UTAH GEOLOGICAL SURVEY

SURVEY NOTES

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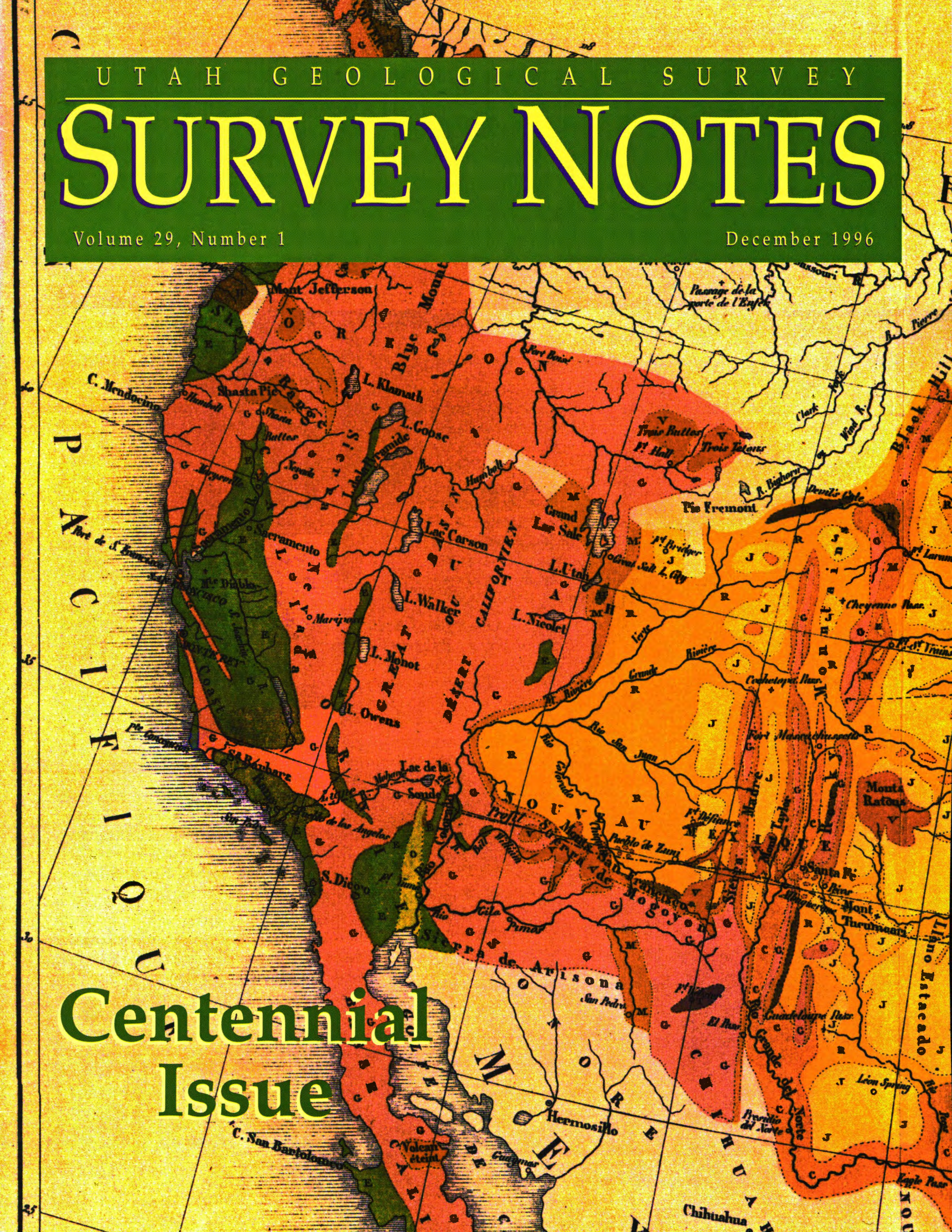

Centennial Issue

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Design by Vicky Clarke

Cover: The first geologic map to include any part of Utah, by Jules Marcou, 1855.

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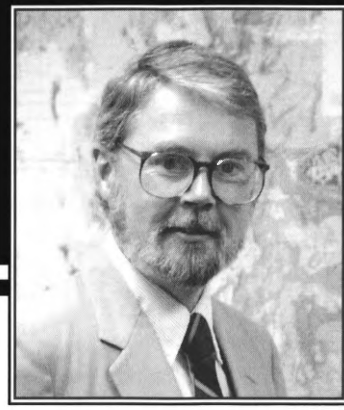


The Director's Perspective

by M. Lee Allison

A Monument to Geology

Utah has a new national monument, dedicated in large part to geologic study, but also likely destined to halt plans for developing the largest coal field in the state. The creation of the Grand Staircase-Escalante National Monument by Presidential proclamation on September 18, 1996, generated intense public debate over the future of the Kaiparowits coal field and other natural resources in the 1.7-million-acre domain.

The purpose of the monument is preservation principally of spectacular geologic resources for scientific study. The proclamation declares that "the monument presents exemplary opportunities for geologists, paleontologists, archeologists...", "Such diverse objects make the monument outstanding for purposes of geologic study", and "The monument includes world class paleontological sites." Supporters of the monument quoted passages from UGS Bulletin 108, The Geology of Kane County, as justification for setting aside the geologic landscape. Opponents, however, quoted just as extensively UGS reports of coal, oil and gas, and coalbed methane resources as reason to prevent designation of the monument.

No mention is made in the monument proclamation of either oil and gas exploration or coal development. While neither is specifically prohibited, a management plan to be developed over the next three years will determine what is appropriate in the monument.

The Utah Geological Survey became very active in disseminating information about the energy and mineral resources in the Kaiparowits region. In response to news media requests, we revealed that the Kaiparowits coal field contained over 62 billion tons of coal, approximately four times the amount previously calculated. This number came from a new, but as of then, unpublished U.S. Geological Survey report (now released as USGS OFR 96-539, "Preliminary investigation of the distribution and resources of coal in the Kaiparowits Plateau, southern Utah". This report is available from the DNR Bookstore or can be found through the USGS homepage at http://sedwww.cr.usgs.gov:8080/energy/kaip.html.

Besides the vast coal resource in the monument, UGS staff conservatively estimated that 2 - 4 trillion cubic feet of natural gas ("coalbed methane") might be recoverable from the coal field.

As the monument rumors became reality, part of the debate turned to the implications for the hundreds of thousands of acres of school trust lands within the monument boundaries known as inholdings. Under

Continued on page 11 . . .

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

The Utah Geological Survey Mapping Program commemorates Utah's Statehood through a review of topographic and geologic mapping in Utah prior to statehood in this issue of Survey Notes. In addition, in keeping with our tradition of recognizing major Utah geologic mappers, we recognize the two geologists who made the earliest contributions to geologic mapping of Utah.

The History of Mapping in Utah Prior to Statehood

by Grant C. Willis

Modern towns, state boundaries, and cultural features are used as landmarks in the following account, although they did not exist during most of the period covered by this history.

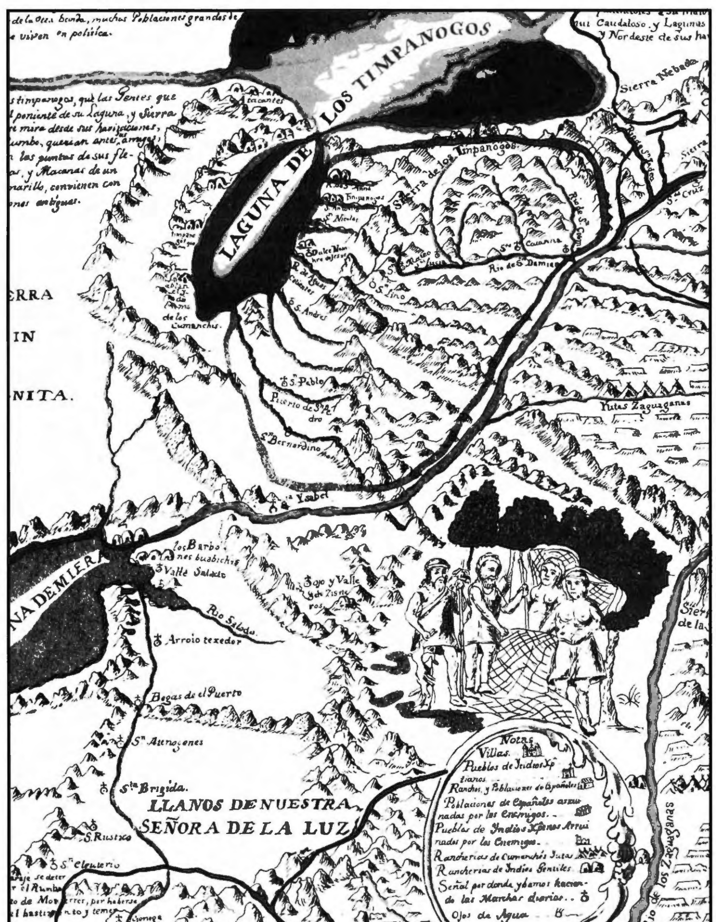
Early Mapping in Utah

In recounting the history of mapping in Utah, it's tempting to begin with the first U.S. Government explorers to enter Utah, the Fremont expedition of 1842. But that would leave out the first and, in many ways, more important chapter. Before there could be a topographic or geologic map, there had to be an understanding of the land. That knowledge came from the Indians, early explorers, and adventurers who opened up the West, brought back tales (some actually true!) of great riches, and turned the eyes of a nation westward.

