UTAH GEOLOGICAL AND MINERALOGICAL SURVEY

QUARTERLY REVIEW

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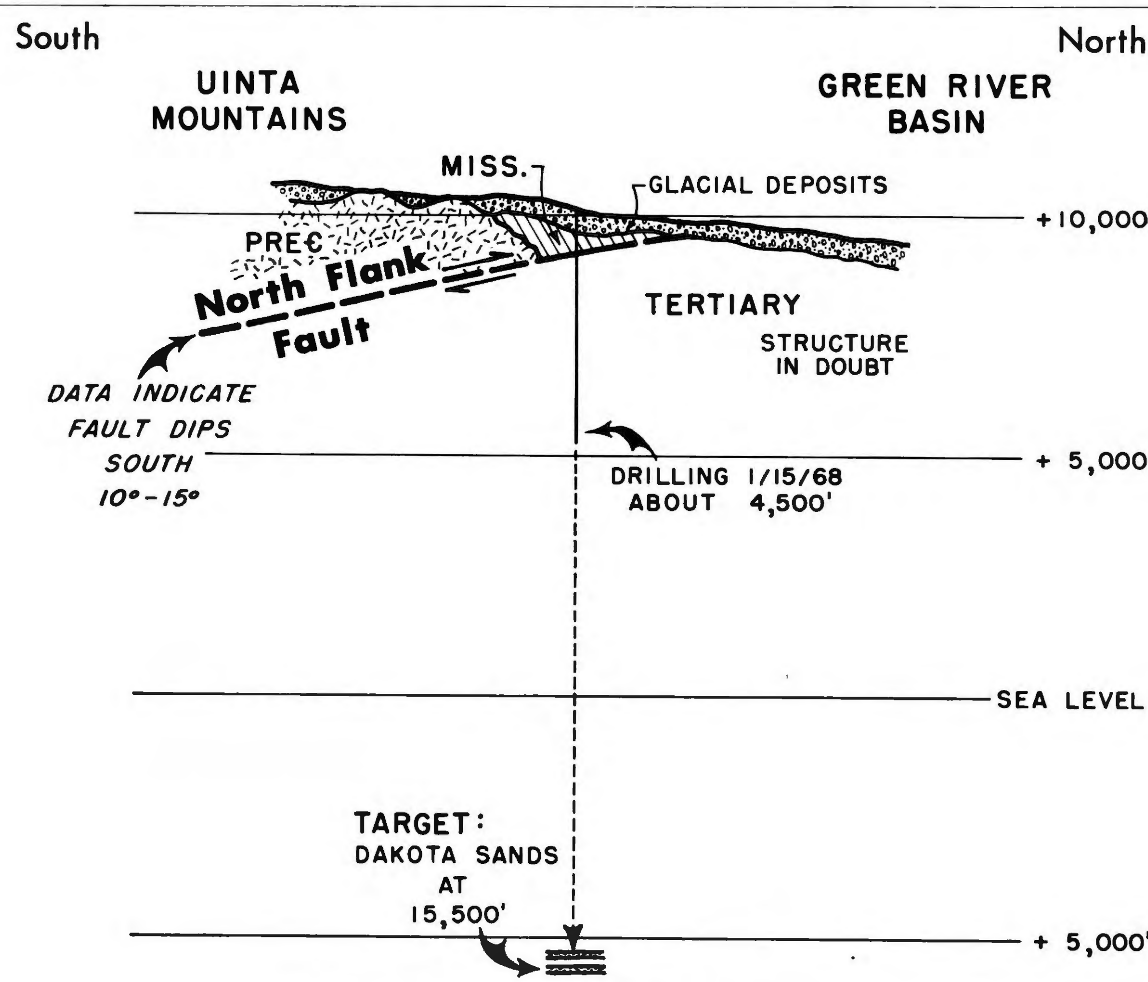
Shell Drills 4 Miles From Wilderness

Shell Oil Company has confirmed drilling information released in the last *Quarterly* relative to the significant Shell No.1 Dahlgreen Creek Unit test in Summit County, Utah.

The well is located 3.5 miles southwest of the Bridger Lake Oil Field and about 1 mile south of the projected trace of the North Flank Fault. This is about *4 miles north of the boundary of the proposed High Uintas Wilderness area.*

From information released by Shell, the Utah Geological Survey concludes the test spudded in Quaternary glacial deposits, entered Madison Limestone (Mississippian age) at 445 feet, and crossed the North Flank Fault at 815 feet. Beds beneath the fault are believed to be Tertiary in age.

As shown in the accompanying cross section, the fault definitely can be tagged an overthrust, and, based upon the projected surface trace and one point of subsurface control, appears to dip southward under the Uinta Mountains at a very low angle, perhaps 10° to 15°. Thus oil-bearing formations of the Green River Basin may extend to the south for many miles beneath the overthrust sheet.



SHELL OIL COMPANY
No. 1 DAHLGREEN CREEK
SE,NE,NW, SEC. 9, 2N., 14E.

SURVEY PROBES ASPHALT RIDGE

Explosions reverberating across the hills and valleys south of Vernal in mid-July accompanied the Survey's probe of the deep-seated structure of the Asphalt Ridge.

The reflection seismograph program was carried out by Petty Geophysical Engineering Company, under contract to the Utah Geological Survey.

Data were recorded from 36 shot holes, evenly spaced along three lines having a total length of nine miles. Two northeast-southwest lines were shot at right angles to the strike of Asphalt Ridge; a connecting line paralleled the ridge along its base. One of the northeast-southwest lines was extended to the south edge of the Ashley Valley Oil Field. There, depth control was obtained from a 7,366-foot well that tested this structure to the Madison Limestone (Mississippian age).

Techniques used in seismic exploration for petroleum were employed. Shot holes were drilled about 1,320 feet apart to a depth of approximately 120 feet. Average explosive charge per shot hole was 50 pounds, and a little more than one ton of dynamite was used for the whole program. Records were obtained from depths exceeding 24,000 feet.

As interpreted, seismic data disclose that Asphalt Ridge is underlain by a major northeast-dipping overthrust fault (see geologic section), concealed by post-fault Tertiary sediments, probably the Green River Formation of Eocene age, overlying a postulated unconformity.

A broad, gentle anticline can be discerned in the beds beneath the plane of the thrust. Strike of the fault is about N. 70° W. The axis of the anticline closely parallels this, indicating the fold probably is a companion structure related to overthrusting. Depth of the Precambrian "basement," beneath the thrust and to the southwest, is about 20,000 feet below sea level.

The concept of an unconformity at the base of the Green River Formation is supported by UGMS surface geologic mapping in 1967.

Deep-seated thrusting probably is reflected upward to the surface by a zone of fracturing and small-scale faulting of random displacement. This zone controls the drainage course of Walker Hollow and the 90° zig-zag bend in the Green River through the north half of T. 6 S., R. 22 E.

