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SIXTEENTH FLOOR MILAM BUILDING
SAN ANTONIO 5, TEXAS

INTERIM GEOLOGIC REPORT

ON THE

GEOTHERMAL STEAM PROJECT

AT

MILFORD, UTAH

INTERIM REPORT ON MILFORD STEAM WELL PROJECT

by

William G. Kane, Consulting Geologist

The discovery of the new geothermic steam well on March 2, 1968 several miles North of Milford, Utah was one of the most significant developments that has taken place in this new field of scientific enterprise in the Rocky Mountain Region during the past year. Since the sensational results of drilling for this new energy source in the Salton Sea area of Southern California were so widely publicized during 1957 a broad new interest has come to this new earth science development. Many of the western states have made geologic studies and appraisals of the geothermal potentials within their borders, printed pamphlets and maps on the locations of prospective areas for exploration and revamped their regulations for giving drilling permits and exploitation concessions on their lands.

The Federal Government, through the Department of the Interior began to distribute circulars and maps to enlighten the public regarding these new important potential values in large segments of our public lands domain. The U.S. Geological Survey made an inventory of all the lands of the 13 western states and designated 1,051,000 acres of Federal lands in the five states of California, Nevada, Montana, Idaho and New Mexico as having "current potential values for geothermal resources" and on the basis of this report all of this land has been withdrawn from entry or sale, pending legislation by Congress for the development of geothermal energy. The U.S.G.S. inventory also noted that another 86.3 million acres in Arizona, Arkansas, California, Colorado, Idaho, Montana, New Mexico, Oregon, South Dakota, Washington and Utah should be classified as "prospectively valuable" for geothermal energy.

As of March 29, 1967 these "prospectively valuable" areas were not placed on a withdrawn status but they were said to be subject to continuing review by the U.S.G.S. specialists and some of these might be reclassified and be subject to withdrawal for sale or entry by order of the Bureau of Land Management. In January 1967 President Johnson requested Congress for legislation on this matter. The Congress had already passed a bill on it during 1966 but the President had vetoed it on the grounds "it did not contain adequate safeguards."

The new legislation requested by the President contains the following provisions:

1) Delete the clause which would have favored holders of existing oil or gas leases, mining claims or permits for future leasing.
2) Maximum lease to any one person of 10,240 acres in any one state
3) Royalty on steam "reasonably susceptible for sale or use" by lessee rather than on steam actually sold or utilized.
4) Provide specific authority for Secretary of Interior to renegotiate or readjust terms of lease at intervals prescribed by regulations.
5) A 60 year lease rather than a perpetual term.
6) If steam produced in commercial quantities, developer must begin production within 10 years rather than 15 or 20 years.
7) All leases would be offered on a competitive basis.
8) Lands administered by the Department of Interior or Department of Agriculture would be limited to only 2560 acres and be subject to special regulations.
9) All royalties would be not less than 10% of value of steam plus not less than 5% of all by-product values.

Copies of the State of Utah and Federal Government maps of Potential Geothermic Steam Areas are included herewith.

From the above indicated state and federal government proposals with respect to land acquisition, it will be seen that the amount of presently owned acreage is one of the critical aspects of any projected development in this field. So far as we know the only acreage that this project can regard as secure is the State lease on School Section 16, T27S-R 9 W which is located one mile east of State Highway #257 about two miles North of Milford in Beaver County, Utah.

We are advised by Mr. Austin Smith of Salt Lake City that the application for this State lease in the names of Austin Smith, Louis Cooper and Dr. Eugene Davie has been approved subject to the presentation of a survey showing the location of a number of wells that are to be drilled on this tract. When we last visited the area Dr. Davie had a surveyor out there making these locations.

Dr. Davie reports that 8 or 10 mining claim denouncements have been made on federal lands located to the North and South of Section 16 but as will be noted from the above new federal land proposals, these will not be acceptable for geothermic steam rights. Although the lands having "prospective values" for such rights apparently have not yet been withdrawn from entry for this use, it is doubtful that under the present circumstances one could hope to make much progress in securing such federal claims until the Congress has passed some legislation setting forth the guidelines and specifications for such claims.

Apart from the probability that concessions cannot now be obtained on such federal lands, the proposed terms on which such concessions would be granted are most unrealistic and would put the prospective investor in such a project in a very unattractive situation to protect himself against competitors who might obtain claims on the adjoining lands to a new discovery.

In spite of all of these unfavorable factors, it is thought that the recent discovery near Milford is a very valuable asset because it is located along the eastern edge of the Western Desert Area described in Special Studies 14 of the Utah Geological & Mineralogical Survey of January 1966.

The broad Milford valley along which the Union Pacific Railroad runs West of the high snow-capped Tushar Mountain Range and the Pavant Range that extend up through the center of the State of Utah to Provo, Salt Lake and Ogden, is characterized by a number of areas where there are or have been significant hot springs occurrences. The Western Desert Area extending from Thermo through Minersville up the West flank of the Mineral Mountain East of Milford on up to the area of extinct volcanoes between Kanosh and Black Rock, appears to be one of the more important of these thermal zones since in most cases the steam coming from these is of volcanic or magmatic origin rather than tectonic, and may therefore be expected to be more dry and free from excessive salt content.

The springs near the Black Rock Mountain have precipitated a considerable amount of sulphur and siliceous material but they are not characterized by travertine deposits or other salts. The same is true of the Bailey Springs near the edge of the Mineral Mountain about 8 miles North of Milford. While it was not possible at this locality to find the exact outcrop of the springs in relation to the granite or porphyry of the mountain, it appeared probable that the hot springs had issued from the contact of the igneous rock of the mountain with some sedimentary rocks in the valley under the overburden or had come up through a fault along the mountain's edge in the igneous rock itself. The whole area at and around these springs for several hundreds of feet was covered by a reddish small pebble conglomerate that was composed mainly of disintegrated granite, prophyry and even some pieces of obsidian, or volcanic glass, that had been washed down from the higher places in the mountain. The North end of this valley between Bailey Springs and Black Rock Mountain has many lava flows right up against the West flank of the mountain.

