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SURVEY NOTES

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Officials Let Problem Slide

In May 1974 a landslide on the south side of Manti Canyon broke the pipeline carrying culinary water to the town. Measures were immediately taken by the townspeople to install a temporary pipe and to start construction of a permanent bypass around the slide, which, however, continued to move (see *Quarterly Review,* Vol. 8, No. 3, August 1974).

A year later in the summer of 1975, the landslide had increased in size and was accelerating rapidly. After a visit to the site by geologists of the Utah Geological and Mineral Survey, it was apparent that a large section of the slide might break loose and dam up Manti Creek. The danger in the canyon was that the naturally formed dam would eventually wash out and release a flood onto the city below. UGMS informed officials of state government of this danger. Simultaneously, Manti's story appeared in newspapers and on radio and television (see *Quarterly Review,* Vol. 9, No. 4, November 1975). The future of Manti became the concern of more than the townspeople. State and federal agencies saw the need for quick action to avert a probable disaster.

In the latter part of August 1975, a series of meetings began that has continued on into 1976. Present at those meetings were federal employees from the Forest Service, Corps of Engineers, National Weather Service, Geological Survey, Soil Conservation Service, Department of Housing and Urban Development, and Federal Disaster Assistance Administration who came from Washington, Denver, Sacramento, and San Francisco as well as from various locations throughout Utah. In addition, members of the State Office of Emergency Services, Utah Geological and Mineral Survey, and Utah National Guard were frequently present. UGMS can

(continued on page 4)

OVERTHRUST BELT . . .

OIL AND GAS FEVER

One of the most intensive campaigns of oil and gas leasing and drilling in recent years is under way in southwestern Wyoming and adjoining Utah and Idaho. Triggered by the discovery in 1975 and the subsequent development of Pineview oil field, 10 miles east of Coalville in Summit County, Utah, activity was further stimulated in 1976 by the discovery of gas and condensate at the Amoco Production No. 1 Champlin-224 Amoco-A test, 15 miles northeast of Evanston in Uinta County, Wyoming. The Pineview field produces from the Nugget Sandstone and Twin Creek Formation, both Jurassic in age. Large quantities of gas and condensate have been recovered on tests of the Nugget at the Amoco well.

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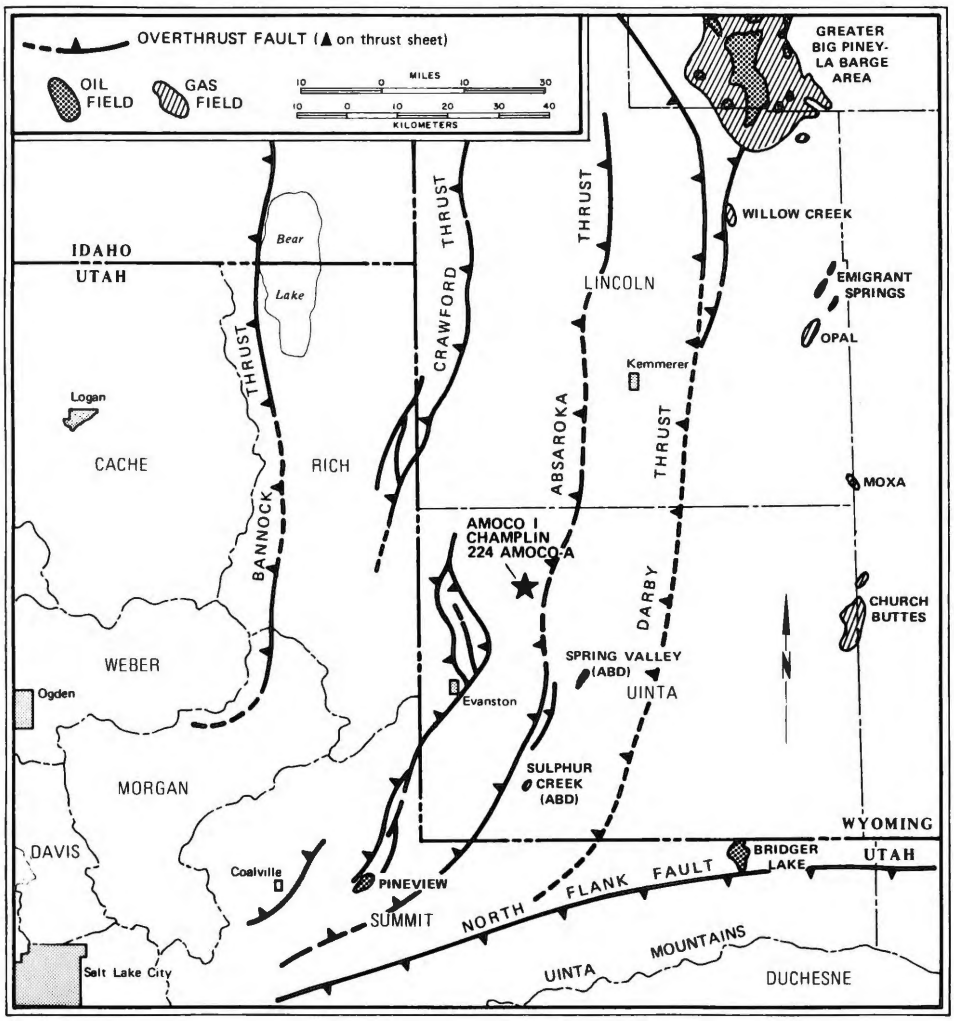


Generalized structure of overthrust area, southwest Wyoming and adjoining Utah. Amoco discovery well in Uinta County, Wyoming is shown by star (center).

