UTAH GEOLOGICAL AND MINERALOGICAL SURVEY

QUARTERLY REVIEW

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Fossil Find Furnishes Link

by Richard A. Robison
Dept. of Geological and Geophysical Sciences, University of Utah

The recent discovery of some unusual fossils in northern Utah has an important bearing on the origin and history of animals related to starfish and sand dollars — and perhaps even man himself.

The similarity between a modern starfish and a modern man is remote. Nevertheless, biologists have long speculated that the phyla Echinodermata, which includes starfish and sand dollars, and Chordata, which includes man, probably had a common ancestry. This idea is based principally on a similarity of embryos and mode of embyro development.

Some animals are known to simulate the evolutionary history of their group during successive growth stages of one individual. Because of this feature it has been suggested frequently that the ancestral echinoderm may have looked like the youngest or dipleurulid embryological stage of certain living echinoderms. Dipleurulid embryos have an oval outline, bilateral symmetry, lack of appendages, and an untwisted alimentary tract that opens at opposite ends of the body. Perhaps the biggest criticism of the idea of a dipleurula-like ancestral echinoderm has been the fact that such an animal was unknown in the fossil record. It is of considerable significance, therefore, that abundant ancient dipleurula-like echinoderms recently were discovered in the Spence Shale of early Middle Cambrian age in northern Utah.

The initial discovery was made during the summer of 1968 by the author and James Sprinkle of the Department of Geology, Harvard University. At that time, the author was engaged in an investigation of basal Cambrian carbonates, and was sponsored by the Utah Geological and Mineralogical Survey. Further collecting and study were supported by a grant from the Research Committee of the University of Utah.

Several hundred specimens have been collected from three localities in the Wasatch Mountains. The primitive echinoderms have a flattened, ovoid, flexible skeleton with double-layered marginal frame, near-bilateral

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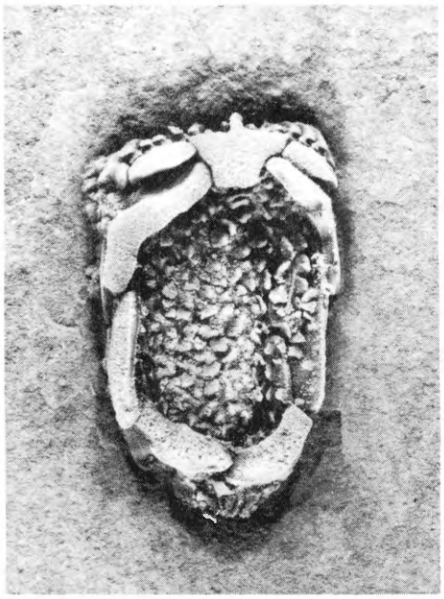


Specimens of *Ctenocystis utahensis* Robison and Sprinkle. Above, anterior view of comb-like feeding apparatus. Left, upper surface. Specimens photographed are latex casts and are enlarged X7½.

Soil Outcrops Scouted

Mapping and sampling of Utah's oil-impregnated sandstone deposits continued through the summer of 1969 with most work concentrated in the Uinta Basin. The project is now in its third year.

Mapping by J. Wallace Gwynn and Edward Dalton in the Hill Creek area of Uintah County extended this deposit from a dot on Map No. 25* (with a question mark doubting its location) to more than 100 miles of outcrop enclosing a 70-square-mile area. The Deep Creek deposit northwest of Vernal, thought to consist of several small sandstone outcrops in the stream valley, was found to extend through discontinuous outcrops for five miles to the west-northwest. The Dragon-Asphalt Wash deposit was determined to be an extension of the giant P. R. Spring deposit in southern Uintah County. Mapping of the Chapita Wells deposit disclosed a hitherto unrecognized gilsonite vein which apparently feeds oil into the sandstones. Reported deposits in Tooele and Sanpete counties were searched for but eluded definite discovery. Petroliferous limestone examined in Wales Canyon west of Wales in Sanpete County may be the basis of one such report. Several deposits of unknown size have been scouted and will be mapped in greater detail as time permits.

The Starr Flat deposit (sec. 24, T. 1 N., R. 3 W., Duchesne County) is now known to be nonexistent, and the South Whiterocks deposit was located three miles east of its previous place on the map because of a typographical error in the original source of data.

Howard Ritzma, Survey petroleum geologist, commented on the work: "We thought we would have the job almost completed by now, but we continue to find new deposits and significant extensions of known deposits. Oil on the outcrop in Utah is much more common than anyone dreamed."

*"Preliminary Location Map, Oil-Impregnated Rock Deposits of Utah," UGMS Map No. 25, dated April 1968.

NEW UGMS PUBLICATIONS

Three new publications have been released by UGMS in the last two months. They are:

Map 28, A ground magnetic survey of the Fountain Green-Moroni area in Sanpete County, Utah, prepared by Ralph T. Shuey, Dept. of Geological and Geophysical Sciences of the University of Utah. The map is 8½ x 11 inches, with a page of explanatory text on the back, and costs 50¢.

