UTAH GEOLOGICAL SURVEY

SURVEY NOTES

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Old Harrisburg Town Site

Washington County

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Design by Vicky Clarke

Cover photo: The old Harrisburg town site, with the Pine Valley Mountains in the distance, Washington County, Utah. Photo by Bob Biek.

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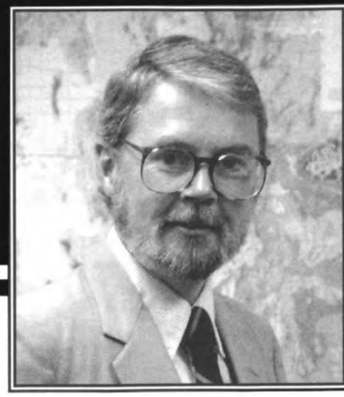

The Director's Perspective

by M. Lee Allison

National Park Service Goes Geologic

Recently, while driving back to Salt Lake City from Denver, I stopped in at Dinosaur National Monument, one of the geologic wonders of the region. Between the visitor's center and the quarry is a spectacular, nearly vertical layer of sandstone with prominent ripple marks. Expecting the sign at the base of the outcrop to describe this geologic feature, I was surprised to find instead that it referred to a few small desert plants near the path. Where was the discussion of the incredible geology for which this area was originally set aside?

Think of the jewels of the national parks in Utah - Zion, Arches, Canyonlands, Bryce Canyon, Dinosaur and so on - and what do you see? Spectacular red and white cliffs and canyons, arches, towering spires, rugged mesas, and other fantastic geologic forms and scenery.

Utah has 12 units in the national park system administered by the National Park Service (not including the Grand Staircase-Escalante National Monument which is run by the Bureau of Land Management). Most of these park units were established principally for their geologic features. So wouldn't you expect that many of the park rangers would be geologists and that park managers would focus a lot of their efforts on geologic issues? In general, that is not the case.

You will be hard pressed to find a geologist not only in Utah's national parks but in any park unit in the country. There are at most about 35 geologists in the national park system and some of those are not doing geology but collecting entrance fees or the like, or regulating pre-existing mines and oil wells. Contrast that with over 900 biologists in the park system and you can easily see why individual parks focus on plants, animals, and biodiversity rather than the rocks, fossils, and minerals.

The Park Service is recognizing this bias and two years ago established the Geologic Resources Division (GRD), based in Denver, to coordinate and promote the role and use of geology in park management and in interpretive services for visitors. We at the Utah Geological Survey are enthusiastic about this new focus and are leading the country in developing cooperative efforts with the NPS.

One of the first projects of the GRD is a cooperative effort with the Utah Geological Survey to geologically map Zion National Park at a scale of 1:24,000. You may recall that Zion closed twice in the past five years due to landslides blocking the main road to, and in, the park. Existing maps are generalized, omit surficial units, and do not identify critical units that are susceptible to geologic hazards such as landslides. New, detailed geologic maps will specifically address these concerns. The UGS previously published geologic maps for Arches and Capitol Reef National Parks. A digital geologic map currently underway for the Grand Staircase-Escalante National Monument, is expected to be completed in June 1998.

In Cedar Breaks National Monument, UGS's Dr. David Madsen is literally

Continued on page 6 . . . .

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Geologic Mapping Marches Forward

by Grant C. Willis

Mapping Program Goals and Accomplishments

The Utah Geological Survey (UGS) Mapping Program has now been in place for almost 15 years. We have emphasized two map series, detailed maps of 1:24,000-scale, 7.5-minute quadrangles, and intermediate-detail maps of counties at 1:100,000 scale. During this time, we have published and open-filed over 145 quadrangle maps (most in color) authored by UGS, U.S. Geological Survey (USGS), and other mappers (figure 1); two county maps; and several special maps.

In the past few years the Mapping Program has shifted its emphasis slightly. The 7.5-minute quadrangle mapping effort continues with only minor changes (see related article on mapping Utah's Dixie). The major changes are in the 1:100,000-scale mapping effort. These maps are now based on 30x60-minute quadrangle boundaries rather than on county boundaries (figure 2), and will be released as printed and digital maps for use in Geographic Information System databases. The maps will be compiled from existing sources to the extent possible. In contrast, county maps were accompanied by detailed comprehensive bulletins, were based primarily on new field mapping, and required one to three geologists up to 10 years to complete. This change will allow us to complete the state in the next 13 years instead of 50 or more years. We will delay producing bulletins until all of the state is mapped, although we will archive useful information collected during quadrangle mapping. County maps to accompany the bulletins will be easy to derive from the digital quadrangle maps.

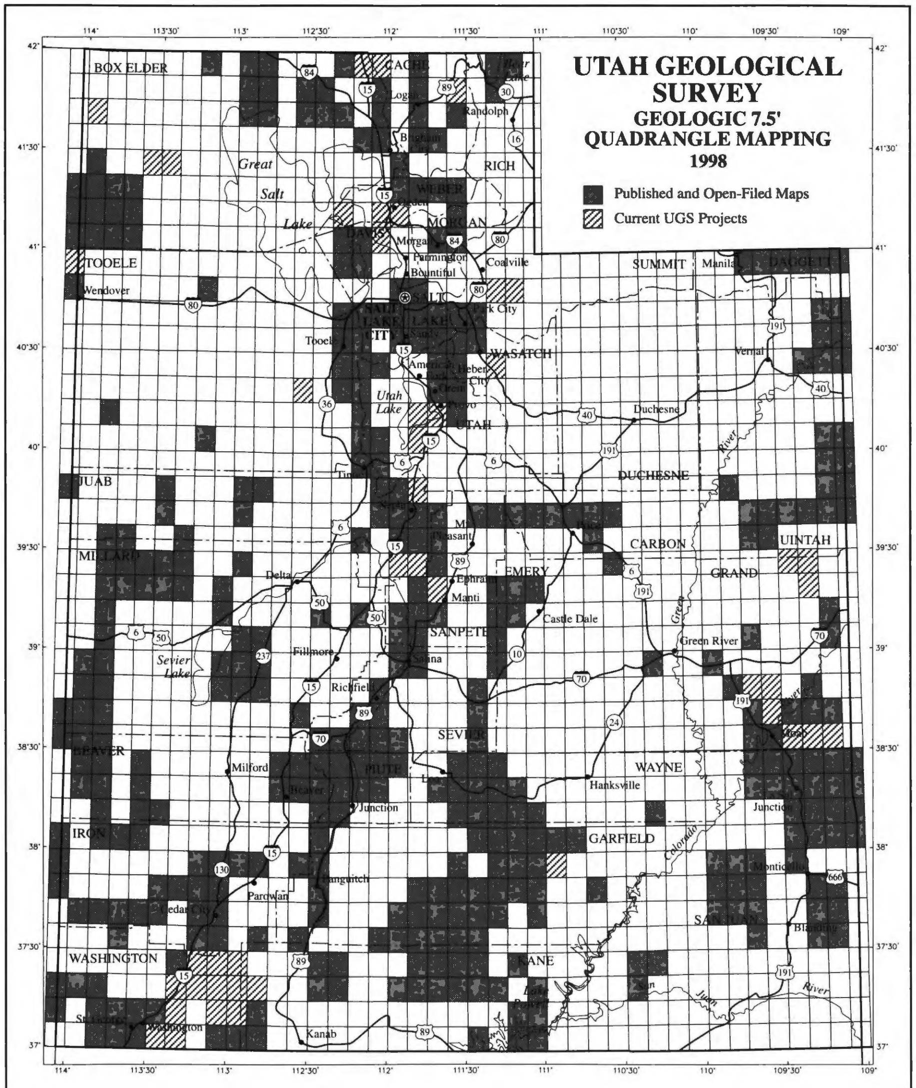


Figure 1. Published, open-filed, and in-progress geologic maps of 7.5-minute quadrangles in Utah. Over 410 quadrangles are completed. The UGS Mapping Program has published or open-filed 145 new quadrangle maps in the past 15 years. Many additional mapping projects are in progress.