Survey Releases Latest Studies

The latest publications of the Utah Geological and Mineral Survey are available through the UGMS Publication Sales Office, 606 Black Hawk Way, Salt Lake City, Utah 84108. When ordering by mail, add 10% for handling and mailing charges—minimum charge is $.25.

Bulletin 108, *Utah Mineral Industry Operator Directory 1975,* compiled by Carlton H. Stowe ($3.00). Bulletin 108 lists by county the names and addresses of mineral operators and their properties in Utah. Within each county the operator is referenced alphabetically by the primary commodity it produces. A map for each county helps the reader in locating the area of the operation. A state map of Utah by county and by township and range is also provided.

Utah Geology, *Vol. 3, No. 1, Spring 1976.* Published biannually. Subscriptions are $6.00 per year. Single issues are $3.50. Handling and mailing charges are included in the subscription price. This issue contains the following articles: "Weathering of the Salt Lake City and County Building Dimension Stone," by Bruce N. Kaliser; "Amatrice Hill Variscite Deposit, Tooele County, Utah," by Hellmut H. Doelling; "Gold Springs Mining District, Iron County, Utah, and Lincoln County, Nevada," by Lee I. Perry; "A Second New Theropod Dinosaur from the Late Jurassic of East Central Utah," by James H. Madsen, Jr.; "Small Channel-Fill Sequences in the Duchesne River Formation Near Vernal, Utah: Possible Examples of Transitions from Meandering to Braided Stream Deposits," by Ted A. Maxwell and M. Dane Picard; and "Earthquake Epicenters in Utah January-June 1975," by Kenneth L. Cook

CHANGE IN GOVERNING BOARD

Mr. Dean D. Kerr, who has served as Chairman of the UGMS Governing Board since it was founded on July 1, 1973, has resigned because of business reasons. The resulting vacancy for a representative of the mining industry has been filled by the appointment of Mr. Kenneth R. Poulson, Manager of the Mining Division of Brush Wellman, Incorporated.

OIL FACTS . . .

UTAH'S PETROLEUM ACTIVITY

How does Utah stack up among the 27 major oil-producing states? According to the latest published information, in 1975 Utah ranked 10th in the production of crude oil and natural gas liquids (see accompanying table). Utah and Colorado were the only two of the top 12 states to show increased oil production over 1974. Utah was up 3 percent, Colorado 1 percent. Utah's growth in oil production is principally the result of one developing oil field, Greater Altamont-Bluebell in Duchesne and Uintah Counties and of Greater Aneth in San Juan County where a massive secondary recovery by waterflood is under way. Nationally, U. S. domestic oil production declined 4.8 percent from 1974 to 1975.

There are other indicators of petroleum activity. The number of active drilling rigs is commonly considered to be an index of exploratory effort in an area. In this category, Utah ranked 11th in 1975 with an average of 26 active rigs, down 38 percent from 9th place in 1974. The decline has continued into early 1976, even though there is considerable oil-leasing activity and drilling in Summit, Rich, and Morgan Counties. Drilling-rig activity for the nation was up about 11 percent.

Another indicator is the proved reserve of crude oil (producible oil remaining in the earth). Utah ranked 12th in this category in 1974 (data is not yet published for 1975) with approximately 0.7 percent of the nation's reserve. All of the top 12 states showed a decline in proved reserves from 1973 except California and Florida.

The demise of the depletion allowance, problems with leasing and drilling of federal lands, and inflationary pressures have forced the industry to explore in areas where drilling is shallower, less expensive, and less geographically remote than in Utah. Data compiled by the Utah Geological and Mineral Survey show that recent drilling costs have averaged $60.68 per foot in Utah, compared with $12.95 in Colorado, $18.82 in Wyoming, and $68.50 in offshore Louisiana. The state average for Utah is distorted somewhat by the deep, expensive drilling in the Greater Altamont-Bluebell field.

In spite of the downward trend in drilling activity in Utah, several large areas in the state have considerable promise for new petroleum discoveries. But it is evident that improved economic conditions will be necessary to induce the drilling required to find that oil.

Ranks of oil-producing states.
[Note: includes onshore and offshore oil production]

Rank: 1975 oil production	Approximate share of total domestic oil production[1] (percent)	Rank: 1975 active rigs	Rank: 1974 crude oil reserves[2]
1. Texas	40.0	1	1
2. Louisiana	21.0	2	3
3. California	10.6	5	4
4. Oklahoma	5.4	3	5
5. Wyoming	4.1	4	6
6. New Mexico	3.1	6	7
7. Alaska	2.3	16	2
8. Kansas	1.9	7	8
9. Mississippi	1.5	12	11
10. Utah	1.3	11	12
11. Colorado	1.2	8	10
12. Montana	1.1	10	13

Sources: *Oil and Gas Journal*, v. 74, no. 4, January 26, 1976; *World Oil*, v. 182, no. 3, February 15, 1976.
[1] Crude oil and natural gas liquids.
[2] Crude oil only.