Tales of Spaniards and Gold

By the mid-1700s the Spanish had established Santa Fe, in central New Mexico, as its northern interior trading center. From Santa Fe they developed trade with Indians over a broad area, probably including much of Utah. Though poorly documented, it is probable that Spanish traders may have entered Utah many times prior to the well-known Domínguez-Escalante expedition.

In 1776 Fray Francisco Atanasio Domínguez and Fray Francisco Silvestre Velez de Escalante led an expedition from Santa Fe into Utah in an attempt to find a route to California that circumvented the harsh, dry deserts, rugged mountains, and hostile Indians of Arizona and Mexico. They traveled northwestward as far as the Uinta basin, probably first entering Utah near Vernal, crossed the Wasatch Range at Strawberry Valley, followed the Spanish Fork River to Utah Valley, and then traveled southwestward to near St. George. At that point they gave up their search and headed directly back to Santa Fe across the harsh canyon country of southern Utah and northern Arizona.



Excerpt from the 1778 map by Bernardo Miera y Pacheco, a mapmaker who accompanied the Dominguez-Escalante expedition. It is the first published map of the Utah area based on first-hand knowledge. Though much is fanciful, many geographic features can be recognized. A few of the main features: Lagunas de Los Timpanogos -Utah and Great Salt Lakes with a narrow neck of land between them; Laguna Demiera - Sevier Lake; Rio Buenaventura (the large river entering the lake on the upper right) - Green River (incorrectly) flowing into Sevier River; Rio de Sta. Damian - Strawberry River. The small circles with a cross identify each of the expedition's camps.

IMPORTANT "FIRSTS" IN UTAH MAPPING

BARON LA HONTON, *"lord-lieutenant of the French colony at Placentia in New Foundland," probably made the first written account of a geographic feature in Utah. In 1689 he wrote an account of a journey up a great western tributary of the Mississippi River he called the "Long River." Near the end of this journey he met four "Mozeemlek" Indian slaves who described a place to the west where "their principal river empties itself into a salt lake of three hundred leagues (700 to 1,400 miles) in circumference" (from the account by Stansbury, 1852).*

FATHERS DOMÍNGUEZ AND ESCALANTE *published the first physiographic map of Utah, and were undoubtedly the first to publish a first-hand geologic observation about Utah. On October 2, 1776, based on their observation of small snail shells, they concluded that the area east of Sevier Lake "seems to have once been a lake very much larger than the present one." These snails (now known as Lymnaea bonnevillensis) lived in ancestral Lake Bonneville (Ives, 1964).*

LIEUTENANT JOHN C. FREMONT *collected the first geologic specimens from Utah for scientific analyses in 1843-44. Professor James Hall discussed the specimens in an appendix to Fremont's 1845 report, the first scientific publication on Utah geology.*

CAPTAIN HOWARD STANSBURY *made the first detailed descriptions of Utah geology and the first scientific report of an earthquake in Utah. During the winter of 1849-1850, while leading one of the earliest railroad surveys of the West, he collected samples and made careful observations about the geology of the Wasatch Range and the Great Salt Lake Desert published in his 1852 report. Stansbury also recorded that, "On the 22d of February [1850], about 3 p.m., a slight shock of an earthquake was felt in the southern part of the [Salt Lake] city, the vibrations being sufficient to shake plates from the shelves and to disturb milk in the pans." Similar to Fremont, he turned his samples and notes over to James Hall, who described them in an appendix to his report.*

DR. JAMES SCHIEL *was probably the first trained geologist to make field observations in Utah. He accompanied the Beckwith (Gunnison) expedition in 1853, which explored possible railroad routes in central and northern Utah. Most of his work consisted of mineralogical and lithological descriptions (Merrill, 1924).*

JULES MARCOU *published the first geologic map of Utah (in a German journal) as part of a geologic map of the United States in 1855.*

Although the purpose of the Domínguez-Escalante expedition was not scientific, the leaders made detailed notes and drawings, including the first observations on Utah geology, and produced the first physiographic map of the region based on first-hand knowledge (page 1). Another important early physiographic map of the southwestern United States, published by Humbolt in 1811, also made use of the reports by Spanish explorers.

This attempt to reach California failed; however, later Spanish travelers used knowledge derived from the Domínguez-Escalante expedition to establish the successful "Spanish Trail" between New Mexico and California, which circled around the northern end of the San Rafael Swell near Price. The many tales of lost Spanish gold mines stem from these travels. However, no gold mines of Spanish origin have ever been proven in Utah.

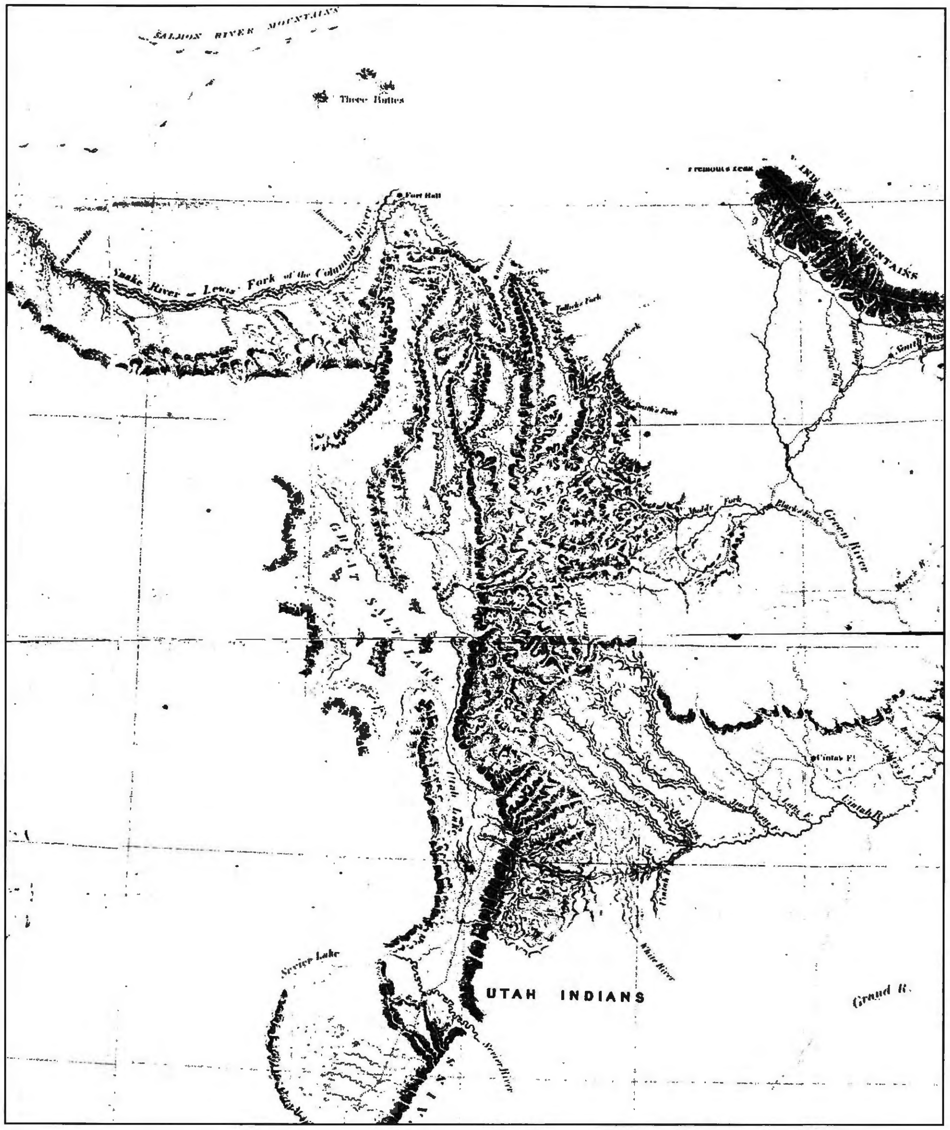
Trappers

The next chapter in the exploration and mapping of Utah focuses on the fur trade. Utah was explored relatively late by trappers. For example, the Great Salt Lake was probably not seen by a European until 1825 (the Spanish may have seen the lake earlier, but there is no written record). By comparison, the Snake River Plain in Idaho was traversed many times after 1805 by members of the fur-trading companies en route to the Columbia River country. Trappers explored Utah late mostly because it was considered a great, harsh desert, natural routes tended to steer trappers to the north, and it was part of Spanish territory (claimed by the Spanish until 1821, and subsequently by the Mexicans until 1848).

British, French, and American trappers and adventurers moved through Utah in greater numbers after 1825. The American trappers were different from the Europeans. The Europeans looked at the West as a place to obtain riches to take to their homes; the Americans looked at it as a place to build their homes. In their exploring, men such as William Ashley, Jim Bridger, and Jedediah Smith noted with interest the potential for mineral wealth, farming, and raising livestock. The European and American trappers weren't map makers, but they brought back notes, diaries, sketch maps, and stories that were used to improve the existing physiographic maps of the West, and to excite a nation's interest.

