Salt Deposits of Sevier Valley, Utah

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ABSTRACT

Salt beds crop out in Sevier and Sanpete counties of central Utah and are mined in the valley of the Sevier River near Redmond. These are the only outcrops of pre-Quarternary salt beds in Utah. They occur in the Arapien Formation of Middle Jurassic age. The Arapien Formation totals more than 6,000 feet of strata, consisting of red and gray shale, siltstone, argillaceous limestone, gypsum, and salt.

The Sevier River, flowing through areas of Arapien salt, once flowed into Pleistocene Lake Bonneville, and it is believed that it became highly charged with minerals and was probably an important contributor to the salinity and mineral content of Great Salt Lake.

Three small companies at Redmond have pits located a short distance north and northwest of town. Rocks in the area are complexly folded, and there is evidence of salt flowage and structural collapse. No accurate estimate of salt reserves can be made, but over 200 feet of bedded salt have been observed. Analyses of salt near Redmond indicate that the salt is composed of ordinary halite, with a few impurities which impart a reddish color. X-ray diffraction of three samples of salt indicates the presence of sylvite, although this was not confirmed by chemical analyses of the same specimens.

So far, mining operations have been sporadic and on a small scale. It is not known whether sufficient reserves exist which would warrant expanded developments.

INTRODUCTION

General Comments

Bedded rock salt occurring in the Jurassic Arapien Formation has been quarried for many years near Salina and Redmond, Utah. Operations near Salina were cited as early as 1880 by C. E. Dutton (1880). The salt is produced mainly for stock consumption and for deicing of roads. In the past, some of it was refined for culinary use. There are two major pits and a smaller one which are being quarried by three companies located at Redmond, Utah. In addition to the active quarries, there are six other pits which have either been produced in the past or have been dug during exploration and development. Bentonite and abundant gravels are found in the area where salt is produced. Bentonite is currently mined and the gravels have been sporadically developed in the past.

Previous Work

Since C. E. Dutton's mention of the occurrence of salt in the region, three principal workers have been concerned with the geological setting of the salt. E. M. Spieker has prepared maps of the regional geology of central Utah; W. N. Gilliland has mapped the geology of the Gunnison

quadrangle; and C. T. Hardy has described and subdivided the salt-bearing Jurassic Arapien Formation. The field work for the present report was conducted in the summer of 1964 and spring of 1965.

Geography

Redmond, Utah, is on U. S. Highway 89 one mile west of the Denver and Rio Grande Western Railroad in the Sevier River Valley in Sevier County, Utah. Redmond is situated 140 miles south of Salt Lake City; other nearby towns are Gunnison and Salina (Fig. 1). The major industry in the