UGMS Studies Coal Gas

Methane has always been a problem in coal mining. It is an odorless, tasteless, colorless, and explosive gas that poses a severe hazard in underground workings. If the methane concentration at the working face exceeds one percent, mining must stop until ventilation has diluted it. Of the gas emitted from coal, 70 to 99 percent is methane. Other gases, usually emitted in minor amounts, are carbon dioxide, ethane, propane, and butane.

During the past six months the Economic Geology Section of the Utah Geological and Mineral Survey has studied gas emissions from 22 coal cores. The samples were taken from drilling operations that cored the coalbeds in the Blackhawk Formation of the Wasatch Plateau and Book Cliffs. The objective of the study is to determine the volume of gas per weight of coal for the various minable coalbeds throughout the state.

This summer, coal cores will be obtained from the Alton field, the Kaiparowits Plateau coal field, and again from other areas in the Wasatch Plateau and Book Cliffs. The UGMS project is a two-year study that is funded in part by a grant from the U. S. Bureau of Mines.

Long-range objectives of the program are the possible use of methane from coal for fuel where it occurs in quantity and the degassing of coal beds in advance of mining as a means of improving mining safety.

DRILLING REPORT ON FILE

The Utah Geological and Mineral Survey has put on open-file the report, *Drilling of Low Sulfur Bituminous Coals in Several Areas of the Wasatch Plateau Coal Field, Utah*, by Fitzhugh D. Davis and Hellmut H. Doelling. In 1975, seven holes were drilled at key locations in the central and southern parts of the Wasatch Plateau. The depth of the holes ranged from 276.4 feet to 1,158.3 feet. The total footage of 4,590.4 feet included 1,935.4 feet of coring. Most of the drilling was done in the Blackhawk Formation of the Mesaverde Group (Late Cretaceous). All coring was done in the lower half of the Blackhawk, which contains important coal seams.

An isopach map of the Hiawatha coal bed in the Trail Mountain and North Horn Mountain areas is included with the report. In place reserves of the Hiawatha bed (4.5-10.5 feet thick) are estimated at over 304 million short tons for the Trail Mountain area.

An isopach map of the upper Ivie coal bed (3.5-7.5 feet thick) in the Johns Peak area is given also. Measured and indicated reserves are estimated at 19,876,000 short tons.

Part of the report deals with the coal quality in the various areas. Appendices contain twenty measured stratigraphic sections and drill logs for the seven holes. The project was funded in part by a grant from the Conservation Division of the U. S. Geological Survey.

UGMS SEEKS DATA

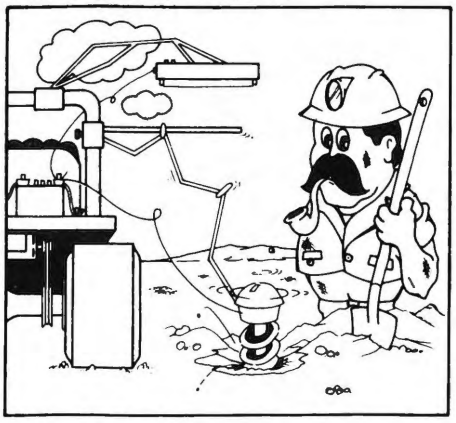
Lead and Zinc Study Under Way

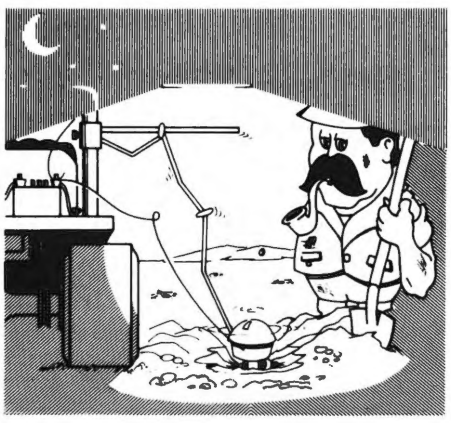
The Utah Geological and Mineral Survey has begun a study of the occurrences of lead and zinc in Utah. The Economic Geology Section of UGMS is doing the study for the U. S. Bureau of Mines' *Mineral Availability System* and for a future UGMS publication on lead and zinc. Lee I. Perry, staff geologist, will head the project, acting as principal investigator. He is planning to visit most properties. Research currently underway has revealed approximately 1,000 occurrences of lead and zinc recorded in published material and much important and useful information that has never been published. Perry is soliciting mine maps, property descriptions, ore reserve data, and information on the mineralogy of the ore bodies from prospectors, mine owners, and mining companies. Those interested should contact Lee Perry at UGMS. Records submitted to UGMS for this study will be returned.