GIS Maps

Two years ago the Mapping Program began work on digital geologic maps

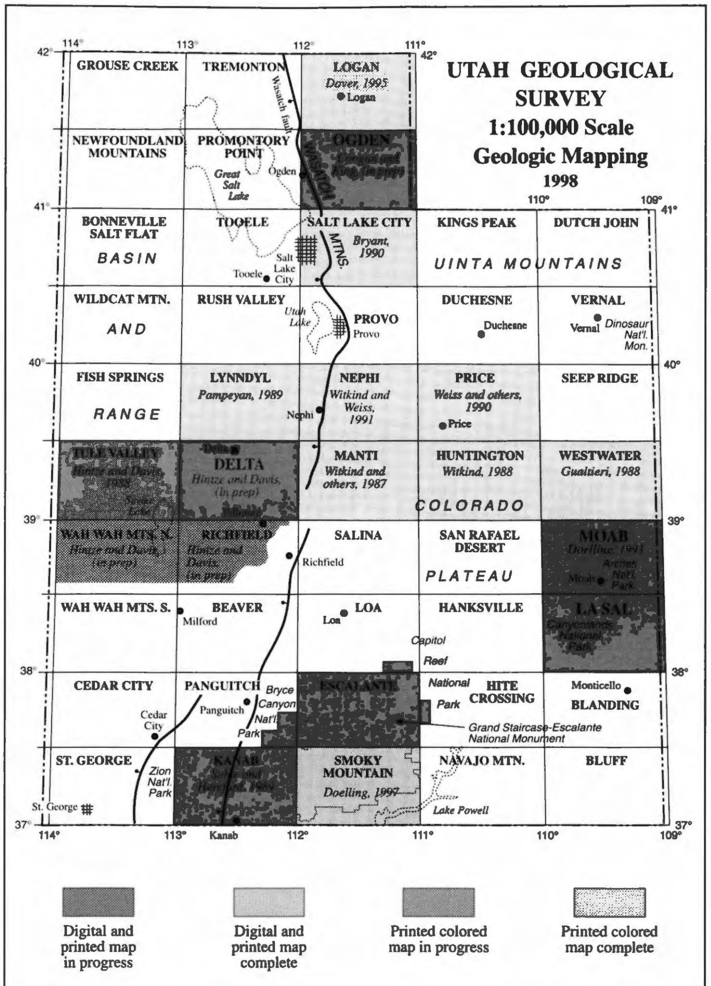


Figure 2. Completed and in-progress printed and digital geologic maps of 1:100,000-scale, 30x60-minute quadrangles in Utah. Authors and publication dates are shown for completed maps.

for use in Geographic Information Systems (GIS), and has now completed two digital maps. GIS have become the basic tool for federal, state, and local government land managers, exploration companies, utilities, and other entities with an interest in geographic features. Information managers were dismayed to learn that virtually no geologic maps were available in digital format. To meet this need and to assure that geologic hazards, resources, and other features are considered in land-management decisions, the UGS is rapidly producing GIS versions of geologic maps. We plan to produce GIS geologic maps of all 46 of the 30x60-minute quadrangles that cover Utah at 1:100,000 scale over the next 13 years.

We are also working on 1:24,000-scale GIS geologic maps of the greater Zion National Park area and on a cooperative project with Washington County and the local cities to produce detailed 1:24,000-scale GIS geologic maps of the rapid-growth areas in the St. George basin.

Digital Maps Have Arrived!

Geologic Map of Utah

The UGS is about to release the long-anticipated 1:500,000-scale Geologic Map of Utah in GIS format. This map is needed by many government and private organizations. Though the scale is small, it provides the first complete GIS coverage of the state. As each of the 30x60-minute quadrangles are completed, these more detailed 1:100,000-scale maps will supersede the state map for most uses.

The GIS version of the Geologic Map of Utah was produced through a cooperative funding arrangement with the USGS Economic Resources Division, and with the support of the Utah Automated Geographic Reference Center. To produce the map, film plates with geologic contacts, faults, and open-water boundaries were scanned by Optronics Specialty Company of Northridge, California on a high-speed drum scanner, producing a high-precision digital file while avoiding the tedious and error-prone hand-digitizing process. Processing software was then used to: (1) clean up the scanned image (scanned maps always have some extraneous clutter that must be removed), and turn the lines into vectors that can be used in GIS and (2) close, attribute, and fill all the polygons using ARC/Info® software. Attributing polygons (identifying and labeling map areas bounded by contacts or faults) is a tedious, labor-intensive process since every polygon on the map (many of them smaller than a BB) must be identified by comparing colors on the paper map against the map key. Polygons that are too small to identify with full confidence must be researched from original sources in map archives. The UGS Mapping Program is working closely with Optronics to review the work and to accurately attribute the map. The UGS and USGS plan to release the digital map in 1998.

Grand Staircase-Escalante National Monument

The UGS recently finished its first 30x60-minute quadrangle digital geologic map, the Smoky Mountain quadrangle of Kane County, Utah and Coconino County, Arizona, which covers much of the southern part of the Grand Staircase-Escalante National Monument. Digital maps of the Kanab, Escalante, and small parts of adjacent 30x60 quadrangles covering the remainder of the monument are in progress and will be completed in June 1998. The Smoky Mountain quadrangle was hand-digitized mostly from the Geologic Map of Kane County, Utah (UGS Bulletin 124 authored by Hellmut Doelling and Fitzhugh Davis).

Contributors to Geologic Mapping in Utah

Malcolm P. Weiss

by Robert F. Biek

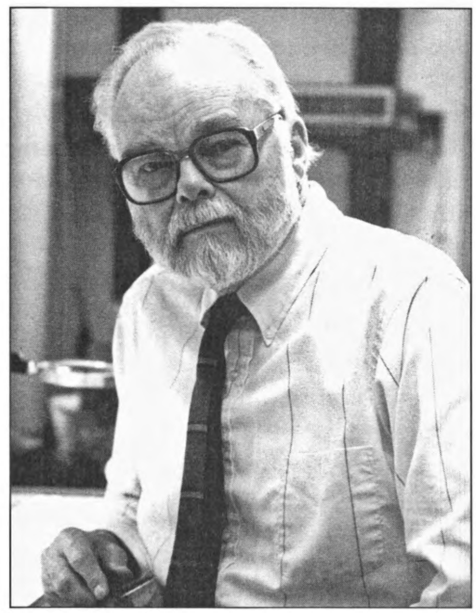
The Utah Geological Survey periodically recognizes a geologist who has made exceptional contributions to the geologic mapping of Utah. In this issue, we recognize Malcolm P. Weiss, whose geologic mapping and research interests in central Utah date back to 1953.

It is difficult to know where to begin, for Mac's career spans 45 years and he continues to publish scholarly papers. Among Utah geologists, Mac is perhaps best known for his geologic mapping and stratigraphic studies on the Gunnison Plateau (San Pitch Mountains) and nearby areas. His career, however, encompasses a much wider realm, with research interests that involve Ordovician stratigraphy, carbonate petrology, modern carbonate environments, and the history of geology, in addition to the geology of central Utah.

The Midwest Connection

Malcolm P. (Mac) Weiss was born June 28, 1921, in Washington D.C., the oldest of three children. His father was a plant pathologist with the U.S. Department of Agriculture. His mother was a modern woman for her time in that she drove a car early on, liked organizations, and was not keen on housework or cooking. She instilled in him an appreciation for the sights and history of our nation's capitol. Mac entered the University of Minnesota at age 17, although without a clear choice of majors. At one point he took an occupational aptitude test that scored some 32 vocations; personnel management was at the top, natural science second, and religion last. His father urged him into the business school, which he enjoyed, but what he really studied hard was ROTC, which may well have saved his life in WWII. Mac was commissioned a 2nd Lieutenant in the Coast Artillery (AA) in June of 1942 and was reassigned in 1944 to the 1252d Engineer (Combat) Battalion. He was shipped to France and the front on Christmas eve 1944; that following May, V-E Day found him and his platoon on the Austria-Czech border. After the war, he was assigned to the Chief of Engineers Office in Washington D.C., where he eventually made Captain. He retired from the Army in 1947, and with a wife, Ruth Havens Penny, and two kids went back to Minnesota.

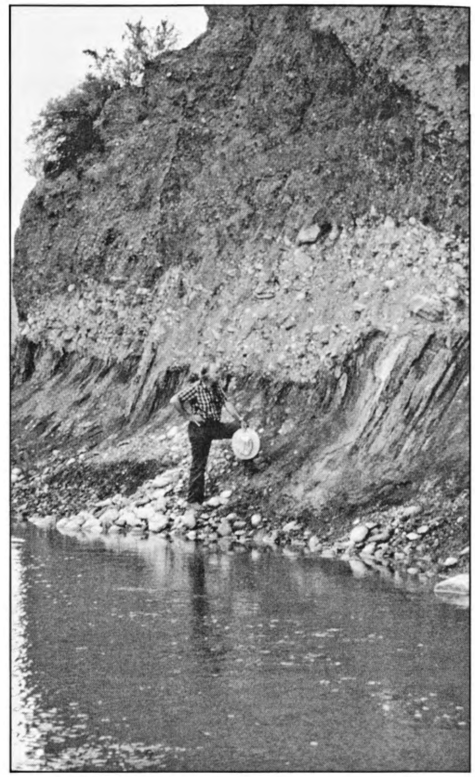
As was true of thousands of others, his family and the war experiences focused his attention marvelously and he finished his bachelor's degree in business administration in 1947. Just for fun, he took the occupational aptitude test again, and this time natural science was at the top, and business near the bottom, next to religion. As a child, Mac spent many hot days in fields of ornamental plants while his father talked about diseases and sprays with the owners, and he vowed never to go into such a hot,



Mac Weiss, 1989, in his office at Northern Illinois University. Among Utah geologists, Mac is perhaps best known for his geologic mapping and stratigraphic studies on the Gunnison Plateau and nearby areas.

buggy vocation as plant pathology - so he chose geology instead! Mac's major professor asked if he had a nickname, because Malcolm was too hard to spell and too fancy to speak. He had three - in a high school Unitarian youth group, in college, and in the army - but wouldn't say what they were, so Charlie Bell said, "How about 'Mac'?" and he has enjoyed the name ever since. Mac earned his masters and doctorate degrees in geology (both with zoology and botany minors) in 1950 and 1953, respectively,

Mac's 1967 OSU field camp class on the western rim of the Wasatch Plateau, looking north to Sanpete Valley.