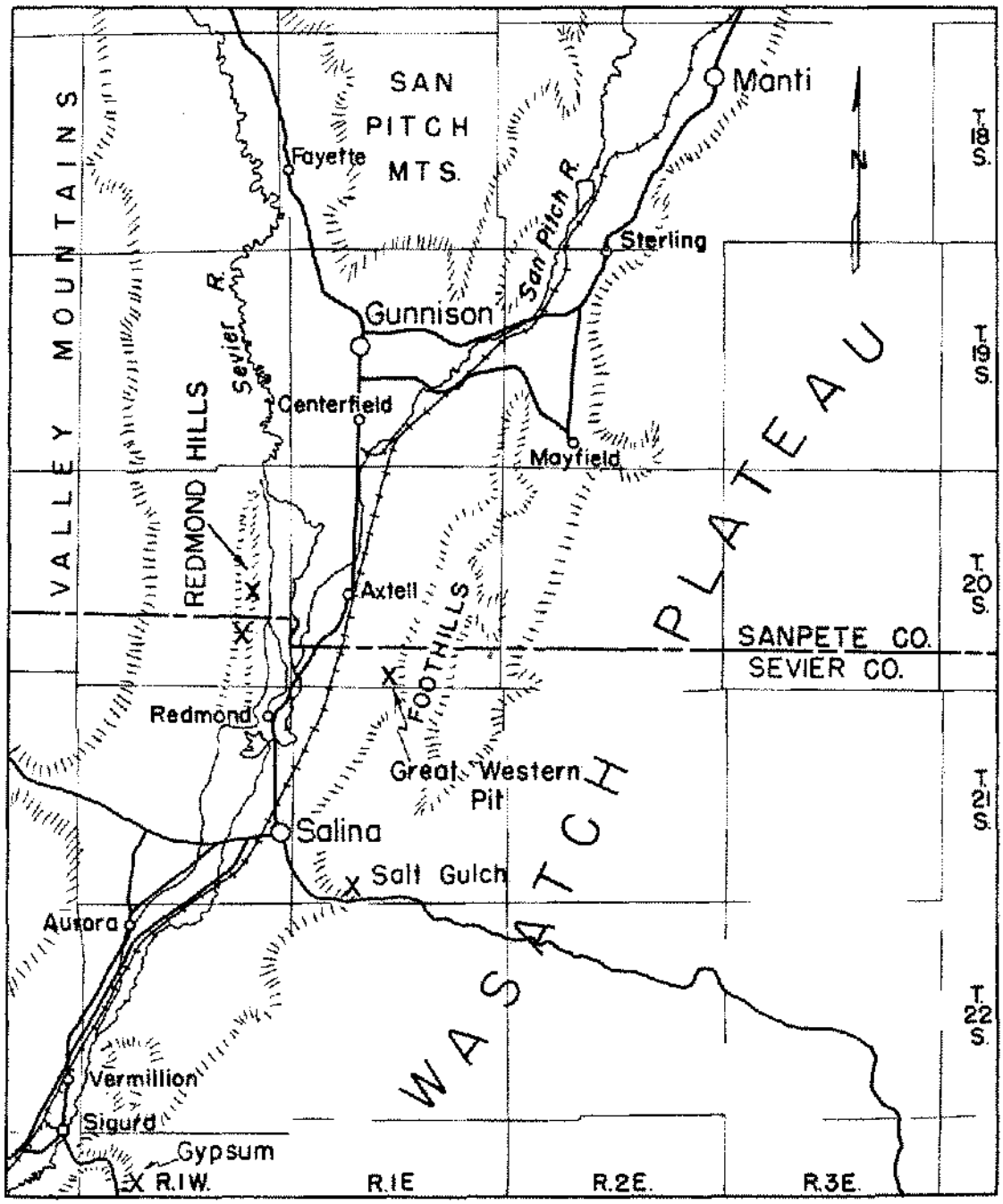

Figure 1. Index map, Sevier Valley salt deposits, Sevier and Sanpete counties, Utah.

area is livestock. Salt, coal, bentonite, and gravel are presently produced in the area, and limestone has been produced in the past. The Redmond-Salina area is at an elevation of 5,100 feet and received 9.6 inches of precipitation per year, mainly during the months of February, March, and April.

GENERAL AREAL GEOLOGY

Topography

The Redmond salt occurs mainly in two areas, the most important of which is in the Redmond Hills, the other being the foothills area of the Wasatch Plateau. The Redmond Hills extend from directly west of the townsite of Redmond six miles northward and lie as bedrock islands in the Sevier River Valley alluvium. The Sevier River Valley is six miles wide and is bounded on the west by the Valley Mountains and on the east by the Wasatch Plateau. The other important area of salt outcrops is the foothills area of the Wasatch Plateau, four miles east of Redmond. The maximum relief of the region is 5,880 feet, the lowest general elevation being at the Sevier River at 5,100 feet above sea level, and the maximum in the Wasatch Plateau at 10,980 feet. The salt is confined to the easily-accessible valley area where the relief is about 300 feet. The lowest outcrop of salt is at 5,200 feet and the highest at 5,400 feet.

Stratigraphy

The oldest rocks in the area are those in which the salt exists, the Jurassic Arapien Formation (Fig. 2). The younger rocks range in age from Tertiary through Recent and include limestone, sandstone, siltstone, pyroclastics, gravels, and valley fill. A brief lithologic description of pertinent rock units follows.

