried over. The UPR kindly provided long-unused house trailers for the geologic staff, but the abundant mice had already staked their claim to the accommodations. Mice seemed to be everywhere, including a mouse nest in the oven, learned after lighting the oven to cook potatoes. Needless to say, everyone slept outside that night.

The field reviews at the completion of the mapping provided the crowning success to the project. Participants explained their findings and suggestions to personnel of the UPR, elected officials, the press, and other scientists. Many took advantage of a great opportunity to hike the backbone of Antelope Island and see the interesting geological features and spectacular vistas along the route.

THE GEOLOGY OF ANTELOPE ISLAND

The rocks of Antelope Island provide a glimpse into geologic history that extends more than three billion years into the past. Though most of earth's geologic history falls into this interval, four unconformities that account for vast amounts of time occur in the rock record, such that much must be surmised by examining the geology of surrounding areas.

The oldest rocks of Antelope Island, the Farmington Canyon Complex, formed the southwest edge of the Wyoming Province, an Archean protocontinent that forms the core of western North America (Condie, 1969). These three-billion-year-old rocks are strongly overprinted by Archean and Proterozoic metamorphism and intrusions such that their earliest history is difficult to decipher (figure 6). However, they included sedimentary-derived rocks, indicating that these processes were active early in the earth's history (Hedge and

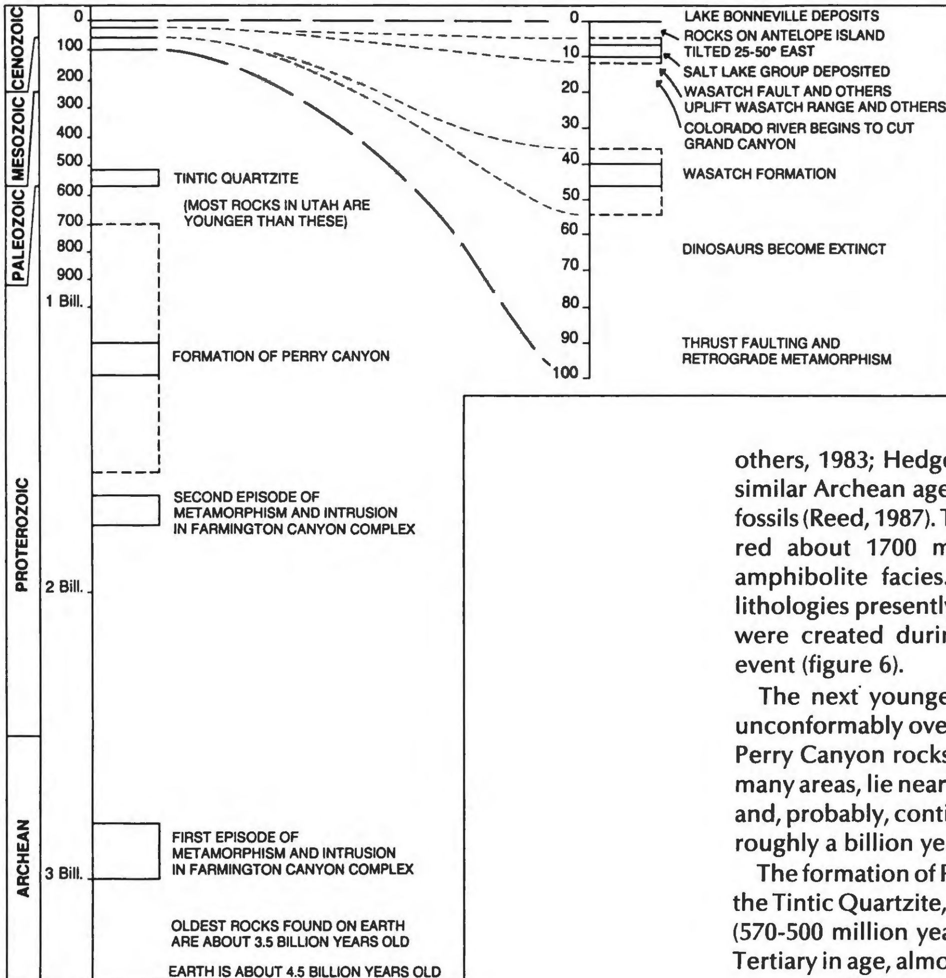


Figure 4. Geochronologic chart showing the approximate age of major units and events that affected rocks exposed on Antelope Island. Unconformities account for the preponderance of time in the rock record.

others, 1983; Hedge and others, 1986). Rocks in Wyoming of similar Archean age contain stromatolites, the earliest known fossils (Reed, 1987). The Proterozoic metamorphic event occurred about 1700 million years ago, altering rocks to the amphibolite facies. Most of the mineral assemblages and lithologies presently seen in the Farmington Canyon Complex were created during this major continental-scale orogenic event (figure 6).

The next younger rocks, the formation of Perry Canyon, unconformably overlie the Farmington Canyon Complex. The Perry Canyon rocks are only slightly metamorphosed and, in many areas, lie nearly horizontal. They include shallow marine and, probably, continental glacial deposits that were laid down roughly a billion years ago (figure 7).

The formation of Perry Canyon is disconformably overlain by the Tintic Quartzite, an oceanic beach deposit of Cambrian age (570-500 million years old). The next younger rocks are early Tertiary in age, almost 500 million years younger. It is likely that twenty to thirty thousand feet of Paleozoic and Mesozoic rocks were stripped off prior to deposition of the Tertiary rocks.

Much of this attenuation may have been structural, occurring during the Cretaceous Sevier orogeny which intensely affected the rocks of the island. The most profound effects of the Sevier orogeny include zones of intense shearing, retrograde chloritic metamorphism, backthrust faults with Archean rocks displaced over Proterozoic rocks, and tight folds (figure 8). The usually brittle Tintic Quartzite contains tight folds and stretched quartzite clasts, suggesting that this deformation occurred under deep burial in semi-brittle conditions and with strong directional pressures (figure 9).

The Tertiary Wasatch Formation unconformably overlies the older rocks on Antelope Island. It is composed of conglomerate with some clasts in excess of 10 feet in diameter. Most clasts were derived from the Tintic Quartzite and from lower and middle Paleozoic carbonate units. They may have been eroded from highlands created after the Sevier orogeny. A thick sequence of reworked bentonitic mudstone, conglomerate and airfall tuff overlies the Wasatch Formation. These rocks have proven difficult to date but are included in the Miocene to Pliocene Salt Lake Formation (figure 10).

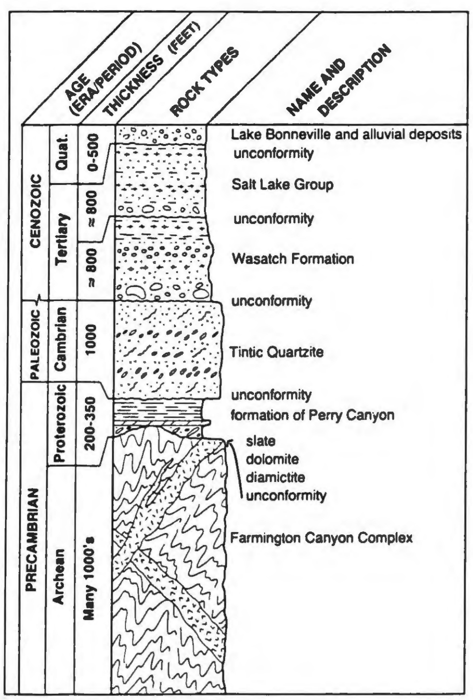


Figure 5. Lithologic column depicting the rock units and rock types exposed on Antelope Island and the position of major uncomformities.

Figure 6. Metamorphic fabrics that give evidence of intense deformation abound on Antelope Island. Additional examples are shown on the front cover.

Figure 7. Excellent exposures of the formation of Perry Canyon diamictite are present on Antelope Island. Incorporated in the rock are very large boulders of gneiss and quartzite, some of which are stretched by intense post-depostional deformation.

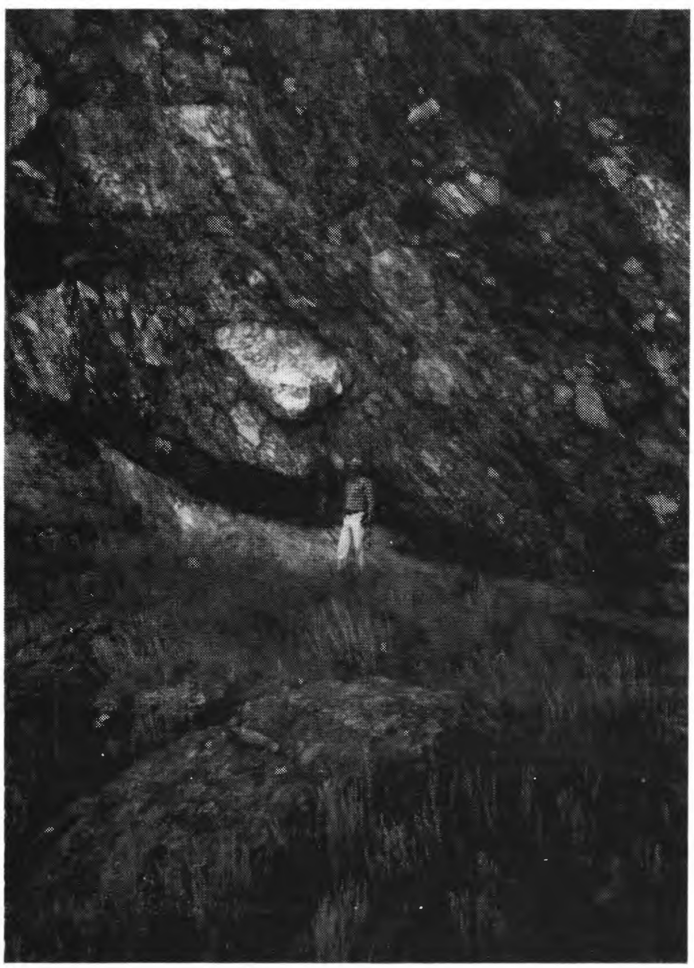
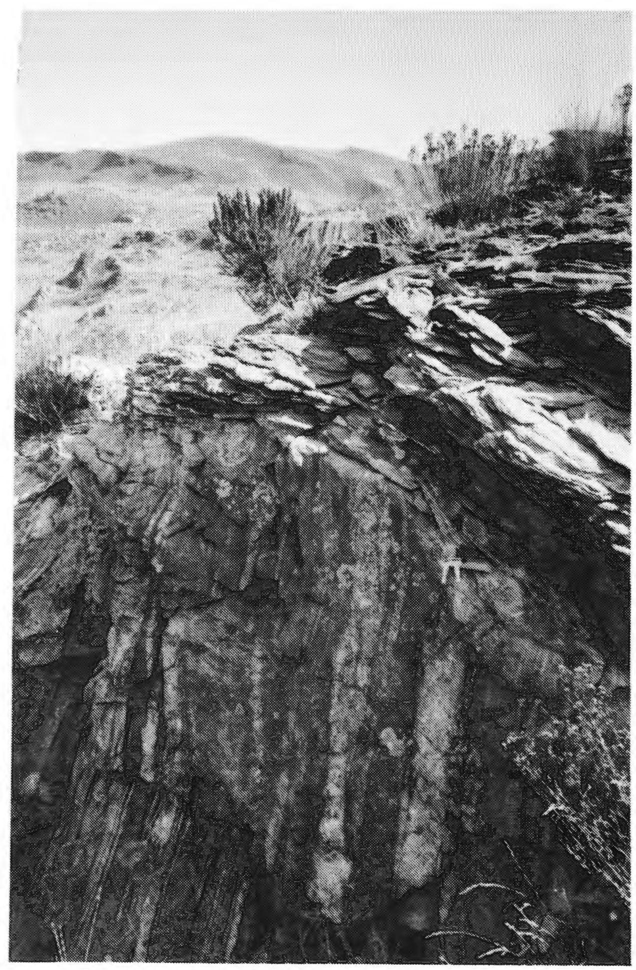


Figure 8. Nonconformity separating gneiss of the Farmington Canyon Complex from diamictite of the formation of Perry Canyon. The diamictite and the upper part of the gneiss outcrop are cut by intense shearing of probable Cretaceous age.