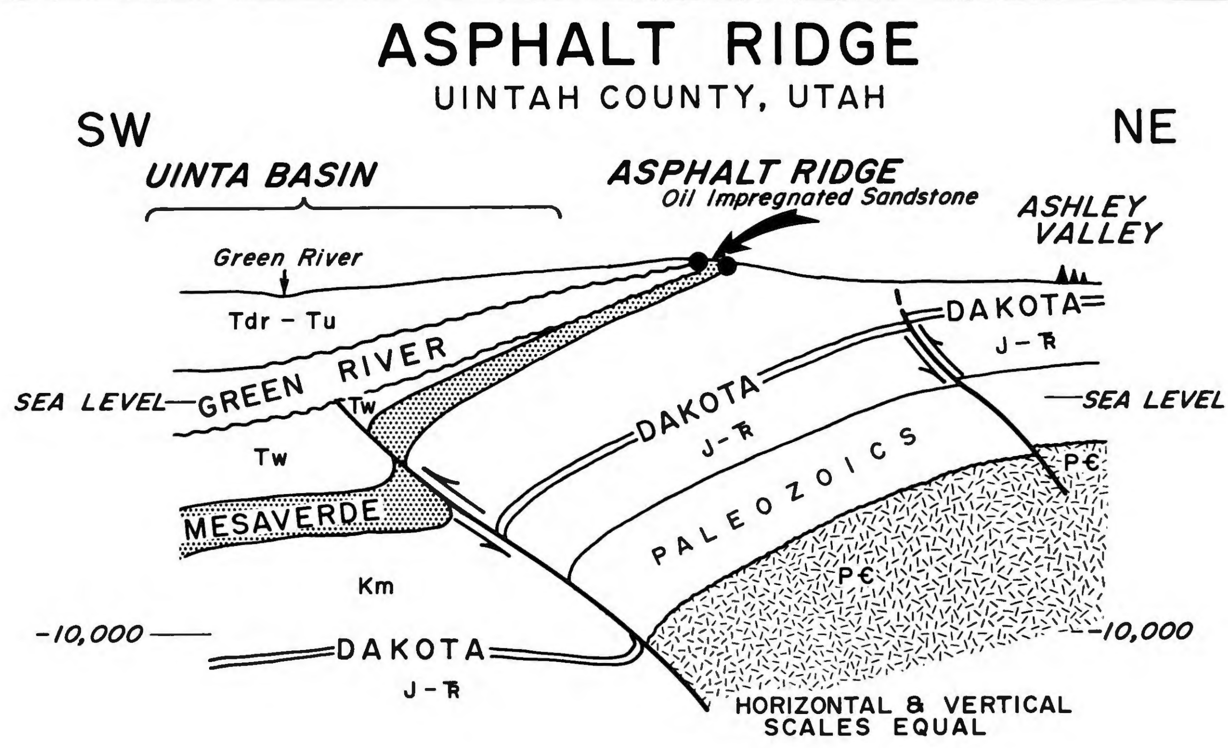
Results of the seismic survey strongly suggest overthrusting exists beneath the entire south flank of the Uinta Mountains and along subsidiary folds, such as Blue Mountain Anticline.

Deep exploratory drilling has proved overthrusting along the south flank of Blue Mountain (Willow Creek) Anticline, five miles east of the Utah boundary in Colorado.

Structural concepts developed by this program are expected to figure importantly in petroleum exploration in future years. Faulting of this kind and associated fracturing and jointing also may have provided conduits for migration of petroleum from depth to form the many deposits of oil-impregnated standstone scattered along the north margin of the Uinta Basin from Tabiona, through Whiterocks, Asphalt Ridge and Raven Ridge.

Surface reconnaissance has turned up one sizable and one minor deposit of oil-impregnated sandstone previously unmapped.

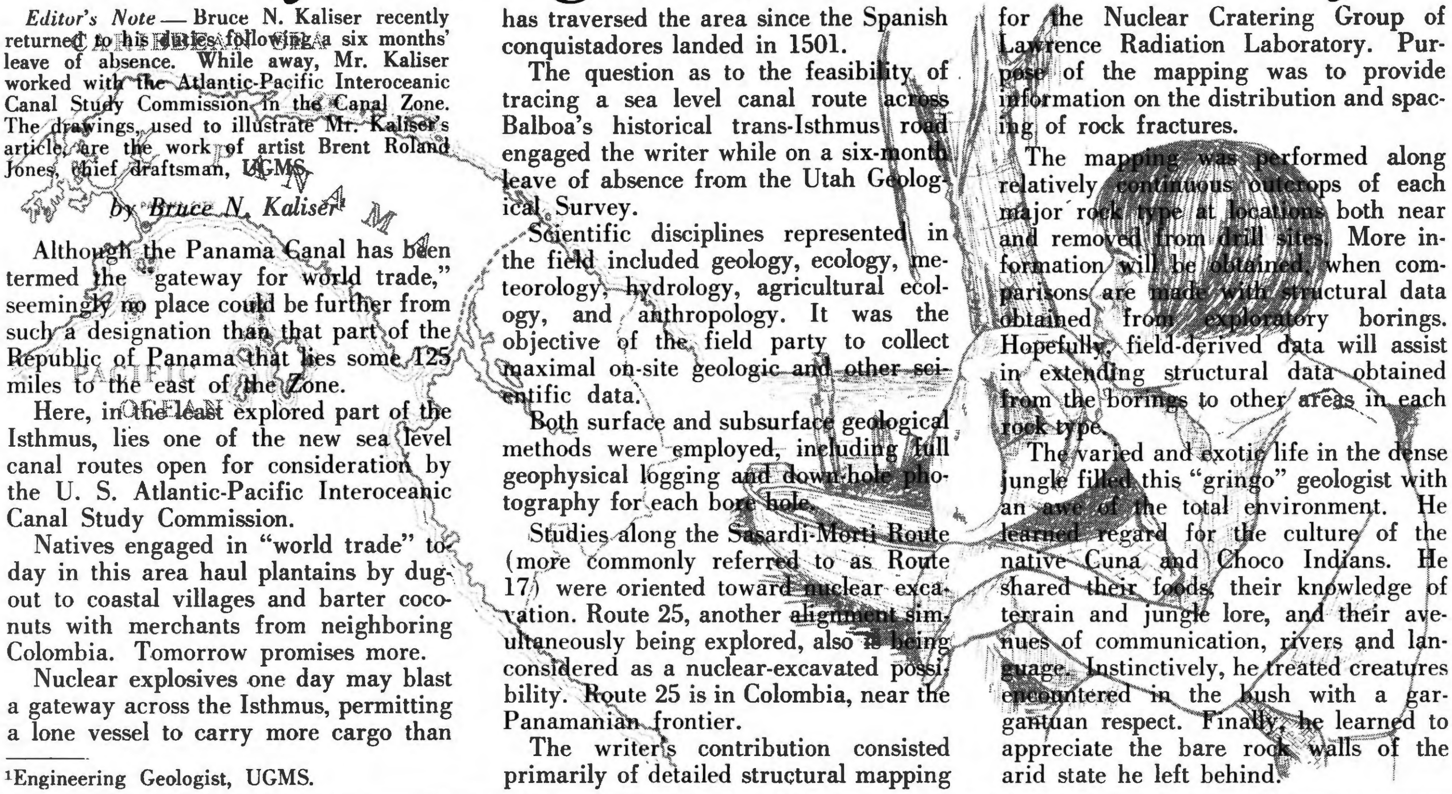
The seismic program and surface mapping were directed by Howard R. Ritzma, UGMS. J. Wallace Gwynn and Wayne Jones assisted with the field work.