Jurassic Arapien Formation. Hardy (1952) has divided the Arapien Formation into five units In general, the Arapien consists of interbedded gray to red shales, some of which are calcareous or gypsiferous, gray calcareous sandstone, arenaceous limestone, salt beds, and lenses of gypsum. The unit from which the salt is produced is probably the topmost, Unit E (Hardy, 1952, p. 22). Spieker (1946) estimates a thickness of 5,000-7,000 feet for the portion of the Arapien Formation which correlates with the basal Twin Creek Limestone in the Central Wasatch Mountains and the Carmel Formation in the San Rafael Swell, although the basal Arapien may be older than the Carmel and the Upper Arapien may correlate in part with the Entrada, Curtis, and Summerville Formations (Hardy, 1952, p. 27).

Eocene Green River Formation. Spieker (1949) describes the Green River Formation as interbedded gray and green shale, white to tan limestone, some oolite, and local sandstone and conglomerate. They lie in angular discordance upon Arapien beds east of Redmond, apparently as a result of strip thrusting.

Unnamed Miocene-Pliocene sequence. Gilliland (1951) describes a complex succession of volcanic sandstone, quartz sandstone, shales, limestone, Mexican onyx, and pyroclastics, some of which has been altered to bentonite. The sediments appear to have been deposited in a fresh water lake. Fresh water mollusks have been reported which are similar to those found in the Salt Lake Group of northern Utah. Many of the limestones are obviously of algal origin.

Tertiary-Quaternary Axtell Formation. The Axtell Formation is generally a gray to buff to orange-brown conglomerate consisting of pebbles and boulders of all other local bedrock, poorly sorted and poorly indurated in a silt and clay matrix. Some interbeds of sandstone are also present. In the Redmond Hills area, the Axtell Formation more remote from highlands, contains a greater percentage of clay silt, and sandstone, and a smaller percentage of gravels and conglomerate. Spieker (unpublished notes) considers the Axtell Formation to be late Pliocene or early Pleistocene in age.

Quaternary gravels. Gilliland describes gravel surfaces in the Redmond Hills as composed of gray gravel beds consisting of well-rounded pebbles of black, lavender, green, and gray volcanics, black to brown chert, and light colored flint and limestone. The gravels are poorly sorted, ranging to a maximum of 4-6 inches in diameter and occurring in a silt and clay matrix.