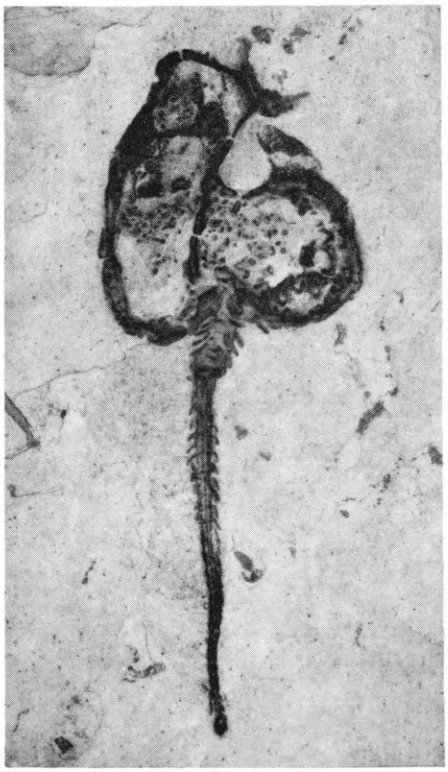
Special Studies 30, Subsurface brines and soluble salts of subsurface sediments, Sevier Lake, Millard County, Utah, by J. A. Whelan, professor of mineralogy, University of Utah. Price $1.00.

Water-Resources Bulletin 11, Reconnaissance appraisal of the water resources near Escalante, Garfield County, Utah, by Harry D. Goode, Dept. of Geological and Geophysical Sciences, University of Utah. This bulletin was published jointly by UGMS and Water Resources Division, Utah Dept. of Natural Resources, and costs $2.00.

These publications are available at 103 Utah Geological Survey Bldg., University of Utah, Salt Lake City, 84112.

(Continued from page 1)

symmetry, peculiar ctenoid feeding apparatus, and mouth and anus at opposite body poles. Lack of radial symmetry and presence of a marginal frame indicate a relationship with "carpoids" of the subphylum Homalozoa. They differ from members of known homalozoan classes, however, by having better symmetry, a distinctly different feeding apparatus, and a double- rather than single-layered frame. In a description published in *Science* by Robison and Sprinkle (November 1969), the animal was named *Ctenocystis utahensis* and was assigned to the new class Ctenocystoidea. The body plan of *Ctenocystis* more closely approaches the hypothetical ancestral dipleurulid echinoderm than any known fossil.



The oldest known stylophoran. An unnamed and undescribed specimen from the Spence Shale of northern Utah. X3½.

Two additional factors add to the significance of the Utah specimens. First, the new ctenocystoid and an associated undescribed stylophoran are the oldest known representatives of the subphylum Homalozoa. Secondly, morphologic studies have led some investigators to conclude that the ancestral echinoderm probably was a homalozoan. The greatest difficulty with the latter item is the fact that the oldest known echinoderm has been collected from rocks of Early Cambrian age and is not a homalozoan. The discovery in Utah of associated early Middle Cambrian ctenocystoids and stylophorans, both of which appear to be relatively specialized and quite distinct, indicates considerable prior evolution. Other homalozoans ultimately may be found in rocks as old as any now known to contain echinoderms.

A British paleontologist, R. P. S. Jefferies, recently proposed that the class Stylophora be assigned to the Chordata rather than to the Echinodermata, and that the higher chordates evolved from a stylophoran ancestor probably during the Late Cambrian. Considerable controversy has been provoked by these proposals. The newly discovered fossils from nothern Utah have an important bearing on the subject.

Quake Epicenters

General earthquake epicenters in or near Utah for January through August 1969, with dates of occurrence and approximate magnitude, are listed below. Unless otherwise indicated, localities are in Utah.

		Magnitude
JANUARY		
7	Salt Lake City area	1.0
15	Nevada Test Site (Winesken)	5.3
23	Emigration Canyon	2.0
30	Nevada Test Site (YISE)	4.6
	(26 rockbursts in January)	
FEBRUARY		
1	Eastern Ida. (42.0N 115.5W)	2.0
4	Southeast of Price	2.0
9	North of Sunnyside	2.0
12	Nevada Test Site	4.8
14	Salt Lake City (12 km SE)	2.2
16	South of Sunnyside	1.0
21	North of Cedar City	2.0
24	Salt Lake City	1.5
25	Eastern Ida. (43.9N 111.0W.)	3.6
26	South of Morgan	2.0
28	Southeastern Idaho	3.0
	(39 rockbursts in February)	
MARCH		
2	Southern Wyoming	1.5
6	Antelope Island region	1.5
7	Southeast Idaho	2.1
8	Promontory Point	1.5
8	Promontory Point	1.5
8	Promontory Point	1.5
13	West of Moab	4.1
20	Nevada Test Site (Barsac)	4.6
21	Nevada Test Site (37.08N 116.5W)	4.9
27	Southwest Utah	1.5
	(39 rockbursts in March)	
APRIL		
4	North of Vernal	2.0
4	South of Sunnyside	2.0
5	Eastern Ida. (43.1N 111.3W)	2.5
10	Richfield	3.5
10	Promontory Point	2.2
11	Near Park City	2.1
16	South of Hanksville	3.5
19	South of Sunnyside	2.0
22	Western Idaho (44.2N 114.5W)	4.9
25	Utah-Nevada border	2.5
26	Western Idaho	4.9
27	Western Idaho	3.7
30	Nevada Test Site	5.4
	(25 rockbursts in April)	
MAY		
1	Antelope Island region	1.5
2	Western Idaho (44.1N 114.7W)	3.6
4	South of Sunnyside	2.0
5	Western Idaho	4.4
7	Nevada Test Site (Purse)	5.7
7	Southern Wyoming	2.0
10	Southern Wyoming	2.0
11	Central Utah	2.0
19	East of Fruita	1.5
20	Southern Wyoming	1.5
23	Near Salina (39.0N 111.9W)	3.8
23	Near Salina (39.0N 111.9W)	3.0
25	Near Wanship	2.0
27	Nevada Test Site (Torredo)	5.0
	(32 rockbursts in May)	