Southwest to northeast cross section, southeast Asphalt Ridge, Uintah County, Utah. Based on a combination of surface, subsurface, and seismic data.

NUCLEAR CRATERING?

Survey Geologist Ends Canal Study



Editor's Note — Bruce N. Kaliser recently returned to his duties following a six months' leave of absence. While away, Mr. Kaliser worked with the Atlantic-Pacific Interoceanic Canal Study Commission in the Canal Zone. The drawings, used to illustrate Mr. Kaliser's article, are the work of artist Brent Roland Jones, chief draftsman, UGMS.

by Bruce N. Kaliser[1]

Although the Panama Canal has been termed the "gateway for world trade," seemingly no place could be further from such a designation than that part of the Republic of Panama that lies some 125 miles to the east of the Zone.

Here, in the least explored part of the Isthmus, lies one of the new sea level canal routes open for consideration by the U. S. Atlantic-Pacific Interoceanic Canal Study Commission.

Natives engaged in "world trade" today in this area haul plantains by dugout to coastal villages and barter coconuts with merchants from neighboring Colombia. Tomorrow promises more.

Nuclear explosives one day may blast a gateway across the Isthmus, permitting a lone vessel to carry more cargo than has traversed the area since the Spanish conquistadores landed in 1501.

The question as to the feasibility of tracing a sea level canal route across Balboa's historical trans-Isthmus road engaged the writer while on a six-month leave of absence from the Utah Geological Survey.

Scientific disciplines represented in the field included geology, ecology, meteorology, hydrology, agricultural ecology, and anthropology. It was the objective of the field party to collect maximal on-site geologic and other scientific data.

Both surface and subsurface geological methods were employed, including full geophysical logging and down-hole photography for each bore hole.

Studies along the Sasardi-Morti Route (more commonly referred to as Route 17) were oriented toward nuclear excavation. Route 25, another alignment simultaneously being explored, also is being considered as a nuclear-excavated possibility. Route 25 is in Colombia, near the Panamanian frontier.

The writer's contribution consisted primarily of detailed structural mapping for the Nuclear Cratering Group of Lawrence Radiation Laboratory. Purpose of the mapping was to provide information on the distribution and spacing of rock fractures.

The mapping was performed along relatively continuous outcrops of each major rock type at locations both near and removed from drill sites. More information will be obtained when comparisons are made with structural data obtained from exploratory borings. Hopefully, field-derived data will assist in extending structural data obtained from the borings to other areas in each rock type.

The varied and exotic life in the dense jungle filled this "gringo" geologist with an awe of the total environment. He learned regard for the culture of the native Cuna and Choco Indians. He shared their foods, their knowledge of terrain and jungle lore, and their avenues of communication, rivers and language. Instinctively, he treated creatures encountered in the bush with a gargantuan respect. Finally, he learned to appreciate the bare rock walls of the arid state he left behind.

[1]Engineering Geologist, UGMS.

OIL-IMPREGNATED SANDSTONE SOUGHT

Three field parties under the direction of Howard R. Ritzma, Petroleum Geologist, UGMS, devoted the summer to a search for new oil-impregnated sandstone deposits.

Areas of search included:

- Northeast Uinta Basin;
- San Rafael Swell, Capitol Reef, San Rafael - Green River Desert areas;
- "Tar-sand triangle" between Dirty Devil and Colorado Rivers, north of Hite Marina, at inlet end of Lake Powell;
- Miscellaneous localities in southern Utah.

As the result of the extensive summer field work the number of known deposits rose from 33 to 45 at summer's end, with leads on four or five more.

Assisting in the project were Wallace Gwynn and William Dalness, field party chiefs, Wayne Jones, Craig Bean, and Alan Pratt, field party chief in the Circle Cliffs area.

One sizable new deposit (the Rim Rock deposit) was discovered in northeast Uinta Basin, within sight of U.S. 40 and the giant Red Wash Oil Field. Findings established that Raven Ridge, in the northeast corner of Uinta Basin, extends for 13 miles from northwest to southeast pushing into Colorado.

Reconnaissance mapping in the area between the Colorado and Dirty Devil Rivers revealed three new deposits, two of which are large and important, and established the large size of another deposit, previously known only from casual reference in the literature.

Although many of the new discoveries appear to be of small size and minor commercial value, several may provide teasing clues to the presence of concealed oil and gas deposits. Much basic information on migration and entrapment of oil was gathered, particularly on the importance of faults, fractures and joints as controls in migration. Field work in northeast Uinta Basin also indicates probable major revision of published stratigraphic and structural concepts in that area.

Deposits of oil-impregnated sandstone fall into two principal groups, in situ and migrated. The in situ deposits are oil fields trapped close to where the oil originated. These traps have been exposed by erosion. Typical of these are the giant P. R. Springs and Sunnyside deposits on the south flank of the Uinta Basin. Migrated deposits are those formed by the rupture of deep-seated oil traps. Such ruptures allow the oil to "leak" to the surface where it is presently found. Most of the deposits on the north flank of the Uinta Basin — Tabiona, Whiterocks, Asphalt Ridge, and Raven Ridge — are thought to be migrated deposits.

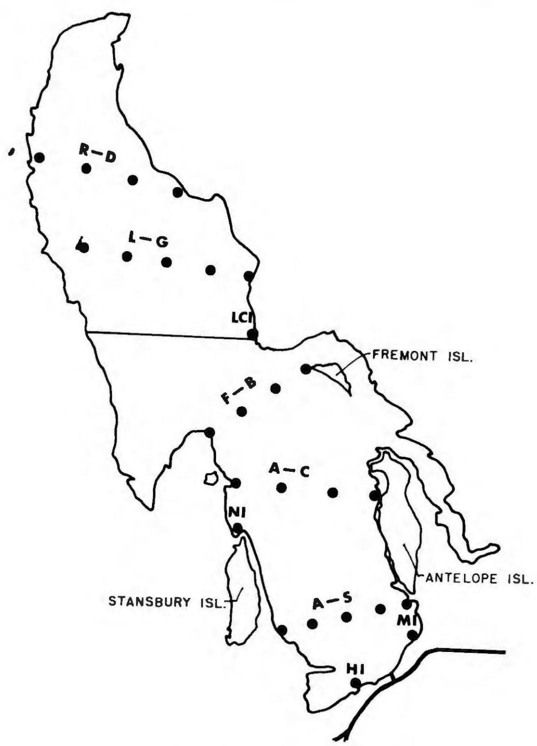
Of great importance was the field investigation conducted by Mr. Pratt in the Circle Cliffs area of central Garfield County. In addition to finding many small deposits, mapping of part of the middle Moenkopi Sandstone around Wagon Box Mesa has revealed what may be one of the largest "tar-sand" deposits in Utah. Limited time and funds prevented completion of this important work.