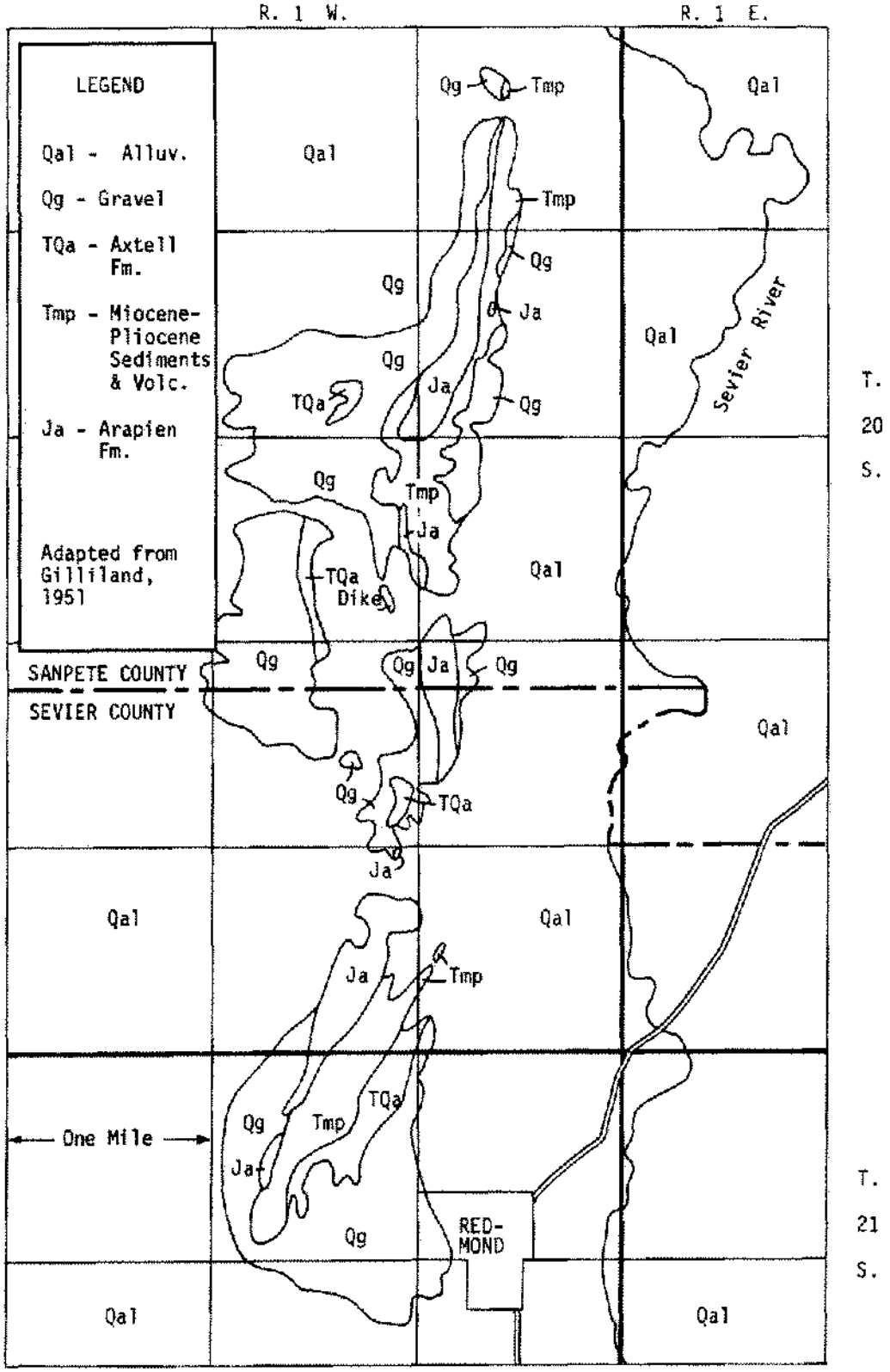

Figure 2. Geologic map, Redmond Hills area.

Quaternary alluvium. The Sevier Valley alluvium consists of a typical fill of silt, sand, and gravel, the coarser material occurring near the bedrock highlands.

Dike. Gilliland, described a small andesite dike known locally as Niggers Heel which is located in the Redmond Hills approximately three and a quarter miles north and a half mile east of Redmond. The dike is approximately 18 feet thick, dips 80° westward, and intrudes Tertiary pyroclastics.

Lava Flow. Gilliland further describes a red, vesicular, andesitic lava flow, which is about six feet thick and is interbedded with bentonite. The flow is a quarter of a mile north of the Albert Poulson salt pit in the northern Redmond Hills.

Structure

The structure of the Arapien Formation east of Redmond is essentially anticlinal and is complicated by strip thrusting which involves both the Arapien Formation and the Green River Limestone (Hardy, 1952). The structure in the Redmond Hills is also anticlinal (Gilliland, 1951). West of the Redmond Hills, the strata of the Valley Mountains dip beneath the Sevier Valley alluvium, and east of the Arapien outcrops in eastern Sevier Valley, the Wasatch Monocline ascends to the top of the Wasatch Plateau. The relationship between the Arapien Formation exposed in the Redmond Hills with that exposed in eastern Sevier Valley is not known. The subsurface structure of the valley is probably complex and is obscured by several hundred feet of alluvium.

SALT

Areal Distribution

The main area underlain by salt-bearing strata, the Redmond Hills, comprises approximately one square mile; it extends four and a half miles northward from Redmond and averages one quarter of a mile in width (Fig. 1).

The principal exposures of salt near Redmond are in the Redmond Hills, 3 to 4 miles north of town and in the foothills four miles east of town. Another exposure is in Salt Gulch, a drainage which dissects the north wall of Salina Canyon, three miles east of Salina (Fig. 1). Salt water and red clays similar to the residuals which overlie the exposed salt in the Redmond Hills were encountered near the bottom of a 547-foot water well drilled at the Gunnison Sugar factory at Centerfield, Utah (Gilliland, 1951). Salt was also encountered 15 feet below the alluvium in seismic shot holes drilled west of the bedrock islands in Sanpete Valley a few miles southwest of Manti, Utah.

