UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

Great Salt Lake and Vicinity, Utah, Satellite Image Map

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GEOLOGICAL SURVEY
RESTON, VA. 22092

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Memorandum for the Record (EC–87–Landsat)

By: Research Cartographer (EROS Cartography)
National Mapping Division

Subject: Great Salt Lake and Vicinity, Utah, Satellite Image Map

During February 1985, subject image map was published by the U.S. Geological Survey. This is a large Landsat Thematic Mapper (TM) colored image map of 1:125,000 scale which is described in general terms by the attached handout. The most significant cartographic aspects of this map are as follows:

- It combines contours taken from line maps with satellite imagery. To do this requires cartographic judgment and skill since contours normally lack positional coincidence with shorelines. In certain cases the 4,205–foot contour is in error where it should have followed the causeway and highway, which are now obviously above the 4,205–foot water level.

- Different wavebands and algorithms were used for the water than for the land, and four images are involved to produce the image mosaic. The procedures involved are quite complex; pertinent technical enquiries should be made to the Chief, Data Production and Distribution Branch, EROS Data Center, Sioux Falls, South Dakota 57198.

- The geometric accuracy of this map is not up to standards. It is expected that TM rms error on such a product should be below 50 m rather than the 70 m indicated. The fact that four images were used and that relief displacement was not compensated contributes to this larger error figure. The control used was derived from 1:24,000–scale line maps.

- Although the map was not completed until 7.5 months after image acquisition, this is a far shorter period than can be expected for conventional map production. The time required to produce such image maps can be further reduced where the situation so demands. Thus, the timely display of important transitory phenomena in map form becomes an obvious new application. This map was printed on February 15, 1985, whereas, image acquisition occurred on June 25 and July 2, 1984.

- Waveband response variations may materially alter the cartographic characteristics of the image map. Those items noted are as follows:

  (1) Bands 5 (1.55 to 1.75 μm) and 7 (2.08 to 2.35 μm) define a significantly different shoreline than band 4 (0.76 to 0.90 μm). In the old salt evaporator beds near the west end of the cross-lake causeway, both bands 5 and 7 define the water boundary a full kilometer inland as compared to band 4. The reason for this anomaly is unknown at this time.

  (2) Neither bands 5 nor 7 are suitable for depicting snow by themselves as these bands show low reflectance for snow, whereas clouds and other naturally white areas have high reflectance. On the other hand the use of bands 5 or 7 will clearly discriminate snow from clouds.

  (3) Band 1 (0.45 to 0.52 μm) displayed near-identical water penetration capability to band 2 (0.52 to 0.60 μm) in the lake. This was unexpected as in ocean areas band 1 has shown much stronger water penetration capability.

  (4) In areas of high contrast, such as this one, the image processing should be customized. The use of a "multiple-point linear-stretch," edge enhancement and filtering to approximate the Log-E-tronic effect of the photographic processing are examples of the type of processing that can improve the final product. Again, technical enquires should be addressed to the EROS Data Center.

Two attachments are included as follows:

- A short paper describing the Great Salt Lake image map.

- A listing of satellite image maps currently available from the U.S. Geological Survey which includes prices and other ordering information. In most cases (including Great Salt Lake) the maps are sold unfolded and mailed in tubes.

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Attachments (2)

United States Department of the Interior

GEOLOGICAL SURVEY
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March 1985

GREAT SALT LAKE AND VICINITY, UTAH
IMAGE MAP

The U.S. Geological Survey has published a new satellite image map of Great Salt Lake and vicinity.

The map is particularly valuable because it displays the lake at its highest level in over 100 years. On July 1, 1984, the water level reached 4,209.25 feet above sea level, nearly 10 feet above the normal level of about 4,200 feet. The lake has no outlet and is continually changing its level according to changes in climatic patterns and runoff from the surrounding mountains.

In March 1985, the lake level stands just above the 4,209-foot mark, and the surrounding mountains contain an average snowpack. The National Weather Service "official" forecast for the summer of 1985 is a high-water level on the order of 4,210.5 feet. Every foot that Great Salt Lake now rises costs the public millions of dollars in the form of damage and repairs to highways, railroads, salt evaporators, wildlife refuges, and storm drainage and sewer systems.