Steeply dipping Twist Gulch strata, overlain by Quaternary gravels, exposed along the San Pitch River below the Gunnison Reservoir. Photo by Steve Mattox, 1987.

from the University of Minnesota. His fondness for limestones got a serious start with his dissertation on the stratigraphy and stratigraphic paleontology of the Upper Middle Ordovician rocks in southeastern Minnesota.

Mac joined the faculty at Ohio State University in 1952, where he started out as a stratigraphic paleontologist and helped revise the stratigraphic classification of the type Cincinnatian (Upper Ordovician) of the Ohio River Valley. OSU, however, had an abundance of tenured paleontologists, so he refocused his career and evolved into a sedimentary petrologist. Carbonate rocks became his speciality, and when oil companies "discovered" carbonate reservoirs in the 1960s, he and his diving buddy, Gray Multer (Fairleigh Dickinson University, St. Croix), taught a series of six National Science Foundation-funded short courses on carbonates in Florida and the Bahamas. That experience led to fieldwork and geologic mapping on fossil and modern reefs in Venezuela and Antigua, teaching on St. Croix, and field trips to, as he says, "other reefy sites."

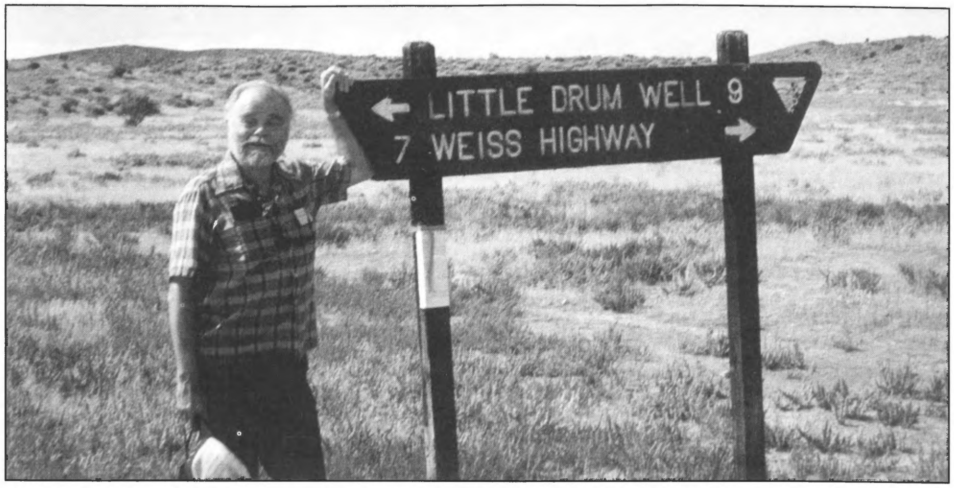
Mac has always enjoyed fieldwork and teaching. In fact, he has been extensively involved in teaching field geology since 1953, when he spent his first summer in central Utah at the OSU Field Station in Ephraim. He was one of three or four junior staff assigned rotating field camp tours with his mentor and then Field Station Director, Edmund M. Spieker. Ruth and their children, now four in number, spent many summers with him in Sanpete County. After Spieker's retirement in 1965, Mac became Director of the Field Station in 1966 and 1967. In the 1967 OSU Alumni Newsletter, Mac noted that one highlight of the 1966 and 1967 field seasons was a class flight over southwestern Utah and the Grand Canyon. The loss of a plane table, later used by small boys in Moroni for home plate, set a limit at the other end of the scale. In all, Mac taught 306 students over 10 seasons at the OSU Field Station from 1953 to 1983. Mac's tenure as Director was cut short, however, when in 1967, he was appointed Professor and Chairman of the newly formed Department of Geology at Northern Illinois University (NIU). He held the Chair through 1972, overseeing a 1.65-million-dollar renovation of the department building and development of the undergraduate curriculum, including a summer field camp, which was originally held in central Utah in conjunction with the OSU camp. Mac retired in 1988, but continued to work on central Utah projects and a geologic map of Antigua. In 1994, he moved to Santa Barbara, California, where he is now Adjunct Professor of Geology at the University of California.

Along the way, Mac co-authored seven geologic maps along the Ohio-Kentucky border as part of the U.S. Geological Survey program to map the entire state of Kentucky at a scale of 1:24,000. He was Chairman of the North American Commission on Stratigraphic Nomenclature from 1978 to 1982. He has published extensively on the Ordovician, carbonate petrology, and both ancient and modern carbonate environments. He also wrote two laboratory manuals for physical geology and topographic maps, countless reviews of textbooks and other articles, and, with colleague and friend the late Robert L. Bates, nurtured an abiding interest in the English language. With all of these other interests, it is no small feat that Mac spent as much time in central Utah as he did.

Mapping and Stratigraphic Studies in Central Utah

Mac's early years in central Utah were devoted to the OSU and NIU summer field camps. Through E.M. Spieker, he became interested in the Late Cretaceous to Early Tertiary stratigraphy of central Utah, especially the lacustrine units. His first research in Utah involved stratigraphic and petrographic work on the Flagstaff Limestone, but much of that work was postponed given the demands of starting a new department on the plains west of Chicago. Nevertheless, he produced his first Utah map in 1965, a 1:250,000-scale map showing the distribution of the Flagstaff and related formations, and in 1967 saw his first master's student working in Utah complete his thesis on the stratigraphy of the Flagstaff Formation in southeastern Utah County.

It wasn't until the mid-1970s, after his Ohio Valley work was completed, that Mac dove headlong into central Utah geology. He contracted with the U.S. Geological Survey (USGS) to help map the Price 1° x 2° quadrangle, including the heart of the OSU Field Station territory he had come to know so well. By the time work started in 1977, the plan had changed because of the region's involvement in the USGS Coal Exploratory Program. The maps would be compiled at 1:24,000 and published at 1:100,000, using the new 30' x 60' quadrangle metric topographic maps for a base. Mac co-authored the Manti 30' x 60' geologic map, which was published in 1987 with USGS geologists Irving Witkind and Terrence Brown; he was lead author on the Price 30' x 60' geologic map, published in 1990, with USGS co-authors Witkind and Bill Cashion; and he was co-author with Witkind on the Nephi 30' x 60' geologic map, which was published a year later, in 1991. Much of the Price 30' x 60' quadrangle, especially the Roan Cliffs north and east of Price, is remote and of difficult access. To this day a smile comes over Mac's face as he recalls how he got to map much of it in the company of Bill Cashion, using the ultimate field vehicle - a helicopter.



Near the Thomas Range, 1987, Mac finds the way.

Among mappers though, Mac is perhaps best known for his work on the Gunnison Plateau of central Utah. He mapped the entire plateau for the Manti and Nephi 30' x 60' quadrangles. The stratigraphically and structurally complex southeastern margin of the plateau begged for more detail than could be shown at 1:100,000, so he re-mapped the Sterling 7.5' quadrangle, which was published in 1994 as UGS Map 159. Maps of the Wales 7.5' quadrangle (with co-author T.F. Lawton), and of the Manti 7.5' quadrangle (with co-author D.A. Sprinkel), are in the UGS publication pipeline. The careful mapping of Mac and his colleagues along the southeastern margin of the plateau has shown that the major stratigraphic and structural complexities there resulted from lateral compression associated with thrusting during the Late Cretaceous Sevier orogeny, accompanied by intermittent, local diapirism of the Arapien Shale, all of which is overprinted by Basin and Range extensional tectonics. Their work has been a key to understanding sedimentation processes along the thrusted margin of a foreland basin.

In 1983, the UGS initiated a geologic mapping program that included provisions to enable qualified graduate students to map a quadrangle as part of their thesis. Mac took advantage of this and in 1984 sent NIU student Steve Mattox to the rugged Hells Kitchen Canyon SE quadrangle in the south-central part of the Gunnison Plateau. Steve must have returned with accolades for Utah geology, the UGS, and Mac, for the next year Mac took on five new graduate students, myself included, who wanted to map in Utah. We worked on the north and west sides of the plateau and nearby Long Ridge. Each of us would like to think that we made important contributions, but in truth we only refined the mapping that Mac had earlier compiled. In all, Mac was advisor or helpful colleague to eight students who mapped 10 quadrangles on the plateau and nearby areas.