The great interest in the West quickly made obvious the need for accurate maps. Map makers produced several very generalized maps of the West during the 1820s and 1830s by questioning the fur trappers as they returned east. These maps showed the largest rivers and mountain ranges, and a few important passes, but not much else. Though they were a vast improvement over Humboldt's map of 1811 and a map by Lewis and Clark produced in 1814, each contained many inaccuracies and large blank spaces. Of particular importance were maps by Stephen Long (1821), A.H. Brue (1833), and Aaron Arrowsmith (1834).

The next maps of importance were based on the travels of Captain Benjamin Bonneville and his chief scout and explorer, Joseph Walker. In 1832, Captain Bonneville took a leave of absence from the U.S. Army to lead a group of men west, ostensibly to trap beaver. However, his activities and later events indicate that he was actually sent west as a U.S. Government spy to assess: (1) British activity in the northwest territory (Columbia River country), (2) Mexican activity in Spanish territory, (3) Indian methods and abilities to wage war, (4) mineral and timber resources, (5) potential for agriculture, and (6) possible emigration routes. Bonneville built a fort on the upper Green River in Wyoming. He then sent a party led by Joseph Walker westward through Utah while he led another group into Oregon. He sent detailed reports back to Washington D.C. on the geography, climate, and Indians of the region. Although he and his men strongly en-



Excerpt from John C. Fremont's 1845 map. Note the fairly accurate detail in the Wasatch Front area, and the large blank areas in the Great Basin and Colorado Plateau.

couraged the government to secure the California and Oregon territories, they showed little interest in the "desert" south of the Great Salt Lake. Two physiographic maps were based on Bonneville's travels. Bonneville and his assistant, Washington Irving, published a map of the West in 1837. Another map maker, Albert Gallatin, published a similar map in 1836 based on Irving's in-progress work.

As a side note of interest to Utah geologists, Bonneville (or some of his men) decided to name the Great Salt Lake after himself. Thus, on his map of the West, he named it "Bonneville Lake", even though it had been called the "salt lake" since Domínguez and Escalante, and was so labeled on many maps. The name "Bonneville Lake" didn't stick, but it later led geologist G.K. Gilbert to choose "Lake Bonneville" as the name of the great inland lake that preceded the Great Salt Lake. Ironically, Bonneville probably never set foot in Utah.

By 1839, settlers were trekking westward into Oregon, and in 1841 the first party of settlers crossed northwestern Utah on its way to California. However, the West was still so poorly mapped that many immigrant parties chose poor routes and suffered great hardships. Nevertheless, the great westward movement had begun, and the stage was set for the U.S. Government to take a more direct role in securing the West.

John C. Fremont Expeditions

Senator Thomas Benton of Missouri was one of the great visionaries of the American West (he claimed to have gained that vision through a meeting with the aging Thomas Jefferson in 1825). In 1841, Benton secured funding from Congress to conduct "thorough" scientific investigations and mapping of the West. He chose his son-in-law, John C. Fremont, a young "hotshot" West Point Army captain and member of the Army Corps of Topographical Engineers, to lead the expeditions.

Fremont conducted five western expeditions, in 1842, 1843-44, 1845-47, 1848-49, and 1853-54. The 1843-44 expedition explored the Great Salt Lake area, followed the Snake River to Oregon, continued to southern California, and then explored northeastward, passing through St. George and the Wasatch Front. During the 1845-47 expedition, Fremont crossed Utah just south of the Great Salt Lake and followed the Humboldt River to California. While in California he led the Bear Flag Revolt against Mexico, and thus played a major role in securing the Mexican Territory, including Utah, for the United States.

Several.important maps were published using information from Fremont and other individuals who were venturing throughout the West. In 1844, Warren published a map that Goetzmann (1967) called "the first essentially correct map of the West," although vast areas were left blank. More important to Utah settlers was a group of maps published by Fremont and his cartographer, Charles Pruess, in 1845. Brigham Young used the Fremont-Pruess maps as he led the Mormons westward into the Salt Lake Valley in 1847. The Wasatch Front area, which Fremont had visited on two expeditions, is one of the more detailed areas on the maps (above).

Fremont's expeditions were decidedly more scientific than any that had been conducted before. The group included naturalists, cartographers, and surveyors who made many important observations and reports. Fremont collected rock and mineral samples, which he sent to New York geologist and paleontologist James Hall to study. Hall's description of fossils collected in Utah was published as an appendix in Fremont's 1845 report, making it the first scientific publication on geologic features in Utah.

The Great Railroad Surveys

As early as 1844, visionaries proposed a transcontinental railroad. The first to approach Congress with a proposal was a northern Senator who recommended a northern route into Oregon territory. Senators from the central and southern states immediately jumped in and proposed routes beginning in their states. Thus began one of those stalemates for which the U.S. Congress is so famous. To settle the endless debate, Congress commissioned a series of expeditions to explore all the possible routes, and hoped that science and terrain would determine the best route. Two expeditions were planned across Utah.

In 1848, Fremont explored a proposed route directly westward from St. Louis across southern Utah. He met with disaster in deep snows in southern Colorado and never made it to Utah. However, his proposed route would have crossed the deep canyons of the Colorado Plateau of southern Utah, an almost impossible plan.

In 1850, Captain Howard Stansbury explored a route along the Oregon and Mormon Trails, and searched for a way through the deep canyons of the Wasatch Range. He was also instructed to search for a route along the old Spanish Trail through central Utah, but he never completed that part of the assignment. Before his expedition started, Stansbury visited prominent New York geologist James Hall and received a two-week crash course in geology. He explored a route across southern Wyoming and spent the winter of 1850 with the Mormons in Salt Lake City. He was so impressed with the possibilities of a railroad route through the mountains of northern Utah that he decided to concentrate on this route; his preferred route turned south from Echo Canyon, passed through Coalville and Kamas, followed the Provo River through Heber City to Utah Valley, and passed around the southern end of the Great Salt Lake. During this time he explored the Great Salt Lake Desert of northern Utah, the islands of the lake, and several of the canyons along the Wasatch Front. He recorded detailed geologic descriptions and collected several hundred pounds of rocks and fossils. After his expedition, Stansbury sent his notes and samples to Hall who wrote a bold 10-page description of the geology of Great Salt Lake area that was published as an appendix in the back of Stansbury's 1852 report on the valley of the Great Salt Lake. In the appendix, Hall discussed geologic sketch maps he made using Stansbury's notes and fossils, but apparently these maps were never published.

After the preliminary surveys of the late 1840s and early 1850s, the passage of the Pacific Railroad Survey Act in 1853 provided government funding for more detailed surveys. Lieutenant John W. Gunnison led an expedition across central Colorado and Utah. After Gunnison and six others were killed by Ute Indians near Sevier Lake, Lieutenant E.G. Beckwith led the group north to Fort Bridger near the Green River in Wyoming. He then explored westward and is credited with selecting the route through Weber Canyon that the transcontinental railroad eventually followed.

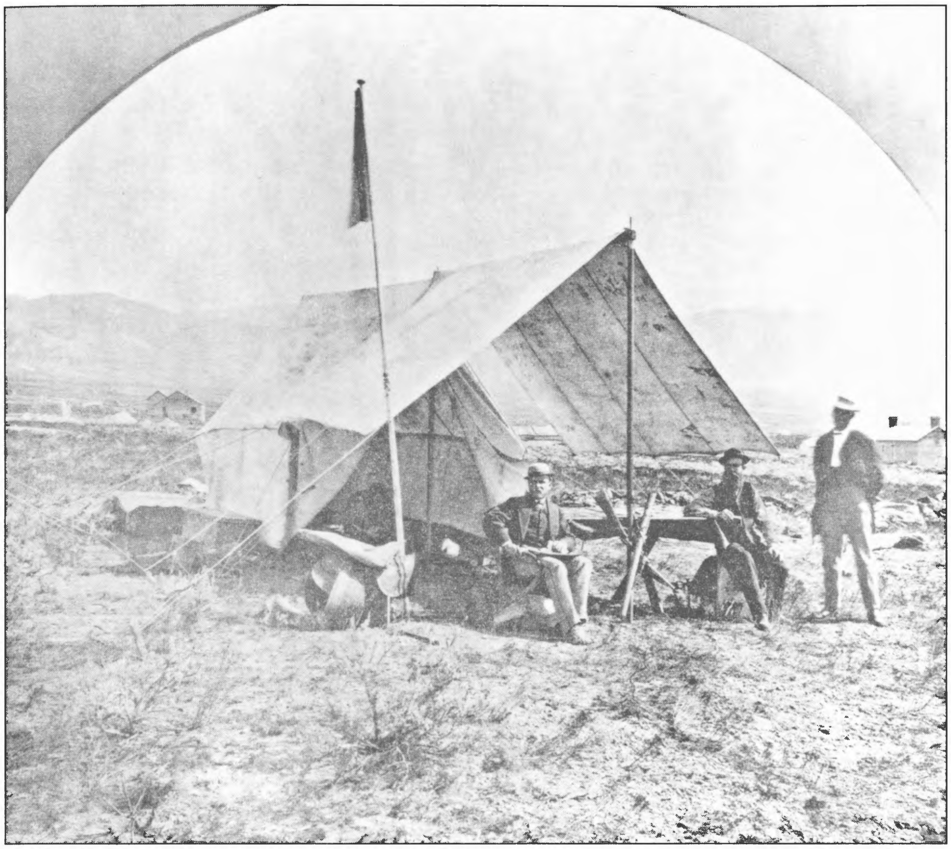
The First Geologic Map of Utah

The railroad surveys of the early 1850s were interested in the engineering geology along the routes, and most expeditions included a geologist. One of these geologists was a Frenchman named Jules Marcou who explored the proposed southern route through central Arizona with the Whipple Survey. Marcou combined geologic information from his and other railroad surveys, from James Hall's writings and drawings, and from his own earlier observations, added them to a map he had published in 1853 of the eastern and central United States, and constructed the first geologic map of the continental United States in 1855, and thus the first geologic map of Utah (front cover). Unfortunately, since his 1855 map was published in an obscure European journal, an 1857 map by James Hall is often credited as the first geologic map of the western United States (Goetzmann, 1967).