The main salt production has been from the two locations nearest Redmond. These are designated the Redmond Hills occurrence and the Great Western Salt occurrence (Fig. 1).

Redmond Hills Deposits. As previously stated, the general geologic structure in the Redmond Hills is anticlinal (Gilliland, 1951). This anticline trends generally north-south and consists of eastward and westward dipping limbs of gravel and pyroclastic beds lying like a blanket over an elongate core of the Arapien salt. The salt core strikes from true north to N 20° E and dips from 80° westward to vertically. The salt is generally covered by a 10-20-foot layer of red silt and clay, which in turn is unconformably overlain by 10-50 feet of gravel (Fig. 4). The clays and silts which directly overlie the salt are similar to the interstitial impurities of the salt and are presumed to be a residual accumulation. A water well drilled to a depth of 547 feet at Centerfield some 5 miles northeast of the Redmond pits encountered similar residual clays and salt water near the bottom of the hole. The limbs of the anticline dip an average 30-40 degrees eastward and 16-21 degrees westward (Gilliland, 1951). The anticlinal expression of the Redmond Hills, even in the Recent gravels, suggests continued upward flowage of the plastic salt beds. The salt is fair to poorly bedded, and in places appears to have been brecciated and recrystallized. The salt has been cut up by large vertical joints and by smaller horizontal stress-release joints which have become filled with a secondary deposit of thinly fissile clay. The clay "beds" in places are sufficiently developed to be misleading and if cursorily examined their orientation would indicate a horizontal trend to the salt. Another interesting "false-bedding" phenomenon are horizontal lineations in the salt quarry walls resulting from solution at various levels at

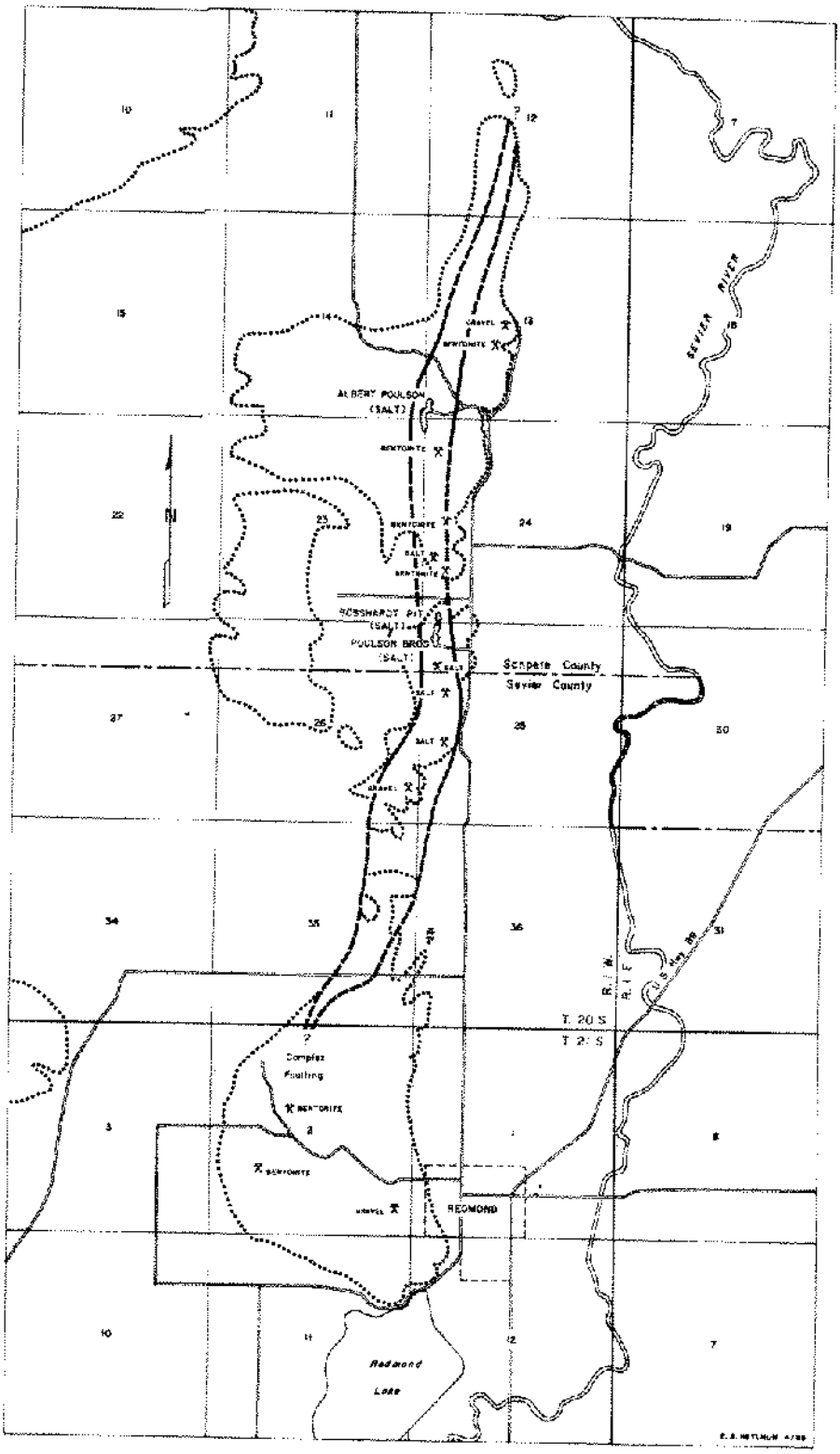
SEVIER RIVER
ALBERT POULSON (SALT)
BENTONITE
GRAVEL
ROSSHARDT PIT (SALT)
POULSON BROS. (SALT)
SALT
Sanpete County
Sevier County
T. 20 S.
T. 21 S.
R. 1 W.
R. 1 E.
Complex Faulting
REDMOND
Redmond Lake
REDMOND HILLS
SEVIER & SANPETE COUNTIES
UTAH
0
1
One Mile
ACTIVE SALT MINES (1965)
OTHER MINES & PROSPECTS
SALT AREA (KNOWN & POSTULATED)