Mac has always been interested in stratigraphy for its own sake - he advised several students who undertook stratigraphic studies in central Utah on the Cedar Mountain, Green River, Colton, Crazy Hollow, and Flagstaff formations, and he, too, has studied these and other Late Cretaceous and Early Tertiary units in central Utah - but he has also been captivated by the role that stratigraphic studies, and mapping, play in elucidating tectonic history. He and graduate student Michael Roche recognized an interval of variegated mudstone with "polished stones" and limestone nodules on the Gunnison Plateau as the Lower Cretaceous Cedar Mountain Formation, expanding on the work of others and resolving a long-standing correlation problem of beds that were previously known as the Late Jurassic Morrison(?) Formation. The upper part of this interval, earlier assigned to an unnamed basal unit of the Indianola Group, is now being formally proposed as a new stratigraphic unit, the San Pitch Formation of the Indianola Group. These two units, the Cedar Mountain and San Pitch formations, record the earliest stages of the Sevier orogeny in central Utah.

Summary

In June 1997, Mac was co-leader of a three-day field trip held in celebration of the 50th anniversary of the OSU Field Station. In October 1997, he was a co-leader for a Geological Society of America field trip that examined the interplay of structural development and deposition in the Sevier thrust belt and proximal foreland basin of central Utah. Mac may be officially retired, but he continues to teach us, as he has since 1953, about the wondrous geology of central Utah.

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. . . . Director's Perspective continued

digging into the past with a trench into a bog that reveals deposits going back about 14,000 years. Charcoal layers reveal numerous forest fires since the end of the last glacial advance. By examining the fossil evidence, we hope to determine what the forest and climate conditions were like that immediately preceded these fires to compare to modern-day conditions and help the park managers better evaluate present forest conditions.

These are just a few examples of how the UGS and the NPS are working together. Following a 'summit' meeting of NPS geologists in November, 1997, in which I was one of two state geologists who participated, the UGS is drafting a plan for expanded cooperative efforts for the benefit of the state's national parks and monuments. The NPS initiatives are producing a sum of geologic results greater than the individual parts. It is an exciting time to be a geologist in the Park Service. The UGS-NPS partnership could set a higher standard of cooperation for the rest of the country.

UPDATE: Geologic Mapping in Utah's Dixie

by Robert F. Biek

Faced with such a diverse scenery and climate, it would be difficult for me to pick a favorite area among Utah's landscape. But for many, it must be Utah's Dixie, the southwestern corner of the state that has hot, dry summers, mild winters, and a geologic diversity that is rivaled by few other places in the West. Utah's Dixie is a burgeoning retirement, retail, and vacation center. Once populated by a few hardy pioneers sent south from Salt Lake City to grow cotton, the region's population grew by 140 percent from 1980 to 1995 and it continues to be one of the fastest growing areas in the state. With such growth comes inevitable pressure on the region's infrastructure and natural resources, and also concern that new development will encroach into geologically hazardous areas.

The UGS's Geologic Mapping Program is entering the fourth year of an ongoing effort to provide detailed 1:24,000-scale geologic maps and reports of the greater St. George area, in the heart of Utah's Dixie. UGS mappers recently completed five geologic maps and accompanying reports in the greater St. George area and additional mapping is underway (figure 1). The multipurpose maps and reports are intended for both geologists and non-geologists for use in resource and hazard assessment, scientific studies, and educational and recreational interests, and give equal attention to bedrock and surficial geology, structure, mineral resources, and geologic hazards. The mapping is supported in part from matching funds from the U.S. Geological Survey's STATEMAP Program.

The St. George basin is renowned for its spectacular red-rock scenery, relatively young basaltic lava flows and cinder cones, unusual silver mineralization near Leeds, classic geologic structures, including the Virgin anticline and Hurricane fault zone, and a variety of other interesting geologic features (figures 2 and 3). It also has two scenic state parks, Quail Creek and Snow Canyon. The multipurpose maps outline this fascinating geology and geologic history.

While these geologic maps contain a wealth of geologic information, many public officials and planners prefer derivative maps that more plainly show where, for example, one can expect to encounter a particular geologic hazard such as landslides or

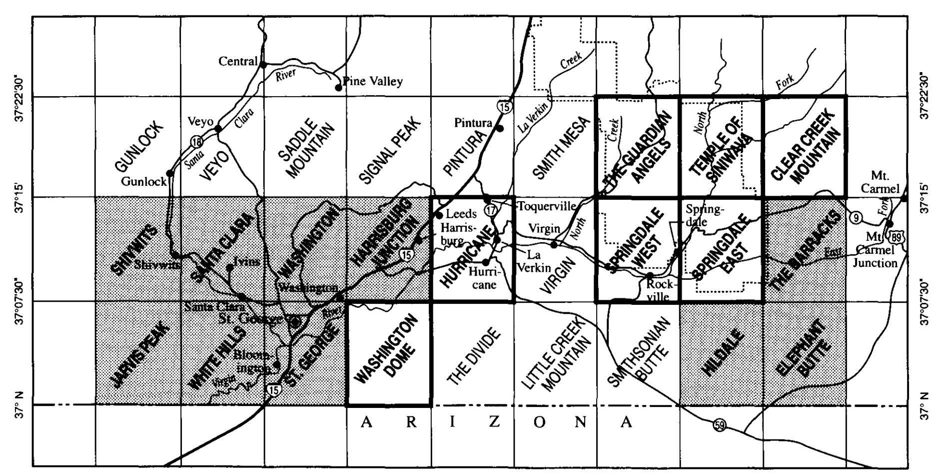


Figure 1. Map showing USGS 7.5-minute quadrangles in the greater St. George area. Recently completed 1:24,000-scale geologic maps and reports are available for the Harrisburg Junction (UGS Open-File Report [OFR] 353), Santa Clara (UGS OFR 339), St. George (UGS OFR 323), Washington (UGS OFR 324), and White Hills (UGS OFR 352) quadrangles. Previously completed maps of the Elephant Butte (UGS Map 126), Hildale (UGS Map 167), Jarvis Peak (UGS OFR 212), Shivwits (UGS Map 153), and The Barracks (UGS Map 147) quadrangles are also available. New geologic mapping, scheduled for completion in June 1998, is underway in the Hurricane and Washington Dome quadrangles. Geologic maps of the Zion National Park region are scheduled for completion in October 1998.

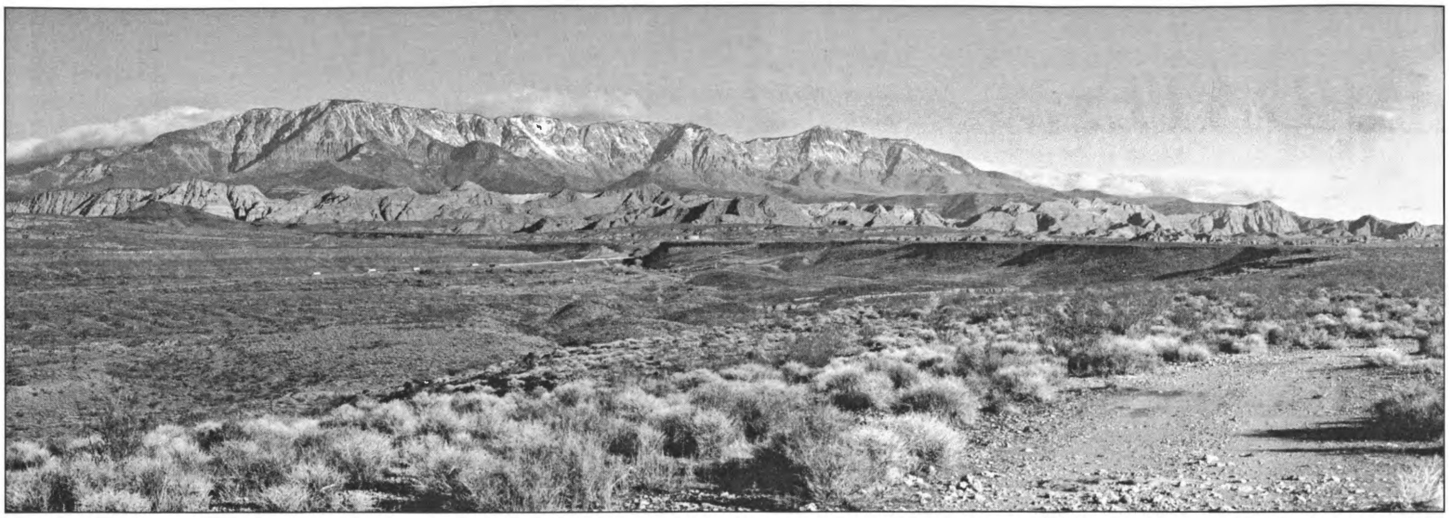


Figure 2. Looking north at the Washington basalt flow and, at extreme left, associated cinder cone. Because it is more resistant to erosion than adjacent rocks, the Washington flow now forms a prominent inverted valley - a sinuous ridge that once was the floor of an ancient valley. The flow is about 30 feet thick along most of its length and forms a flat, gently sloping surface from its source to a point where it entered the ancestral Virgin River. Interstate 15 passes through the flow at Grapevine Pass, near the center of the flow. The Navajo Sandstone forms the light-colored hills in the middle distance. The Pine Valley Mountains, capped by a Miocene-age intrusion, lie in the distance.