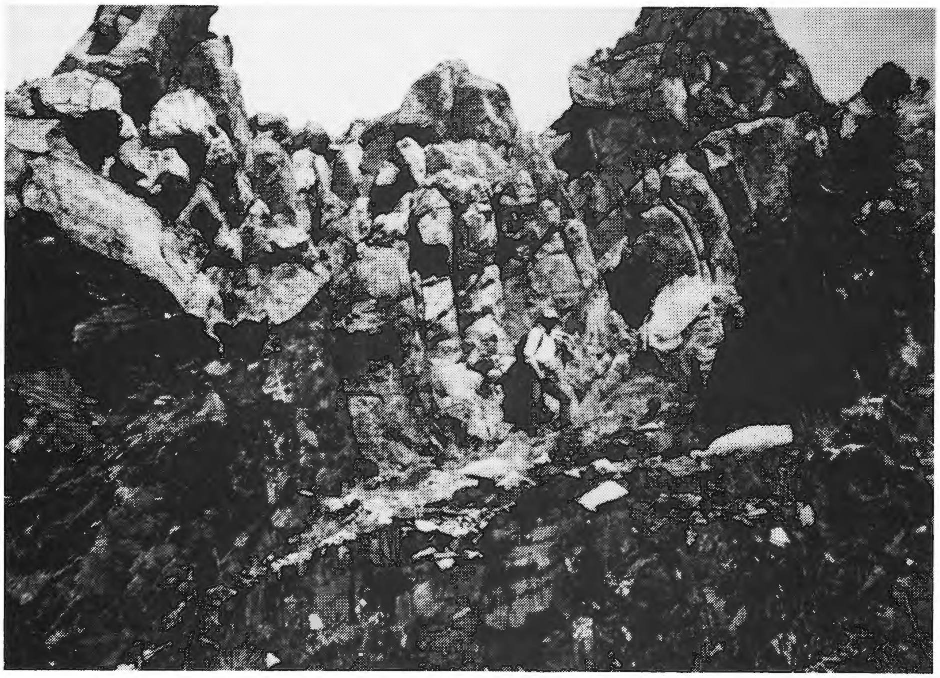
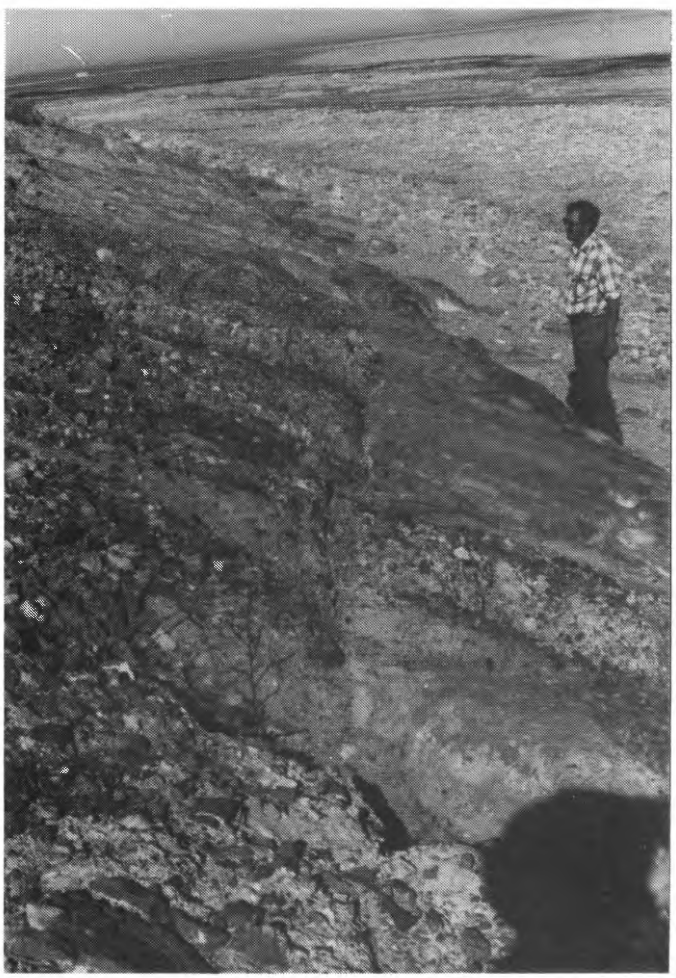


Figure 9. Tightly folded Cambrian Tintic Quartzite. Quartzite rocks usually deform in a brittle manner when subjected to deformational forces. The plastic folding indicates that very deep and confined conditions were in effect during the Cretaceous period when the rocks were deformed.



Basin and Range normal faulting has dominated in the last few million years. The island is bounded on the west by the East Great Salt Lake fault, which may be offset in excess of 7000 feet. Similar faults occur offshore to the east (Smith and Bruhn, 1984). The Wasatch and Salt Lake Formation rocks are tilted about 30 degrees to the east, indicating rotation of the island in Pliocene or Quaternary times due to movement on these faults.

Most of the island is mantled by well-preserved Lake Bonneville deposits (figure 11 and front cover). They occur as high as 5250 feet, over 150 feet higher than similar deposits along the basin margins, indicating that isostatic rebound has occurred since decline of Lake Bonneville. Modern Great Salt Lake deposits rim the island and have been important in reconstructing the recent history of the lake.

Economic resources have played a significant role in the history of Antelope Island. The early pioneers mined slate from outcrops in the formation of Perry Canyon. Copper and related mineralization has tantalized prospectors for years, especially since the island is aligned with the Oquirrh Mountains in which the gigantic Bingham mining district is found. However, large deposits have not been discovered to date.

Gravel is the only product that has been successfully produced. In 1980, the Utah Department of Transportation quarried 16 million cubic yards of lacustrine deposits from 2.5 square miles in the southeast part of the island. It was transported on a 13-mile-long conveyor belt to near 5600 West and North Temple where it was used to build Interstate 80.

Figure 10. Late Tertiary volcanic ash and breccia deposits are exposed at the north tip of Antelope Island. The brecciated material consists of very angular fragments of early Paleozoic quartzite, shale, and limestone. Probably interlayered, these lithologies are complexly faulted.

Figure 11. Aerial view of the west shore Antelope Island. Cuspate white oolitic beaches and rough rocky salients combine to form picturesque scenes. Lake Bonneville levels are clearly notched into the ridges.

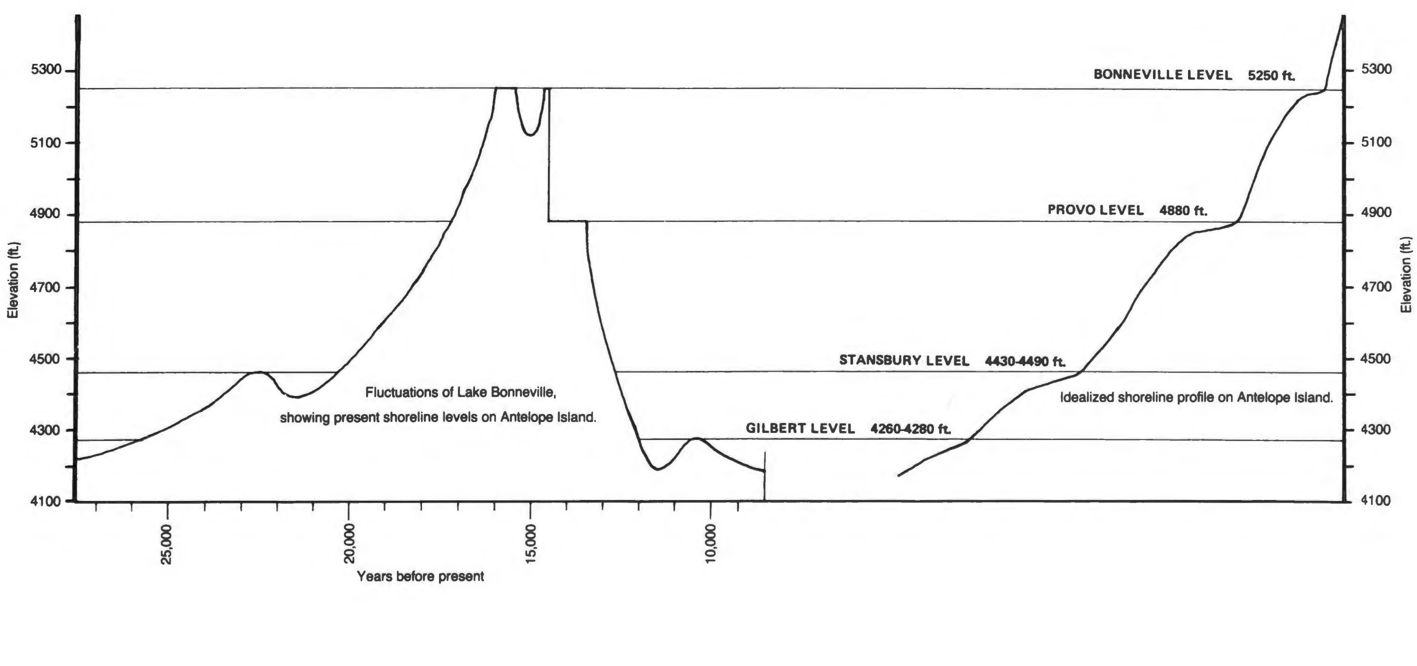
FASCINATING GEOLOGIC FEATURES OF ANTELOPE ISLAND

Antelope Island State Park will be an important outdoor classroom for the entire Wasatch Front community. It has geologic features that can interest grade school students to doctorate researchers. Ancient metamorphic rocks are probably better exposed there than anywhere else in the state (front cover, figures 6 and 8). Unconformities, Lake Bonneville shorelines, and classic examples of many rock types are distinct enough for even the beginner to understand. Shear and fault zones, retrograde metamorphism, semi-brittle deformation and the detailed Bonneville history are just a few of the challenges facing the advanced student. Following are a few of the features we found to be of particular interest.