(Continued on page 8)

Utah Court Rules on Water Rights

by Bruce N. Kaliser,
Engineering Geologist, UGMS

A recent Utah State Supreme Court decision dealing with water rights, filed September 16, 1969, may have a profound affect on adjudication of water rights in the State of Utah.

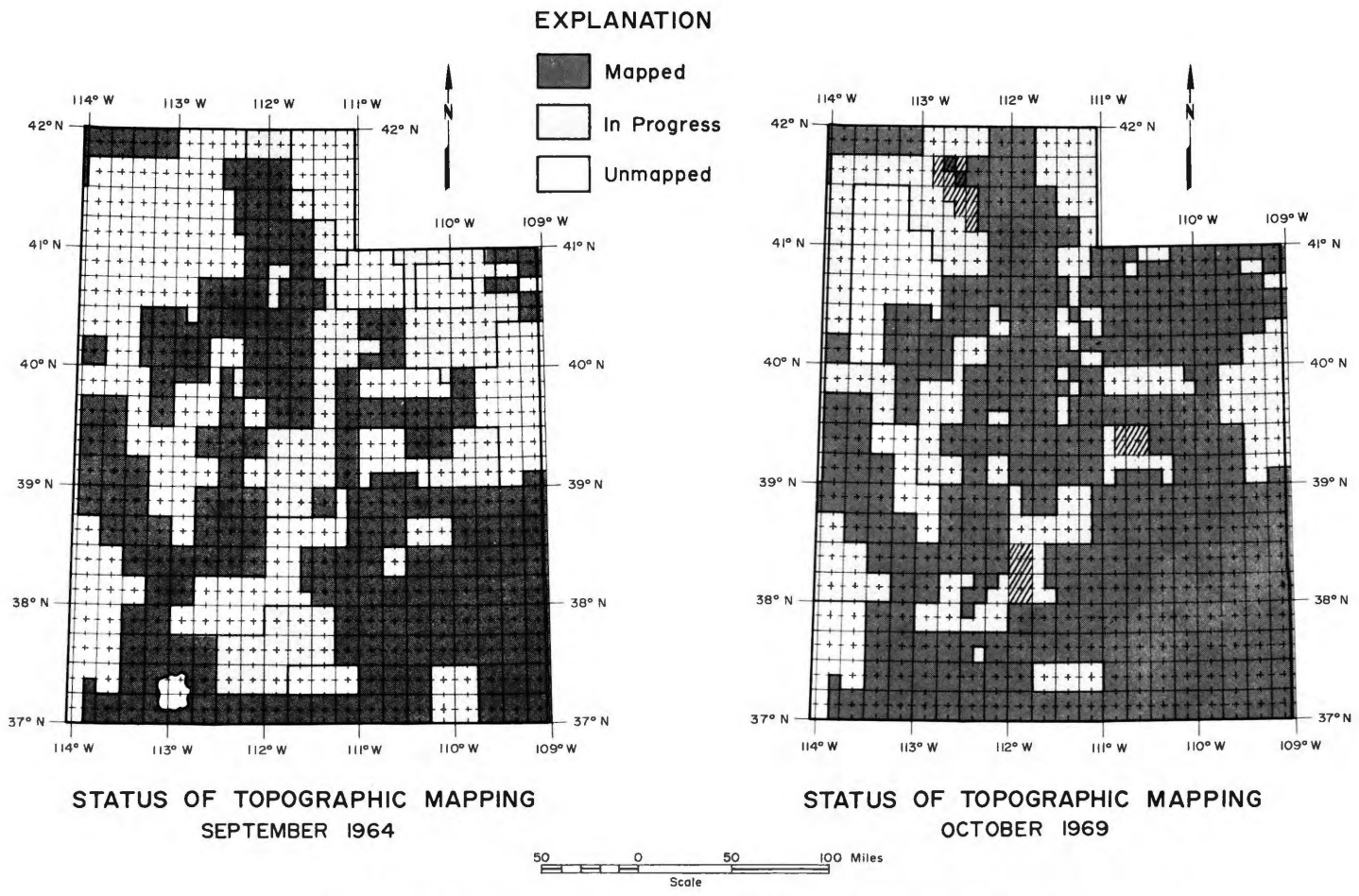
Plaintiffs in the case were five families of Murray City who have domestic wells, all with established rights granted by the State Engineer. Murray City, the defendant, has the right to withdraw 750 gallons per minute from the Murray artesian basin. Prior to 1953, Murray City drew water from seven wells known as the Baker wells, which by 1959 drew only about 220 gallons per minute. In 1959 the city drilled a new well in the basin in order to withdraw its full allocation. All the old wells were subsequently abandoned and sealed in May of 1964 with approval of the State Engineer. The new well diminished the flow of the domestic wells of the Murray residents who brought suit in district court against Murray City. The court found for the plaintiffs and directed the city to "*permanently* replace the plaintiffs' water in amount and quality equal to the level of their prior use."