Field work has outlined about half of the deposits and has pointed out three areas covering nine deposits that need more detailed work. In the meantime, as time and weather permit, other deposits will be examined to insure that no major resources are overlooked.

Reserves of oil in oil - impregnated sandstones and limestones within the Uinta Basin probably total between five and eight billion barrels. Reserves in central-southeast Utah cannot be estimated on the basis of present information, but are without doubt as large as those of the Uinta Basin.

Lake Mineral Sampling Study

Although it has been known for years that the content of dissolved solids in Great Salt Lake is anything but uniform, it was the growing commercial interest in recovery of chemicals, other than sodium chloride, that gave birth to current research.



Great Salt Lake Sampling Sites

If recovery methods are to be effective, both the amounts of chemicals present in the lake's water and their distribution must be known.

Many factors influence the distribution and relative amounts of the several components and dissolved solids present in the lake. These include the increment of fresh water; evaporation rates; temperature fluctuations; wind-induced and density currents; basin configuration; organic effects; pollutants; amount of brine withdrawal by commercial operations; contributions from springs and subsurface sources; and particularly, possible effects of the Southern Pacific Railroad causeway.

Then, too, the lake is noted for its treachery. Fierce, sudden storms imperil any lake research.

All the same, perennial sampling of critical areas over a period of years was an obvious requirement; so, in 1963 the Utah Geological Survey, in cooperation with the Water Resources Division of the U. S. Geological Survey, began a series of investigations on a quarterly basis. Those initial results and conclusions have been published by the USGS (Handy and Hahl, 1963, 1964 and 1966) and Handy (1967).

Three years later (April, 1966) the Utah Survey began an independent program of sampling at monthly intervals. To date more than 1,000 samples have been taken for analysis. In order to make the results of sampling meaningful, sites (shown on the accompanying map) were selected for sampling at the indicated intervals.

The sample positions are described as follows:

—(LG) Little Valley Harbor to Gunnison Island Line — Station numbers 1, 2, 3, 4, and 5.

—(LCI) Lake Crystal Salt Company (mouth of intake canal).

—(FB) Fremont Island to Bird Island Line — Station numbers 1, 2, 3, and 4.

—(AC) Antelope Island to Carrington Island Line — Station numbers 1, 2, 3, and 4.

—(NI) National Lead Company (mouth of intake canal).

—(AS) Antelope Island to Stansbury Island Line — Station numbers 1, 2, 3, 4, and 5.

—(MI) Solar Salt Company (mouth of intake canal).

—(HI) Hardy Salt Company (mouth of intake canal).

—(RD) Rozell Point to Dolphin Island Line — Station numbers 1, 2, 3, and 4 (this line was established in July, 1967).

The present method of sampling has evolved through experience. Various bottle sampling techniques were tried but proved too cumbersome and slow. In May, 1967, a pumping system was successfully tried.

Now, a hand-operated pump with plastic coated parts is attached to the gunnel of the boat and to an ordinary garden hose, marked at one-foot intervals.

The pumping procedure provides:
- —Less contamination;
- —Faster operation;
- —More accurate temperature and density readings;
- —Less weight and bulk to handle and
- —Easier operation for personnel.

Although the pumping action entrains air into the sample, this is not known to be a disadvantage.

Each sample is analyzed in the Geological Survey Laboratory for the components listed. In addition, current, time, temperature, density and turbidity characteristics are noted.

From the results of analyses, average compositions of brines are being computed monthly for the north and south positions of the lake, and for each five-foot depth interval. Averages are weighted for area of influence of the station.

The results of plotting analytical data indicate periods of evaporation from the lake and areas of groundwater inflow. Averages are furnishing new data on the seasonal variation in the composition of the lake, and will lead to revised evaluation of the cause of this variation.

The above research, together with studies made in cooperation with the USGS and Morton Salt Company, are detailing the effects of the causeway, and particularly the growth and character of the salt cake on the lake bottom north of the causeway. These studies also are offering possible explanations for the dense brines found by Handy (1967) in the deeper portions of the south half of the lake.

IS GREAT SALT LAKE REALLY TWO?

*by Harry Suekawa**

The railroad causeway, built in 1957 to replace the old Lucin wooden trestle, essentially has divided the Lake into two very different parts.

The only effective "free flow" of brine between the northern arm and the southern arm is through two, 15-foot wide culverts.

As a result of this division, the north arm has reached — and, at times, surpassed — the saturation point in dissolved solids, while the south arm fluctuates in amount of dissolved solids and may even be losing some to the north arm. This condition of imbalance is due to unequal amounts of fresh water inflow into the separate arms.

The south arm is fed by the Bear, Jordan, and Weber Rivers and a considerable amount of groundwater. The only sources of fresh water inflow available to the north arm are Locomotive Springs and groundwater. Consequently, since the railroad fill was completed, brines from the south arm have been *and are now* a source of inflow to the north end.

Due to the greater amounts of inflow into the south arm, there is a difference in elevation between the two arms. The north arm is lower; so a surface current from south to north rushes through the causeway culverts. This current is variable in flow from season to season.

The strong current observed during the spring, summer, and fall seasons lessens in the winter. Another current was found to be flowing through the culvert, approximately six feet below the surface. However, this current *flowed in the opposite direction.* Apparently, the denser brine of the north end is flowing *beneath* the lighter waters from the south (mainly because of the hydrostatic head difference).

This phenomenon prompts an hypothesis that density stratification in the south arm is a direct result of en masse infiltration of dense water from the north sliding beneath the waters of the south arm. This seems to be an attempt by the lake to impose an equilibrium condition upon itself. A cooperative program, with the USGS, Morton Salt Company, and the UGMS participating, was begun in 1966 to determine just what overall effect the causeway has on the lake.

In addition to the study of lake waters in the immediate vicinity of the causeway (research done mostly by the USGS), the UGMS is trying to delineate the boundaries and characteristics of a dense layer of brine on the bottom of the south arm.