The Transcontinental Railroad

The railroad surveys showed that several routes were feasible. Thus, the arguing continued and nothing was done until the Civil War diverted attention away from the West. However, the railroad surveys were by far the most detailed scientific, including geologic, surveys of the West prior to the Civil War. They provided reasonably accurate, though sparsely detailed, physiographic maps of the West, and proved what the trappers had claimed many years before; the West had great potential as a place to expand a nation.

After the Civil War, a transcontinental railroad seemed long overdue, and construction plans were quickly developed. By this time the most logical route was evident. California was a state and the San Francisco-Sacramento area was by far the most important economic center in the West. Mining was the major industry in northern California and on the eastern side of the Sierra Nevada Mountains near Carson City. Salt Lake City was well established and could provide support during construction and business after construction. Well-established wagon roads existed along the route, and Stansbury's and Beckwith's old reports showed that the route was feasible. Thus, there was little argument for any other route.



Clarence E. King with his field party near Salt Lake City, October, 1868. Photograph by T.H. O'Sullivan (from U.S. Geological Survey photo library).

The Four Great Geologic Surveys

By the latter half of the 1860s the West was a very different place than in the days of Fremont and Stansbury. The geography was well known and homesteaders had settled every major fertile valley. The days of exploration of uncharted territories was over and the need for careful, systematic surveys had arrived. Three men, Ferdinand V. Hayden, Clarence E. King, and John W. Powell, recognized this opportunity to enhance their budding careers in geology. Independently, each convinced Congress to fund a survey of the western territories and to assign themselves as leaders. Topographical surveys had been the domain of the U.S. Army Corps of Topographical Engineers, which was quick to respond with a survey of its own, led by Lieutenant George M. Wheeler. The four surveys, which operated independently, continued into the late 1870s before they were disbanded. All four leaders became national folk heros, and two (King and Powell) later became directors of the U.S. Geological Survey. The four great surveys represented a new era in mapping and scientific research. Prior to this time, government expeditions to the West were best described as "explorations," in which explorers took a quick look at a few scattered sites, collected a few samples, and crudely surveyed in the locations of major mountains, rivers, and passes. Maps contained little detail, were wrong in many areas, and had huge blank areas. The four great surveys took a fundamentally different approach. They: (1) used careful survey methods to create accurate, detailed topographic and geologic maps, many of which stood as the best available maps until the early 1960s; (2) made systematic inventories of the flora, fauna, strata, and mineral resources; and (3) proposed educated interpretations of observed geologic phenomena. Together, the four surveys mapped most of the topography and geology of Utah at a scale of at least 1:506,880 (1 inch = 8 miles). Of course, few areas were studied in detail, and many of the geologic descriptions turned out to be wrong (for example, many of the Tertiary intrusive rocks were defined as Precambrian), but the topographic maps were accurate and reliable, and the geology was known in at least rudimentary detail.

Hayden Survey — Geological and Geographical Survey of the Territories

Ferdinand Hayden led his first survey in 1867. He did most of his work in New Mexico and Colorado, but his geologic mapping overlapped slightly into eastern Utah. He conducted subsequent surveys in Idaho, Montana, and most notably, the Yellowstone region. Some of these surveys also overlapped into northeastern Utah.

King Survey — A Geological Exploration of the Fortieth Parallel

In 1867, Clarence E. King was nearing the end of a mapping project for the California State Geological Survey. He reasoned that the U.S. Government needed to conduct a detailed geologic study of the corridor along the soon-to-be-completed railroad, and convinced Congress to fund the project. King and a team of surveyors, geologists, biologists, and support personnel started at the eastern California border and over the next several years mapped an 180-mile-wide corridor across Nevada, Utah, Wyoming, and northern Colorado. King, aided by geologists S.F. Emmons, Arnold Hague, and James D. Hague, and paleontologist F.B. Meeks (who also worked with the Hayden Survey), published seven topical monographs of several hundred pages each, and an atlas of several maps. Their geologic maps were at a scale of 1:253,440 (1 inch = 4 miles) and in Utah covered the area north of latitude 40° 13′ N. (a line approximately through Provo and Vernal).

Powell Survey — Geographical and Geological Surveys of the Rocky Mountain Region

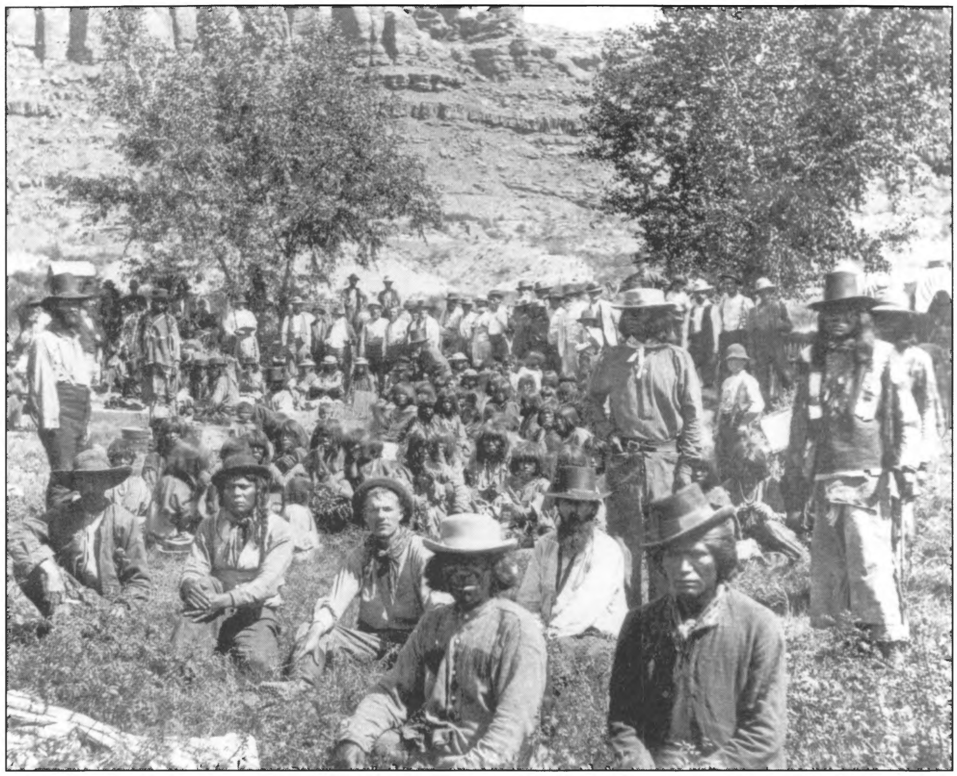
John Wesley Powell was the last of the civilian geologists to successfully solicit congressional funding for a geologic survey of the West. He had to settle for the harsh desert country ignored by the King and Hayden Surveys. Three publications from the Powell Survey were particularly significant to Utah geology: an 1877 report on the geology of the Henry Mountains by G.K. Gilbert, Powell's 1879 report on the lands of the arid regions of the United States, and C.E. Dutton's 1880 report on the geology of the high plateaus of Utah.

Wheeler Survey — Geographical Surveys west of the 100th Meridian

The Army Corps of Topographical Engineers responded with the most grandiose plan of all, a survey of U.S. territories west of the 100th meridian (central Nebraska). Its survey largely overlapped the other surveys, but it had slightly different goals because it was a military operation. Primarily, Wheeler intended to construct detailed topographic maps that focused on water, terrain, and other items of interest to military operations. His contingent included a large number of geologists, botanists, zoologists, and other scientists, but Wheeler had little patience and allowed little time for these civilian scientists, and as a result their scientific contributions suffered. However, the Wheeler Survey included one geologist of particular note, perhaps the most renowned geologist with Utah ties, G.K. Gilbert. Gilbert was an assistant during the early part of the Wheeler Survey and did much of the geologic mapping of southern Utah that was included in a portfolio of topographic and geologic maps. The geologic maps were published at a scale of 1:506,880 (1 inch = 8 miles) and covered the area south of latitude 40° 40′ N. (an east-west line through Salt Lake City) and west of longitude 111° 00′ W. (a north-south line through Price). Gilbert tired of working under Wheeler and later joined the Powell Survey.