The higher court found that the trial court's decision imposed upon Murray City a sweeping and pervasive responsibility "that was inequitable and inconsistent with the objectives of our water laws . . . It seems tantamount to requiring it to insure to the plaintiffs a continuous supply of 100 percent of their allocated flow henceforward, i.e., we assume, forever." Hydrologic and geologic factors affecting a groundwater basin do not remain constant, our knowledge of the underground water is inexact and annual precipitation and recharge of the basin are unpredictable.

The court decision points out that to maintain the water table at a sufficiently high level to sustain pressure in wells in higher areas frequently results in wasteful losses. The objective of our water law of seeing that all available water is put to beneficial use could not be adequately fulfilled if high water levels throughout an artesian basin had to be maintained.

The "rule of reasonableness" has been codified by neighboring western states and is found to be consistent with Utah's statutory law. An analysis of the total situation is taken into account: the quality of water available, the average annual recharge in the basin, the existing rights and their priorities. "All users are required where necessary to employ reasonable and efficient means in taking their own waters in relation to others to the end that wastage of water is avoided and that the greatest amount of available water is put to beneficial use," stated the judge in the decision.

STATE OF UTAH



Areas mapped cooperatively by UGMS ad USGS are designated by hatching

KAIPAROWITS PROJECT PROMISES POWER

The long-awaited Kaiparowits Power Project came a step closer to reality on September 25 when the agreement between the State of Utah and the U. S. Department of the Interior was formally signed, assuring adequate water from Lake Powell for the project, a giant coal-fired power facility.

The coal deposits in the Kaiparowits region of southern Utah have long been of interest to the Utah Geological Survey. The Survey's *Quarterly Review* of February 1965 described the plan initiated in 1962 for exploration of these deposits and negotiation for water from Lake Powell, part of Utah's allotment from the upper Colorado River.

In August 1966, the *Quarterly* reported successful negotiation with the State of Utah for 102,000 acre-feet of Lake Powell water to generate power from 14.6 million tons of coal per year, and cites the importance of this program "as the most important single item in Utah's economic development with respect to payrolls, taxes and school finances." The developer was to have started construction of the power complex in five years or lose the contract.

These Cretacous deposits on the Kaiparowits Plateau in Kane and Garfield counties are found in all the formations: Dakota Sandstone (100+ ft.), Tropic Shale (300-600 ft.), Straight Cliffs Sandstone (1,100-1,150 ft.) and Wahweap Sandstone (0-1,000 ft.). The Utah Geological Survey estimates one-half of the 1,430-square-mile area in the Kaiparowits field could contain more than 700 million tons per square mile, or 10 billion tons of recoverable coal.

The August 1967 issue of the *Quarterly* announced publication of seven geologic maps showing the coal-bearing horizons in the Kaiparowits Plateau. These maps were prepared by the USGS and modified by the Utah Geological Survey.

Resources Co., subsidiary of Arizona Public Service Co., is the operating company, and co-venturers are Associated Southern Investment Co., subsidiary of Southern California Edison, and New Albion Resources Co., subsidiary of San Diego Gas and Electric Co. The total investment by the developers will be $750 million.

The project was initiated in 1953, and 40 exploratory core holes were drilled in 1965. The plans are now advanced to the point where further evaluation of these cores should be finished by the spring of 1970 and more detailed drilling completed in the next 18 to 24 months.

The proposed location of the plant is between Wahweap Creek and Warm Creek, about 15 miles east of Glen Canyon City in Kane County. The coal deposits are located on the plateau 15 miles north of the proposed plant site.

Provisions for control of air and water pollution emanating from the power facility are written into the contract. The plant's equipment must remove 99½ percent of the smoke and ash emitted by the plant, and in addition, the design and operating criteria will be reviewed at least every 10 years by the Secretary of the Interior to insure use of new anti-air pollution technology.

The water returned to Lake Powell must average no warmer that 90°F in any 24-hour period, and the contractor must comply with all applicable State and Federal water pollution laws.

The means by which the coal is to be mined, transported and used are not yet determined, and the power plant itself, with all the considerations of efficiency, economy, technology and impact of the environment is yet to be designed.

The developers will ask the State for an extension of the 1970 deadline for construction bids, and indications are that it will be granted. Delays in negotiations with the Interior Department caused the time lag.

The electric power will go to Arizona and California. Future industrial expansion in Utah would be served by power development throughout the West. The approximately 2,500 new jobs expected to be created in Kane County could support a town about three times that size, more than tripling population of the county.

Property taxes after ultimate development of the entire project will probably exceed $12 million per year. Sales, income, corporate franchise and other taxes and coal royalties will provide additional State income.