Figure 3.

Figure 4. Gravels overlying salt deposit.

which the surface of quarry-bottom ponding has stood (Fig. 5). A maximum of 200 feet of salt is exposed by quarry operations, but operators estimate the total thickness to be 800-1,200 feet. Current work indicates a thickness ranging from 600 to 1,000 feet.

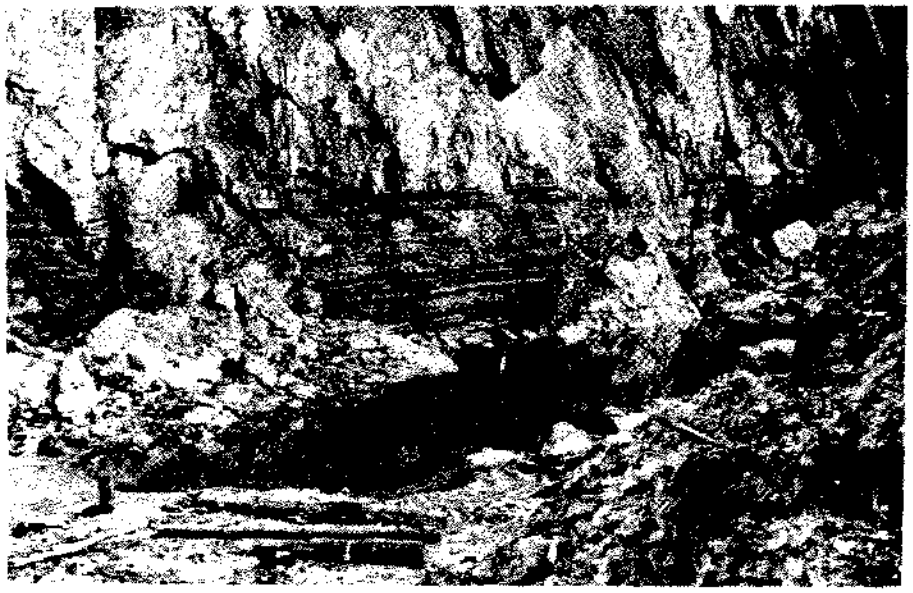

Figure 5. "False bedding" formed by solution action of sump pond.