U.S. Geological Survey

The three civilian survey leaders frequently returned to Washington and competed for funds. Adventures that enthralled the public and glossy colored map portfolios were the best means of gaining the attention of congressmen and loosening purse strings. Powell's famous trips down the Green and Colorado Rivers were as much publicity stunts as they were scientific studies. The Wheeler Survey didn't have to fight for funds, but it still competed for the congressional spotlight. By the late 1870s, jealousy and competition among the four surveys had reached the point that Congress decided to intervene. In 1879 it disbanded the four surveys and created the U.S. Geological Survey (USGS). The popular young geologist Clarence King was assigned to be first director. King resigned after two years, and was replaced by another geologist made famous by his western exploits, John Wesley Powell.



John W. Powell (standing to left, with empty sleeve) with Southern Paiutes near St. George, September 1873. The Kayenta (slope) and Navajo (upper ledge) Formations are in the background (from Smithsonian Institute, provided by U.S. Geological Survey photo library).

The new USGS completed and published most of the projects started by the three civilian surveys. However, it only completed a small part of the large portfolio of maps started by the Wheeler Survey, mostly because the Wheeler Survey was deeply resented for its better funding, military connection, and Wheeler's caustic personality. In Utah, the leading USGS geologist was G.K. Gilbert. Gilbert completed his study of the Henry Mountains begun years earlier during the Wheeler and Powell Surveys, and a landmark study of Lake Bonneville (USGS Monograph 1).

By the late 1800s mining was the great boom industry. Many major mining districts had been discovered, gold rushes were as common as spring showers, and speculation was rampant. Electricity was the modern wonder, and petroleum and coal were rapidly replacing wood and water as the energy sources of the industrial revolution. Thus, naturally, much of the early focus of the USGS in Utah was on petroleum, coal, and mineral resources. Geologic mapping was primarily in conjunction with economic research and most maps were centered around mining districts or potential oil fields.

Epilogue — Statehood to Present

The USGS was the major geologic mapping organization in Utah until the early 1980s, although the Utah Geological (and Mineralogical) Survey (UGS; formed in 1931), universities, the American Association of Petroleum Geologists, the Geological Society of America, and the Utah Geological Association (and its predecessors) also published some maps. In recent years, geologic mapping responsibilities have shifted to the UGS. The UGS Mapping Program has produced over 150 geologic maps in the past 13 years.

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A TRIBUTE TO UTAH MAPPERS

JAMES HALL

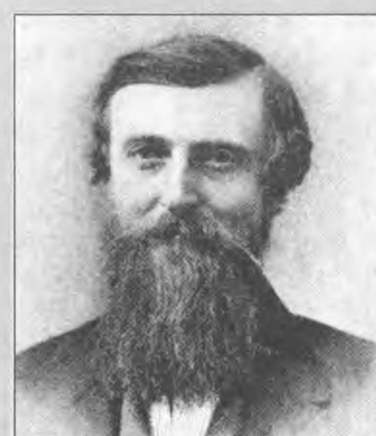
James Hall published the first descriptions of geologic features and rocks in Utah, and the second geologic map. He was born in Hingham, Massachusetts on September 12, 1811. The son of a mill operator, he spent his boyhood days exploring ponds and marshes. He excelled as a student and was accepted at prestigious Rensselaer College, where he was influenced by the prominent early American geologist Amos Eaton.

With his lifelong interest in nature, Hall quickly fell in love with paleontology. At that time fossils were the only way to date and correlate strata, and thus were the foundation of geologic studies. Hall scoured the formations of the east for fossils, and quickly gained recognition as one of the leading paleontologists in America. Every good geologist had his own collection, and Hall was determined to have the best. His insatiable desire to beg, borrow, trade for, or steal (some claimed) new specimens gained him many bitter critics.

Hall spent most of his career as the New York State Paleontologist, but he published on any new fossils that he could acquire. He invited western explorers to visit him so he could instruct them on the types of samples to collect and on how to describe the geology they saw. Hall described and illustrated fossils collected by one of these explorers, John C. Fremont, in an appendix to Fremont's 1845 report. Many of the specimens were from Utah, making this appendix the first scientific publication on Utah geology. Hall later tutored Howard Stansbury, who spent most of 1850 in Utah, and published a similar appendix in Stansbury's (1852) description of the Great Salt Lake Valley.

With Hall's background and reputation, it is not surprising that he sharply criticized the first geologic map to cover the United States from coast to coast, published by his bitter rival Jules Marcou, in 1855. Two years later, Hall published his own geologic map of the United States west of the Mississippi, which is commonly credited as the first geologic map of the west (Goetzmann, 1967). Hall's map is an improvement over Marcou's, but Hall had the benefit of working from Marcou's map.

Hall was certainly unique among American geologists. Of his brilliance and determination there was probably not an equal; and probably not of his temperament either. None dared to face him, including the legislators whom he cowed into funding his research year after year. It was a matter of great honor to have worked as an assistant under him, and to have lasted longer than someone else before being driven off by him. He often enforced his opinions with a shotgun, but at the same time was always quick to help a promising young geologist, even when he himself went unpaid. James Hall died in New York in 1898.



JULES MARCOU

Jules Marcou published the first geologic map of Utah in 1855. He was born April 20, 1824 in eastern France near the Jura Mountains. A bright, devoted student, he published three papers on mathematics before the age of 20. Due to poor health, he took frequent long walks in the country, where he developed an interest in fossils. Recognizing his interest, the family physician introduced him to the leading Swiss geologist of the day, Louis Agassiz. In 1845, with Agassiz's encouragement, Marcou published his first geologic work, on the geology of the Jura district of France. The excellence of this work brought him enough acclaim that he was appointed the Chair of Professor of Mineralogy at the Sorbonne in Paris, and then as Traveling Geologist.

Having few commitments, he visited many of the prominent American geologists of the day. Apparently, he clashed with James Hall almost from the first, who viewed him as arrogant and who thought that he flaunted his European geologic background. Marcou had a strong interest in geologic maps, and one of his first projects in America was to compile a geologic map of the United States and British provinces east of the 106th meridian (eastern Wyoming). This early map brought him much attention and an opportunity to join the early railroad surveys of the West. He accompanied the Whipple Survey, which followed the 35th parallel across central New Mexico and Arizona in 1853. He later claimed to be the first geologist to cross the continent with a government expedition.

After returning to Europe (following a dispute with the U.S. government over the ownership of his notes and collections), he added new information gained from his and other western railroad surveys to his earlier geologic map, creating a geologic map of the entire continental United States and its territories. He recognized the importance of being the first to publish a geologic map of the United States, and was determined to beat anyone else to press. Thus, he sought out a German geologic journal that published his map in 1855. This 1855 map is the oldest known geologic map of Utah. It was republished in a French journal in 1856, but with an 1855 date. He again published the map with a few minor corrections in 1858 in the United States (the version shown on the front cover).

Marcou's maps were severely criticized by American geologists. Particularly harsh were published reviews by geologists James D. Dana, James Hall, and W.P. Blake. With the resentment and criticism that existed, Marcou's return to the United States in 1860 is somewhat surprising. However, he joined Louis Agassiz, his early mentor, at Harvard University where he spent a long career. He published many articles on American geology and became embroiled in several other long-standing debates. In his later years he published works for the U.S. Geological Survey, including a catalog of maps of America from 1752 to 1881, which includes several of his own maps and accomplishments.

Survey News

Long-time UGS geologist **Hellmut Doelling** was honored for his extensive contributions to Utah geology. Watch for the dedication in the Utah Geological Association (UGA) Fall 1996 guidebook on the geology of the Paradox basin. The guidebook is sponsored jointly by the UGA, U.S. Bureau of Indian Affairs, Ute Mountain Ute Tribe, Four Corners Geological Society, Utah Geological Survey, U.S. Geological Survey, and Colorado Geological Survey.

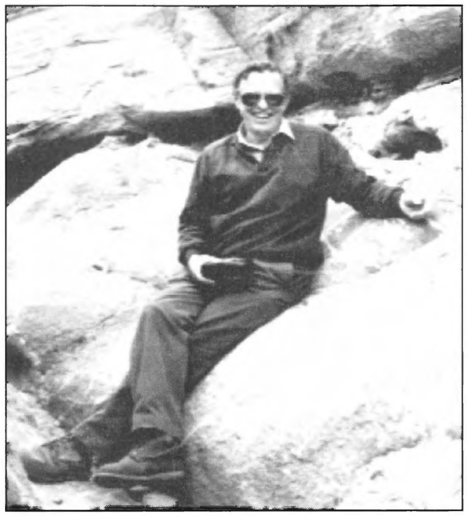
Cheryl Ostlund is the new Administrative Secretary in place of **Rosalyn Dechart** who retired in order to get away from us at last, and to finish her spring yard work (spring of 1992). Cheryl previously worked with Parks and Recreation, before that with Water Rights, and with Water Resources - a total of seventeen years with the Department of Natural Resources!

Roy Adams got back from Pakistan, and has since accepted a position at Energy and Geoscience Institute at the University of Utah Research Institute, but he still has to sift through that data.

Kimm Harty has accepted the position of Deputy Director for the UGS, replacing **Bill Lund** who is now the official representative for the UGS at the "southern branch" in Cedar City. He can be contacted at SURO, Southern Utah University, P.O. Box 9053, Cedar City UT 84720.