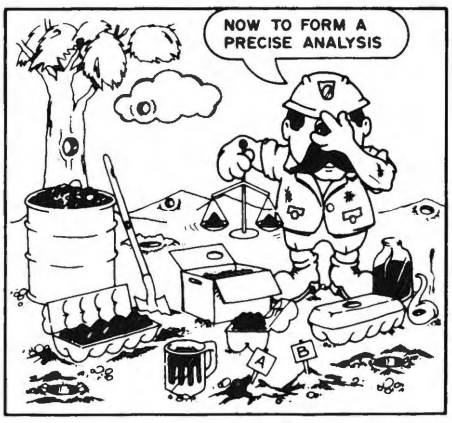
UGMS, in cooperation with the U. S. Bureau of Mines, has studied uranium and fluorspar in the past and is planning a study on the occurrences of iron ore in the state.

ROCKY RIDGES

by Greg McLaughlin







REVEALS MAJOR OVERTHRUSTING

Uinta North Flank Well Abandoned

American Quasar Petroleum No. 1 Cow Hollow, NW¼NW¼ sec. 17, T. 2 N., R. 11 E., Summit County, drilled to 18,922 feet in the Jurassic Morrison Formation, was abandoned in November 1975 as a deep, expensive dry hole. But the structural information revealed by the well may send geologists back to their drafting tables for a restudy of the area.

The test was about two miles north of the projected (but concealed) trace of the Uinta overthrust which separates the Uinta Mountain uplift from the Green River Basin. Drilling commenced on July 31, 1974, and operations officially ended November 10, 1975.

The well penetrated glacial deposits and Tertiary formations to 4,350 feet and then crossed an unconformity into the Triassic Thaynes Formation. It continued through a normal Triassic and upper Paleozoic section to 9,310 feet where a large overthrust fault was penetrated with Mississippian limestone and fault gouge on the upper Cretaceous Mesaverde Formation. The well then penetrated a normal stratigraphic section of Mesaverde, Hilliard (Mancos), Frontier, Aspen, Dakota, and Morrison Formations. At total depth the well reached 9,509 feet below sea level.

It is not known whether the unexpected mass of overthrust Triassic and Paleozoic formations represents a concealed extension of the Uinta overthrust sheet, a fault slice in front of the Uinta overthrust, a giant slide block detached from the Uinta Mountain uplift, or a thrust sheet which moved west to east over this part of the Green River Basin. Seismic evidence favors the last explanation.

GSA Field Trip Guidebooks Available

Two guidebooks produced by Dr. H. D. "Hank" Goode, Professor of Geology at the University of Utah, for the Geological Society of America field trips in October 1975 are available at the Utah Geological and Mineral Survey. *Great Salt Lake and Deposits of Lake Bonneville at Little Valley, Utah* (15 pages, $2.00) and *Environmental Geology of the Middle Wasatch Front* (22 pages, $3.00) were prepared as guides to one-day field trips and can be used to retrace the route followed by the GSA groups. Supply of both guidebooks is limited.

ELECTED REGIONAL PRESIDENT

Howard R. Ritzma, Assistant Director of the Utah Geological and Mineral Survey, has been elected president-elect of the American Association of Petroleum Geologists' Rocky Mountain Section for 1976-1977. He will serve as president of the group when it convenes in Salt Lake City in 1978.

AAPG is the largest geological organization in the world, and its Rocky Mountain Section covers ten western states and brings together eight local geological associations. There are about 3,500 members in these associations and about 2,275 AAPG members in the Rocky Mountain Section. Geologists in western Canada also participate in section meetings.

PROBLEM SLIDES

(continued from page 1)

count ten meetings and there have probably been more. Airplanes and helicopters have been employed to give many of these people an aerial view of the slide. Reports have been written and more reports have been called for.

The result of all this official activity? Some state funds have been provided for channel clearing, but thousands of dollars of federal money has gone for travel and meeting expenses and yet almost nothing spent to alleviate problems posed by the slide. The people of Manti are still waiting for action.

COMMON ENERGY EQUIVALENTS

Generalized comparisons of the heat content (Btu) of common energy sources.

	Approximate heat value
1 ton of bituminous coal	25 Mcf of natural gas 189 gallons of gasoline 4.17 barrels of crude oil
1 Mcf of natural gas	0.04 tons of coal (80 lbs.) 7.58 gallons of gasoline 0.17 barrel of crude oil (7 gals.)
1 gallon of gasoline	0.0005 ton of coal (10.56 lbs.) 0.132 Mcf of natural gas (132 cf) 0.022 barrel of oil (0.917 gal.)
1 barrel of crude oil	0.24 ton of coal (480 lbs.) 6 Mcf of natural gas 45.5 gallons of gasoline

Source: *Energy Perspectives*, Battelle Memorial Institute, September 1973.
cf = cubic feet; Mcf = 1,000 cubic feet; crude oil barrel = 42 gallons.

Units normally used in the U. S. for common energy sources and their interrelationships in terms of the Btu.