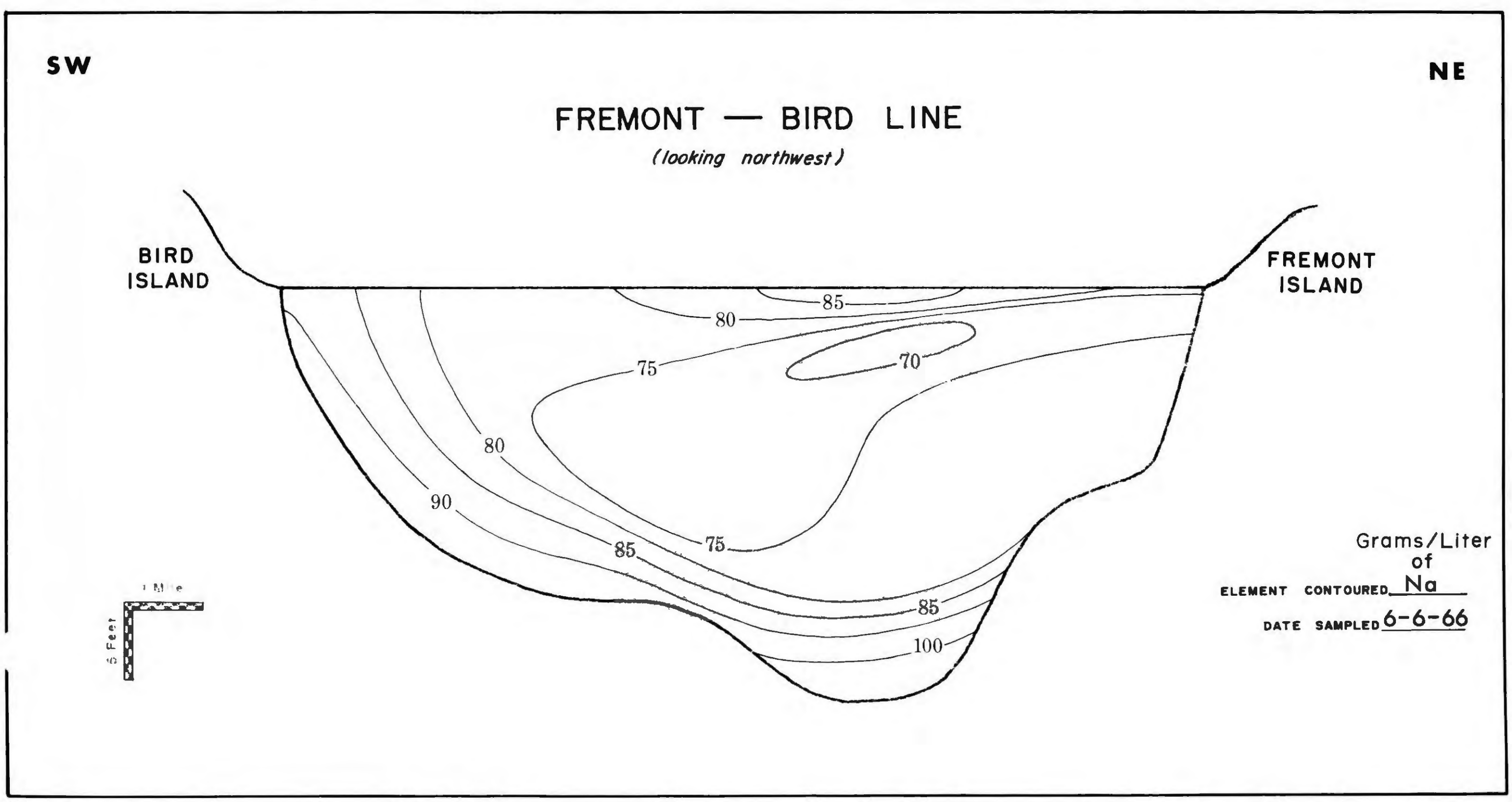
The fact that a layer of almost saturated brine exists over the bottom of the whole southern arm of the lake is difficult to accept. Any mixing of waters in such a shallow body of water should rule out such a possibility.

However, in almost every case where samples are taken from a bottom depth of 20 feet or more, the water shows a considerable increase in specific gravity and chemical constituents contrasting with the water immediately above. These bottom samples are of a murky brown color and smell of hydrogen sulfide. Temperature and water level changes during the year do not seem to affect the presence of this layer.

However, the layer does fluctuate both in vertical and horizontal directions. There is limited mixing at the interface, between the denser water and the typical water of the south arm. The dense water compares with water of the northern arm in ionic concentration versus specific gravity ratios.

It is thought that some relationship between the water of the northern arm and the causeway is causing this phenomenon in the south.

*Geologist, UGMS.



QUAKE DAMAGE YEARLY EVENT!

by Kenneth L. Cook[1]

During the past 15 years, Utah has experienced an average of nearly one damaging earthquake per year. This past year, one such earthquake occurred to maintain the average.

An earthquake is considered damaging, if (at least) dishes or windows are broken, plaster cracked, or bricks toppled from chimneys.

The damaging 1967 earthquake had an epicenter three miles north of the town of Marysvale, and occurred at 4:20 a.m., Oct. 4. The Richter magnitude was 5.5, according to the Wood-Anderson seismograph of the U. of U.'s Department of Geophysics.

That quake was felt over a wide area in southern Utah — to Dugway on the north, Green River on the east, Kanab on the south, and Milford on the west.

The temblor damaged plaster on a wall and dislodged bricks from the chimney of the LDS ward in Joseph; cracked plaster on a home in Elsinore; knocked bricks from chimneys in Monroe; and caused a small rockslide along the main highway in Marysvale Canyon.

Quakes are not new to this area, however. The epicenters of the recent quakes lie in the active Sevier-Tushar fault, along which there have been about 50 earthquakes in the last 115 years.

The largest quakes recorded were in Richfield in 1901 (Richter magnitude of 6.7) and in Elsinore in 1921 (two with Richter magnitude of 6.1), which did about $200,000 damage.

5-MONTH TALLY

Date	Location*	Approx. Magnitude*
Aug. 1	Near Strawberry Reservoir	
Aug. 2	Near Logan, Utah	<2.0
Aug. 2	Colorado	<3.5
Aug. 4	Colorado	<3.5
Aug. 4	Colorado	<3.5
Aug. 5	Green River Desert, Utah	<3.0
Aug. 7	Near Glen Canyon, Ariz., Utah Border	<3.0
Aug. 7	Near Glen Canyon, Ariz., Utah Border	<3.0
Aug. 8	Southwest Wyoming	<3.0
Aug. 9	Denver, Colo.	<5.3
Aug. 9	Southwest Wyoming	<3.0
Aug. 11	Southwest Wyoming?	<3.0
Aug. 11	Near Logan, Utah	<2.0
Aug. 12	Colorado	<3.0
Aug. 13	Near Logan, Utah	<2.0
Aug. 13	NE Idaho Area (3 aftershocks)	<4.0
Aug. 13	Near Price, Utah	<3.0
Aug. 14	Southwest Wyoming	<3.5
Aug. 16	Near Strawberry Reservoir	<3.0
Aug. 16	Near Logan, Utah	<2.0
Aug. 17	Colorado	<3.0
Aug. 17	Near Price, Utah	<3.0
Aug. 18	Colorado	<3.0
Aug. 18	Southwest Wyoming	<3.5
Aug. 18	Wyoming	<3.5
Aug. 19	Wyoming-Idaho Border—North of Logan	<3.5
Aug. 21	Near Logan, Utah	<2.0
Aug. 21	Near Logan, Utah	<2.0
Aug. 21	Near Logan, Utah	<2.0
Aug. 22	Near Logan, Utah	<2.0
Aug. 22	Wyoming-Idaho Border	<3.5
Aug. 23	Near Fillmore, Utah	<3.0
Aug. 23	Near Logan, Utah	<3.0
Aug. 24	Idaho-Wyoming Border	<3.0
Aug. 24	Near Logan, Utah	<2.0
Aug. 25	Colorado	<3.0
Aug. 25	Near Logan, Utah	<2.0
Aug. 27	Henry Mountain Area, Utah	<3.0
Aug. 29	South of Spanish Fork, Utah	<3.5
Aug. 29	South of Spanish Fork, Utah	<3.5
Aug. 29	Southwest Wyoming	<3.5
Aug. 30	Wyoming	<3.5
Aug. 30	Near Logan, Utah	<2.0
Aug. 31	Wyoming-Idaho Border	<3.0

NOTE: There were only 12 recognized rockbursts near Price, Utah, that were of significant size. These are not included in the above tally.