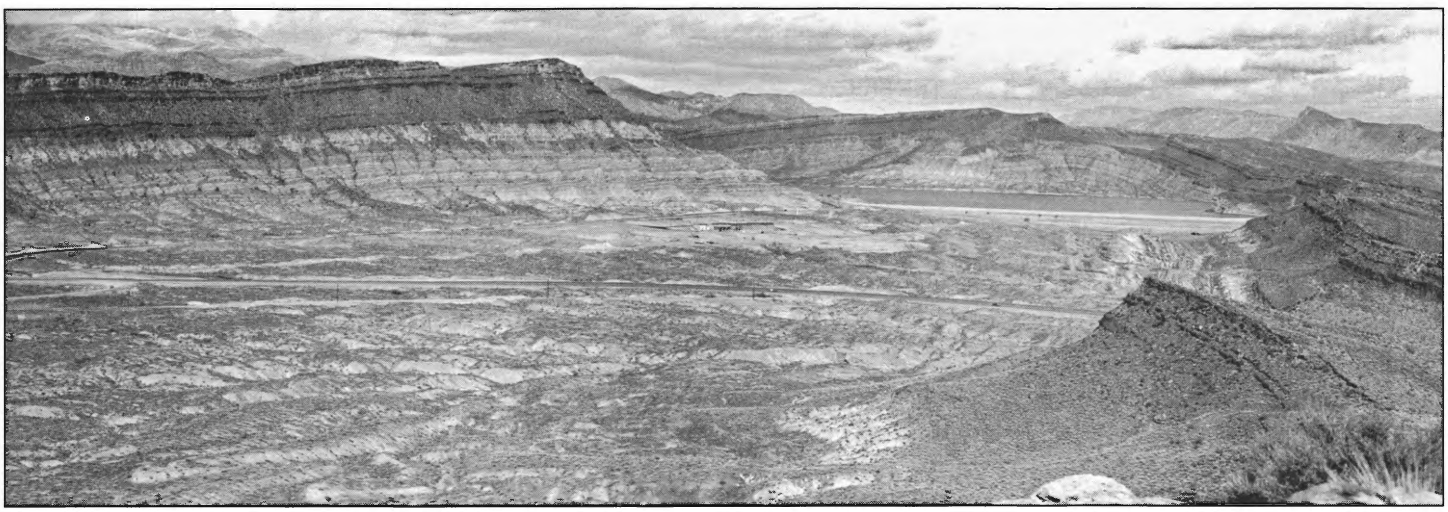
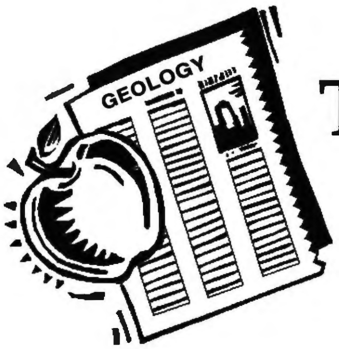


Figure 3. Looking northeast towards Quail Creek Reservoir, which straddles the axis of the Virgin anticline. The flanks of the anticline are neatly outlined by the resistant Shinarump Conglomerate Member of the Chinle Formation, below which are ledgy slopes of the upper red member of the Moenkopi Formation. Red- and white-banded strata of the Shnabkaib Member of the Moenkopi Formation form the eroded floor of the anticline. Numerous, small thrust faults and subsidiary folds are found along the northwest flank of the anticline.

swelling soils. To that end, the UGS's Applied Geology Program is preparing a proposal to produce a folio of digital, 1:24,000-scale geologic-hazard maps for rapidly growing areas in the greater St. George area. The new geologic maps, and other geologic and geotechnical information, will form the basis for these derivative maps. Each hazard map will include an interpretative text that discusses the nature and distribution of the hazard, criteria for hazard classification, and recommendations for site-specific investigations in potential hazard areas. It is anticipated that hazard maps will be prepared relating to earthquakes, slope failure, problem soil and rock, flooding, and shallow ground water.

UGS mappers, in cooperation with the National Park Service and the U.S. Geological Survey, are also preparing digital, 1:24,000-scale geologic maps of the Zion National Park Resource Management Area (figure 1). The maps will provide a framework for archaeological and other investigations in the park, and form an important layer in the park's Geographic Information System. Geologic maps of the Clear Creek Mountain, Springdale East, Springdale West, Temple of Sinewava, and The Guardian Angels quadrangles are in progress and are scheduled for completion in October 1998.



Teacher's Corner

by William F. Case

Easily Accessible Examples of Igneous, Metamorphic, and Sedimentary Rocks in Wasatch Front Canyons

Igneous, metamorphic, and sedimentary rock types are well-represented in Wasatch Front canyons. The purpose of this article is to direct teachers to locations where examples of the rock types can be seen. Little Cottonwood, Big Cottonwood, Parleys, Emigration, and Farmington canyons were selected because sites are within a short walking distance from bus or car parking. Selected rocks in these canyons include: (1) igneous rocks: quartz monzonite and diorite, (2) metamorphic rocks: quartzite, slate, gneiss, and marble, and (3) sedimentary rocks: shale, limestone, sandstone, siltstone, and conglomerate. The age of the rocks ranges from about 3 billion to 24 million years old (Hintze, 1988).

IGNEOUS

Quartz monzonite, a very close relative of, and locally known as "granite", is a gray, "salt and pepper" igneous rock exposed in the lower reaches of Little Cottonwood Canyon. It is exposed on the Temple Quarry Nature Trail on the south side of Little Cottonwood Road (SR 209) near the mouth of Little Cottonwood Canyon. The quartz monzonite intruded into the Wasatch Range between 24 and 31 million years ago (Hintze, 1988).

METAMORPHIC

Slates and quartzites are exposed in lower Big Cottonwood canyon at the geologic road sign "Storm Mountain Quartzites", about 3 miles from the mouth of the canyon. The black slates and "rusted"quartzites are part of the Big Cottonwood Formation, and are about 900 million years old (Hintze, 1988).

Seven miles from the mouth of the canyon, white marble intruded by dark diorite exposed in a road cut on the north side of the canyon. The geologic road signs, "Blind Miner", "Mississippian Marble", "Big Cottonwood Mining District", are in the turnoff area across from the outcrop. The sign indicates that the marble is a metamorphosed Mississippian-age (360-320 million years) limestone. The diorite is 72.4 million years old (James, 1979).

A gneiss that may be as much as 3 billion years old is exposed at the north end of the bridge, where 300 East becomes Skyline Drive in northern Farmington City. The gneiss has dark schistose (lots of mica) and light gneissose (quartz and feldspars) layers. The gneiss is part of the Farmington Canyon Complex .

SEDIMENTARY

A short (just less than one mile) walk on uneven but level ground that used to be the I-80/Foothill Drive off-ramp leads to an outcrop of limestone, sandstone, siltstone, and shale on the north side of the mouth of Parleys Canyon. Walking south, the rocks appear in sequence as gray limestone, orange sandstone, and red siltstone and red shale. The limestone is part of the Jurassic (208-163 million years) Twin Creek Limestone Formation, the sandstone is the Jurassic Nugget Sandstone Formation, and the siltstone and shale make up the upper member of the Triassic (245 - 208 million years) Ankareh Formation.

A beautiful red conglomerate with clasts up to cobble size crops out near the junction of the Emigration Canyon road and the road to Pinecrest in Emigration Canyon. The conglomerate is the Cretaceous (144-66.4 million years) Kelvin Formation.

References

Hintze, L.F., 1988, Geologic history of Utah: Brigham Young University Geology Studies Special Publication 7, 202 p.

James, L.P., 1979, Geology, ore deposits, and history of the Big Cottonwood Mining District, Salt Lake County, Utah: Utah Geological and Mineral Survey Bulletin 114, 4 pl., 98 p.

"Glad You Asked"

Robert F. Biek

"What is a geologic map and what is it used for?"

Geologic maps: a few lucky geologists make them; many geoscientists, engineers, and planners use them; untold scores of people wonder what they are all about. Perhaps the most common question we are asked, those few of us who do make geologic maps, is, simply, "What is a geologic map?" This query is often followed by "What are geologic maps used for?", "Hasn't it been mapped before?", and, if the person is really inquisitive, "What do all those lines, colors, and symbols represent?" It must be a puzzling sight - a lone geologist, often miles from the nearest road, looking at rocks, putting lines on a map or aerial photograph. One rightfully wonders what it is that person is doing.