Source	Common measure	Equivalent	Approximate Btu[1] content
Coal	ton (short)	2,000 pounds	12,000-13,000/pound (bituminous) 25,000,000/ton (bituminous) 6,000,000/ton (lignite)
Natural gas	Mcf	One thousand cubic feet at standard conditions	1,000/cubic feet 1,000,000/Mcf
Gasoline	gallon (U. S.)	4 quarts (5.8 pounds)	132,000/gallon 22,800/pound
Oil (crude)	barrel	42 gallons (285 pounds) 6.8 pounds/gallon	6,000,000/barrel 144,000/gallon 21,000/pound

Source: *Energy Perspectives*, Battelle Memorial Institute, September 1973.
Btu = British thermal unit; Mcf = thousand cubic feet.
[1] A Btu is the amount of heat required to raise the temperature of one pound of water one degree Fahrenheit.

UGMS and MSU to Produce Rockhound Book

The Utah Geological and Mineral Survey and the Mineralogical Society of Utah are combining expertise in a UGMS bulletin designed to help the "rockhound" interests in Utah. The publication will have maps showing the locations of minerals, rock specimens, fossils, and gem material in Utah. Carlton H. Stowe, UGMS Mineral Information Specialist, is coordinating the project with Walter Elieson, MSU President. Although several MSU members are already hard at work at plotting gem, mineral, and fossil sites on maps, the publication date is still indefinite. Anyone wishing to contribute information to the project should contact Carlton Stowe at UGMS.

The Mineralogical Society of Utah will hold its annual gem and mineral show, May 21-23, 1976, at the National Guard Armory, 5189 South State Street, Murray, Utah.

American Mining Congress' Coal Show

The American Mining Congress held its 1976 Coal Show at Cobo Hall in Detroit, Michigan, May 10-13. The Utah Geological and Mineral Survey and the state of Utah Industrial Promotion Division teamed-up with display materials of Utah's natural resources, mineral activities, coal field information, and the potential for coal development.

Carlton H. Stowe, UGMS Information Specialist, represented the two agencies and handled inquiries on every facet of Utah's geological, mineral, and industrial resources. Of particular interest, he noted, were the UGMS Monograph Series 1, 2, and 3 on Utah coal fields. The convention was attended by over 20,000 people. The show emphasized the latest developments in coal mining machinery, equipment, and supplies to improve productivity, safety, and the environment. More than 400 exhibitors introduced products and services in the areas of coal exploration, mining, and processing.

DEEPEST WELL IN THE WORLD

Drilling of the deepest well in the world was completed in 1974 at Lone Star Producing, Baden No. 1, in Beckham County, Oklahoma. The record of 31,441 feet does not seem to be in danger of being surpassed.

The deepest well in the Rockies, Union Oil Company's test in the Hells Half Acre area of central Wyoming, reached 22,431 feet in March 1976. Union Oil is now testing gas shows at 20,214 feet.

Utah's record of 20,450 feet was set by Phillips Petroleum in a dry hole near Manti, Sanpete County, in 1974.

Utah's deepest production comes from Gulf Oil's Ute Tribal No. 1-34-Z-3 in the Altamont field of Duchesne County where oil flows from 17,732 feet.

DEEP ALTAMONT WELL DRY

A routine completion report filed by Flying Diamond Corporation revealed that the deepest well drilled to date in the Greater Altamont-Bluebell Field, No. 1 Mecham in sec. 7, T. 1 S., R. 4 W., Duchesne County, was a dry hole. The well was drilled to 18,750 feet on the north edge of the field near the bottom of the Uinta Basin syncline. At total depth the well was still in Eocene or Paleocene sediments (Wasatch? or Flagstaff?). Attempts to complete the well involved perforating 2 7/8-inch production liner run to 18,660 feet and acidizing and testing at depths ranging from 17,844 to 18,537 feet—the deepest operations of this sort attempted in Utah. The well was spudded (drilling began) September 20, 1973, reached total depth March 18, 1975, and was officially abandoned November 1, 1975.

OVERTHRUST BELT

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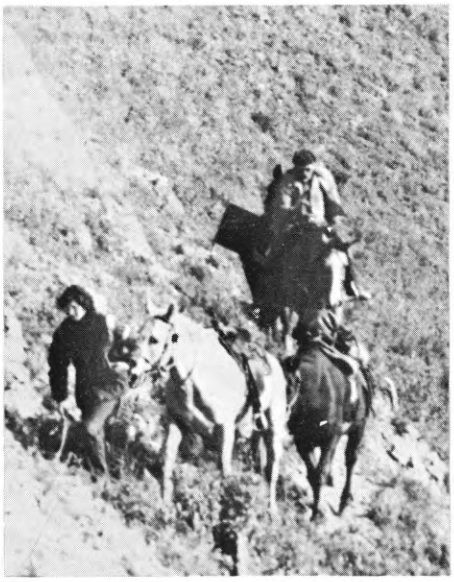

Above left: Seismic cables and geophones were packed by horses across remote areas. *Above right:* Horses and geophysicists struggle up a steep mountain side in southwestern Wyoming. *Bottom left:* Tents were used to shelter delicate recording instruments. *(photos courtesy of Mountain Fuel Supply Company)*