Photo Credit

The photographs for "Corpsmen Remove Mudslide" in the August *Quarterly,* by Bruce N. Kaliser, were used with permission of the *Ogden Standard - Examiner.* This acknowledgement was inadvertently omitted when the story was published.

Petroleum Demands Spiral

A survey by Chase Manhattan Bank indicates that at least 250 billion dollars — more than 10 times the cost of the Apollo space program — will have to be invested by 1980 to meet demands for petroleum in the Free World.

The University of Utah may find the Utah Geological and Mineralogical Survey is a profitable appendage, according to the financial statement recently released by the Survey.

For fiscal 1969, the total budget was $265,939; 27 percent ($72,750) of this amount derived from the State general fund. Of the total expenditures for the same period, 40 percent ($103,-317) was paid out at the University; 77 percent ($79,300) of this last sum was paid in salaries and wages.

Project Brine Fly

The brine fly, *Ephydra cinerea* and *E. hians,* will be the object of a two-year study if the plans of the action committee for Operation Brine Fly materialize. The fly, known since 1843 to occur occasionally in astronomical numbers on and around the Great Salt Lake, infests the water surface and shoreline, at times discouraging visitors to the beaches and making swimming a crawly experience.

Little is known about the biology of the brine fly and its place in the ecology of the lake beyond the fact that eggs are laid in the water, the pupae attach themselves to the bottom, and hatch into adult flies three to four weeks after the eggs are laid.

The two-year program might begin with a pilot eradication project early next spring. An estimated budget of $25,000 for the first year was proposed.

UGMS FINANCIAL STATEMENT

July 1, 1968 - June 30, 1969

SOURCE OF FUNDS:

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Appropriations & Allotments		
Mineral Leasing Fund: Fiscal Income	$ 93,189.	
Land Grant Maintenance Fund	100,000.	
General Fund	72,750.	
		$ 265,939.
Other		
Publications Sales (Restricted)	$ 24,863.	
Services Rendered (Restricted)	3,219.	
Reimbursement from State agency	406.	
		$ 28,488.
Carry-Over		
Operating Funds	$ 35,957.	
Publication Receipts	11,936.	
Services Rendered	575.	
		$ 48,468.
TOTAL FUNDS AVAILABLE	$ 342,895.	$ 342,895.
TOTAL FUNDS USED (detailed below*)	$ 261,184.	
FUNDS ENCUMBERED	6,074.	
UNENCUMBERED BALANCE	75,637.	
	$ 342,895.	$ 342,895.

• EXPENDITURES BY IBM ACCOUNTING • EXPENDITURES BY PROGRAMS

Employment Costs		
Staff	$ 83,698.	
Summer Assistance	23,571.	
Time Card Wages	37,282.	
Employee Benefits	10,862.	
		$ 155,413.
Cooperative Costs		
U.S. Geological Survey	$ 33,325.	
U.S. Bureau of Mines	1,500.	
		$ 34,825.
Contract Service		3,200.
Examination Costs & Travel		15,133.
Equipment, Supplies & Maintenance		31,964.
Printing Costs & Consignment		18,039.
Remodelling		2,610.
TOTAL FUNDS USED		$ 261,184.

Administration	$ 20,764.	
Services to Public & State	34,265.	
Examinations		
Energy Minerals & Fuels	38,034.	
Mineral Commodity Studies	18,359.	
Great Salt Lake	46,845.	
Urban & Eng. Geology	9,218.	
Regional Structural & Strat	18,236.	
Cooperative Studies		
U.S. Geological Survey		
Topographic Mapping	20,000.	
Water Resources	13,325.	
U.S. Bureau of Mines		
Oil Field Brines	1,500.	
Publications (Preparations)	35,774.	
Oil Well Sample Library	2,254.	
Remodelling	2,610.	
TOTAL FUNDS USED	$ 261,184.	