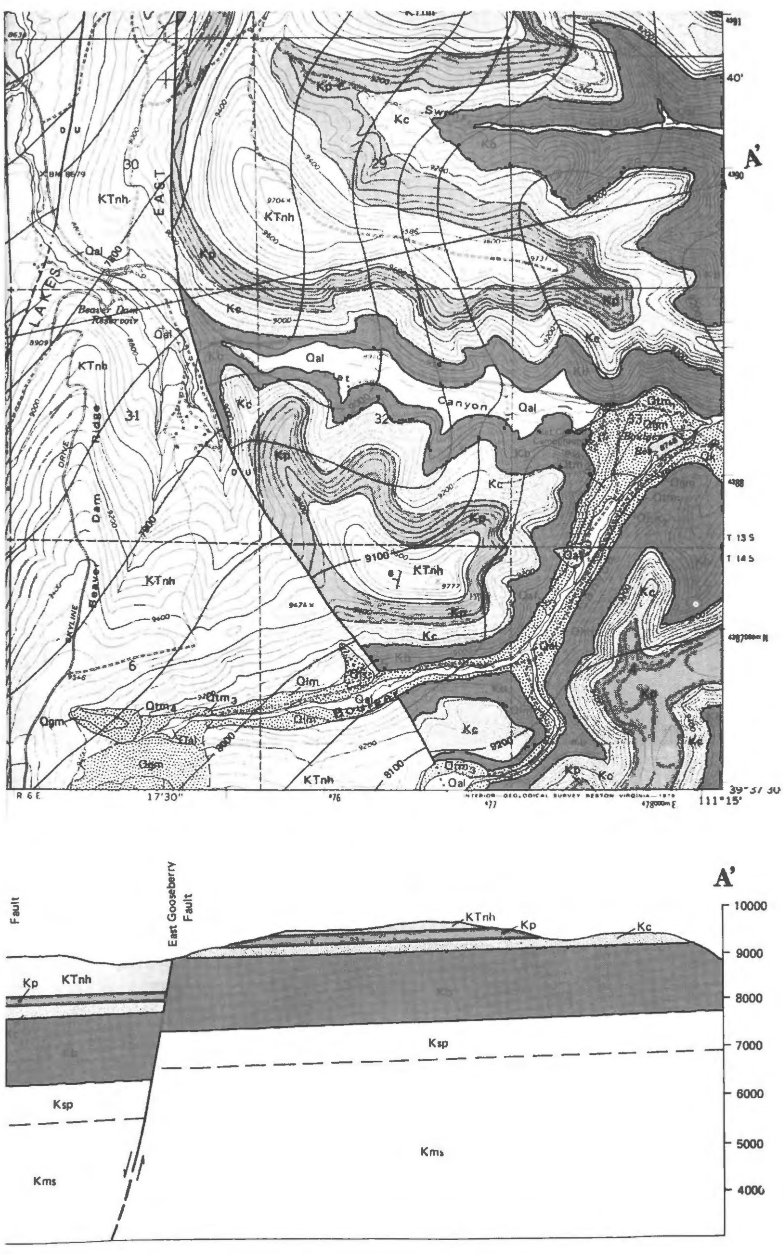
Geologic maps graphically communicate vast amounts of geologic information - they are to a geologist what blueprints are to an architect, what a highway map is to a traveler, or what a painting is to an artist. Geologic maps display three-dimensional features on a flat piece of paper, with the added benefit of depicting the relative age, composition, and relationships among rocks and sediments at and near the earth's surface. A detailed geologic map shows what it is you are standing on; where other similar rocks or sediments may be found; how old they are; what they are composed of and how they formed; how they have been affected by faulting, folding, or other geologic processes; and what existing or potential mineral resources and geologic hazards are nearby. It would require volumes of text to describe what a geologic map can show on a single sheet of paper. It should come as no surprise then that geologic maps are the most fundamental and important geologic database for the earth sciences.

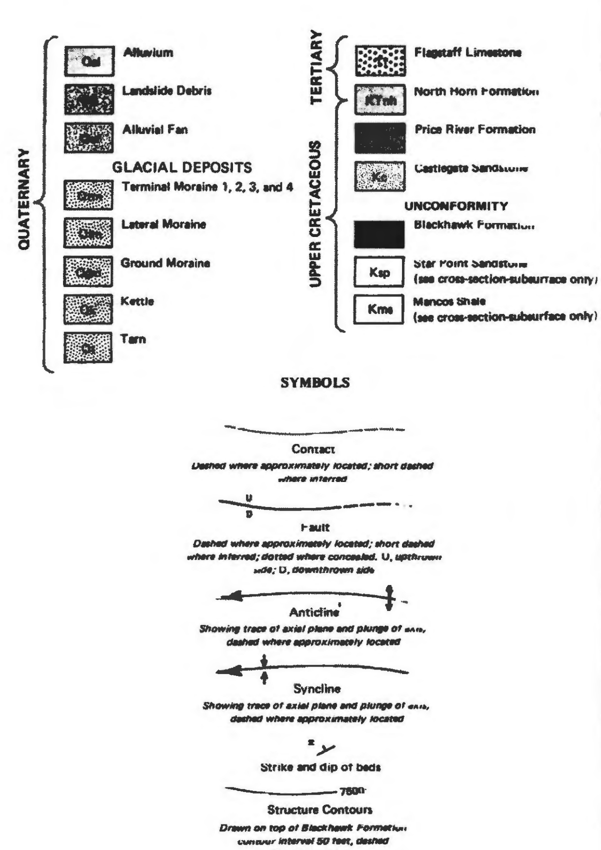
There are many types of specialized geologic maps - for example those that focus on bedrock geology, structure, geologic resources or hazards, or the geology of surficial sediments. Most maps produced by the Utah Geological Survey give equal weight to each of these factors and so are considered multi-purpose geologic maps. The UGS's Geologic Mapping Program focuses its efforts on publishing 1:24,000-scale and 1:100,000-scale geologic maps, the same scale as the popular U.S. Geological Survey 7.5-minute and 30 x 60-minute topographic maps. The 7.5-minute map is the standard scale for detailed geologic mapping, where one inch on the map represents 24,000 inches, or 2,000 feet, on the ground. The geologic maps are printed over these topographic base maps, allowing users to accurately determine their location with respect to mapped geologic features.

A geologic map is the principal tool that geologists use to convey information about the structure and stratigraphy of the earth's surface; the location and type of geologic hazards such as landslides and faults; and the location and type of resources such as sand and gravel, cement rock, and ore deposits. It is a tool that can be used in many ways - from learning about the geologic history of an area, to natural-resource and hazard assessment, to providing information for intelligent land-use planning and growth - and indeed, is as useful for its descriptive as well as predictive nature.

In an accompanying article, Grant Willis summarizes the status of geologic mapping in Utah. While Utah has been mapped at small scales (large areas with limited detail), it is easy to see that modern, detailed (1:24,000) and intermediate (1:100,000) scale mapping is lacking for large areas. Maps of this resolution are needed today to respond to a variety of resource availability, hazard, and planning questions. It is also important to note that geologic maps are not a commodity that can be ordered up in a short period of time. They are built on a long history of previous geologic investigations in the vicinity and typically take months or even years to produce. Geology, like other sciences, is evolving. Mapping often is refined as new geologic information becomes available. Geologic maps can become obsolete over time, not because the geology changes, but because our understanding of it increases.

As for all those bright map colors and funny symbols, well, think of them as geologic shorthand. They may appear cryptic, but each geologic map is accompanied by a chart that explains exactly what each line, color or symbol means. Each map color, for example, represents a unique map unit - a sequence of rocks or sediments sufficiently distinct in age, composition, or environment of deposition so as to be differentiated from all other map units. By tracing map units across the countryside, geologists can locate faults, folds, and other geologic structures. To help users understand the three-dimensional, subsurface arrangement of the rocks, maps normally include cross sections or block diagrams. Geologic maps may be complex and their interpretation can require considerable training, but at the most basic level, reading a geologic map is not much different from reading a highway map. Given basic map-reading skills, it is a relatively simple matter to tell what type of rock you are standing on, what mineral resources or hazards may be nearby, and to answer a host of other geologic questions.





A portion of the Fairview Lakes geologic map and cross section, reduced from the original 1:24,000-scale version. Accompanying explanation shows symbols used. The map is printed on a topographic base to allow users to accurately determine their location with respect to mapped geologic features.

Survey News

People

Welcome to new employees **Rich Giraud** and **Pat Stokes**. Rich is in the Applied Program, and comes to us from Maxim Technologies Inc., where he was a project geologist investigating geologic hazards and environmental problems. He will be working on a scientific analysis of statewide debris flows. He has experience in regulatory, exploration, and field geology and worked on the Juneau Icefield Research Program. Pat replaces Vicki Whitaker as the Bookstore Manager. Pat worked in retail sales and hotel management in Salt Lake City, Dallas, and Santa Barbara and worked with Applied Research as a financial planner.

Werner Haidenthaller, the UGS Associate Director, has accepted a position as Financial Manager with the recently created Department of Workforce Services. He became the Accounting Officer in 1988 and has continued to forge ahead. **Monson (Bill) Shaver** was recently reclassified from Archaeological Assistant to Archaeologist. Congratulations to both!