We said farewell to **Brigitte Hucka**, who planned to take care of her husband Vladimir, a long-time Professor with the College of Mines in the University of Utah. Sadly, he has just passed away. We hope you join with us in expressing our sympathy.

Noah Snyder worked several jobs while here, most recently in the ground-water group. He decided that a Ph.D. program at MIT may hold more opportunities and thus has said goodbye.



Hellmut Doelling examining Precambrian-Pennsylvanian unconformity in the Paradox basin.

Our newest geologic mapper is **Bob Biek**, who actually has already published with us (Map 137), and worked with the North Dakota Geological Survey; his last project was mapping the Teddy Roosevelt National Park.

Dar Day has worked a the Sample Library for so many years that he has become part of the curated collection. However, he just accepted a new job, one with no rock hauling, and will leave this month. Best of luck!

Sandy Eldredge, geologist with the UGS for more years than she likes to admit, has accepted the position of Program Manager for the Geologic Extension Services. Congratulations!

Ailan Lynch is the new secretary in the Mapping/Applied section replacing **Linda Lambert** who left us in September. Ailan just moved here from California where she worked for Caltrans.

Janae Wallace is logging core for the Ground-water group in Applied, and **Gabrielle Woodbury** is a newcomer to the Paleoecology section.

Cooperative Mapping Project in Zion National Park

The Utah Geological Survey (UGS) Mapping Program, the U.S. Geological Survey (USGS), and the National Park Service (NPS) recently reached an agreement to conduct detailed geologic mapping of the Zion National Park Resource Management Area. The project will focus on five quadrangles that include the southern part of the park, and will benefit federal, state, and local governments, and private land owners in the area. The UGS will provide 70 percent of the funding for the project and will be the lead mapping agency. The maps will be published in color by the UGS.

The maps will be digitized to fill a critical gap in the Park Service's Geographic Information System (GIS) database. GIS databases contain "layers" of information on important natural and cultural features of an area, and are essential to modern land-use planning and ecosystem management. Land managers can select any combination of layers on the computer screen to identify possible conflicts and make better decisions.

Grant Willis, UGS Mapping Program Manager, and Laird Naylor, Zion National Park research specialist, worked together to develop the project. UGS senior geologist Hellmut Doelling and Willis will do most of the field mapping. The USGS will contribute partially completed mapping by Ed Sable, a retired USGS geologist who spent most of his career mapping in southern Utah. Wayne Hamilton, former NPS and National Biological Survey geologist, and author of the current geologic map of Zion National Park, will also participate and will study sediments trapped in ancient lakes that formed behind landslide and lava dams in several canyons in the park.

The Rockhounder

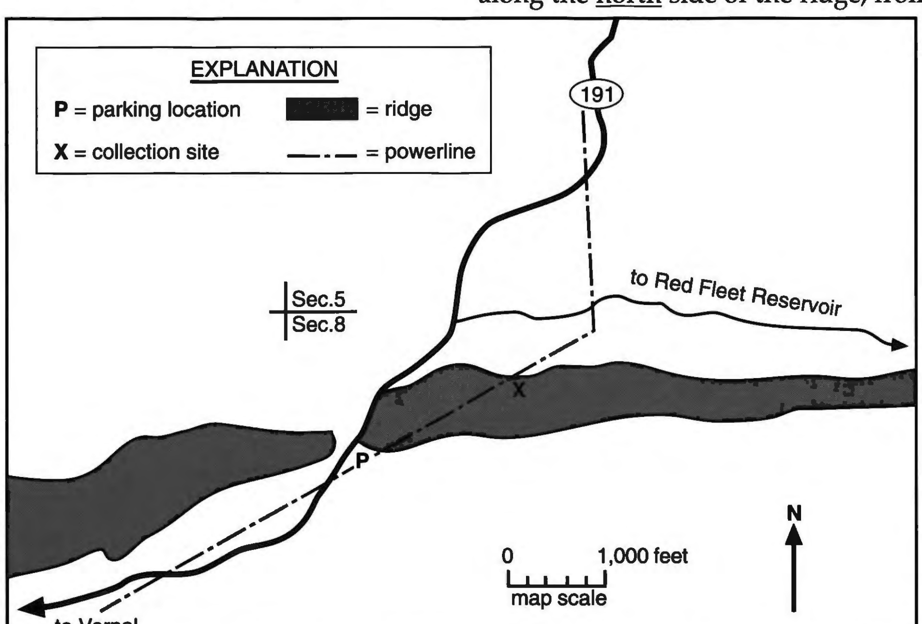
Belemnite Fossils near Vernal, Uintah County

by Kimm M. Harty

Paleontologic information: Belemnites (*Pachyteuthis densus*) are extinct squid-like creatures that belong to the cephalopod class of molluscs. Like modern-day squid and cuttlefish, the belemnite, an invertebrate (lacking a backbone), had an internal skeleton of calcium carbonate. It is this cigar-shaped skeleton that is preserved as a fossil. Belemnites lived in Utah about 160-165 million years ago, during the middle Jurassic Period, in a warm shallow sea that invaded much of eastern Utah. Like squid, belemnites moved about by drawing water into their bodies, then squirting it out jet-like, through a funnel. Belemnites were some of the first fossils discovered in Utah, and were first identified in Utah by John Wesley Powell in the late 1800s.

How to get there: From the intersection of U.S. Highways 40 and 191 (Main Street and Vernal Avenue) in Vernal, travel north on Highway 191 9.9 miles to a pull-off area on the east (right) side of the road. To find the pull-off easily, look for the pile of sand used in road maintenance about 100 feet before the blue and white sign that reads "Curtis Formation." Visible ahead and to the northeast is a partly vegetated, east-trending ridge composed of greenish-gray bedrock. Look overhead for the northeast-trending electric-transmission line that crosses the ridge. Walk east, along the <u>south</u> side of the ridge, to where the transmission poles cross the ridge top (about 1/4 mile). Be careful crossing beneath the barbed-wire fence that parallels the road at the pull-off.

Where and what to collect: Belemnites are scattered on the ground along the <u>north</u> side of the ridge, from



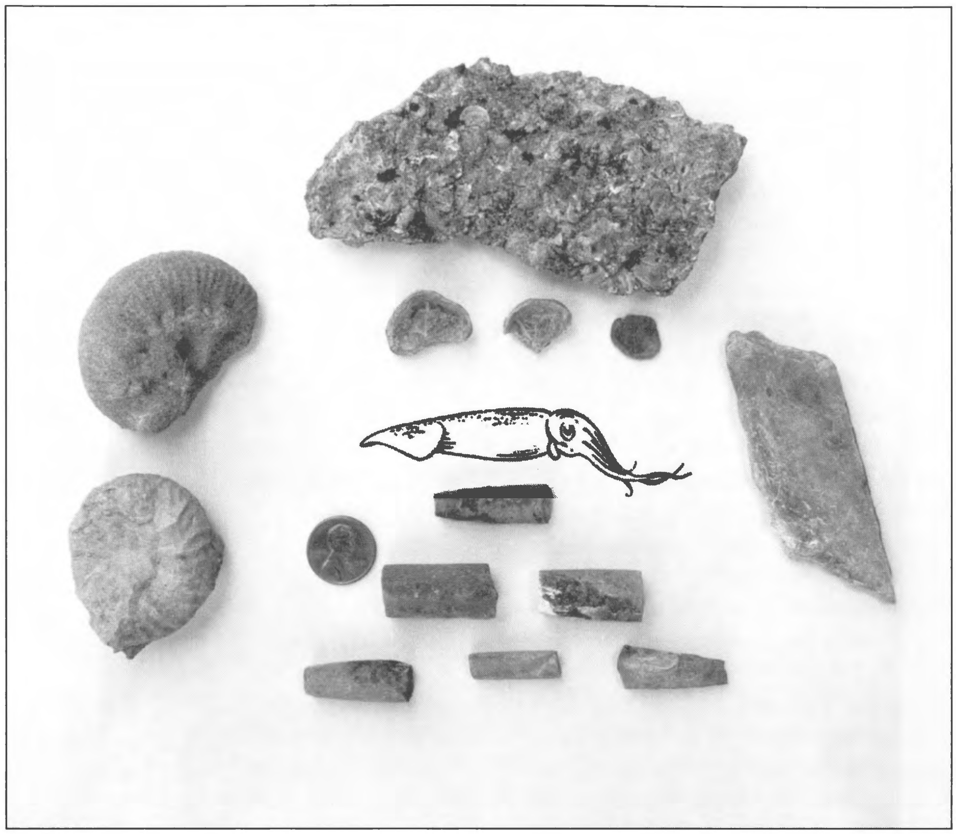
General location of fossil site.

about where the transmission line crosses the ridge, eastward about 1,000 feet. The ridge is composed of weathered shale, but at the collection site, look for thin slabs of gray and pink fossiliferous limestone containing small pink oyster shells. Belemnites are associated with this limestone layer, as are ammonoid fossils of the genus *Cardioceras*. Selenite gypsum crystals and crystal fragments also litter the ground.

Useful maps: Steinaker Reservoir and Donkey Flat 7.5' topographic maps and a Utah highway map. Topographic maps can be obtained from the Bookstore at the Department of Natural Resources building, 1594 W. North Temple, Salt Lake City, UT, (801) 537-3320.