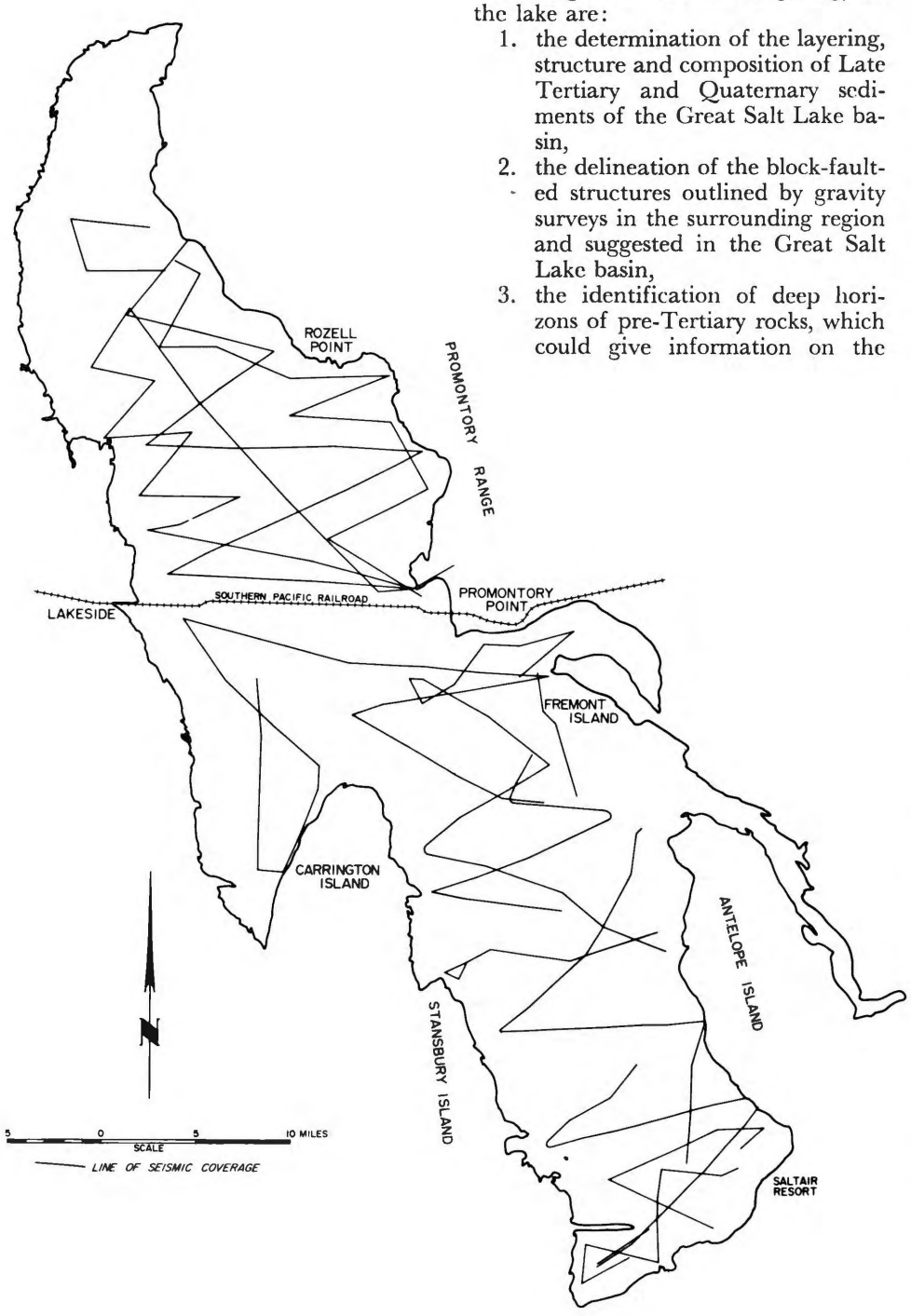
Seismic Survey Scientists Explore Lake

by Robert B. Smith,
Department of Geological and Geophysical Sciences, University of Utah

The Great Salt Lake and its associated sedimentary basin, their origins, structure, composition and associated economic values have been the subjects of growing interest in recent years. Little is known about the subsurface geology of the Great Salt Lake and its unique association with the general geologic structures of the eastern Basin and Range.

The information required to synthesize the general subsurface geology of the lake are:

1. the determination of the layering, structure and composition of Late Tertiary and Quaternary sediments of the Great Salt Lake basin,
2. the delineation of the block-faulted structures outlined by gravity surveys in the surrounding region and suggested in the Great Salt Lake basin,
3. the identification of deep horizons of pre-Tertiary rocks, which could give information on the controversial problems of the Laramide geology,
4. the delineation of buried salt bodies, associated salt flowage structures and zones of brine deposition.



Seismic Survey of Great Salt Lake

Because of the wide expanse (more than 1,500 square miles) of dense and shallow saline water and lack of easily implemented exploration methods, little was done to explore in detail the subsurface geology of this large area until September 1968, when a reconnaissance sub-bottom sparker profile demonstrated the merit and feasibility of a complete seismic reflection survey of the lake. The 1968 sparker profile used a 2,000 Joule sparker source and produced useful penetration up to 400 ft.

This profile, from Promontory Point to Lakeside, delineated a general eastward dip of the bottom and sub-bottom sediments terminating in a prominent Glauber's salt basin at a normal fault west of Promontory Point. Several of the bottom and sub-bottom structures shown on this profile were interpreted as zones of sediment arching and faulting probably produced as a result of Glauber's salt flowage.

A complete seismic survey of the lake was financed by a grant from the National Science Foundation to the author, Department of Geological and Geophysical Sciences at the University of Utah. The survey, conducted in August and September 1969, was a cooperative effort. Utah Geological and Mineralogical Survey provided transportation on the lake and the University of Wisconsin (Milwaukee) the instrumentation which consisted of a 30 kw Westerbeck generator, a 3,000 psi air compressor, and a 10-cubic-inch Bolt air-gun seismic source, hydrophone streamers, an EG & G seismic amplifier, Kronhite filter systems, a Gifft wet paper graphic recorder, a Timesfax graphic recorder, and a four-track one-quarter inch analog tape recorder.

Approximately 450 line miles of seismic reflection data were acquired in the north and south ends of the Great Salt Lake (see map). Navigation was provided using shipboard triangulation methods and a small-boat radar for intersection of radar-visible bench marks along shore lines.