Stump Ridge fault, folded Tintic Quartzite.

The Stump Ridge fault is a north-trending reverse fault directly west of Monument Peak. The rocks of the Farmington Canyon Complex are juxtaposed against younger rocks with a minimum displacement of 800 feet. Rocks have been tightly folded near the fault, including normally brittle rocks of the Tintic Quartzite (figure 9). The folding is most apparent near the north end of the fault.

Figure 12. Lake Bonneville shoreline elevations on Antelope Island. Shoreline elevations from Doelling and others (1988) and D.R. Currey, pers. communication, 1988. Figure modified from Currey, Atwood, and Mabey (1984).



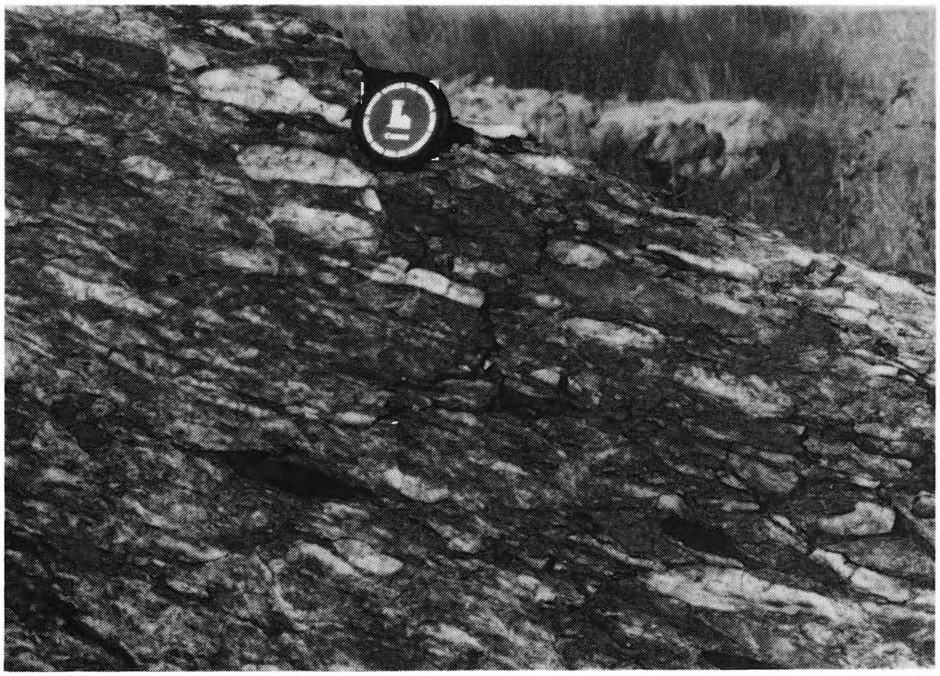


Figure 13. The Tintic Quartzite contains folded layers of metaconglomerate in which the clasts have been stretched through intense deformation. This stretching is most apparent in the pebble-size clasts which were originally subrounded to well rounded, but have now been elongated to more than three times their original length.

Tertiary outcrop on north tip of Ladyfinger.

Tertiary rocks on the north end of the island consist of gray, reworked volcanic ash and brown breccia of sedimentary rocks (figure 10). The ash is massive but contains faint color laminations, and it is poorly to moderately indurated. The breccia is very poorly sorted with clasts up to 1 foot in diameter. The clasts consist of angular olive-green shale, Paleozoic limestone and quartzite, and Precambrian metamorphic and sedimentary rocks. This relatively small outcrop, approximately 1200 feet long and 75 feet wide along the east-west shoreline, was uncovered during excavation of a gravel pit. The outcrop is cut by numerous faults, some of which are strike slip.

Conglomerate in the Wasatch Formation.

Boulders of quartzite and carbonates, as much as ten feet in diameter, were encountered in the upper member of the Wasatch Formation on the east side of Antelope Island. The quartzite boulders are from the Tintic Quartzite, and the carbonates are from Cambrian to Mississippian formations. There are presently no bedrock outcrops of Paleozoic carbonates on Antelope Island, and no outcrops of Tintic Quartzite near these deposits. The upper member of the Wasatch Formation is probably alluvial fan deposits that accumulated at the foot of an ancient mountain range. The large boulders have been reworked into shoreline deposits by ancient Lake Bonneville.

Shorelines of Lake Bonneville.

Shorelines representing the four basin-wide stillstands of Lake Bonneville are well developed on Antelope Island (front cover, figures 11 and 12). Extensive gravel deposits formed by wave action at these shorelines cover all but the highest parts of the island. The highest and most prominent wave-cut platform and gravel deposits form the Bonneville shoreline, particularly visible as the flat area south of the main ridge. Lake Bonneville reached this highest level about 16,000 years ago (Currey and others, 1984).

Shearing in the Farmington Canyon Complex.

The Farmington Canyon Complex on Antelope Island has been sheared in many places (figures 7, 8, and 13). The sheared zones are characterized by intense shear cleavage, phyllonite, and retrograde metamorphism. The Antelope Island shear zone, the largest such zone on the island, is at least 4 miles long and up to 3000 feet wide. This shear zone trends N 20° to 25° E, and dips steeply northwest. The shearing and retrograde metamorphism probably formed during the Cretaceous Sevier orogeny, when these rocks were affected by thrusting along the overriding Willard thrust fault or underlying Ogden thrust fault.

Breccia siltstone in the dolomite member.

The dolomite member of the formation of Perry Canyon locally contains brecciated purple siltstone which has been emplaced in vertical spaces within the dolomite (figure 14).

Diamictite of the formation of Perry Canyon.

One of the most outstanding views of diamictite in Utah can be seen on Antelope Island (figure 7).The diamictite member of the formation of Perry Canyon is dark brownish-black, with poorly sorted, angular to rounded clasts that range from the size of sand to over seven feet in length. The clasts consist of metamorphic rocks from the Farmington Canyon Complex, and quartzite boulders. The diamictite has an average thickness of 10-20 feet, but ranges from 0 to 200 feet, probably due to paleotopographic relief.

Figure 14. Lavender brecciated slate of the formation of Perry Canyon fills a 'dike' in the dolomite member below. Although not common, they raise questions as to their origin. Sandstone dikes have also been noted in the dolomite member.

Other Geologic Features of Interest on Antelope Island.

- —Sand dunes consisting of oolitic sand along the shoreline in Bridger Bay and White Rock Bay.
- —Quartz dikes stained with large splotches of malachite
- —Attenuation and silicification along faults
- —Gravel beaches along the present shoreline
- —Landslides of different ages and sizes
- —An isolated, complex mass of metasedimentary rocks south of Monument Peak.
- —Quartz dikes and associated melted country rock on Elephant Head
- —Tufa-encrusted rocks common at and below the Provo shoreline
- —Tectonic breccia near faults
- —Intensely contorted rocks
- —Large-scale migmatites

CONCLUSIONS

Antelope Island State Park offers some attractions that can be seen in only a few other places in the world. Because of its relative isolation, the natural environment has been mostly spared from the changes brought on by settlement and improper development. Its value is increased because of its proximity to a large metropolitan area. A unique set of environments exhibit an interplay of geology, geography, climate, wildlife, and steppe-type botany. Particularly attractive are the following:

Great Salt Lake vistas: The Great Salt Lake is one of two major salt lakes in the world. The views from the island surpass those from most places along the mainland. Antelope Island shorelines, unlike those of the mainland, are not cluttered with private property development, introduced vegetation, power lines or fences. Excellent, high-vantage points are common.

Oolite sand beaches: Many Antelope Island beaches are comprised of oolite sand. Oolite beaches are found at other localities around the Great Salt Lake, including Saltair, but most are inaccessible.

Lake Bonneville shorelines: The basin of Ice Age Lake Bonneville is a showcase for ancient lacustrine features. Areas around the present Great Salt Lake exhibit these features the best. Many of the features have been obscured by development or are in inaccessible desert areas, thus, Antelope Island is a premier place to view them.

Basin and Range features: Basin and Range physiography is well displayed from Antelope Island viewpoints. The island itself is a fault-block mountain range bounded by sediment-filled basins.

Ancient metamorphic terrane: Antelope Island is a great place to see some of the oldest rocks in North America in a large variety of lithologies and forms.

Almost from the beginning Antelope Island has been looked upon as a place for recreation, solitude, sightseeing, and fun experiences. Brigham Young held annual outings on Antelope Island to enjoy such activities as concerts, athletic contests, plays, hiking, sailing, swimming, cook-outs, story-telling around camp-fires, and rodeos. In the early 1900s it was predicted that Antelope Island would be the Coney Island of the west (Bywater and Barlow, 1909).

More modern ideas for the development of the island have included marinas, scenic drives, camping areas, shelters and restrooms, equestrian trails, hiking trails, bicycle trails, golf courses, tennis courts, hotels and restaurants, gambling casinos, restoration of pioneer buildings and relics, a museum or information centers, a preserve for wildlife and buffalo, swimming facilities (fresh-water showers, swimming pools, etc.), amusement centers, wild animal park, sightseeing viewpoints, and off-road opportunity for motorbikes and ATVs.

The UGMS investigations of the park resulted not only in a better understanding of the island's geology, but provided valuable information that can be used by planners and developers. Some of the information will be of use in the creation of tourist exhibits and sites, some relates to the availability of ground water and local construction materials, some will help mitigate geologic hazards such as landsliding, windblown sand, erosion by sheetwash and rising waters of Great Salt Lake, and some will aid engineering planning, such as siting waste disposal facilities, buildings, and roads. The UGMS staff, now more acquainted with the geology of the park, will be a better resource to the UPR staff during planning and as problems or needs arise. Because of our understanding of the island's geology and geologic processes, the following insights for development are noted:

Erosion control: When the Division of Parks and Recreation plans the development of the island, the most difficult problem to overcome will be that of erosion. This, more than any other concern, will dictate park development. The thin veneer of Bonneville sediment that mantles the bedrock is highly susceptible to erosion. Bonneville sediments are mostly loosely compacted coarse sand held in place by the vegetation. The natural drainages blend aesthetically with the ridges and meadows of the island. Heavy vehicular traffic over meadows and steep slopes quickly breaks through the mat of root systems provided by the grasses and bares the easily erodable Bonneville sediments. The few unpaved roads and trails on the island, even those that were better engineered, all show deep gullying and ugly scars. The land is so fragile that in critical areas buffalo trails and wallows are deeply gullied,indicating that even heavy foot traffic creates problems. Fortunately the buffalo like to follow contours in their wanderings, rather than going up steep slopes.