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

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



Specimens found at the site, clockwise from top: fossiliferous limestone and small oyster shells; gypsum crystal; belemnite fossils (with tapered ends missing) and belemnite sketch; ammonoids - note the fine ridges (growth rings) on the shells. Penny for scale. Sketch modified from Hansen, W.R., 1969, The geologic story of the Uinta Mountains: U.S. Geological Survey Bulletin 1291, p. 92.

Miscellaneous: A hard hat and water are recommended. Be careful traversing the ridge, as some slopes are steep. Visit the site on a dry day; the weathered shale slopes are treacherous when wet. Do not collect on State Park land surrounding nearby Red Fleet Reservoir. Please carry out your

Director's Perspective

. . . continued from inside cover

federal and state law, school trust lands must be managed for the financial benefit of the school children of Utah. The School and Institutional Trust Lands Administration (SITLA) acts as the trustee for the children and the UGS serves as geologic advisors to SITLA. In his speech declaring the monument, the President promised to expedite the exchange of trust lands out of the monument for federal lands of comparable value elsewhere in the state or to pay the trust for those lands. The UGS is working to make information available to help ensure the school children and the citizens of Utah get fair compensation for the inholdings by undertaking a comprehensive inventory and assessment of their energy and mineral resources. In addition, the UGS will be evaluating federal lands elsewhere as potential exchange parcels.

More interest in the monument's potential resources was generated when Conoco Inc, in partnership with Rangeland Exploration, announced they had vast areas of the monument under lease for oil exploration and had planned to drill a number of wells within the next six months. Conoco identified 30 to 50 geologic targets holding perhaps as much as 3-5 billion barrels of oil. This exploration play most certainly is based on the Precambrian source rock concept studied and reported by the UGS for many years.

With geologic resources becoming a focus in the debate over the future of the monument and its inholdings, the UGS will continue to be thoroughly involved by providing the best scientific and technical data we can. It may prove to be a monumental job.

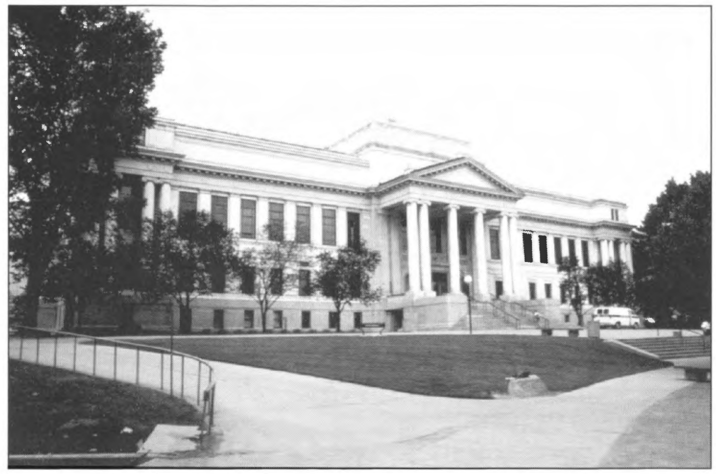
"Glad You Asked"

by Rebecca Hylland

Utah's Stone Building Heritage

"Where did the stone used to construct some of Utah's older buildings come from?" This was a question recently prompted by the state's Centennial activities. Almost all of the stone buildings in Utah built before the turn of the century were constructed from local stone. Typically, the first buildings constructed at town sites were homes and out buildings. As communities grew, municipal, commercial, and church buildings were built. The use of stone as construction material in Utah varied among communities because some towns lacked a nearby source of suitable building material and could not economically import stone from other localities. Other towns had the rock resources, but lacked people with stonemason skills. In both cases, rough field stone (backyard cobbles), wood, or brick and/or adobe were used to construct buildings. In communities that had available stone and a local stonemason, buildings of quarried stone are abundant.

One area that had suitable building stone and stonemasons to quarry it is Sanpete County. Stonemasons of Manti, Ephraim, and Spring City utilized an oolitic limestone to construct many of the local church and government buildings. Outcrops of this white limestone can be seen in the hills and low ridges of the Sanpete Valley. Quarries were located northeast of the town of Ephraim and northeast of the Latter-day Saint (LDS) Temple in Manti. Some of the buildings constructed with the oolitic limestone are the Manti Courthouse, the LDS Manti Temple, Ephraim City Hall, and the Spring City Meeting House. Farther north, this limestone was also used to construct the Maeser Memorial Building at Brigham Young University in Provo, and in Salt Lake City, the Kearns Residence (the Governor's Mansion) and the Park Building on the University of Utah campus.



The Park building located on the University of Utah campus is made of white oolitic limestone from Sanpete County (photo by Bryce Tripp).

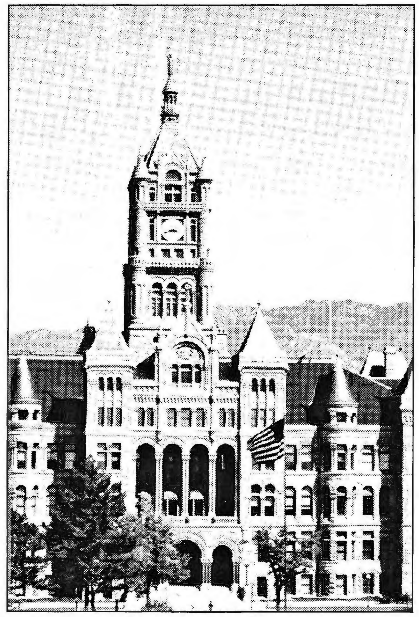
Several turn-of-the-century homes and the city hall in Midway, Wasatch County, were built with stone locally called pot rock. The geologic name for pot rock is tufa, composed of either calcium carbonate or silica that precipitates from spring water. The tufa in Midway was easily quarried from active and inactive hot-spring (hot-pot) deposits by using picks, axes, crow bars, and plows, and by blasting with explosives. Tufa is soluble in water and softens when used for basements and foundations where moisture is present, and therefore is poor for use in underground construction. Tufa was also used in a few homes in Pleasant Grove, Utah County, where it was called soft rock.

Willard, Box Elder County, showcases several homes made of field, or rubble stone. Most of the older homes (early 1850s to mid-1880s) were built with the stone found on or near the construction site. The source of these stones is granite, gneiss, schist, quartzite, and silicious limestone bedrock weathered out of Willard Canyon. One unique field-stone home in Willard is the Joseph Nicholas house. Constructed in the late 1850s, the holes used to support the scaffolding used during construction were never filled with mortar and are visible in the walls. Two other notable houses are the Robert Bell Baird and the Mason homes. The former is a field-stone house that was built in the early 1880s. A structural feature that sets this home apart from others is not the masonry, but the musical notes that are carved into the barge boards under the eaves (Robert Bell Baird was a local musician). The Mason Home is an 11-room house and is reportedly the largest stone home in Willard. It was built in 1860 from granite quarried near the mouth of Willard Canyon.

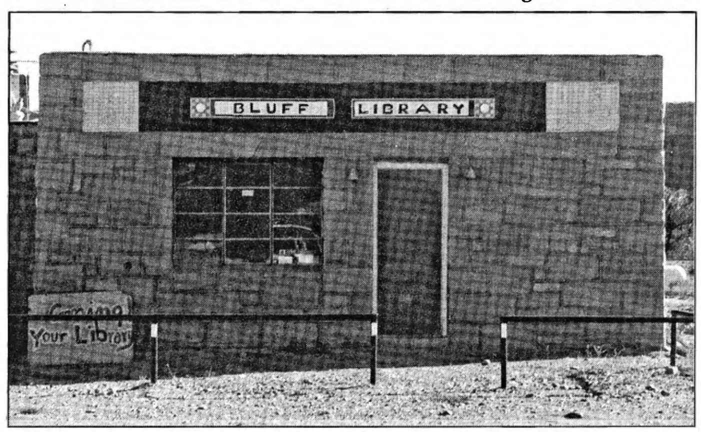
Many of the stone houses in Beaver, Beaver County, are constructed from local basalt and tuff. A majority of the basalt homes were constructed of field stone collected from dry stream beds and hillsides. Fort Cameron, built on the east side of Beaver in the early 1860s was constructed from basalt reportedly quarried in the eastern foothills. One building, believed to have been the laundress quarters, is all that remains of the fort today. Other buildings that are made of basalt are the Beaver Woolen Mills building, the Co-op store, and the Thomas Fraser home, all built in the early 1870s. Tuff became the dominant building stone in Beaver during the 1880s because it was lighter in weight and easier to shape than basalt. Basalt was still used for foundations and basements because it is less permeable than tuff. If you have an opportunity to visit Beaver, notice that most of the tuff houses are located on the east side of town, while the majority of basalt buildings stand west of Main Street. Could this be because the area west of Main Street is the older part of town?

In Bluff, San Juan County, sandstone was commonly used for building construction. Several sandstone homes are visible along the main road through town. The sandstone was quarried and gathered from the cliffs north of Bluff. This building stone was reported to be the Navajo Sandstone, but is most likely the Bluff Sandstone Member of the Morrison Formation, which is the uppermost rock unit in the cliffs surrounding the town. The Bluff Sandstone is slightly softer than other Utah sandstones, which may be a contributing factor in a number of stone buildings that have collapsed in this community during the past 100 years.