Awards

The Western States Seismic Policy Council (WSSPC) named the UGS as the winner of its 1997 Award for Excellence in the category of Outreach to the General Public for its strategy of increasing earthquake awareness in Utah. **Sandy Eldredge**, Program Manager of the Geologic Extension Service, led the effort, which was begun in 1994 with a cost-sharing grant from the U.S. Geological Survey's National Earthquake Hazard Reduction Program to produce public information (PI) publications. The popular PI series is a staple of earthquake-hazard workshops and conferences for teachers, real-estate agents, and scientists, and has been distributed to local media and government officials. **Gary Christenson**, Program Manager of Applied Geology and a WSSPC delegate, accepted the award on behalf of the UGS during the WSSPC's Annual Conference in Victoria, British Columbia.

Grants

The UGS is the recipient of two grants and one federal contract. The National Science Foundation (NSF) awarded a $77,868 two-year grant to the UGS to define the hunter-gatherer antecedents to agriculture in northern China by investigating ancient weather and environmental records of the region. It is the first time the NSF has awarded a grant to the UGS. **David Madsen**, primary author of the proposal, will be the principal investigator on the project. The Chinese region has marked similarities to the Great Basin of North America and, while much is known about the hunter-gatherer antecedents here, little is known about that area of the world. This study is part of a continuing research project which seeks to compare the two areas to determine ways climatic change affects people in environmentally similar, but historically different, areas of the world. This will mark David's seventh research-related visit to China. He was invited to present his paper, "The Effects of Rapid Climate Change During the Pleistocene/Holocene Transition on Human Foragers in the Tengger Desert, China, and the Great Basin, USA," at the 1997 fall meeting of the American Geophysical Union in San Francisco.

David is also the principal investigator on a $35,000 one-year project aimed at defining the Gilbert shoreline and Old River Bed on Dugway Proving Grounds. The Old River flowed into Lake Bonneville when early peoples first entered the region around 10,000 years ago. The study will be used to help managers locate paleo-Indian sites on the U.S. Army base. This project is part of an ongoing examination of Camels Back Cave that David is conducting for the UGS and the Army. The cave is an extraordinary resource that contains evidence of human occupation dating back at least 7,500 years.

The U.S. Department of Transportation (DOT) awarded the UGS a $20,000 contract to test the creation, operation, and maintenance of a digitized repository for the National Pipeline Mapping System. The DOT's Research and Special Programs Administration's Office of Pipeline Safety is managing the project. **John Hansen** is the Project Geologist on the contract.

Presentations

The recent **Geological Society of America** Annual Meeting in Salt Lake City was notable for the participation of UGS staff. The UGS co-sponsored the event and **Director Lee Allison** was the convention's General Chair. He was also a panelist for a "Hot Topic" scientific debate on the Grand Staircase-Escalante National Monument entitled "Environmental Preservation vs. Resource Exploitation vs.

Tourism." **Roger Bon** served as the Special Events Chair, and **David Madsen** co-authored and presented a Theme Session presentation on "Great Basin Aquatic Geology."

Technical Session presenters included **Francis Ashland, Bob Biek, Richard Giraud, Hugh Hurlow, Mike Lowe, Dave Tabet, Janae Wallace,** and **Grant Willis.** In addition, **Kent Brown, Mike Hylland, Mike Lowe, Dave Tabet**, and **Janae Wallace** co-authored other technical-session presentations. Check the UGS website for abstracts of these papers (www.ugs.state.ut.us).

Field Trip leaders included **Hugh Hurlow, Barry Solomon**, and **Bill Lund** (Hurricane Fault); **Hellmut Doelling** (Southeastern Utah National Parks); **Doug Sprinkel** (Sevier Thrust Belt); **Mike Hylland, Bill Black**, and **Mike Lowe** (Wasatch Front); **Francis Ashland** (Snyderville Basin); **Francis Ashland** and **Gary Christenson** (Shurtz Lake Landslide); **Tom Chidsey** (Ferron Sandstone); and **Sandy Eldredge** (Antelope Island).

UGS staffers also contributed to the success of the Association for Women Geoscientists' Perspectives: A 20th Anniversary Celebration of Achievement conference. **Bea Mayes** was the Convention Chair, **Martha Hayden** coordinated the field trips, and **Sandy Eldredge** was responsible for registration. Martha and **Francis Ashland** helped run a geologic field trip from Snowbird to Park City. **Dave Tabet** presented a funding grant proposal to the Rocky Mountain Section AAPG Foundation, securing a $1,000 contribution to help with the expenses for the meeting. The UGS was an official sponsor of the highly successful convention, which convened at Snowbird, Utah, just before the GSA meeting.

Likewise, at the recent science symposium on the Grand Staircase-Escalante National Monument in Cedar City, the UGS staff was well-represented. **Lee Allison** chaired the field trip committee and hosted 68 eager trekkers on a 3-day excursion into the monument, following tour-guide leader **Hellmut Doelling**. Hellmut and **David Gillette** were panelists on the concluding Plenary Session and served as discipline synthesizers for their respective specialties. Hellmut was also a panelist on the introductory session, "Perspectives on Science and the Monument," delivered a paper on "Geography and Resources of the GSENM," and participated in a poster session presentation with **Grant Willis, Kent Brown**, and **Kelli Bacon** on "Digital GIS Geologic Mapping of the GSENM." David also presented a poster session on "Recommendations for Paleontological Research in the GSENM." In addition to those staffers, **Dave Tabet** co-authored a paper on "Variations in the Chemistry of Straight Cliffs Formation Coals"; **Tom Chidsey** delivered a paper on "Hydrocarbon Potential in the GSENM"; and **Bob Gloyn** delivered a paper he co-authored on "Titanium-Zirconium-Bearing Fossil Placer Deposits in the Cretaceous Straight Cliffs Formation." **Kimm Harty** and **Janine Jarva** presented the poster session "Geologic Hazards of the GSENM."

Tom Chidsey was a featured speaker at the American Association of Petroleum Geologists regional meeting in Denver. He discussed "Heron North Field, Navajo Nation, San Juan County, Utah: A Case Study for Small Calcarenite Carbonate Buildups." He also presented that topic at the Utah Geological Association's November monthly meeting.

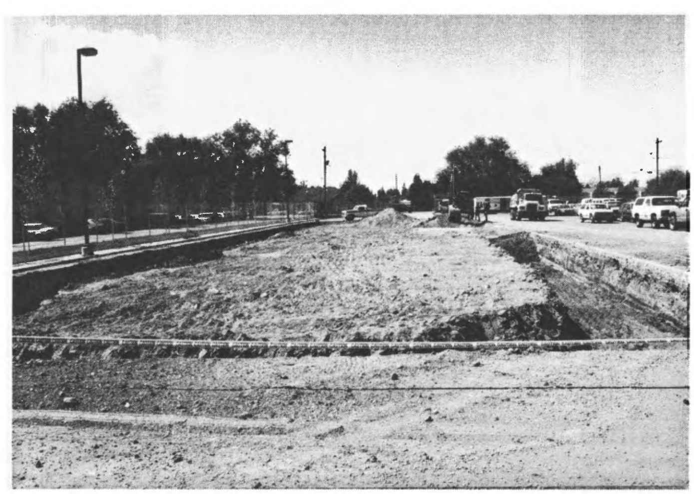
Howard R. Ritzma

Howard passed away October 30, 1997 in Salt Lake City at age 75 from pneumonia. He was born in Berwyn, Illinois to Louis and Annette Ritzma and went on to a B.S. in geology from Miami University of Ohio, where he was a member of Sigma Nu. He then completed an M.S. in geology from University of Wyoming.

Howard served in the Air Corps Weather Service in Canada and Alaska during WWII.

Howard worked as a geologist for Mobil Oil, Southern California Petroleum Corporation, and Ball Associates. In 1967 he joined the Utah Geological Survey as a petroleum geologist specializing in tar sands, and he also served as Assistant Director. In recent years, he was a private consultant in geology, specializing in oil and gas resources. For most of his career he was active in the Utah Geological Association.

The New UGS Sample Library



Construction is underway for the new, 14,000 square-foot Sample Library. The facility will house a substantial collection of Utah rock cores and cuttings and is scheduled for completion in spring, 1998. *Photo by Carolyn Olsen.*

Energy News

1997 Summary of Mineral Activity in the State of Utah

by Roger L. Bon

Authors note. This summary is an excerpt of a more complete summary of mineral activity which is included in the 1998 Economic Report To The Governor, published by the Office of Planning and Budget (OPB). Contact Roger Bon at 801-537-3363 for more information.

Minerals Summary

The value of Utah's mineral production in 1997 is estimated to be $2.3 billion, an increase of $75 million from 1996, making 1997 the second-highest year in total value after 1995. Contributions from each of the major industry segments are:

- base metals, $949 million (41 percent of total);
- industrial minerals, $533 million (23 percent of total);
- coal, $523 million (23 percent of total); and
- precious metals, $289 million (13 percent of total).

The changes in Utah's mineral valuation by industry segment for the period 1995-1997 are shown in Figure 1. Compared to 1996, the 1997 values of: (1) base metals decreased $11 million, (2) industrial minerals increased $100 million, (3) coal increased $23 million, and (4) precious metals decreased $37 million. Prices decreased for most base metals (copper, molybdenum, and magnesium) in 1997, while precious-metal prices were mixed; silver prices increased while gold prices decreased. Coal prices declined slightly in 1997. Industrial mineral prices increased modestly for most commodities but were lower for several others.