Paved, well-engineered roads will initially be more expensive but will avoid the erosion problems inherent in dirt or gravelled roads. Not only are they better in the control of erosion, but they will minimize the chances of damage to visitor vehicles.

Geologic hazards: Several geologic hazards should be considered in the park's planning. Sand dunes, some partially stabilized, occur at the north end of the island and may cause hazards by migrating across and covering roadways. They can also blow against building walls. Care should be taken against destabilizing dunes by cutting into them during construction or by removing vegetation.

The recent high level of Great Salt Lake destroyed causeways and beach facilities on Antelope Island. Future planning should be based on a 4,217-foot lake level.

Debris flows occur when gullies and washes, choked with erosional debris, are flushed during wet cycles. Such debris damages roadways, either by eroding them or by covering them with rock debris.

Antelope Island lies within a high-risk seismic area. Buildings should be engineered to withstand ground shaking and, where vulnerable, liquefaction. Liquefaction (quick sand) may occur when water-saturated clean, sandy material, such as might be found near springs, is shaken by an earthquake.

A few large landslides have been mapped on Antelope Island. Smaller landslides and slumps are abundant, especially near water-saturated areas along the east shore of the island. Most have developed in colluvium or in Lake Bonneville deposits. Care should be taken to avoid developing such areas.

Water supply and construction resources: While Antelope Island is well suited as a natural area and wildlife park, commercial development may bring undesired results. The water supply is limited. While there seems to be enough for wildlife and limited park uses, extensive water development, such as needed for motels or golf courses, may overtax the water supply.

Most of the better springs are found on the east side of the island at elevations between 4,400 feet and the Bonneville level of 5,250 feet. Many others are lower, but they contain undesirable concentrations of sodium and chloride ions. Unfortunately the better supplies of water are not in the northern part of the island. Past needs have been met by use of wells along the north causeway to the island.

Construction materials, especially for causeway construction, are limited. Although large quantities of material were removed from Antelope Island for the construction of Interstate Highway 80, the material was only suitable for embankment and fill. The gravel content ranged from only 10 to 20 percent, the rest was dominantly sand. Exposures elsewhere are of similar composition. In a few places along the north and east shore small accumulations of better quality gravel have been found. Much riprap from the Tintic Quartzite is available at the north end of the island.

Sewage disposal: Sewage disposal may create another problem. Highly fractured bedrock occurs at or near the surface over all of the island. Unconsolidated sediments needed for dispersal for sewage septic systems or even for sewage treatment are limited and impermeable layers occur within the thin sediments. The best areas are directly upslope from the areas that have been developed as beaches and swimming areas in the past. If sewage reaches the open bedrock fractures or ponds on impermeable layers it could mix freely with the water supply or flow directly to the beach areas. Thus it is possible that sewage produced on the island would have to be transported back to the mainland for proper disposal or taken care of by an alternative waste water disposal system.

The island's geologic environment can accommodate the wastes produced by day users and limited overnight campi ng, but the island's lack of water and limited potential for waste disposal preclude intensive development, such as for motels, condominiums, golf courses, or other extensive high-use development.

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PRETTY, GREAT SALT LAKE LEVEL

Date (1986)	Boat Harbor South Arm (in feet)	Saline North Arm (in feet)
Feb 01	4206.50	4205.80
Feb 15	4206.50	4205.75
Mar 01	4206.60	4205.75
Mar 15	4206.70	4205.85
Apr 01	4206.80	4205.95
Apr 15	4206.80	4205.90

Source: USGS provisional records.

errata *Volume 22 Number 4, page 12.*

We regret that a line was dropped from the credits for the lead article on radon. Dane Finerfrock is with the Utah Bureau of Radiation Control, not UURI, while Dennis Nielson, who is with the University of Utah Research Institute, was dropped completely. We regret the typo, especially since both of them did such a fine job of the reviews.

Mea Culpa

Contributors to Geologic Mapping in Utah
Charles Butler Hunt

by Michael L. Ross

The UGMS would like to note outstanding contributions of those who pioneered geologic mapping in Utah or who laid the foundation of geologic thinking about Utah. We plan to honor a geologic mapper annually in *Survey Notes.* This is the first of the series and our initial candidate is Charles Butler Hunt. Charlie has made innumerable contributions to understanding the geology of Utah through his publications, commentaries, lectures, and dynamic leadership within the scientific community. Although much of Charlie's geologic portfolio includes work from throughout North America, this article focuses only on his contributions to Utah geology. His abilities as a geologist and a logical thinker have been demonstrated in such subjects as surficial deposits, igneous geology, structural geology, soils, physiography, economic deposits, archeology, and geologic history. His list of publications is second only to the list of field areas in which he has worked. His commentaries on report writing, radiocarbon dating, mountain collecting, and the siting of high-level radioactive waste repositories, to name a few, have been poignant, thought provoking, and sometimes humorous. Utah is truly fortunate that a large portion of his work and life were spent here.

Charles Butler Hunt was born August 9, 1906 in West Point, New York. Charlie graduated with honors from Colgate University, receiving a B.S. degree in geology in 1928. Later that year he entered Yale University to work on a Ph.D. While in college Charlie worked as a field assistant for the United States Geological Survey (USGS) accompanying field parties in Montana, Utah, and New Mexico. His work in Utah involved assisting C.H. Dane with geologic mapping along the Colorado River. Charlie left Yale in 1930 to accept a geologist position with the USGS. That same year he married Alice Parker, his companion and associate during the remainder of his career.

In 1935, Charlie was assigned as chief of a USGS field party to study the geology of the Henry Mountains region, Utah. The survey (1935-1939) was the last big pack-train project conducted in the West and it allowed Charlie to follow in the footsteps of G.K. Gilbert, one of America's great geologists (see *Survey Notes,* v. 22, no. 3). In the 1930s, the Henry Mountains region was still frontier—sparsely populated and a long distance from communication lines, supplies, railroads, and medical services. Roads, when they existed at all, were unpaved trails across the barren landscape. Most of the surveying was done from horseback, but many areas like the rugged country along the southeast flank of the San Rafael Swell required many rocky climbs along narrow ridges and descents down steep-walled canyons. The field investigations involved geologic mapping with a plane table and alidade at scales of 1:63,360 and 1:31,380 without the benefit of a base map. During the 1939 field season Charlie participated with several other noted geologists in the naming and defining of the infamous term "cactolith." As Charlie puts it, "the term was intended to call attention satirically to the absurd nomenclature geologists were developing by applying new names to the infinite variety of shapes intrusions can form." After completion of the Henry Mountains survey, Charlie continued to work in Utah on mapping and describing manganese deposits of the southwestern United States.

During the Henry Mountains survey, going to Green River for supplies was always an adventure due to the changing weather conditions. A supply truck crosses Muddy Creek on U-24 near Hanksville, careful not to stop in the mud or move too fast and drown the engine.

Charlie was assigned as Assistant Chief and later Chief of the USGS Military Geology Unit during World War II. The unit combined the disciplines of geology, soil science, and engineering to aid the war effort, but it also helped to initiate the development of engineering geology. Shortly after the war Charlie became Chief of the USGS Regional Geology Branch. While at this position he directed numerous field investigations throughout the country. One of these investigations was mapping the rugged La Sal Mountains of Utah. The La Sal Mountains laccolithic center exhibits igneous rock types and structures similar to those in the Henry Mountains. During the 1950s, Charlie published USGS professional papers on both of these Tertiary igneous complexes. During this time he also published an excellent paper on the geology of Lake Bonneville, once again following in the footsteps of G.K. Gilbert.

In June of 1953, Charlie took a leave of absence from the USGS to serve as Executive Director of the American Geological Institute (AGI) until 1955. Charlie also served as editor for the *GEOLOGICAL NEWSLETTER,* a predecessor of *GEOTIMES,* during his tenure with AGI. As Executive Director, his proposal for a new format for the newsletter increased circulation and interest in the struggling AGI (Geotimes, v.3, no.3).

Upon returning to the USGS and until his retirement in 1959, Charlie conducted research in the Death Valley area of California. It was during the late 1950s that he published two interesting and entertaining manuscripts, the first a delightful combination of geochronology and archeology entitled "Dating Mining Camps with Tin Cans and Bottles." The second was a humorous manual on the art of collecting mountains, which contains Hunt's First Law: The qualities of mountains improve as the square of the distance.

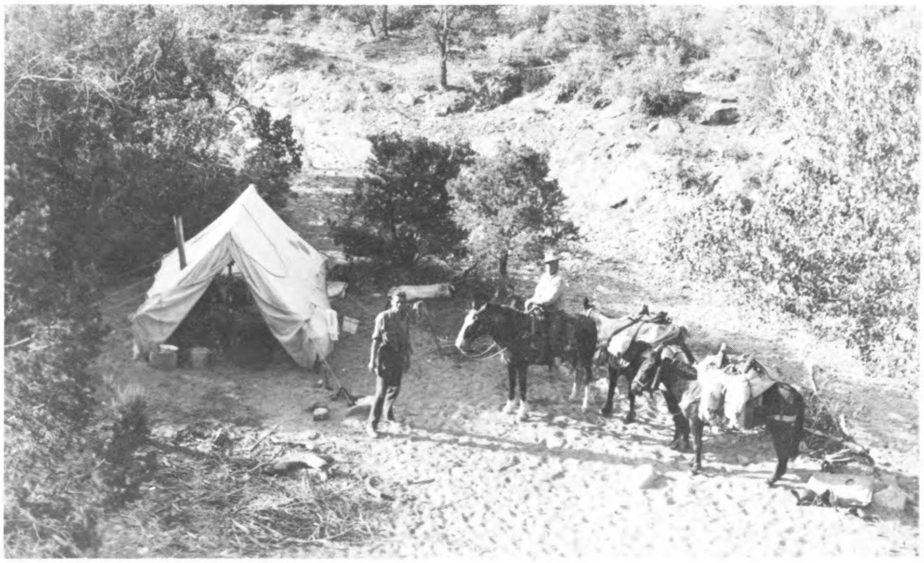
Charlie's retirement was only temporary because he soon joined the faculty at Johns Hopkins University. During his twelve years at Johns Hopkins, he directed numerous theses and research projects. His Utah geology interests were again in the Colorado Plateau area, specifically the geologic history of the Colorado River and the physiography and archeology of the Henry Mountains. He also continued to publish, authoring textbooks on the geology of soils and the physiography of the United States. Charlie was invited to New Mexico State University as a Distinguished Visiting Professor in 1973 and after a year was appointed Adjunct Professor.