By the end of 1975 the two wells in the Pineview field had produced 225,000 barrels of oil and in early April 1976 were producing about 1,100 barrels per day. The Amoco discovery 40 miles to the north-northeast is reported to have 497 feet of gas-condensate "pay" sand as calculated from electric log analysis. The "pay" is the upper part of the Nugget

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OVERTHRUST BELT

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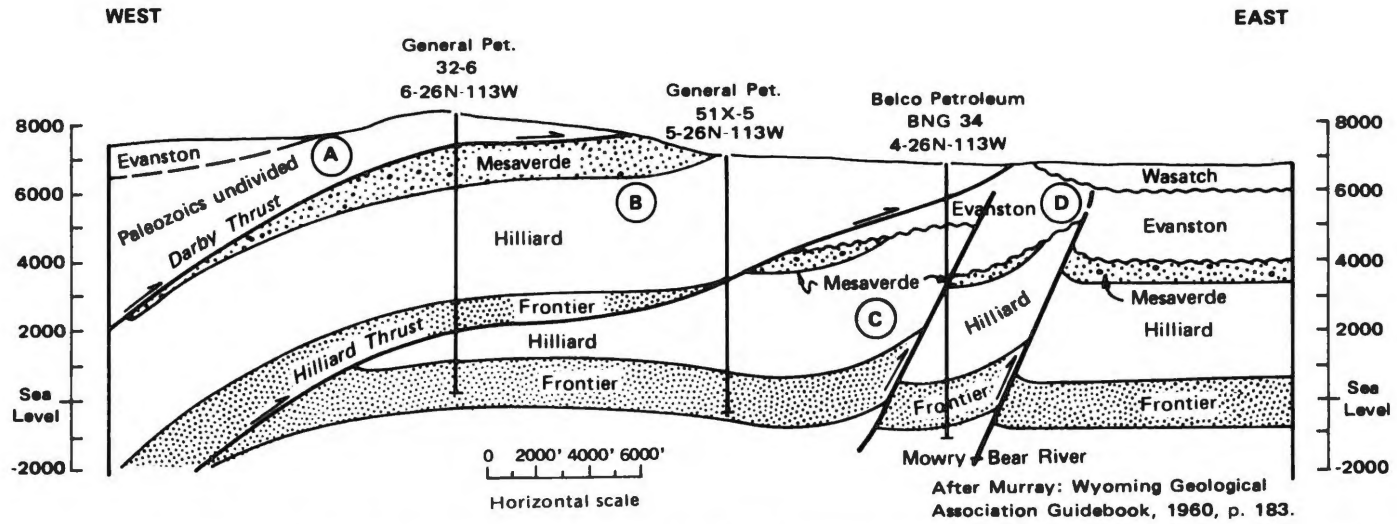

Section across Hogsback-LaBarge area of Greater Big Piney-LaBarge field illustrates overthrust block (A), intermediate block (B), and subthrust or basin block (C). High angle thrusting concealed by younger sediments at (D).

Sandstone, which is 827 feet thick in the well.

National attention has been focused on the two discoveries in this area known as the "overthrust belt." The overthrust belt is a geologic province that extends southward from western Canada through western Montana, eastern Idaho, western Wyoming and into northeastern Utah. It swings sharply around the west end of the Uinta Mountains and continues southward and westward through Utah, crossing Washington County and extending into southern Nevada. In some areas the belt is distinct and easily seen. Elsewhere it is covered by younger sediments and volcanic rocks or obscured by younger structures.

The complex structure of the overthrust belt has been a challenge to petroleum explorationists for decades. It is