Great Western Deposit. These salt beds lie in an isolated fenesterlike block of the Arapien Formation bounded by faults, probably associated with strip thrusting of the overlying Green River Formation. The salt beds strike N 20°E and dip 45° eastward toward the axis of a small

syncline (Hardy, 1952). About 200 feet of salt is exposed in the pit, but the total exposed thickness of salt-bearing strata, which also includes shale, siltstone, and sandstone is 770 feet. The bedding in the salt is more distinct here than it is in the Redmond Hills deposit due to a greater abundance of interbedded silt and clay.

Geologic History. The salts in the Arapien Formation were deposited in a southwestern extension of the Sundance Sea which extended into central Utah in Jurassic times (Gilliland, 1951). The saline facies of the Sundance Sea, though probably confined to a narrow belt, extended from central Utah northward to northern Utah where, in the Coalville area, Jurassic salt was found in a deep well. Following the withdrawal of the sea, the area was subjected to several periods of orogeny during which the rocks were buckled and clastics were deposited in basins adjacent to highlands. Volcanic activity intermittently prevailed being most pronounced in Mid-Tertiary. Stokes (1956) attributes the fault complex on the western flank of the Wasatch Plateau to upward growth and subsequent collapse of underlying salt. If his hypothesis is correct, it could well explain the salt cored anticline in the Redmond Hills. Hence, the vertical bedding may be, in fact, flow structures (Fig. 6). The brecciated nature of the salt could also indicate flowage.

Figure 6. Flowage or bedding? Poulson Brothers Pit.

The Sevier River, which drains the region, once flowed into Pleistocene Lake Bonneville. The river continued to supply water to the shrinking Lake Bonneville and to the Great Salt Lake Basin until the lake dropped below 4, 630 feet in elevation. It is believed that this river, flowing through areas of Arapien salt, became highly charged with minerals and was probably an important contributor to the salinity and mineral content of Great Salt Lake. The total dissolved solids increase markedly as the river flows through the Redmond area.

Lithology

In general, the salt is massive deep brick-red in color due to finely disseminated red clay, and is opaque to semitranslucent in hand specimens. The red salt contains occasional pure white salt beds up to 2 feet thick and scattered pockets of pure, transparent crystalline halite of collecting quality. One interesting halite specimen consisted of a compact, silky mass of parallel, fine, needlelike halite crystals similar in appearance to satin spar. Despite its deep red color, the salt is remarkably pure.

Chemistry. Gilliland (1915) has published a chemical analysis of the salt from the Poulson Brothers salt pit in the Redmond Hills.

Salt (NaCl)	95.60%
Silica	2.16
Sulphates	1.10
Calcium	0.51
Iron and alumina oxide	0.04
Magnesium	0.04
Iodine	0.03

Another sample of salt, from the Albert Poulson mine, was analyzed at the University of Utah, as follows:

Sodium	37.57%
Calcium	0.59
Chlorine	59.36
Sulphate	2.48

These analyses indicate that the salt is composed of ordinary halite, with a few impurities which impart a reddish color. X-ray diffraction indicates the presence of sylvite, although this was not confirmed by chemical analyses of the same specimens.

Salt Pits.

Albert Poulson Company pit. (Location #9). Sections 13, 14, 23, and 24, T. 20 S., R. 1 W., Sanpete County.

This pit is owned and operated by the Albert Poulson Salt Co. of Redmond, Utah. The pit measures 750 feet long and ranges from 150 feet wide at the south end to 50 feet wide at the north. At present, the salt is being quarried from a 50-foot salt face in the south end of the pit, which is overlain by about 30 feet of residual saliniferous clay and gravel. The salt itself strikes north-south and dips from 80° westward to vertically, and its thickness is about 1,000 feet (operators estimate 800-1,200 feet). Gravels and volcanics containing bentonite drape over the salt, and on the east side, strike N 14° east and dip 20° east. The salt is quarried and hauled to Redmond, where it is sold in chunks, as quarried, for cattle salt or crushed and used as sheep salt. The salt sells for $5.85 per ton. In the past, the quarry has been operated by the Morton Salt Co. of Salt Lake City.

An interesting sidelight are slender, hollow, very delicate salt stalagmites and stalactites being formed in the walls of the pit as a result of water dripping from above.