As the map provides a wealth of specific information as to conditions in the area, it will help those who must plan to minimize the damage expected from any continued rise in the lake level.

The map has been gridded so that geodetic reference can be made to any point on the map with an expected error of no more than 70 meters (230 ft).

The map is based on Landsat Thematic Mapper imagery acquired on June 25 and July 2, 1984. Two satellite passes, 8 days apart, completely recorded the lake, but during that period the water level remained within an inch or so of its July 1 peak level. The map is a mosaic of four Landsat images and is published at a scale of 1:125,000. The map was published only 7 months after acquisition of the Landsat images, a much shorter time than required for normal map production. Thus, the timely display of such important transitory phenomena is a valuable application of satellite-acquired data.

The unique features of this map are the elevation contours and their relation to the shoreline of the lake and the spectral response of the water and land.

Contours and Shoreline: The contour at 4,200 feet in the southern part of the lake marks the level of the lake in September 1982 before the lake began its historic 2-year rise of almost 10 feet. This also was the approximate level of the lake when Utah was settled in 1847.

The contour at 4,205 feet marks the peak level in 1983 in the southern part of the lake.

The 4,205-foot contour in the northeastern part of the lake shows the submerged outline of the Bear River Migratory Bird Refuge, one of the major Federal bird refuges in the United States. It was established in 1928.

The shoreline of the northwestern part of the lake at 4,205 feet marks the peak level there in 1984. This shoreline was 4 feet lower than the level in the southern part of the lake because of restriction of flow by the railroad causeway of the Southern Pacific Transportation Co. This created differences in the salinity, and therefore the density, of the water. However, the opening in the causeway was greatly enlarged during the summer of 1984 which has reduced the water-elevation differences.

The shoreline of the southern and northeastern parts of the lake reached its peak level of 4,209 feet during 1984, the highest level since 1878.

The dashed contour at 4,212 feet shows the outline of the lake at the historic high level of 1873. Historic records extend back to 1843.

In the flat areas surrounding much of the lake, changes in the position of the shoreline as the lake rises can be quite accurately forecast by interpolating between the present shoreline and the 4,212-foot contour.

Spectral Response of the Water and Land: Because the spectral response of the water and that of the surrounding area are so different, it is almost impossible to properly depict detail in both areas using one set of response criteria. To solve this problem, the satellite data, which are in digital form, were separated into two data sets, one for the water and one for the land. Two separate criteria were applied and even the waveband selection was different for the water than for the land. As a result, more information is displayed in both the water and land areas than would have been possible if only one criterion had been applied.

The salinity varies in different parts of the lake (6 percent in the southern and northeastern parts and 20 percent in the northwestern part), but the differences apparently are not directly responsible for variations of the blue color of the lake. The darker color in the southern part could be attributed to a number of causes, one of which may be a massive algal bloom.

Mineral evaporation ponds in the southwest corner of the lake are outlined by dikes. The purple color shown on the map is due to dye added to enhance evaporation.

The vegetated areas (red) east of the lake receive 12 inches or more precipitation annually and are partly irrigated. They are in stark contrast to the unvegetated gray and white areas west of the lake that receive less than 8 inches of precipitation annually.

Additional Information: Three other products related to the Great Salt Lake area are of interest and are currently available. They are:

- U.S. Geological Survey line map titled "Great Salt Lake and vicinity," scale 1:125,000 (1974).
- Utah Geological and Mineralogical Survey Map No. 73 titled "Major Levels of Great Salt Lake and Lake Bonneville," scale 1:750,000 (1984).
- U.S. Geological Survey Circular 913 titled "Water-Level and Water-Quality Changes in Great Salt Lake, Utah, 1847-1983" (1984).