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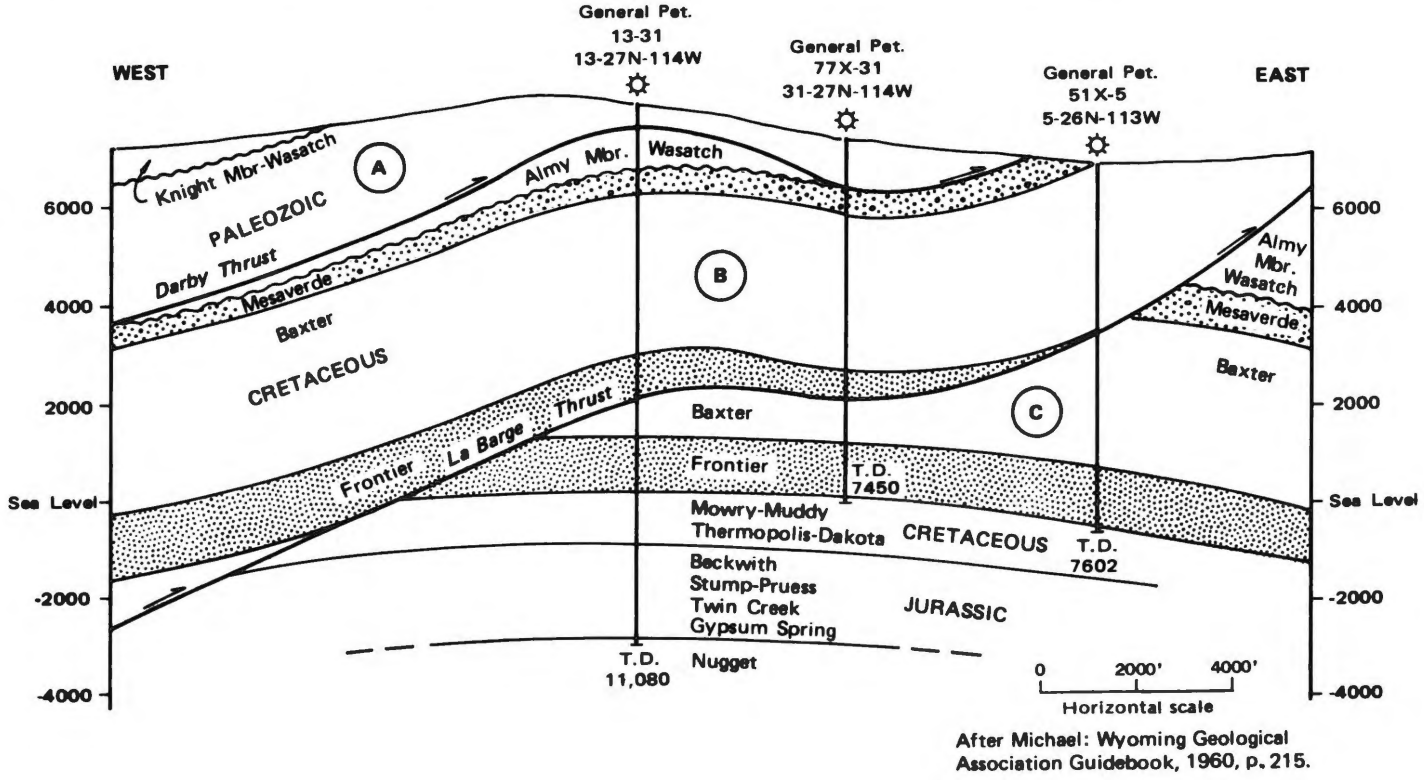


Section across Hogsback unit (generalized) of Greater Big Piney-LaBarge field showing overthrust block (A), intermediate block (B), and subthrust or basin block (C). Note undulating fault planes.

OVERTHRUST BELT

(continued from page 6)

characterized by multiple, low angle, overthrust faults, most west-dipping but some nearly flat-lying. In places the fault surfaces are gently undulating. The general dip of the faults is to the west, the direction from which they moved. The thrust sheets may be visualized like a stack of overlapping shingles. Much of the already complex thrust structure may be complicated even more by higher angle thrust faults or normal faults.

The distance these overthrust sheets have moved is measurable in tens of miles, in some instances as far as 50 to 70 miles. Most of the plane along which the movement took place is a soft, easily deformed shale that (with water) has acted as a lubricant on which the great thrust mass could slide. The uppermost thrust sheet in a particular area is usually referred to as the overthrust sheet or block. Beneath this may be one or more intermediate sheets or blocks, and beneath these a stable or in-place basin or subthrust block. In drilling a well in the overthrust belt, groups of formations may be repeated several times, and careful geologic well-site work is needed to keep the operation from getting "lost." Oil and gas may be found in several blocks–overthrust, intermediate, subthrust–or in all. The Amoco discovery well has apparently found a major gas-condensate field in the overthrust Jurassic Nugget Sandstone at about 7,450 feet. However, drilling continues and will test the Cretaceous Frontier Formation in the intermediate block below the Absaroka Thrust at about 14,500 feet. How deep the well might have to go to test the subthrust beneath the Darby Thrust is not known.

The discoveries in the overthrust belt have triggered leasing all the way from Montana to southern Utah. The area of most leasing activity is in southwest Wyoming and adjacent Utah and Idaho. The first leases have involved hundreds of thousands of acres, mostly federal lands. Extensive leasing of private and state lands has also proceeded at a brisk pace. Idaho, which still does not have any oil production, has suddenly found itself involved in a leasing boom in its eastern counties. Reports credit Amoco with 600,000 acres in Utah and Wyoming under lease and option. Holdings by Chevron are about 180,000 acres. Hundreds of thousands of acres have been leased by other companies and lease brokers in all three states.

Although the overthrust belt oil play is new and exciting in 1976, the area is a historic one in Rocky Mountain oil annals. Oil seeps in southwest Wyoming, most along the overthrust faults, were known by Jim Bridger in the 1840's and were exploited by pioneer wagon trains as a source of lubricating oil and medicine. The *Latter-Day Saints Emigrant's Guide* published in 1848 gave an account of one such oil spring or seep.

The Spring Valley oil field was discovered in 1900 and the LaBarge field in 1924. The discovery of major gas and oil reserves, which grew into the Greater Big Piney-LaBarge field, resulted from drilling in the late 1940's and in 1950 and 1951. Twenty-five years later the new surge of activity centers in the area where seeps were skimmed for oil more than a century ago.

Geophysical activity has also greatly accelerated in the overthrust belt. Some of the work is being conducted in extremely rough terrain. One large seismic program has employed horses and mules to traverse remote back country. Fleets of snowmobiles have been used to keep operations moving through the winter months.