Charlie returned to Utah in 1976 to accept a Visiting Scholar position at the University of Utah until 1980. From 1981 to 1985, he served as a member on the Geology Work Group whose duties involved analyzing sitings for the proposed High-Level Radioactive Waste Repository in southeastern Utah. At 83 Charlie is still active, investigating Utah geology, writing, and reviewing manuscripts for various publishers. He also continues to write commentaries on a variety of subjects including the preservation, study, and development of scenic southeastern Utah.

Charles B. Hunt has received numerous awards and recognition for exceptional work and research during his career, including Distinguished Lecturer for the AAPG, Visiting Geoscientist for AGI, Distinguished Service Award from the U.S. Department of the Interior, and honorary memberships in Phi Beta Kappa, Sigma Xi, and the Utah Geological Association. The numerous National Science Foundation research grants he was awarded over the years attest to the significance of his work.

Mount Ellen triangulation flagpole securely in place, Charlie Hunt (without hat) and packer Charlie Hanks pose for a picture while catching their breath. The flagpole stood for a year despite occasional gale force winds around the eleven-thousand-foot peak.

Packtrain moving along a ledge in the Moenkopi Formation near Mount Holmes. Mapping in the Henry Mountains required building trains for the pack animals. Ledges were relatively easy, but much rock work was needed to get across the massive sandstone cliffs of the Glen Canyon Group.



Charlie Hunt (without hat) and packer Charlie Hanks at a spike camp near Mount Holmes. Spike camps are working camps that might be used overnight or for several days. Most of the time the tent served as a kitchen and storage area and sleep was under the stars. During wet or cold weather the tent provided comfortable sleeping quarters.

We at the UGMS hope to continue with Charlie Hunt's enthusiasm for researching and documenting the geology of Utah. We hope that Charlie isn't embarrassed by this well-deserved adulation. We want him to know that Utah and his professional colleagues are sincerely grateful for his contributions toward the continued geologic mapping of Utah. Below is a short, selected bibliography of Charles B. Hunt.

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NEW GEOLOGIC DATABASES FOR UTAH

by Mark E. Jensen

The Utah Geological and Mineral Survey has the responsibility to obtain geologic information about the State of Utah, and then to make that information available in a usable form for planners, scientists, developers, elected officials, students, and the public-at-large. To fulfill part of this responsibility, the Mapping Section maintains computerized databases to store, search for, and retrieve geologic information. Currently we maintain operating databases for stratigraphic information, radiometric age determinations, and geologic maps. Another database for igneous rock petrography and chemical compositions is in the planning stage, and the current USGS database for geologic names in Utah is running.

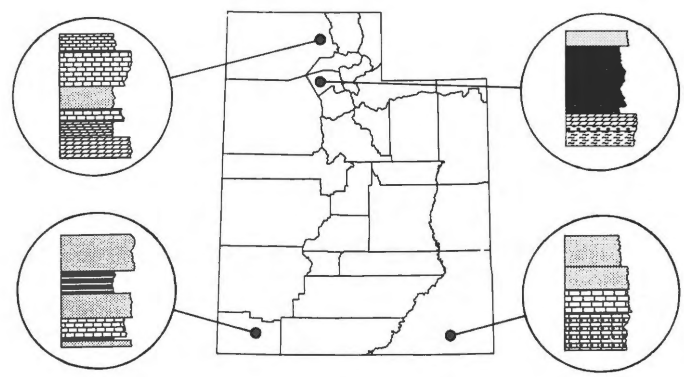
The UGMS encourages geoscientists to send copies of unpublished or published measured sections, radiometric dates, new unpublished geologic maps, or igneous rock compositions to be included in the databases and make your valuable information available to others studying the geology of Utah. We realize that researchers may not want to submit unpublished data prior to completion of a project or publication, but any data they are willing to release is appreciated. As these databases of Utah geologic information become more complete, the timesaving and research possibilities increase tremendously.

To submit data, please complete the enclosed information forms (pages 20-21) for the applicable database. The blank forms may be photocopied in order to submit additional data, or can be obtained by contacting the UGMS. To submit measured sections, attach the completed form to a copy of the section. Send the forms and data to:Mapping Section, Utah Geological and Mineral Survey, 606 Black Hawk Way, Salt Lake City, Utah 84108. For more information on these databases, contact Mark Jensen, Grant Willis, or Michael Ross at the UGMS.

Utah Stratigraphic Information Database

Have you ever wanted to quickly determine which stratigraphic sections have been measured in your study area, and where to find a copy of the section? The Utah Stratigraphic Information Database may be able to help. The database now contains over 1000 measured sections, but there is still a long way to go to adequately cover all parts of the state. Hundreds of measured sections in Utah have never been published but still contain important data. You can help by submitting any new or old unpublished sections that you, your colleagues, or your students have measured.

The Utah Stratigraphic Information Database is designed to manage data from measured stratigraphic sections of bedrock or surficial stratigraphic units, and data from drill holes for which accurate formational tops have been picked. The basic geologic unit for this database is the formation, but sections of members or groups are also entered. Each measurement is entered separately, so that information can be retrieved by formation or by members within each formation. The geologic, lithologic, location, and reference information submitted on the enclosed information form (page 20) is entered for each measurement, and all information that is entered can be retrieved. The database can be searched by most of the information fields listed on the enclosed form — geologic information, location, or reference. Copies of unpublished or rare stratigraphic sections are maintained in the UGMS files. The Utah Stratigraphic Information Database is available for use on a limited basis in the Utah Geological and Mineral Survey office. There is a nominal charge for printed output from the database, but those researchers who submit sections can receive an equal number of section printouts free of charge.



Utah Geochronometry Database

Many radiometric age determinations have been obtained for geologic materials within or near Utah, but finding the results of these determinations can sometimes be difficult. The Utah Geological and Mineral Survey is currently entering data into a database designed to manage radiometric age data obtained from all methods of absolute dating (K-Ar, Ar-Ar, Rb/Sr, fission track, ^{14}C, U-series, or other absolute dating methods). All earth scientists who have published or unpublished age determinations are encouraged to submit their data (page 21), so that it can be useful to other researchers and to avoid unnecessary expense and repetition of laboratory work.

Each sample is given a unique file number, and multiple analyses can be recorded for each sample. Most of the data fields shown on the enclosed information form (page 21) will be entered into the database. The data can be retrieved according to numeric age range, geologic unit, dating technique, location, or reference. The Utah Geochronometry Database is available for limited public use at the UGMS office.

Geologic Map Database

Have you ever tried to locate the most recent, most detailed, or just any geologic map that covers a particular area of the State? We have, many times, and it is often not an easy task. Geologic maps covering parts of Utah have been produced by many sources over the years: the UGMS, the U.S. Geological Survey, many different universities, and numerous private companies. Most have been published, but many have not. The UGMS continually collects these maps, and maintains a database on all known Utah geologic maps, published or unpublished, including those in our collections and those we don't have.

Each entry in the database records the scale of the map, the complete reference, location information about the map, and whether or not the map is contained in our collection. The location information includes the names of all 7 ½ minute, 30 minute by 60 minute, and 1 degree by 2 degree quadrangles in which all or part of the geologic map is included, and the maximum and minimum latitude and longitude covered by the map (for irregularly shaped maps the northernmost, westernmost, etc. points are entered). Information contained in the Geologic Map Database is available for public use on a limited basis at the UGMS office.

Continued from ***Director's Corner.***

We at UGMS believe that the information provided by multipurpose geologic maps is essential for wise development of large land units. When the Utah Division of Parks and Recreation requested us to provide information for their plans for the park, we welcomed the opportunity. Almost half the UGMS staff including the Director became involved in some way and U.S. Geological Survey and University of Utah geologists joined the team. The Division of Parks and Recreation specifically needed to know the potential for potable water on the island, the hazards to be avoided when constructing roads and facilities, the geologic resources of the park such as construction materials, and the park's recreation potential from a geologist's perspective.

It is no surprise that the geologically related recreation and tourism resources of the island are abundant. The island is a typical basin and range structure and a wonderful area to see and understand Great Basin geography, geology and structure.

The island consists mostly of Utah's very oldest and very youngest rocks including beautiful examples of Lake Bonneville and Great Salt Lake features. UGMS has alerted the Division of Parks and Recreation to areas of special geologic interest.

As for the water resources on the island ... they are very limited. Even so, UGMS-generated information about groundwater resources may prove useful in identifying watering places for buffalo as well as tourists.

Our mapping identified many specific geologic hazards to be reckoned with. The island is bordered to the west by a major active fault and also would be affected by movements of the Wasatch Fault. The earthquake hazards related to these faults can be planned for but not easily avoided. Other geologic hazards such as a few large landslides, many smaller landslides, areas of rockfalls, and specific areas vulnerable to debris flows, stream flooding and lake inundation were identified. These can be avoided when the park is developed.

Most of the island has limited capacity for sewage waste disposal and landfills to support future development. From a geologic perspective it is reasonable to concentrate future development in the already partly-developed northern area of the island.

Development of the island could be very destructive to it. Most of the island's surface is covered by a thin veneer of sediments which are easily eroded. Our conclusion is that vehicle traffic of all kinds should be restricted to designated well-engineered paved roadways to protect the island's surface. Bicycles and horseback riders also can easily damage the land surface, creating gullies and unsightly eroded areas unless limited to specific trails designed for erosion control.

The island is still wonderfully unspoiled. The Division of Parks and recreation plans to protect southern and western parts of the island from vehicles and crowds. One way to do this is to deliberately not provide easy access. An east-side parkway and a central loop road would provide access to about 1/3 of the island, including many scenic vistas, geologic points of interest, trailheads, beaches and outdoor adventure but minimize the easy access to the wilder parts of the island.

From my perception this project has been a major success. The Division of Parks and Recreation had the foresight to ask for geologic information early on in their planning process and were generous in their logistic support. They had considered virtually all of the concerns UGMS raised but with limited scientific basis for action. With this information they can now provide less costly and better designed facilities, and deliberately provide visitors access to the island's geologically interesting sites. With the conclusion of this project, another segment of the state is better understood geologically and that helps UGMS to better understand other areas in the Basin and Range province and Utah in general.

UTAH STRATIGRAPHIC INFORMATION DATABASE

Utah Geological and Mineral Survey / Mapping Section
606 Black Hawk Way
Salt Lake City, UT 84108 (801-581-6831)

UGMS use only

Record No: ____
File Loc.: ____
Digitized: ____
Completed: ____

Please complete this form and attach to the measured section.

Type of data: MEASURED SECTION or DRILL HOLE

GEOLOGIC DATA

FORMATION NAME: ____________________
(Formal or informal formation name. Write (inc) after formation name if this is an incomplete section.)