Date	Location*	Approx. Magnitude*
Sept. 1	NE of Thistle, Utah (3 poss. aftershocks)	2.2
Sept. 1	Near Thistle, Utah	2.0
Sept. 1	Near Castle Dale, Utah	2.5-3.0
Sept. 2	Near Huntsville, Utah	3.0
Sept. 3	Near Price, Utah	<2.0
Sept. 4	Yellowstone Nat'l Park	3.2
Sept. 5	Utah-Wyoming Border—ENE of Logan, Utah	2.5
Sept. 6	Near Richfield, Utah, Possible foreshock	2.0
Sept. 8	Near Fillmore, Utah	2.5
Sept. 8	Near Price, Utah	2.8
Sept. 9	Near Price, Utah	3.3
Sept. 11	Near Soda Springs, Idaho	3.0
Sept. 11	SE Idaho	3.0
Sept. 11	SW Wyoming	2.5
Sept. 12	Promontory Mountains	2.0
Sept. 12	Near Huntsville, Utah	2.2
Sept. 13	Salt Lake-Ogden Area	2.0
Sept. 14	Utah-Wyoming Border—East of Ogden, Utah	2.5
Sept. 15	Near Richfield, Utah—Possible foreshock	2.5
Sept. 16	SW Wyoming	2.7
Sept. 16	Salt Lake City, Utah	<2.0
Sept. 16	Near Fillmore, Utah	<2.3
Sept. 17	W of Enterprise, Utah (2 small aftershocks)	3.0
Sept. 17	Near Strawberry Reservoir	2.0
Sept. 18	Near Price, Utah	2.3
Sept. 18	Near Fillmore, Utah	2.5
Sept. 20	Near Castle Dale, Utah	2.6
Sept. 22	Near Heber City, Utah	2.0
Sept. 22	Terrace Mountains	3.3
Sept. 23	Central Idaho	3.3
Sept. 23	Bryce Canyon	2.3
Sept. 24	Magna, Utah — Felt in Salt Lake	Final 2.6
Sept. 24	Magna, Utah-Felt in Salt Lake (Cracked Plaster)	Final 3.0
Sept. 24	Terrace Mountains?	2.0
Sept. 24	Terrace Mountains	2.5
Sept. 25	Magna, Utah — Prob. aftershock	<2.0
Sept. 25	Magna, Utah — Prob. aftershock	<2.0
Sept. 25	Magna, Utah — Prob. aftershock	<2.0
Sept. 25	Magna, Utah — Prob. aftershock	<2.0
Sept 26	Magna, Utah — Prob. aftershock	<2.0
Sept. 26	Near Salt Lake City, Utah	<2.0
Sept. 29	Utah-Wyoming Border — East of Logan, Utah	2.3
Sept. 29	Near Richfield, Utah — Poss. foreshock	2.5
Sept. 30	Near Castle Dale, Utah	2.6

NOTE: There were only 8 recognized rockbursts near Price, Utah, that were of significant size. These are not included in the above tally.

Date	Location*	Approx. Magnitude*
Oct. 2	Southwest Wyoming	<2.8
Oct. 4	Marysvale Canyon, Utah Area (Prob. foreshock)	2.1
Oct. 4	Marysvale Canyon, Utah, 3 miles north of Marysvale, Utah. Damage to church in Joseph, Utah. Some Monroe and Joseph. Damage in Elsinore. Other areas reported minor damage. Seven felt aftershocks reported	Final 5.5
Oct. 4	Marysvale Canyon, Utah**	3.2
Oct. 4	Marysvale Canyon, Utah**	2.7
Oct. 4	Marysvale Canyon, Utah**	2.4
Oct. 4	Marysvale Canyon, Utah**	2.3
Oct. 4	Marysvale Canyon, Utah**	2.3
Oct. 4	Marysvale Canyon, Utah**	2.1
Oct. 4	Marysvale Canyon, Utah**	2.0
Oct. 4	Marysvale Canyon, Utah**	2.3
Oct. 4	Marysvale Canyon, Utah**	1.6
Oct. 4	Marysvale Canyon, Utah**	2.1
Oct. 4	Marysvale Canyon, Utah**	2.2
Oct. 4	Marysvale Canyon, Utah**	2.8
Oct. 4	Marysvale Canyon, Utah**	2.4
Oct. 4	Marysvale Canyon, Utah**	3.2
Oct. 4	Marysvale Canyon, Utah**	3.2
Oct. 4	Marysvale Canyon, Utah**	3.4
Oct. 4	Marysvale Canyon, Utah**	2.3
Oct. 4	Marysvale Canyon, Utah**	1.7
Oct. 5	Near Salt Lake City, Utah	1.0
Oct. 5	Marysvale Canyon, Utah	3.0
Oct. 6	Marysvale Canyon, Utah	1.8
Oct. 6	Near Utah Lake, Utah	2.0
Oct. 7	Marysvale, Utah	2.3
Oct. 7	Colorado	<3.0
Oct. 9	Marysvale Canyon, Utah	2.4
Oct. 9	Marysvale Canyon, Utah	1.7
Oct. 13	Near Price, Utah	<2.5
Oct. 16	Marysvale Canyon, Utah	1.7
Oct. 16	Near Logan, Utah	<2.0
Oct. 16	Southwest Wyoming	<2.8
Oct. 18	Near Logan, Utah	<2.0
Oct. 18	Northeast of Fillmore, Utah	<2.8
Oct. 18	Southwest of Levan, Utah	2.5-3.0
Oct. 19	Near Logan, Utah	<2.0
Oct. 20	Near Salt Lake City, Utah	2.1
Oct. 21	Near Marysvale Canyon, Utah area	2.5
Oct. 22	Near Marysvale Canyon, Utah area	2.1
Oct. 22	Southeast of Cedar City, Utah	<3.1
Oct. 22	Near Manti, Utah	2.0-2.5
Oct. 23	Near Moroni, Utah	<2.5
Oct. 24	Marysvale Canyon, Utah	2.5
Oct. 25	Near Salt Lake City, Utah	1.7
Oct. 25	Four rockbursts near Sunnyside, Utah measured from	2.6-3.3
Oct. 26	Near Logan, Utah	<2.0
Oct. 28	Marysvale Canyon, Utah	1.7

[1]Chairman, Department of Geophysics, University of Utah.