The extremely shallow water (maximum depth 30 feet, average depth 15 feet) and large areas of dense, high-

(Continued on page 7)

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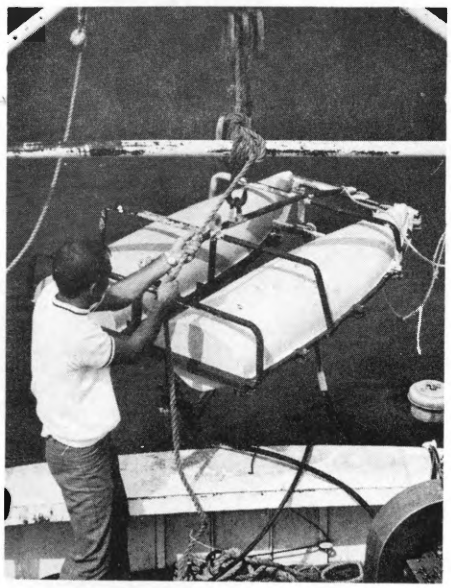
velocity salt beds and algal reefs caused operational and interpretive problems. The shallow water restricted the use and firing chamber size of the air-gun seismic source and limited the survey to areas of six feet or more of water. These factors in turn produced severe water layer reverberations which must be removed by digital deconvolution before general interpretation may begin.

Preliminary interpretation of the seismic data indicates deeper basin development at the south end of the lake and shallower basin deposition to the north associated with apparently more complicated structural control. Confirmation of the results obtained from the 1968 sparker profile show deeper structures than those originally interpreted. Maximum depths of useful penetration appear to be approximately 4,000-5,000 feet.

A total field magnetometer survey of the lake in conjunction with the seismic survey is planned for the spring or summer of 1970. The magnetic information combined with the seismic data will provide a more complete synthesis of the subsurface geology of the Great Salt Lake.

The detailed seismic reflection data are on file in the office of the Utah Geological Survey, University of Utah, for inspection.



Graduate student Matt Mikulich lowering air gun float assembly into water.

Professor Smith adjusting seismic amplifier and recorders.

WATER PLANNERS WARNED

Man cannot ignore nature or be indifferent to natural occurrences as world population soars, and floods and droughts take a greater toll of life and property, warns a scientist of the Geological Survey, Department of the Interior.

Speaking before the American Water Works Association at Ocean City, Maryland, recently, Dr. Raymond L. Nace, a research hydrologist, U.S. Geological Survey, Washington, D.C., said that the actions of man and the laws of nature are too often at cross purposes, especially in the realm of water management.

"While the laws and rules of men can be modified or repealed, natural laws are implacable and unchangeable, and violations of them bring inevitable retribution," Nace said, adding that "nature has no whip to keep men 'in line' but the lash of disaster, which she uses inexorably; history is full of disasters."

Nace believes that three attitudes commonly lead planners and advisors into programs and actions that provide only illusory solutions to problems:

* Blind faith in science or technology
* Worship of Bigness
* Disdain for the landscape

"The belief that science and technology can solve any water problem becomes defeating when it obstructs consideration of nontechnological factors that are vital for solution," said the hydrologist, emphasizing that "water problems are people problems, and people had best guide technology, rather than look to technology for blueprints and templates.

"In a real sense," the scientist said, "no final solution for water problems can be expected; rather, planners and managers will have to make an endless series of judgments and decisions to meet new situations. These are reasons why hydrologists and engineers cannot solve water problems.

"A common assumption that nature exists almost exclusively for man's benefit bespeaks a degree of intellectual arrogance that reflects an unfortunate ignorance of nature," Nace said.

"Scripture says that men always squander their patrimony;" Nace concluded, "the marvel is that after 6,000 years of civilization, we still have a patrimony to squander. It is high time that we come of age in our dealings with water and landscapes by closing the gap that exists between our legal, social, and political customs, and our scientific and technological expertise."

Bear Lake Environs Investigated

UGMS Report of Investigation No. 40, *Geology for Planning Bear Lake Area, Rich County,* by Bruce N. Kaliser, has been released and was presented to a joint meeting of the Rich County Commission and the Rich Soil Conservation District on October 6th. Copies were distributed to State and Federal agencies that play a role in the planning or enforcement of environmental preservation.

This report is the first comprehensive study for planning purposes to have been undertaken in Utah. Effects of climate on the geology, construction conditions, groundwater occurrence and quality, geologic application to sanitation, seismicity and faulting, earth stability and landslide potential, earth materials, mineral resources, scenic sights of geologic significance, and specimen collecting for the tourist are described.

Powell Bank Study

The Bureau of Reclamation has prepared a report on the activities of their geologists in the Lake Powell area and their conclusions on storage of water in the river banks ("Bank Storage, Lake Powell," by J. Neil Murdock and Lloyd Calder).

The Navajo Sandstone is the most important formation involved in bank storage. It is 1,200 to 1,800 feet thick and is underlain by the relatively impervious Chinle Formation.

The Navajo is friable and porous but contains only small pore spaces and therefore absorbs water by capillarity, but it is not highly permeable. Tests by the Bureau show that the average pore diameter is .03 mm and the porosity averages 24.7 percent by volume.

The foundation rock of the dam site was grouted during construction. The grouting agents penetrated the pore spaces in the sandstone for only a short distance.