PREVIOUSLY USED OR NEW UNIT NAME: ____________________
(Only names that have been applied to this unit at this location)

TOTAL FORMATION THICKNESS (feet): ________ or (meters): ________

MEMBER INFORMATION (Write inc) after member name if this is an incomplete section of a member.)

	Member Name	Thickness (ft)	(meter)	Lithology (use symbols shown below)
Top	1.			
	2.			
	3.			
	4.			
	5.			
Base	6.			

FORMATION LITHOLOGY: _____, ______ (use this space only if no members are listed above. Use symbols shown below.)

GEOLOGIC PERIOD(S): ____________ GEOLOGIC EPOCH(S): ____________

OVERLYING UNIT: ____________ UNDERLYING UNIT: ____________

DOES THIS SECTION CONTAIN RADIOMETRIC AGES OR DIAGNOSTIC FOSSILS: Yes( ) No( ) If yes, explain in comments section below.

LOCATION AND REFERENCE DATA

INFORMAL SECTION NAME (Geographic locality): ____________________

COUNTY: ____________ STATE: ____________

7-1/2 MINUTE QUADRANGLE: ____________

LATITUDE: ____° ____' ____" N, LONGITUDE: ____° ____' ____" W

UTM ZONE: ______, ____________ mN, ____________ mE.

TOWNSHIP:___,RANGE:___,SECTION:_____,QUARTER SECTION:___of___of___

REFERENCE: ____________________

COMMENTS: ____________________

sandstone........ss	conglomerate...............cg	quartzite......qt	slate.....sl
limestone........ls	breccia....................br	argillite......ag	silt......si
dolomite.........dl	diamictite, tillite........di	lava flow......lf	sand......sa
shale............sh	clastics, interbedded......ci	tuff...........tf	clay......cl
siltstone........st	volcaniclastic deposits....vc	marl...........ma	gravel....gr
mudstone.........md	evaporites.................ev	coal...........co	rubble....ru

UTAH GEOCHRONOMETRY

DATE FORM COMPLETED:______________________
NAME (SUBMITTER):______________________

UGMS USE ONLY
File #:______
File loc:______
Source:______
Entered:______
Lit. ref:______

ANALYSIS	MATERIAL	AGE (my)	TECHNIQUE
1.	______	____+-____	______
2.	______	____+-____	______
3.	______	____+-____	______
4.	______	____+-____	______
5.	______	____+-____	______

GEOLOGIC UNIT
______________________ (Most common name)
______________________ (Alternate names--fm, gp,
______________________ mbr, tongue, intru, cmplx, informal, previous, etc.)

ROCK TYPE:______________________
DATE COLLECTED:__________ COLLECTORS NAME:______________________
FIELD SAMPLE No:______________ LAB SAMPLE No:______________
LABORATORY:______________ DATE ANALYZED:______________
SAMPLE TYPE (drill core, outcrop, float, etc.):______________
IS SAMPLE FROM A MEASURED SECTION?______________

ANALYTICAL DATA (constants, % constituents, C-13 adjust., etc.)
____
____
____

COMMENTS (location of sample in strat sequence, reliability of calculated age, etc.):______________________
____
____
____

SIGNIFICANCE OF AGE:______________________
____

KEY WORDS (geographic area, district, mine, etc):______________
____

LITERATURE REFERENCE:______________________
____
____

LOCATION
Lat:____° ____' ___" Long:____° ____' ____" (required)
UTM zone:____, __________mN, __________mE (optional)
T.____, R.____, Sect.____, ____of ____of____;BM____ (optional)
State:______________, County:______________
7 1/2' Quadrangle:______________________

Please fill in all blanks as applicable. Return form to:
Utah Geological and Mineral Survey, 606 Black Hawk Way, Salt Lake City, Utah 84108 (801-581-6831)
[\GEOCHRON.GCW 1-25-89]

WANTED
High-Quality Geologic Mappers

by Grant C. Willis

With over 1400 7 ½′ quadrangles in Utah left to be mapped, there is an opportunity for everyone to get in on the excitement (see figure 2 of the "Update" article). Since 1980 the UGMS has conducted a highly successful contract mapping program in which 42 contracts have been drawn up between the UGMS and outside geologists. Almost every agreement has resulted in a published map or is still in progress. The key to past success is the mutually beneficial arrangement existing between contractors and the UGMS. In the agreement the contractor agrees to provide the UGMS with a complete geologic map drafted on a mylar base, a handcolored copy of the same, one or more detailed geologic cross sections, a lithologic column, and a text describing the stratigraphy, structure, economic geology, geologic hazards, and other geologic information pertinent to that quadrangle. Quaternary geology is given the same emphasis as the bedrock geology. All materials meet the UGMS multi-purpose format.

In exchange for the above, the UGMS provides $1500 expense money, aerial photographs, mylar base maps, and in some instances pays additional laboratory expense. However, the biggest benefit provided by the UGMS is publication of the geologic map in full color with all scribing, drafting, typesetting, and publication expenses provided by the UGMS. Anyone who has ever prepared a map and text for publication knows the effort and expense this could save. The UGMS intends to publish all acceptable maps, but reserves the right to schedule publication to fit the constraints of its budget and time.

This program was established to promote graduate student mapping in Utah, however, much to the benefit of the state, it quickly expanded to include professors and other professional geologists. Many former geology students who mapped quadrangles as part of their thesis or dissertation saw the opportunity to have their hard work published. With some additional effort, they revised or remapped a few areas, converted text and symbols to UGMS standards and guidelines, and submitted the map for publication. Other contracts have been made with geologists interested in geologic mapping. The primary requirements are a geology degree, past mapping experience or, in the case of students, a thesis advisor with mapping experience, familiarity with Utah geology, and most important, lots of self motivation.

If you are interested in such an arrangement with the UGMS, contact Grant C. Willis or Hellmut H. Doelling, Utah Geological and Mineral Survey, 606 Black Hawk Way, Salt Lake City, Utah 84108.

AAPG Cross Section of Utah

by
Grant C. Willis

Have you ever wondered what Utah would look like at twenty-to-one vertical exaggeration? At that scale State Street would look like the "Widow Maker" hill climb, the bunny hill at Alta would be the ultimate challenge for any skier brave enough to attempt it, and Mount Timpanogos would loom more than 25 miles above the valley floor. Sound strange?

That scale was the unusual requirement for a geologic cross section through Utah recently completed by UGMS geologist Lehi F. Hintze, assisted by Grant C. Willis and Hellmut H. Doelling. As part of their highway geologic map series, the American Association of Petroleum Geologists (AAPG) includes a greatly exaggerated cross section that vividly portrays the structural geology of each state. Even in low-relief geologic terrains, such as the central United States, structures appear Everest-like. Given the complex geology of Utah, the structural features appear incredibly complex. On the cross section, which roughly parallels latitude 39° N., the most prominent feature is the San Rafael Swell, which appears as a gigantic asymmetric dome. The Paradox Basin forms a massive depression to the east, walled in by the Uncompahgre Uplift near the Colorado border. In the west, the complex high-angle faults leave the cross section looking like someone went wild with a pair of scissors and then glued everything back together while blindfolded.

One of the biggest challenges faced was trying to resolve all the different interpretive cross sections prepared by geologists over many years. The thrust faults of western Utah are probably the least understood and most inconsistently handled by past geologists. Even the names of the thrust faults aren't consistent.

The accentuated cross section will be accompanied by a cross section with no vertical exaggeration that will help users visualize the "real" geology of Utah. The map and cross sections are due to be published soon.

Update on Geologic Mapping by the UGMS

by Grant C. Willis

Utah Geological and Mineral Survey geologists are working on three long-term mapping projects. These include the UGMS-sponsored county mapping and quadrangle mapping projects and the jointly sponsored UGMS-U.S. Geological Survey COGEOMAP project. The joint UGMS-USGS CUSMAP project was not funded for the current year. Each of these has been featured in past issues of Survey Notes (county mapping-Summer 1986; quadrangle mapping-Spring 1985; CUSMAP-Winter 1986; COGEOMAP-Summer, Fall 1987).

County mapping — Hellmut H. Doelling, Lehi F. Hintze and Fitzhugh D. Davis continue to progress on the county map series. The Kane County study is currently in press and will be published in Spring of 1989. The Grand County and Millard County studies are moving forward with completion of mapping scheduled for 1990 (figure 1).

Quadrangle mapping — Grant C. Willis, Mark E. Jensen and Michael L. Ross devote full time to quadrangle mapping in the state. In addition, Hellmut H. Doelling, Lehi F. Hintze, Fitzhugh D. Davis, Michael A. Shubat and John S. Hand work part time on quadrangle mapping projects. Much of the full time mappers' effort is devoted to managing projects by contract and USGS geologists. Since 1983, 31 geologic quadrangle maps have been published by the UGMS. Currently, an additional 81 projects are in progress. Figure 2 shows locations of both.

COGEOMAP — Charles G. Oviatt and Fitzhugh D. Davis continue to expand the COGEOMAP projects in western Utah. A surficial geologic map of the Sevier Desert is near publication. Field work for surficial geologic maps of the Black Rock Desert, Sevier Desert, and Fish Springs Flat areas has been completed, with map and report preparation in progress. A study of the surficial geology of the Scipio Valley area is planned to begin June 1, 1989.

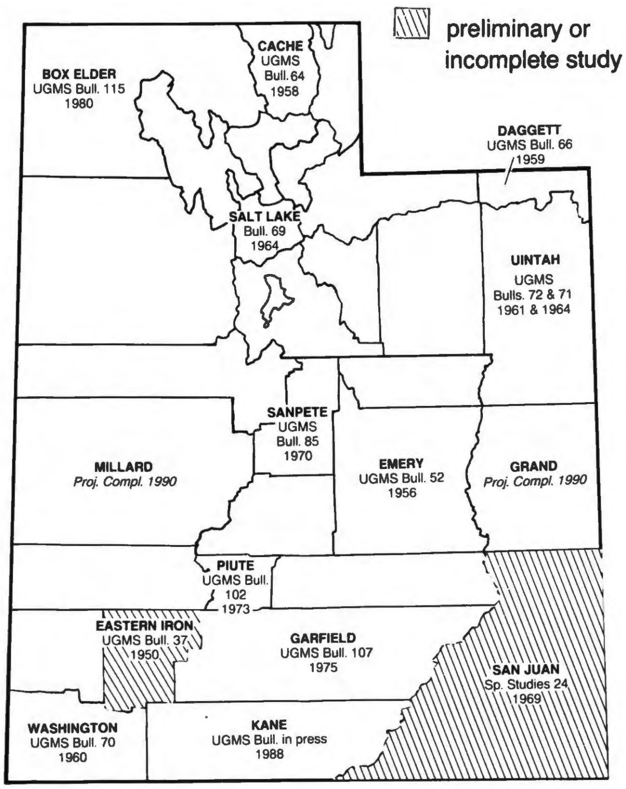


Figure 1. County geologic mapping and studies in Utah.