In early April 1976 major drilling within the overthrust belt was as follows:

	Drilling wells	Announced locations
Wyoming		
Lincoln County	5	2
Uinta County	3	14
Utah		
Summit County	6	5

One location was tentatively announced for Bonneville County, Idaho. Locations were expected to be announced for Rich and Morgan Counties, Utah, the first oil and gas tests ever in these Utah counties.

The overthrust belt oil and gas play shows great promise for the future economic well-being of the region. Because the new gas reserves are close to existing pipelines and less than 100 miles from the Salt Lake Valley, many years of future supply of this precious fuel resource are assured.

INSTRUMENT PLATFORM

UGMS Installs Tower in Lake

On April 19 a Bell-214 helicopter lifted a 40-foot high steel tower, weighing two tons, from a vacant lot next to the Utah Geological and Mineral Survey's shop at 2176 West 2300 South and set it down at a preselected location in Great Salt Lake. The tower had been constructed by Walter M. Katzenberger of the UGMS staff to serve as a fixed platform on which to mount instruments that will record continuous measurements of winds, waves, currents, temperatures, precipitation, evaporation, and other characteristics of the lake environment. Because of the increasing recreational and industrial use of Great Salt Lake, UGMS is striving to supply the greatest range of information possible to assist future planning.

The cost of the tower was paid by state funds that the 1975 legislature appropriated to the Division of Great Salt Lake and that were, in turn, given to UGMS to build the tower. In the next issue of *Survey Notes* we will feature a report on the tower project.

Tower is airlifted to Great Salt Lake. *(photo courtesy of Salt Lake Tribune)*

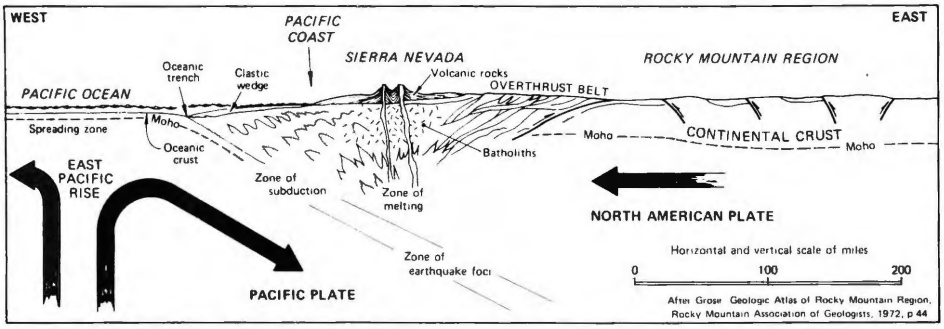
MOVING PLATES TRIGGER THRUSTS

Plate tectonics theory provides an explanation for the formation of the remarkable overthrust belt that extends from northern Alaska to Central America. It is a controversial explanation but here goes.

The belt is conceived to have been formed by the gigantic compressive forces of the North American plate moving from east to west against the Pacific plate on the west. The North American plate is visualized as overriding the Pacific plate, which moves downward beneath it in the subduction zone (left side of accompanying illustration). The rigid continental crust of the North American plate tends to rupture, its greatest mass being thrust under the shingle-like slivers of overthrust material that resist the westward movement of the plate. Thus, the overthrust belt is only a thin-skinned manifestation of the ponderous movements of the earth's crust and mantle.

This compressive geologic episode is thought to have lasted from late Cretaceous through middle Eocene time, from 90 to 50 million years before the present. The accompanying illustration is "frozen" in early Eocene time when the overthrust belt stopped moving. In western Wyoming, younger Eocene sediments are found flat-lying across strongly folded and faulted older sediments.

Plate tectonic theory further envisions fragmenting and continued westward drifting of the western part of the North American plate with the formation of the Basin and Range structure (not shown) of the Great Basin between today's Wasatch Mountains and Sierra Nevada.



Conjectural section showing the formation of overthrust belt in the context of plate tectonic theory (Eocene time, 50 million or so years ago).

State of Utah—Department of Natural Resources
UTAH GEOLOGICAL AND MINERAL SURVEY
606 Black Hawk Way
Salt Lake City, Utah 84108

Address Correction Requested

GSL LAKE LEVELS

Great Salt Lake levels recorded (in feet above sea level) by the U.S.G.S. are:

Date	Boat harbor (south arm)	Saline (north arm)
February 1	4,200.80	4,199.20
February 15	4,201.10	4,199.40
March 1	4,201.20	4,199.60
March 15	4,201.50	4,199.70
April 1	4,201.65	4,199.85
April 15	4,201.85	4,200.05

The level of the south arm stood 1.25 feet higher on April 15, 1976, than on the same date in 1975.

CORRECTION

The price we reported for *Roadside Geology of U. S. Interstate 80 between Salt Lake City and San Francisco* in the previous issue of *Survey Notes* (February 1976, Vol. 10, No. 1) should have been $3.00 plus 5% for handling. The book is sold by Varna Enterprises, P. O. Box 2216, Van Nuys, CA 91404.

UTAH GEOLOGICAL AND MINERAL SURVEY
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