Revised 2/13/85

Department of the Interior
U.S. Geological Survey

SATELLITE IMAGE MAPS
(As of January 1985)

National Mapping Division

Title	Form	Scale	Image Date	Ordering Site	Price
Alaska					
North Slope north of 68th Parallel	25 Black/white RBV or MSS mosaics	1:250,000	1983	W	(each) 2.40
Arizona	Sepia mosaic	1:500,000	1973	W	3.60
Phoenix	Sepia mosaic	1:250,000	1972	W	4.00
Connecticut					
Hartford	Color Photomap (Skylab)	1:250,000	1973	E	4.00
Dist. of Columbia					
Washington, DC & Vic.	Color image, enhanced	1:100,000	1982	E	5.50
Washington, DC & Vic.	I-1616;Landsat Thematic Mapper, color combinations	1:100,000	1982	E	6.60
Florida	Color mosaic	1:500,000	1973	E	6.10
Pensacola Bay	Color image	1:500,000	1973	E	2.40
Lake Seminole	Color image	1:500,000	1973	E	2.40
Apalachee Bay	Color image	1:500,000	1974	E	2.40
Okefenokee Swamp	Color image	1:500,000	1974	E	2.40
Gulf Hammock	Color image	1:500,000	1974	E	2.40
Lake George	Color image	1:500,000	1973	E	2.40
Charlotte Harbor	Color image	1:500,000	1973	E	2.40
Lake Okeechobee	Color image	1:500,000	1973	E	2.40
Sanibel Island	Color image	1:500,000	1973	E	2.40
The Everglades	Color image	1:500,000	1973	E	2.40
Florida Keys	Color image, enhanced	1:500,000	1974	E	2.40
Georgia	Color mosaic	1:500,000	1974	E	4.00
Maryland/Virginia					
Chesapeake Bay & Vic. Winter 1976-1977	Color mosaic	1:500,000	1977	E	4.00
Upper Chesapeake Bay	Color image, enhanced	1:250,000	1972	E	4.00
Upper Chesapeake Bay	Color image, enhanced	1:500,000	1972	E	3.10
Massachusetts					
New Bedford	Black/white RBV mosaic	1:100,000	1978	E	3.10
Montana					
Pumpkin Creek	Color image	1:500,000	1973	W	4.00
Nevada					
Las Vegas	Color mosaic/topo map on reverse	1:250,000	1981	W	6.10
New Jersey	Color mosaic	1:500,000	1972	E	2.40
Tennessee					
Dyersburg	Color image/topo map on reverse	1:100,000	1982	E	6.10

Title	Form	Scale	Image Date	Ordering Site	Price
Utah					
Great Salt Lake & Vic.	Color image, enhanced	1:125,000	1984	W	5.50
Washington					
Wenatchee	Landsat mosaic with planimetric base	1:250,000	1978	W	4.00
Wyoming					
Medicine Bow River	Color image	1:500,000	1976	W	4.00
Dry Fort Cheyenne Riv.	Color image	1:500,000	1973	W	4.00
West-east corridor from Pacific Ocean to Northern Louisiana	Apollo 6 Photomaps (Black/white—4 sheets)	1:500,000	1968	W	4.00 (Per Set)
	FOREIGN AREAS				
Antarctica					
Ellsworth Mountains	Blue-tone mosaic	1:500,000	1974	E	4.00
Victoria Land Coast	Blue-tone mosaic	1:1,000,000	1973	E	4.00
McMurdo Sound Region	Black and white image	1:250,000	1974	E	3.10
McMurdo Sound Region	Black and white image	1:500,000	1974	E	2.40
McMurdo Sound Region	Blue-tone image	1:1,000,000	1974	E	4.00
Bahamas					
Berry Islands	Color image (Hydrographic Information)	1:500,000	1977	E	6.10
Iceland					
Vatnajckull	Color image (fall)	1:500,000	1973	E	2.40
Vatnajokull	Black and white image (winter)	1:500,000	1973	E	2.40
Yemen	Color mosaic				
	I-1143-A Geographic	1:500,000	1973	E	3.10
	I-1143-B Geologic	1:500,000	1973	E	3.60

ORDERING SITES:

E = Eastern Distribution Branch
1200 South Eads Street
Arlington, Virginia 22202

W = Western Distribution Branch
Box 25286, Federal Center, Building 41
Denver, Colorado 80225

Prepayment required. Make check or money order payable to "Department of the Interior-USGS." Add $1.00 on all orders of less than $10.00 for postage and handling. For mailing outside the USA (except to Canada and Mexico), add 25% of the total amount remitted to cover surface transportation. If airmail is requested, USGS will bill for the full cost of mailing. Customers outside the USA, please remit by International Money Order or check drawn on a U.S. bank.