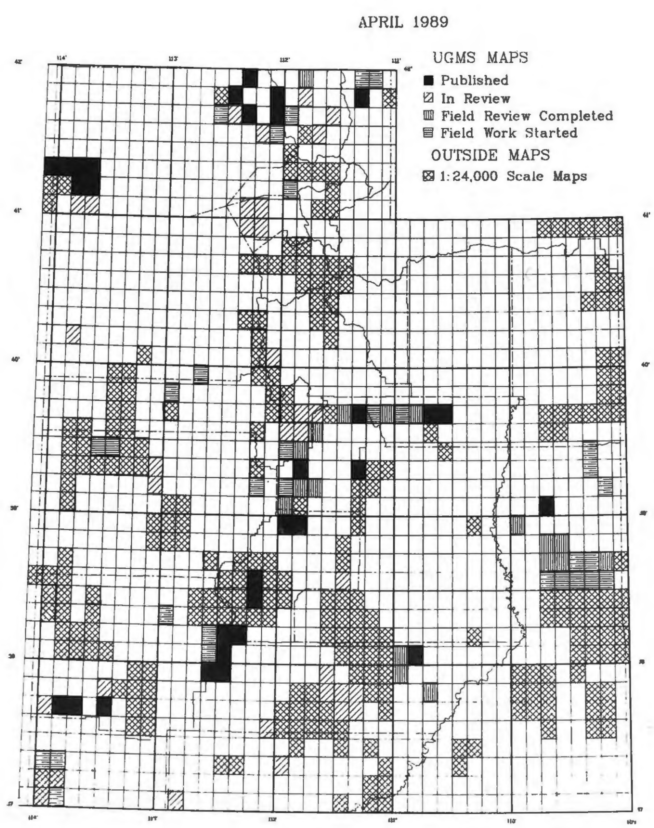


Figure 2. This map indicates the status of 7½' quadrangle geologic mapping in Utah. "UGMS maps" include maps by the UGMS mapping and economic sections, maps under contract to the UGMS, and maps by USGS geologists that are published by the UGMS under a cooperative agreement. "Outside maps" primarily include maps published by the USGS independent of the UGMS and by Brigham Young University Geology Studies.

Books & Papers

Geologic time by W.L. Newman, 1988, 20 p., free from USGS.

U.S. Geological Survey: earth science in the public service, 1988, 28 p., free from USGS.

Revisions to stratigraphic nomenclature of Jurassic and Cretaceous rocks of the Colorado Plateau, 1988, 69 p., $3.75 from the USGS as Bulletin 1633. Chapter B refers specifically to fairly pervasive units occurring in Utah.

Mineral resources of the Lost Spring Canyon Wilderness Study Area, Grand County, Utah, by S.J. Souliere, J.E. Case, and D.D. Gese, 1988, 12 p., $1.50 from USGS as Bulletin 1754 C.

Analytical results and sample locality map of soil and rock samples from the Wah Wah Mountains Wilderness Study Area, Beaver and Millard Counties, Utah, by B.M. Adrian, P.L. Hageman, L.J. Cox, and K.S. Panter, 1988, 26 p., $4.25 from USGS as Open-File Report 88-232.

Analytical results and sample locality map of stream-sediment and heavy-mineral-concentrate samples from the Diamond Breaks Wilderness Study Area, Moffat County, Colorado and Daggett County, Utah, by T.A. Delaney and others, 1988, 13 p., $4.50 from USGS as Open-File Report 88-394.

Selected chemical composition of the C coal bed, Emery coal field, Utah, by S.S. Crowley, F.O. Simon, and R.W. Stanton, 1988, 60 p., $9.75 from the USGS as Open-File Report 88-526.

Neotectonics of the Uncompahgre Uplift, eastern Utah and western Colorado, by R.W. Ely, I.G. Wong, and Ping-Sheng Chang, 1986, p. 75-92, from the Colorado Geological Survey as Contributions to Colorado seismicity and tectonics.

Sediment deposition behind Sheep Creek barrier dam, southern Utah, by B.P. Van Haveren, W.L. Jackson, and G.C. Lusby, 1987, p. 185-362, in Journal of Hydrology, New Zealand, v. 26, no. 2.

USGS Research on mineral resources, 1989; program and abstracts, edited by K.S. Schindler, 1988, 98 p., from the USGS as Circular 1035 includes two abstracts which include UGMS geologists as co-authors. The first is on the Tooele 1° x 2° quadrangle CUSMAP assessment with information from Mike Shubat; the second is on the Delta 1° x 2° quadrangle CUSMAP projects with input by John Hand and Mike Shubat.

Mineral resources of the Cottonwood Canyon Wilderness study Area, Washington County, Utah, by B.B. Houser, J.L. Jones, J.E. Kilburn, H.R. Blank, Jr., U.S. Geological Survey; R.H. Wood II, U.S. Bureau of Mines; and K.L. Cook, University of Utah. 1988. p. C1-C14. 1 plate in pocket. USGS Bulletin 1746-C.

Mineral resources of the Red Mountain Wilderness Study Area, Washington County, Utah, by B.B. Houser, J. L. Jones, J.E. Kilburn, H.R. Blank, Jr., U.S. Geological Survey; R.H. Wood II, U.S.S Bureau of Mines; and K.L. Cook, University of Utah. 1988. p. D1-D13. 1 plate in pocket. USGS Bulletin 1746-D.

Mineral resources of the Behind the Rocks Wilderness Study Area, Grand and San Juan counties, Utah, by C.G. Patterson, M.I. Toth, J.E. Case, G.N. Green, H.M. Barton, U.S. Geological Survey; and J.R. Thompson, U.S. Bureau of Mines. 1988. p. B1-B18. 1 plate in pocket (Mineral resources of wilderness study areas; upper Colorado River region, Utah.) USGS Bulletin 1754B.

Hydrogeology of the Great Basin region of Nevada, Utah, and adjacent states, by R.W. Plume and S.M. Carlton. 1988. Lat about 36° to about 42°, long about 111° to 120°. Scale 1:100,000 (1 inch = about 16 miles). USGS Hydrologic Investigation HA-0694-A.

Major ground-water flow systems in the Great Basin region of Nevada, Utah, and adjacent states, by J.R. Harrill, J.S. Gates and J.M. Thomas. 1988. Two sheets. Lat. about 36° to about 42°, long. about 112° to 120°. Scale 1:100,000 (1 inch = about 16 miles). USGS Hydrologic Investigation HA-0694-A.

General hydrogeology of the aquifers of Mesozoic age, upper Colorado River basin; excluding the San Juan Basin; Colorado, Utah, Wyoming, and Arizona, by G.W. Freethey, B. A. Kimball, D.E. Wilberg and J.W. Hood. 1988. Two sheets. Lat. about 36° to about 43°, long. about 106° to about 112°. Scale 1:2,500,000 (1 inch = about 40 miles). USGS Hydrologic Investigation HA-0694-A.

List of U.S. Geological Survey geologic and water-supply reports and maps for Utah, 1988, 310 p., U.S.G.S. Catalog. This bargain at $3.00 gives a full list for the publications dealing with Utah. A valuable source book for geologists and land-use researchers.

Mineral resources of the Fifty Mile Mountain Wilderness Study Area, Kane County, Utah, by Bartsch-Winkler, S., and others, 1988, 20 p., 1 pl., U.S. Geological Survey Bulletin 1747-A.

Paleohydrologic reconstruction of flood frequency on the Escalante River, south-central Utah, by R.H. Webb, J.E. O'Connor and V.R. Baker, *in* Flood geomorphology (V.R. Baker, editor and others). New York, NY: John Wiley & Sons, 1988. p. 403.

Metamorphic history of the east-central Basin and Range Province; tectonic setting and relationship to magmatism, by E.L. Miller, P.B. Gans, J.E. Wright and J.F. Sutter. Rubey Volume, *in* Metamorphism and crustal evolution of the Western United States (W.G. Ernst, editor). 1988. p. 649-682.

Fluctuations of water level, water quality and biota of Great Salt Lake, Utah 1847-1986, by Doyle Stephens and Ted Arnow. Utah Geological Association Publication, *in* Cenozoic geology of western Utah; sites for precious metal and hydrocarbon accumulation (R.S. Kopp, editor and others). 16, 1987. p. 181-194.

Ground water in the Great Basin part of the Basin and Range Province, western Utah, by J.S. Gates. Utah Geological Association Publication *in* Cenozoic geology of western Utah; sites for precious metal and hydrocarbon accumulation (R.S. Kopp, editor and others). 16, 1987. p. 75-89.

Chemical evolution and volatile fugacities of the Pine Grove porphyry molybdenum and ash-flow tuff system, southwestern Utah. by J.D. Keith and W.C. Shanks, III. Special Volume - Canadian institute of Mining and Metallurgy, *in* Recent advances in the geology of granite-related mineral deposits (R.P. Taylor, editor and others). 39, 1988. p. 402-423.

Evolution and early Proterozoic history of the margin of the Archean continent in Utah, by Bruce Bryant. Rubey Volume, *in* Metamorphism and crustal evolution of the Western United States (W.G. Ernst, editor). 7, 1988. p. 431-445.

Petrogenesis of rare-metal granites from depleted crustal sources; an example from the Cenozoic of western Utah, U.S.A., by E.H. Christiansen, J.S. Stuckless, M.J. Funkhouser-Marolf and K.H. Howell. Special Volume - Canadian Institute of Mining and Metal-

lurgy, *in* Recent advances in the geology of granite-related mineral deposits (R.P. Taylor, editor and others). 39, 1988. p. 307-321.

U.S. Geological Survey ground-water studies in Utah, by J.S. Gates, 2 p. Available from U.S.G.S. as OFR 88-0157.

Concentration of He, Co_2, and O_2 in soil gases, and soil types at Roosevelt Hot Springs Known Geothermal Resource Area, Utah, by M.E. Hinkle, and Theodore Botinelly. 30 p. Available from U.S.G.S. as OFR 88-0259.

Geologic map index of Utah, H. Kit Fuller, 1988. Available from U.S.G.S.

Utah catalog of topographic and other published maps, 1986, from the U.S.G.S.

Geohydrology of the Navajo Sandstone in western Kane, southwestern Garfield, and southeastern Iron counties, Utah, by G.W. Freethey. 1988. 43 p., 2 oversize sheets. (NC, Da, M, Wb, U, Db; USGS, WRD, Room 1016 Administration Bldg., 1745 West 1700 South Salt Lake City, UT 84104.) Microfiche $5.50; paper copy $10.75.