Salt Lake City has innumerable stone buildings. Much of the locally quarried stone came from Red Butte Canyon near Fort Douglas, Emigration Canyon, and Little Cottonwood Canyon. Red rock quarried from Red Butte and Emigration Canyons is the Nugget Sandstone, which was used to build many of the homes in Salt Lake City's older neighborhoods. It was also used to construct foundations and is visible in the Avenues, Fort Douglas, and in many homes east of Salt Lake City's central downtown area. Granite was the rock-type quarried from Little Cottonwood Canyon. Buildings constructed from this black- and white-speckled granite are the Salt Lake LDS Temple built in 1894, and the State Capitol completed in 1913. An example of a structure made of non-local stone is the Salt Lake City and County Building. The gray sandstone blocks used to construct this building were quarried in southeastern Utah County, near the town of Kyune.



Built in 1894, the Salt Lake City and County Building was constructed from sandstone quarried near Kyune, Utah (photo by Bryce Tripp).



The Bluff library, formerly the county jail, was constructed with hand-hewn sandstone blocks (photo by Sandra Eldredge).

Many Utah communities have stone buildings (too many to mention in a brief article). If you are interested in further reading, the references below should provide a place to begin your studies. Other information can be obtained through the Division of State History's library and the libraries of the University of Utah, Brigham Young University, and Utah State University.

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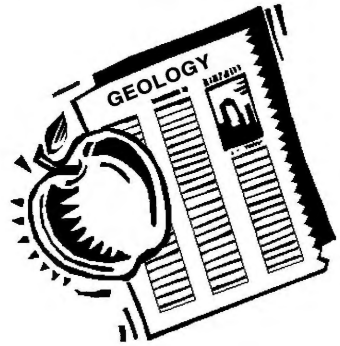

Teacher's Corner

By Bill Case

Mineral-identification Software Reviews

Note: The following reviews of Mineral Mastery (TM) and Gemstone (TM) are not intended to imply endorsement of the software by the Utah Geological Survey. The reviews are presented as information that may be useful to teachers.

Do you sometimes need answers to the following questions?

- What minerals contain gold or silver - or both?
- What does a graph of the specific gravity of metallic minerals look like?
- Which minerals have a blue streak?
- What is the relative rarity of opal?
- What is the hardness range of isometric minerals?
- How do I teach students to use a physical-property key to identify minerals?

These and other questions can be answered using the mineral-identification inquiry database MINERAL MASTERY from DataWave Software. Tom Gleason, DataWave Software(TM), has written this user-friendly program that identifies minerals using physical properties and chemical composition. The program contains a database of over 200 minerals. A "lesson" facility allows teachers to write "word problems", which students solve to identify minerals. Teachers can design lessons that give hints used to identify minerals. The program also includes an online glossary of mineralogic terms. Teachers can add minerals to the database and mineralogic terms and their definitions to the glossary using a dBASE(TM) compatible database manager.

MINERAL MASTERY is a DOS program requiring 512KB of RAM and 1.1MB of storage space; the program can be run from a floppy disk. Although it is a DOS program, Tom Gleason, the designer, claims it runs better through Windows 3.x. A 35-page instruction document, demonstration inquiry, sample lesson, various examples of mineral identification procedures, and registration form are provided with the program. Registration for the software is $1.00, payable to Tom Gleason, DataWave Software. The software can be downloaded from the UGS Teacher's Corner home page, **http://utstdpwww.state.ut.us/~ugs/tcorner.htm**, or, from the UGS Bookstore conference, #32 on the Utah State Bulletin Board at 801-538-3383. Once downloaded, the file, MINMAST.EXE, can be self-extracted into a directory that has at least 1.1MB available, by typing MINMAST.

If you want to answer questions like:

- How can I tell the difference between diamond and glass?
- What are the physical properties of synthetic gems?
- How do I judge the quality of pearls or diamonds?
- What does an Elbaite crystal look like?
- Is JET an airplane or a gem?
- What gems are black?

Connect to **http://www.xs4all.nl/~mineral/software.html** to get information and download GEMSTONE, a shareware program designed by Robert J. Williams, certified gemologist. GEMSTONE has a database of physical properties of synthetic and natural gems including fluorescence, refractive index, specific gravity, and hardness. The program also has gem-identification keys and a discussion about determining the quality of gems, emphasizing diamonds and pearls. According to Mr. Williams, GEMSTONE will be of use to "...jewelers, antique dealers, collectors, in vestors, hobbyist, rock hounds, and students [and teachers]." This DOS program is very user-friendly. The registered version of GEMSTONE is $19.95.

Other World Wide Web sites that have information about minerals, crystals, and gems are:

http://www.unige.ch/crystal/w3vlc/edu.index.html (Crystallography World Wide - Teaching and Education)

http://www.xs4all.nl/~mineral/chem.html (Chemistry and Crystallography)

http://www.mcli.dist.maricopa.edu/aaim/linear/L0.html (Testing Hardness of a Mineral)

http://cc.weber.edu/~czacher/rocks.html (Making Artificial Crystals)

http://www.demon.co.uk:8/bltpub/Geog/Minerals/demo.html (multimedia minerals CD-ROM demo)

http://geology.wisc.edu/ (online geology courses including Principles of Mineralogy that has an exercise, and The WWW and Mineralogy, that

New Publications of the UGS

Geologic map of the Dewey quadrangle, Grand County, Utah by H.H. Doelling, 20 p., 2 pl., 1:24,000, 1996, M-169 . . . . **$7.25**

Radon-hazard potential of the central Sevier Valley, Sevier County, Utah, by B.J. Solomon, 48 p., SS-89 . . . . . **$5.50**

Utah mineral activity summary for 1995, by R.L. Bon, R.W. Gloyn, and D.E. Tabet, 15 p., 1996, C-91 . . . . **$4.60**

Geologic map of the Logan 7.5' quadrangle, Cache County, Utah by J.P. Evans, J.P. McCalpin, and D.C. Holmes, 16 p., 2 pl., 1:24,000, 1996, MP-96-1 . . . . **$6.80**

Outcrop study of the lower Green River Formation for reservoir characterization and hydrocarbon production enhancement in the Altamont-Bluebell field, Uinta Basin, Utah, by A. Garner and T.H. Morris, 61 p., 1996, MP-96-2 . . . . **$6.00**

Total thickness of coal in the John Henry Member of the Straight Cliffs Formation, Kaiparowits coal field, Utah, by R.E. Blackett, 1 page, 1"=6.4 miles, 5/96, PI-37 **Free**

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And from the *Utah Geological Association*, the latest guidebooks, Environmental & engineering geology of the Wasatch Front region, W.R. Lund, editor, 541 p., 1995, UGA-24 at **$40.00**, and Geology and resources of the Paradox Basin, A.C. Huffman, Jr., W.R. Lund, and L.H. Godwin, editors, 460 p., 1996, UGA-25 at **$45.00.**

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UGS Board visits Ferron dinosaur excavation

On Friday July 12, 1996, the Utah Geological Survey Board, along with friends and family members, visited the site of a dinosaur excavation conducted by Utah State Paleontologist, Dr. David D. Gillette. With the assistance of volunteers from the Utah Friends of Paleontology (UFOP), Gillette led tours of the site, which is located in the San Rafael Swell near Ferron, Utah, in the Salt Wash Member of the Morrison Formation. It contains the articulated skeleton of a theropod dinosaur, possibly *Allosaurus*. The visitors each had an opportunity to use air scribes (miniature air chisels) to remove the rock matrix and expose the bones. Lunch was served in the 100° heat and included lots of water and cold drinks. Channel 4 News was also on hand to do a story, which was aired nationwide over the weekend on local ABC affiliates.

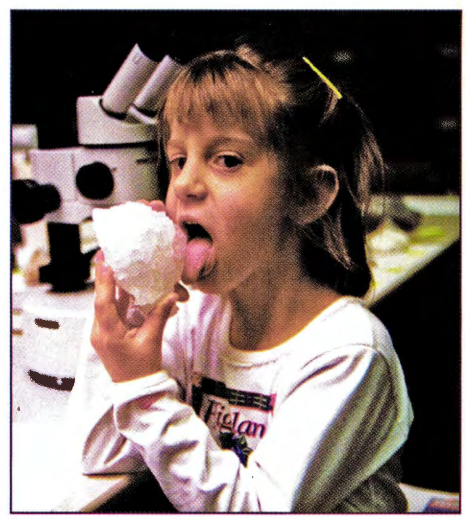
The Paleontology Program has been part of the Utah Geological Survey for less than two years, so this field trip provided an excellent opportunity for the UGS Board to get a hands-on examination of the program and see the benefits of a project like this in terms of education and scientific value.

State Paleontologist, Dave Gillette, demonstrating field techniques used to expose vertebrae. Photo by Sarah George.

"Take our children to work day"

On April 25th, our office was invaded by the little people. Actually, half were not so little, and a few even did some work assisting their parent. Seventeen of these potential future geologists and paleontologists visited us throughout the day and were treated to activities with each UGS program. From painting fossil casts, using 3D glasses to see neat map relief, viewing crystals through a microscope, watching debris flow videos, and identifying rocks and minerals, they had fun.

Matt and Derek Clarke, assisted by Bob Gloyn, checking out the microscope.



April Ashland - a true geologist identifying a mineral.

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