*The locations and approximate magnitudes given are preliminary determinations. The final determinations will be printed in the Seismological Bulletin published by the Department of Geophysics. This list was compiled by J. Larry Wilson, technician-analyst, Department of Geophysics, U. of U.

**Probable aftershock.

Reports Placed On Open File

Two reports of significance have been placed on open file and are available for inspection and reproduction in the offices of the Utah Geological Survey.

They are:

"Determination of Oil Shale Potential, Green River Formation, Uinta Basin, Northeast Utah," by H. R. Ritzma and de Benneville, K. Seeley, Jr., (Report of Investigation No. 37, November 3, 1967);

"Reflection Seismograph Survey, Asphalt Ridge Area, Uintah County, Utah," by Petty Geophysical Engineering Company, (unnumbered report, November, 1967).

The report discusses depositional pat- study of the Green River Formation, based on mechanical (electrical, gamma ray-neutron, etc.) logs, combined with lithologic information when possible. The paper's focus is on the western two-thirds of the basin where sections of the shale-rich Green River Formation are thickest. Depths of 2,000 to 4,500 feet to possible rich shale preclude exploitation by mining. However, in situ processes of converting kerogen in the shale o oil — particularly by some thermonuclear means — may be possible at safe depths.

The report discusses depositional patterns in the Green River and regional structural history. Seven thickness maps of the Green River Formation and its principal members are included.

In the main, the report supports proposals for deep-core drilling in the western Uinta Basin (see page 2).

Devastation of Caracas Wasatch Front Portent?

Last summer,* Caracas, Venezuela, was devastated by an earthquake that flattened dozens of buildings and claimed hundreds of lives.

Using the U. S. Uniform Building Code as a standard, Caracas is a Zone 2 seismic zone (on a scale from 0, no destruction, to 3, complete destruction).

All its structures were required to comply with earthquake resistive specifications comparable to those outlined in the American building code.

However, the quake caused pancake-collapsing of four high-rise apartment buildings, as well as destruction of many one- and two-story houses.

The state of Utah also falls within Zone 2. Its city buildings,** like those of Caracas, are based on California practice. Its buildings are not dissimilar to those of Caracas.

The magnitude of the Caracas temblor was moderate—6.5 on the Richter scale. Its epicenter, approximately 30 miles from the city, was believed to lie in the Caribbean.

History records four other ravaging Caracas quakes, which occurred between 1641 and 1900.

The period of time during which Utah's history has been recorded would encompass only one, the last, of these shocks. Earthquakes have exceeded a magnitude of 6.5 twice (1901, 1909) in this state's 130-year history.

The southern slopes of the Sierra de Avilla mountain range, which border Caracas on the north, are characterized by triangular facets, believed by many geologists to be a clear indication of recent fault displacement of considerable magnitude. Most of Utah's metropolitan population today can see similar truncated spurs on the western slope of the Wasatch Mountains.

Shaking and ground failure were responsible for the damage resulting from the Caracas earthquake. In addition, there were landslides—fortunately isolated in their occurrence. Although all structures were founded on alluvium in the Caracas Valley and on large alluvial fans along the Caribbean coast, intensity of destruction varied throughout the city. The unconsolidated sediments, which underlie most of the Wasatch Front—Utah's most populous area—could not be expected to behave in better fashion to seismic vibrations.

Obviously, recognizable similarities exist between the Wasatch Front and the Caracas region, but is recognition enough to assure the preservation of Utah communities?

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*July 29, 1967.

**The uniform Building Code has not been officially adopted. Architects conform to it in designing practice.

QUAKES — Continued

Oct. 30	Near Moroni, Utah	2.0-2.5
Oct. 31	Idaho-Wyoming Border — North of Logan, Utah	3.0-3.5
Oct. 31	Marysvale Canyon, Utah	1.7-2.0
NOTE:	There were only 12 recognized rockbursts near Price, Utah, that were of significant size. These are not included in the above tally.	
Nov. 1	Near Nephi, Utah	2.0-2.5
Nov. 1	West of Enterprise, Utah-Nevada Border	2.5-3.0
Nov. 1	Northwest Utah	2.0-2.5
Nov. 2	West of Enterprise, Utah-Nevada Border	2.5-3.0
Nov. 2	Near Nephi, Utah	2.0-2.5
Nov. 4	Near Ephraim, Utah	3.0
Nov. 8	Near Nephi, Utah	1.5-2.0
Nov. 8	Near Price, Utah	<2.0
Nov. 8	Near Nephi, Utah	2.0-2.5
Nov. 9	West of Enterprise, Utah-Nevada Border	2.5-3.0
Nov. 13	West of Enterprise, Utah-Nevada Border	3.8
Nov. 13	Near Logan, Utah	<1.0
Nov. 13	Near Salt Lake City, Utah	1.0-1.5
Nov. 15	Near Logan, Utah	1.0
Nov. 15	Southwest Wyoming	2.5-3.0
Nov. 16	Near Logan, Utah	1.0
Nov. 17	Near Logan, Utah	1.0
Nov. 17	Southwest Wyoming	2.0-2.5
Nov. 22	Near Salina, Utah	2.0-2.5
Nov. 24	Southwest Wyoming	2.0-2.5
Nov. 26	Near Logan, Utah	1.0
Nov. 26	Near Dugway, Utah	1.0
Nov. 27	Denver, Colorado (felt over wide area, minor damage)	5.1
Nov. 27	Denver, Colorado (felt)	4.5
Nov. 27	Denver, Colorado	3.5
Nov. 28	North Central Utah	2.0-2.5
Nov. 29	Near Salt Lake City, Utah	1.0-1.5
Nov. 29	Near Green River, Utah	2.5-3.0
Nov.29	Ephraim, Utah	2.0-2.5
NOTE:	There were only 12 recognized rockbursts near Price, Utah, that were of significant size. These are not included in the above tally.	
Dec. 1	Southwest Wyoming, ESE of Logan, Utah	2.0-2.5
Dec. 3	Sunnyside, Utah	1.5-2.0
Dec. 3	Near Price, Utah	1.5-2.0
Dec. 4	Near Logan, Utah	1.0
Dec. 5	Near Marysvale, Utah	2.0-2.5
Dec. 6	Sunnyside, Utah	1.5-2.0
Dec. 6	Southwest Wyoming	2.5-3.0
Dec. 7	Huntsville, Utah (felt)	Final 3.5
Dec. 7	Huntsville, Utah	2.0-2.5
Dec. 7	Logan, Utah	1.0
Dec. 8	Near Gunnison, Utah	2.0-2.5
Dec. 9	Huntsville, Utah	Final 3.0
Dec. 10	Huntsville, Utah	2.0-2.5
Dec. 10	Huntsville, Utah	1.5-2.0
Dec. 10	Project Gas Buggy, near Farmington, New Mexico	5.3
Dec. 11	Near Sunnyside, Utah	1.5-2.0
Dec. 13	Near Levan, Utah	2.0-2.5
Dec. 14	Near Sunnyside, Utah	1.5-2.0
Dec. 15	Near Sunnyside, Utah	2.0-2.5
Dec. 15	East of Ogden, Utah, on Border	2.0-2.5
Dec. 18	California earthquake	5.5
Dec. 20	Near Salt Lake City, Utah	1.0-1.5
Dec. 20	Near Green River, Utah	1.5-2.0
Dec. 22	Soda Springs, Idaho	3.0-3.5
Dec. 22	West of Enterprise, Utah-Nevada Border	2.0-2.5
Dec. 22	North Central Utah	1.0-1.5
Dec. 24	Near Price, Utah	1.5-2.0
Dec. 24	Near Logan	1.0
Dec. 24	Near Logan	1.0-1.5
Dec. 27	Near Logan	1.0
Dec. 28	Near Heber City, Utah	1.5-2.0
Dec. 29	Northeast of Kamas, Utah, on Border	1.5-2.0
NOTE:	16 recognized rockbursts near Price, Utah, were not included in the above tally.	