UGMS Staff

Tracy Grover, lately of the Agricultural Research Service in Logan, Utah, has joined the UGMS as our new Mapping Geotech. Welcome aboard!

Best wishes to *John Hand,* who is pursuing his career as a Geologist/Technical Applications Coordinator for Cyprus Coal in Denver, Colorado.

Congratulations to Geotech *Christine Wilkerson* who recently became a mom! Baby boy Jeremy Dustin arrived at a healthy 9 lbs. 6 oz. ... mom, dad and babe are busy getting acquainted!

New Publications from UGMS

Evaluation of seismicity relevant to the proposed siting of a superconducting supercollider (SSC) in Tooele County, Utah, by W.J. Arabasz, J.C. Pechmann, and E.D. Brown, 107 p., Miscellaneous Publication 89-1 .... $8.50

Geologic map of the Nephi quadrangle, Juab County, Utah, by R.F. Biek, 95 p., 2 pl., Open-File Report 148 .... $11.00

Coal quality characteristics of Utah's coal beds in and near potentially producible coal tracts, A.C. Keith, 175 p., Report of Investigation 219 .... $9.60

Survey Notes v. 22 no. 4: Assessing the radon hazard in Utah, by D.A. Sprinkel, 26 p., single issues free while supply lasts.

Geologic map of the Aurora quadrangle, Sevier County, Utah, by G.C. Willis, 21 p., 2 pl., Map 112 .... $5.00

The Davis County flood warning and information system, by Mike Lowe, S.R. Williams, and S.W. Smith, 15 p., Open-File Report 151 .... $2.50

Subsurface map and seismic risk analysis of the Salt Lake Valley, by Hugh Radkins, Mary Murphy, and G.T. Schuster, 82 p., 3 pl., 4 color plates, Open-File Report 152 .... $19.00

Mineral occurrences of the Tooele 1° x 2° quadrangle, west-central Utah, by B.T. Tripp, M.A. Shubat, C.E. Bishop, and R.E. Blackett, 85 p., 3 pl., Open-File Report 153 .... $12.00

A short course in petroleum geology, with examples from Utah's petroleum provinces, by Carol N. Tripp, UGMS Open-File Report 150:

Volume 1 — The Short Course, 186 p. $16.50
Volume 2 — Student Manual, 208 p. $18.00
Volume 3 — Teacher Guide, 61 p. $6.50
Volume 4 — Wildcat, a simulation game, 66 p. $6.50

An exceptional result of the Mineral Lease contracts described in *Survey Notes volume 22 number 4* in Doug Sprinkel's article. Interactive instruction is the intent of this group of publications, the target group is junior high students although they can be used as a fast refresher for college students. The simulation game (vol. 4 and vol. 3) gives a good understanding of many basic geologic and petroleum exploration concepts while introducing players to Utah's provinces and fields. The final chapter in volume 2 is titled "Careers in Geology" and gives students a brief overview.

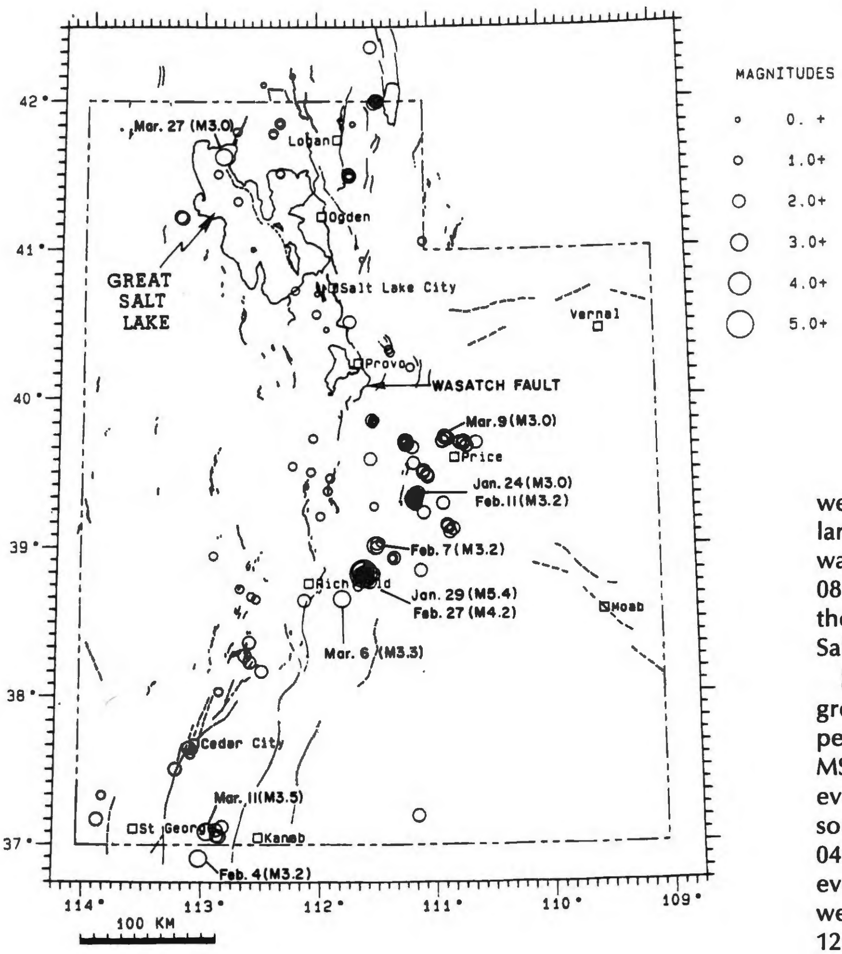
Water-related geologic problems of 1983 in southeastern Utah, by Fitzhugh D. Davis, 89 p., UGMS Open-File Report 149 .... $8.50
This report, in conjunction with UGMS Miscellaneous Publication 89-4, sums up and evaluates the reported geologic problems related to the 1983 wet year. Most of the publications of this period, like these two from the UGMS, are being published in the hope that future wet period problems may be forestalled in the future. This OFR covers occurrences from Grand, Wayne, San Juan, Garfield, and Kane Counties.

Utah Earthquake Activity

by Susan J. Nava

University of Utah Seismograph Stations, Department of Geology and Geophysics

January 1 — March 31, 1989



During the three-month period January 1 through March 31, 1989, the University of Utah Seismograph Stations located 207 earthquakes within the Utah region (see accompanying epicenter map). Of these earthquakes, 111 had a magnitude (either local magnitude, M_L, or coda magnitude, M_C) of 2.0 or greater, ten had a magnitude of 3.0 or greater, and nine were reported felt.

The largest earthquake during the report period was a shock of M_L5.4 on January 29 at 09:06 p.m. MST, 26 km southeast of Salina, in north-central Sevier County. The Salina earthquake was felt widely in central and northern Utah (maximum Modified Mercalli Intensity V to VI), and in northern Arizona, western Colorado and southwestern Wyoming. The largest aftershock of the January 29 Salina earthquake was an M_L 4.2 event that occurred on February 27 at 08:13 a.m. MST, that was felt in four counties. During the report period, 51 earthquakes associated with the Salina sequence have been located.

Eight other earthquakes of magnitude 3.0 and greater occurred in the Utah region during the report period: an M_C 3.2 event on January 24 at 04:37 p.m. MST, located 15 km west of Huntington, an M_C 3.2 event on February 4 at 05:26 a.m. MST, located 50 km southwest of Kanab; an M_C 3.2 event on February 7 at 04:49 a.m. MST, which was felt in Manti; an M_C 3.2 event on February 11 at 01:37 p.m. MST, located 11 km west of Huntington; an M_L 3.3 event on March 6 at 12:41 a.m. MST, which was felt in Koosharem and Glenwood; an M_C 3.0 event on March 9 at 07:33 a.m. MST, located 10 km east of Helper, an M_C 3.5 event on March 11 at 11:30 p.m. MST, which was felt in Springdale, Rockville, and in Colorado City, Arizona; and an M_L 3.0 event on March 27 at 04:41 a.m. MST located 25 km west of Promontory. Four additional earthquakes were reported felt in Utah during the report period: an M_L 2.7 event on February 2 at 09:15 p.m. MST, which was felt in Beaver, an M_L 2.8 shock on February 3 at 07:04 a.m. MST which was felt in Salina and Ephraim; an M_L 2.7 event on February 3 at 11:08 a.m. MST, which was felt in Helper and Manti; and an M_L 2.5 event on March 5 at 11:51 p.m. MST, which was felt in the West Desert, and in Wendover, Nevada.

Additional information on earthquakes within Utah is available from the University of Utah Seismograph Stations.

Note

The U.S. Geological Survey, in conjunction with the UGMS and several other entities, is planning a July 26 celebration for "the last map." Diehard readers of *Survey Notes* may recall vol. 10 no. 1 of February, 1976, which carried an article titled "Mapping nearly complete in Utah." It referred to the U.S.G.S effort to have topographic coverage of the entire state. The July 26 commemoration ackowledges the last 7.5-minute completion.

As you note in Grant's articles ("Wanted" and "Update") and Genevieve's "Director's Corner," the 7.5-minute series at 1:24,000 is considered one of the most useful in our terms; it gives good detail but still covers a large area. This scale is preferred for most of our geologic mapping (Antelope Island was mapped at this scale), partly because of its utility, but partly because such excellent base maps, covering the whole state, are available. They are the hiker's boon, the explorationist's *vade mecum,* the surveyor's exemplar, the 4-wheeler's mainstay, and they make possible a range of overlay information (geology, for example is overlain on the topographic base) that would certainly be 3 or 4 times longer in the making — if it were done at all — if these maps did not exist. We are, understandably, quite eager to join in this celebration.

Watch your newspaper for more information on this event, and buy a topographic map from the Earth Science Information Center of the U.S.G.S. at 125 South State, room 8102.

Another Note

It is always nice to see renewed activity in our field, and in those fields it affects, partly because it renews our reason for being. Cyanco is building a new sodium cyanide plant in Nevada, but most of the stock is held by Mining Services International, a Utah-based explosives company. This shows a trend toward increased exploration and mining that bodes well for Utah's economy.

And speaking of money, the Winter 1989 issue of Drill Bits has an article on using shredded money from the U.S. Federal Reserve Bank as a lost-circulation material — money down the hole takes on a new meaning.

American Barrick Resources is in full swing at the Goldstrike mine in Nevada. They'll draw on the experience at the Utah Mercur operations to build an autoclave facility at Goldstrike.

BP Minerals America has begun construction on the Barneys Canyon site in the Oquirrh Mountains. The mine will provide over 100 jobs and average 80,000 oz/yr for the 7-8 years this disseminated gold prospect may last.

ASOMA, Inc. has purchased the Drum gold mine near Delta from Western States Minerals Corp.

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Address correction requested

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