Studies based on nine observation wells, monitored monthly, showed the pre-Lake Powell water table roughly parallelled the surface topography. Within 10 miles of the reservoir the water table rose uniformly from the river to well above the surface of Lake Powell.

Field tests showed the permeability rate of the sandstone diminished with time. This factor plus its initially low permeability and consequent slow movement of water through it indicate that equilibrium between friction in the aquifer and the head in the reservoir may not be reached within 100 years.

Present data indicate that as soon as the voids in the sandstone are filled there will be no further loss of water into the bank. Structurally there is no way the water can seep out of the reservoir basin.

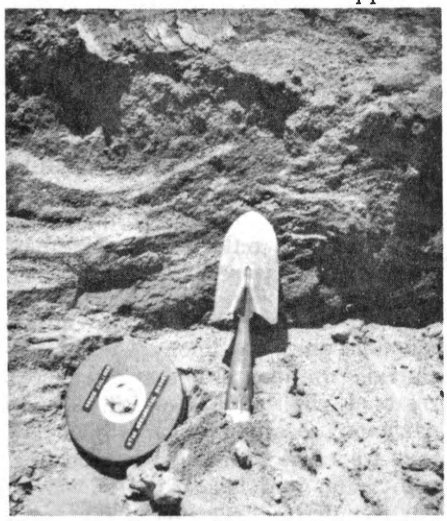
The August *Quarterly* described a plan for an interdisciplinary research project centered around Lake Powell. One of the questions raised at a field conference held in Flagstaff in June 1969 was the fate of the water stored in the reservoir walls. The Bureau of Reclamation's study started in 1963 when reservoir storage began and is continuing. The accumulation and refinement of data should give increasingly accurate estimates of bank storage in the area of Lake Powell.

PLEISTOCENE SUNFLOWERS UNEARTHED

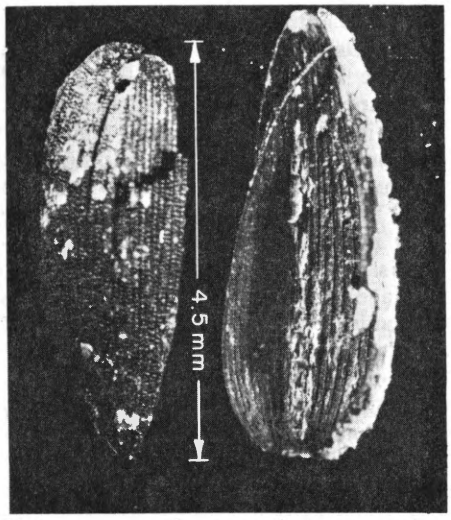
Organic material found by UGMS personnel in Pleistocene sand in a building excavation on the University of Utah campus turned out to be seeds of a sunflower, genus *Helianthus*. The work prior to construction of the new Mines building last spring brought the find to light.

The cluster of seeds was trapped in a layer of coarse sand deposited by Lake Bonneville and overlain with alternating silt and clay beds. Apparently an inflorescence sank to the bottom and was buried in the sediment.

Identification of the material was made by the Seed Branch of the Agricultural Research Center at Beltsville, Md.



Excavation for new Mines building at University of Utah unearthed mass of seeds. The exact location is at tip of trowel.



Pleistocene sunflower seeds in excavation in Bonneville sand.

(Continued from page 2)

JUNE

1	South of Sunnyside	2.0-2.5
2	South of Sunnyside	2.0-2.5
2	South of Sunnyside	2.0-2.5
2	Teasdale	2.0
3	Southeast of Sunnyside	3.0
4	Southern Wyoming	3.0
4	Southwest of Sunnyside	2.0-2.5
6	South of Sunnyside	2.0-2.5
6	South of Hanksville	2.5-3.0
11	Bear Lake	3.0
11	Park Valley	2.8
18	South of Monroe	3.3
20	5 quakes southwest of Sunnyside	2.0-2.5
21	2 quakes southwest of Sunnyside	2.0-2.5
22	South of Sunnyside	2.0-2.5
23	4 quakes southwest of Sunnyside	2.0-2.5
24	2 quakes southwest of Sunnyside	2.0-2.5
28	Southwest of Sunnyside	2.0-2.5
29	Southwest of Sunnyside	2.0-2.5
30	Southeast Wyoming	3.5

(70 rockbursts in June)

JULY

1	Bear River Bay	1.3
1	Southern Utah	1.5
10	South of Sunnyside	1.5
10	South of Sunnyside	1.8
20	South of Sunnyside	2.0
20	South of Nephi	2.1
23	Rangely, Colorado	3.1
21	South of Sunnyside	2.5
31	Gunnison	3.5

(60 rockbursts in July)

AUGUST

2	South of Sunnyside	2.5
3	South of Sunnyside	3.0
6	South of Fillmore	2.3
10	Northwest of Watson	2.0
15	Zion National Park	2.0
19	Orange Cliffs region	2.0
20	Moab	2.1
27	South of Sunnyside	2.1
27	South of Sunnyside	3.0

(15 rockbursts in August)

These earthquakes were recorded by the University of Utah seismograph stations under the direction of Kenneth L. Cook. All locations and magnitudes are preliminary determinations; the final determinations will be printed in the University of Utah Seismological Bulletin, issued quarterly.

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*
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