Exciting reports from the southwestern part of the State tell of a significant oil discovery in Washington County.

Willard Pease Drilling Company, Grand Junction, Colorado, has drilled the well on "farm-out" from Buttes Gas and Oil of Oakland, California, and Lloyd Corporation, Los Angeles. The company is testing in SWNE Sec. 25 T. 40 S., R. 13 W., about 2.5 miles northeast of Toquerville.

The well was shut down for repairs at a depth of 4,333 feet. Upon re-entry it was found that oil had filled the hole to 2,033 feet. Reportedly the oil is 40° gravity and of very good quality. The operators are preparing to complete the well at a depth of about 4,600 feet.

Leasing activity in Washington County has quickened and a number of significant wildcat test wells are expected to be announced shortly.

The Utah Geological Survey has the following publications on sale in which various aspects of the geology of Washington County are discussed:

—Bulletin 70, Geologic Atlas of Utah, Washington County, $3.50.

—I.A.G. Guidebook, 1963, Guidebook to the Geology of Southwestern Utah, $9.00.

—Utah Geol. Soc. Guidebook No. 19, 1965, Geology and Resources of South-Central Utah, $5.00.

—Reprint 95, Regional Gravity Survey of the Hurricane Fault Area and Iron Springs District, Utah, by K. L. Cook and Elwood Hardman, 75¢.

Reprint 90 (50¢), a paper by Andrew Edmunds Kurie reprinted from the Geological Society of America Bulletin, contains a map which covers the drill site of the discovery and section A-A′ almost bisects the well site. A review of this paper in the *Quarterly*, November, 1967 discussed oil prospects and stated prophetically: "a number of hitherto unsuspected structural traps appear to exist along the fold."

QUARTERLY REVIEW

State of Utah ....*Calvin L. Rampton* *Governor*

University of Utah ......*James C. Fletcher* *President*

College of Mines & Mineral Industries ....*George R. Hill* *Dean*

Utah Geological & Mineralogical Survey ....*William P. Hewitt* *Director*

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Diggin's . . .

The Utah Survey hopes to publish as part of it's Special Studies series a part of the talks given during the Governor's Conference on Geologic Hazards and Federal Disaster Assistance recently held on the University of Utah campus.

These will include: "Cloudburst Floods As A Geologic Hazard," Ray E. Marsell, Professor Emeritus of Geology, U. of U.; "Earthquake Hazards in Utah," Kenneth L. Cook, Chairman, Geophysics, U. of U.; "Geologic Aspects of Foundation Damage," William P. Hewitt, Utah Survey Director; "Community Action and Natural Hazards," (with particular reference to California's attempts to solve them) Lloyd Cluff, Chief Engineering Geologist, Woodward, Clyde, Sherard and Associates, Oakland, California.

An excellent presentation on landslide hazards in Utah by Harry D. Goode, U. of U. Geology Department, will be covered in a UGMS bulletin dealing with "Landslides of Utah" by John Ford Schroeder, Jr.

The Utah Survey wishes to remind those planning field work in Utah in 1968 to advise, UGMS of their place of the interest, in order that information may be included in the May issue of the *Quarterly Review.*

The total amount of drilling for uranium in Utah for the year 1967 was 606,-000 feet, or 5.6 percent of the national total of 10,764,000 feet, according to a recent U. S. Atomic Energy Commission release.

Two of Utah's neighbors, Wyoming and New Mexico, accounted for 54.8 percent and 23.4 percent, respectively, of the national total.

Of the 10,674 feet of drilling in 1967, 51 percent was in search of new deposits and 49 percent was devoted to blocking out previously known ore bodies. The national total of surface drilling for 1966 was 4,200,000 feet.

Ore was found,* for the national net reserves increased by 7,000 tons of U_3O_8 after shipment in 1967 of ore containing 10,700 tons of U_3O_8. Estimated ore reserves for the nation, exploitable at $8 per pound of U_3O_8, stood at 148,000 tons of U_3O_8 at the end of the year.

*See *Quarterly Review,* August, 1967, page 4.

The U. of U. Chemistry Department's research division on chromatographic theory, long-time occupants of the Utah Survey Building's second floor, moved to new laboratories and offices Jan. 16.

Situated in a multimillion dollar structure north of the Ute Stadium, the chemists — postdoctorates, graduates and work-study students — now occupy four recently completed offices and three labs.

Several weeks earlier, the Civil Engineering Department vacated laboratories it occupied in the Utah Geological Survey Building.

Consequently, except for space allotted for a classroom, the entire building — one of the oldest and smallest on the campus — now is available to the Survey.

A fireproof map vault, a laboratory area and an office for the petroleum geologist have been readied on the first floor. The second floor is being remodeled to accommodate a drafting room, ladies' lounge, laboratories, and additional offices.

Better service to the public and better functioning of the now-scattered components of the Survey may be expected.

Bridger Lake Oil Field chalked up its one million-barrel mark early in December.

Five wells were producing by the end of November, and — upon completion of a pipeline outlet into Wyoming — the field is expected to show a significant increase in production during the early months of 1968.

Petroleum Information tentatively reports a total of 61 "wildcat" exploratory tests were drilled in Utah last year. Of these, 52 were unsuccessful and 9 were oil finds. No gas discoveries were made. The discovery ratio, 14.75 percent, was the highest in the Rocky Mountain region.

The total number of wells drilled for oil and gas in Utah during 1967 was 139 — 71 dry holes, 58 oil and 10 gas wells.

Activity, down slightly from that reported in 1966, showed a marked increase as the year ended.

During the month of December, the UGMS Analytical Laboratory conducted 356 analyses, of which 338 were brines and the remainder rock analyses.

The laboratory performed a total of 8,650 analyses during 1967, an average of 720 per month.** This was an increase of better than 140 analyses over the monthly average for the year previous.

**Addition of 105 standards would bring 1967's monthly average to 825 analyses.