Poulson Brothers Salt Co. pit. (Location #6). NW 1/4 NW 1/4 section 25, T. 20 S., R. 1 W., Sanpete County (Fig. 7).

This pit is being worked by the Poulson Brothers Salt Co. of Redmond. Mining is being done from a pit measuring 650 feet by 120-150 feet, and the salt is being removed from a 30-foot salt face overlain by red residual clay capped by gravel. The salt here dips vertically and is estimated by the operators to be 900-1,000 feet thick, and by actual field measurements is 600 feet thick.

Figure 7. Poulson Brothers pit, Redmond Hills area.

Bosshardt Brothers salt pit. (Location #7). SW 1/4 SW 1/4 section 24, T. 20 S., R. 1 W., Sanpete County.

This pit, essentially continuous with, but divided by a thin dirt wall from the Poulson Brothers pit to the south, is being quarried by the Bosshardt Brothers of Redmond. The pit is 275 feet by 180 feet and salt is being removed from a 20-foot salt face overlain by 20-30 feet of clay and gravel overburden. Bosshardt Brothers also produce bentonite from the pyroclastics adjacent to the salt in the Redmond Hills.

Great Western salt pit. (Location #2). SE 1/4 section 33, T. 20 S., R. 1 E., Sevier County.

This pit was dug into impure brick-red bedded salt which contains an abundance of red clay. The salt beds strike N 20°E and dip 45° east. About 200 feet of salt is exposed in the pit, but the total section containing salt is about 770 feet thick, and consists of interbedded salt, red shale, siltstone, and minor fine-grained sandstone. Selenite needles occur occasionally in the overlying weathered material. An abundance of salt solution cavities is visible on the surface. The pit is not being produced at present and contains a pond, which dries up in the summer. The concrete foundation of the old Great Western Salt Plant exists at the site.

Location #3. NW 1/4 SW 1/4 section 25, T. 20 S., R. 1 W., Sevier County.

This is an abandoned pit in clayey and silty, brick-red rock salt containing pockets of colorless transparent salt. The salt is interbedded with silt and clay and overlain unconformably by gravel. The salt strikes N 20°W and dips 68° west.

Location #4. SW 1/4 NW 1/4 section 25, T. 20 S., R. 1 W., Sevier County.

This pit has been stripped into poorly sorted gravel and saliniferous red shale and sandstone, which appear to dip westward. There has been no massive salt development as such, but some gravel may have been produced.

Location #5. NW 1/4 NW 1/4 section 25, T. 20 S., R. 1 W., Sanpete County.

This pit has been dug into essentially horizontal surficial gravel, exposing the top edge of a steeply dipping salt bed striking N 10 E. The salt is massive, transparent, relatively pure, and appears to have been brecciated and recrystallized.

Location #8. NW 1/4 SW 1/4 section 24, T. 20 S., R. 1 W., Sanpete County.

This is a large ponded pit in gravels underlain by 10-15 feet of compact, deep red salinifeous silt. Salt may exist at depth.

Location #1. NE 1/4 section 32, T. 21 S., R. 1 E., Sevier County.

This pit is located on the west side of Salt Gulch, which dissects the north wall of Salina Canyon three miles east of Salina. The salt is impure, massive and brownish-red, and it contains small inclusions of pure crystalline halite. About 50 feet is exposed in the pit, but considerably more exists, as evidenced by salt springs. Thin clay interbeds indicate a 20° east dip. This is the southernmost salt occurrence presently developed in the area.

Annual Production.

Total annual salt production from the three active quarries in the Redmond Hills amounts to 10,000 tons annually.

Uses.

The majority of the salt produced in the currently quarried pits near Redmond is either sold in raw chunks, as quarried, for cattle salt or crushed for sheep consumption. Gilliland (1951) states that the natural iodine content is such that no more need be added to make the salt fit for stock consumption. Except for scattered pure pockets of crystalline halite, the salt has been refined for human consumption, but, at present, the salt is not being so processed. A considerable amount of the salt is sold in the winter for application to roads. Pierce and Rich (1962) discuss the possible use of cavities washed into massive bedded salt for the storage of liquified petroleum gas and radioactive waste.

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