Mines and New Mine Permits

Sixty-three large mines (excluding sand and gravel) were active in 1997. These mines, grouped by industry segment, are: base metals -3, precious metals - 2, coal - 12, and industrial minerals - 46. Ninety-six small mines reported production in 1996 (latest data available). Small mines are grouped as follows: industrial minerals - 66, gemstones - 13, precious metals - 11, fossils - 3, and other - 3.

Through the end of November 1997, the Utah Division of Oil, Gas and Mining received five Large Mine permit applications (five acres and larger disturbance) and 29 new Small Mine permit applications (less than five acres disturbance). One application was made to change from Small Mine to Large Mine status (limestone quarry). These numbers represent a decrease of four Large Mine permit applications and a decrease of five Small Mine permit applications compared to 1996. New Large Mine permits include two limestone quarries, a gypsum quarry, and a beryllium mine near an existing operation. New Small Mine permits are grouped as follows: (1) industrial minerals - 20, (2) precious metals - 8, and (3) other - 1 (geodes).

National Rankings

The U.S. Geological Survey ranked Utah seventh in the nation (down from fourth) in the value of nonfuel minerals produced in 1996. Utah accounted for nearly 4 percent of the U.S. total nonfuel mineral production value. Utah ranked:

- first in beryllium, and gilsonite;
- second in potash, molybdenum, and copper;
- third in gold, and magnesium metal;
- fourth in phosphate rock, magnesium compounds, and silver;
- sixth in salt; and
- seventh in bentonite clays.

Mineral Production Trends

According to the U.S. Geological Survey, between 1986 and 1996 the value of nonfuel mineral production in Utah ranged from $374 million to over $1.8 billion. The total for 1996 represents the second-highest for nonfuel mineral valuation for the state, $280 million less than 1995, the year of record mineral production. The Utah Geological Survey's estimate for the value of nonfuel mineral production for 1997 is $1.8 billion, nearly $100 million more than 1996.

Mineral exploration statewide is expected to be slightly higher in 1997 than in 1996. Thirty-two Notices of Intent (NOI) to explore on public lands were filed with the Division of Oil, Gas and Mining through November 1997, compared to 32 for all of 1996, 22 for 1995, 34 for 1994, and 54 for 1993.

Outlook for 1998

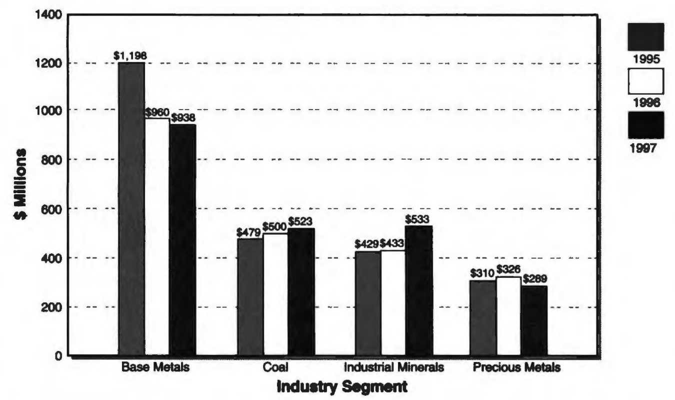
Operator surveys indicate that base-metal production should remain relatively steady in 1998 while a sharp decline in gold production is expected; coal production will increase as will most industrial mineral commodities. An accelerated decline in base- and precious-metal prices which began in the fourth quarter of 1997 could impact those metal values in 1998 if the trend continues.

New mines which are in early development include two relatively small copper mines and one lead, zinc, and silver mine. In addition, one new coal mine completed its first full year of operation and two additional coal mines are in the planning stages. Two industrial mineral quarries were opened in 1997 and two additional quarries will open in 1998.

Conclusion

Utah's mining industry is producing most major commodities at near-record levels and will continue to produce at high levels for the foreseeable future. The notable exception is gold production. There are currently three active gold producers, down from a recent high of five. One mine will cease production in 1999 and another will begin phasing out over the next few years. Proposed new mine developments will add only a modest amount of precious-metal production, mostly silver. Current prices for base- and precious-metals are approaching multi- year lows and could have a moderate affect on mineral values in 1998. On the upside, both coal and industrial minerals continue to set production records. Several new operations began in the past year and several more are planning to open over the next two years. Many industrial mineral prices are at or near their historic highs which is encouraging new developments and expansion of existing facilities. Coal prices are at a 15-year low, but should improve in 1998. Two new coal mines are being planned which will help maintain record- and near-record production levels for the next several years.

Mineral Valuation - Gross Value Estimate: 1995 to 1997



Preliminary Analysis: the Conoco National Monument Well

by M. Lee Allison

Conoco appears to have discovered one of the largest natural gas deposits ever found in the state of Utah. Further analysis is needed to understand why it is not productive.

On Thursday, December 18, 1997, Conoco briefed state officials on the results of their wildcat well in the Grand Staircase-Escalante National Monument. The well was plugged and abandoned as a dry hole at a total depth of 11,911 feet, bottoming in Precambrian-age metamorphic rocks. No Chuar Group or other Precambrian sediments were encountered.

Geophysical well logs indicate the Cambrian Muav Limestone and Tapeats Sandstone are fully charged with gas, which was determined on testing to be methane with a trace of CO2. Porosities of the two formations are low. Production tests, including hydraulic fracturing, reportedly recovered water but only traces of gas and oil.

Conoco is investigating whether the hydrocarbons may be hydrodynamically displaced to the southwest of the Rees Canyon structure, as they are in the Upper Valley field. If so, there is potential to find an oil reservoir on the flank of the anticline or on other nearby similar anticlines, such as at Smoky Mountain. The Tapeats Sandstone is porous and permeable in other wells in and around the Monument, including to the northeast in the BHP "28-1 Federal" well which produced at a rate of 5 million cubic feet (MMcf) of CO_2 per day from the formation.

Conclusions

Hydrocarbons are present in Cambrian reservoirs in the Kaiparowits basin in possibly large quantities. Precambrian sediments are a possible but unconfirmed source of the hydrocarbons. Precambrian source rocks were not directly beneath the reservoir which means that any geological structures in the area could contain Precambrian-source hydrocarbons.

If Conoco is correct, then the hydrocarbons in reservoirs in the region may all be hydrodynamic. Other than at Upper Valley, no wells have been drilled off-structure in the basin. Thus, it is possible that any of the anticlines in the region could have stacked reservoirs (Triassic, Permian, Mississippian, and Cambrian) on their flanks which have never been tested, even though most of the anticlines have had wells drilled on their crests.

Based on the initial analysis of the Conoco results, the petroleum potential of the Kaiparowits basin and the Grand Staircase-Escalante National Monument is now proven and is significantly larger than previously recognized.

New Publications of the UGS

Geologic map of the Hayes Canyon quadrangle, Sanpete County, Utah, by D.H Petersen, 18 p., 2 pl., 1:24,000, 9/97, MP97-3 .... $7.00

Geologic map of the Hatch quadrangle, Garfield County, Utah, by R.A. Kurlich III and J.J. Anderson, 17 p., 2 pl., 1:24,000, 9/97, MP97-5 .... $7.00

Commonly asked questions about Utah's Great Salt Lake and ancient Lake Bonneville (German version of PI-39), by J.W. Gwynn (translation by B. Long-Murdock), PI-55, 22 p., 10/97 .... $1.75

Interim geologic map of the White Hills quadrangle, Washington County, Utah by J.M. Higgins, 94 p., 2 pl., 9/97, 1:24,000, OFR 352 .... $10.10

Interim geologic map of the Harrisburg Junction quadrangle, Washington County, Utah by R.F. Biek, 124 p., 2 pl., 9/97, 1:24,000, OFR 353 .... $11.20

Interim geologic map of the Cedar Pass quadrangle, Millard County, Utah by L.F. Hintze, 2 pl., 10/97, 1:24,000, OFR 354 .... $4.00

Interim geologic map of the Deadman Point quadrangle, Millard County, Utah by L.F. Hintze, 2 pl., 10/97, 1:24,000, OFR 355 .... $4.00

Interim geologic map of the Burbank Pass quadrangle, Millard County, Utah by L.F. Hintze, 2 pl., 10/97, 1:24,000, OFR 356 .... $4.00

Interim geologic map of the Big Jensen Pass quadrangle, Millard County, Utah by L.F. Hintze, 2 pl., 10/97, 1:24,000, OFR 357 .... $4.00

Ferron Sandstone reservoir type logs and lithofacies, Emery County, Utah, by P.B. Anderson, T.C. Chidsey Jr., and Kevin McClure, 2 pl., OFR-358, 12/97 .... $3.50

Interim Geologic Map of the Smoky Mountain 30' x 60' Quadrangle, Kane and San Juan Counties, Utah and Coconino County, Arizona by Hellmut H. Doelling, 2 pl., 1:100,000, OFR-359, 12/97 .... $6.00

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