The soil all over the discovery well area is an eroded surface of the same reddish pebble conglomerate as described above and over near the East side of Section 16 large boulders of monzonite prophyry were found. Along the East line of this section we found the quarter-corner and 150' North of here a tongue of igneous rock prophyry and gneiss extended about 1/4 mile West into its SE$\frac{1}{4}$. From the close proximity of the edge of the mountains and the extension of igneous rock into Section 16 it is apparent that its East half will not have very much valley fill other than the detrital material from the disintegrated prophyry, granite and gneiss. This reddish conglomerate material is cemented by a siliceous matrix such as that described above in the Bailey Spring locality.

In the first well drilled on the top of the opalite ridge decomposed greenish granite cuttings were fround from 86' to 116' depth and this well is believed to have drilled 4' into the solid prophyry before it was lost. The fourth well drilled, the discovery well, had chloritic decomposed green granite cutting from 80' to 90' and other decomposed granite with hard opalitic beds in between down to 230'. While it is difficult to distinguish the cuttings of the conglomeratic granite detrital material from the solid granite it does seem likely that any well drilled between the opalite ridge and the mountain will find the solid granite or prophyry within several hundred feet depth and it may therefore be hard to get a well down here to 1000'. The shallow depths at which steam will be found in this area may preclude the higher temperatures and rock-pressures that might be found at greater depths. On the other hand when it is considered that the discovery well was 258° F at 240' depth whereas the normal pressure gradient is only 1.2° F per 100', this indicates unusually high heat. In the next 25' depth at 265' (T.D.) the temperature moved up from 250° to 278° at the well head.

In view of the fact that insufficient preparations had been made to handle the steam found in this well, a considerable amount of steam started seeping out at the surface about 70 feet South of the well when it was shut in. In order to protect the field from such steam seepage in the shallow beds, it was deemed necessary to have Halliburton come in and do a complete cement job on the well plugging all the formations from top to bottom. The picture included in this report is the only evidence remaining of this exciting and unexpected discovery.

It is believed that the next well that is drilled should have a rig that is capable of drilling several thousand feet and be prepared for high pressure. It is this writer's opinion that the next well should be located within a few hundred feet and East of the opalite ridge and that an effort be made to drill 1000' straight down and then attempt to whipstock the hole westward in an effort to get under the long lateral vent through which the great masses of opalite had exuded to form this ridge.

It is thought that this long outcrop of vertically standing opalite beds that formed in this vent is an unusual situation and a striking picture of it is included in this report. If indeed the steam that brought up this almost pure silicification phenomenon has plugged itself off beneath this ridge there could be a sizeable cavity down there holding a considerable reserve volume of superheated magmatic fluid or gaseous material that might flash into high pressure and high temperature steam when its pressure has been tapped and released. For this reason it is thought that the deeper we might get the new well before we get over under the opalite ridge, the better chance there would be of getting a big well.

Naturally the cost of drilling a deep well that would provide proper protection for the production that would be hoped for, would be expensive. We might conceivably duplicate the shallow well like the #4 well to 260' and provide it with better surface protection for $10,000 or less, but to drill a well that could go to two or three thousand feet with full protection for a big well with high temperature and pressure might cost $150,000.

The only example of an actually operating steam power generating project in U.S.A. is at the Geysers, located in Sonoma County, California about 100 miles North of San Francisco. Between 1955 and 1960 eleven wells were completed here producing over 1,000,000 lbs. of dry steam per hour at a pressure of 60 psi and temperature of 350° F. Pacific Gas and Electric opened its first power generating plant there in 1960, put in their second unit in 1963 for a combined output of 26,000 kwh, and were expected to have their third and fourth units on stream this year for a total of 81,000 kwh.

It is calculated that it takes about 20 lbs. per hour of dry steam to produce 1 kwh and the wells at Geyser will average about 5,000 lbs./hr. The cost of developing steam at Geyser ranges from $60 to $90 per foot of completed steam well including drilling, geology, roads, testing, well-head equipment, casing and administration, although the drilling itself could be contracted for up there for $10 to $14 per foot. Their cost of steam delivered to the power plant is 2.5 mills/kwh of electric energy delivered to the transmission line, but the overall cost including power generation has not been published.

It is reported that the cost of installing the generating plant at Lardarello, Italy was $113 per kwh and that the first plant (rebuilt) at Geysers cost $152 per kwh but, had a new generator been installed, it would have cost $192 per kwh. From a perusal of a considerable amount of data on the subject of costs of plants and cost of kwh generated from them, the following figures seem to be indicated for the various types of generating plants:

Types of Plant	Cost of Plant per KWH	Cost of power mills/Kwh
Geothermal Energy	$63 - $143	2-3
Thermoelectric	$110 - $125	4.6 - 7.74
Nuclear Energy		5.42 - 11.56
Hydroelectric		5 - 11.36

In view of the very unfavorable land factors in this situation at this time and taking into consideration the extreme difficulty that will be encountered in drilling through the opalite beds at the surface as well as the porphyry or gneiss that may be found at shallow depth, it is apparent that whoever undertakes to drill the exploratory well here must be well provided with a substantial amount of risk capital, some well experienced operating personnel and probably some capable administrative talent to be able to make the most of the government leasing arrangement that will be made available.

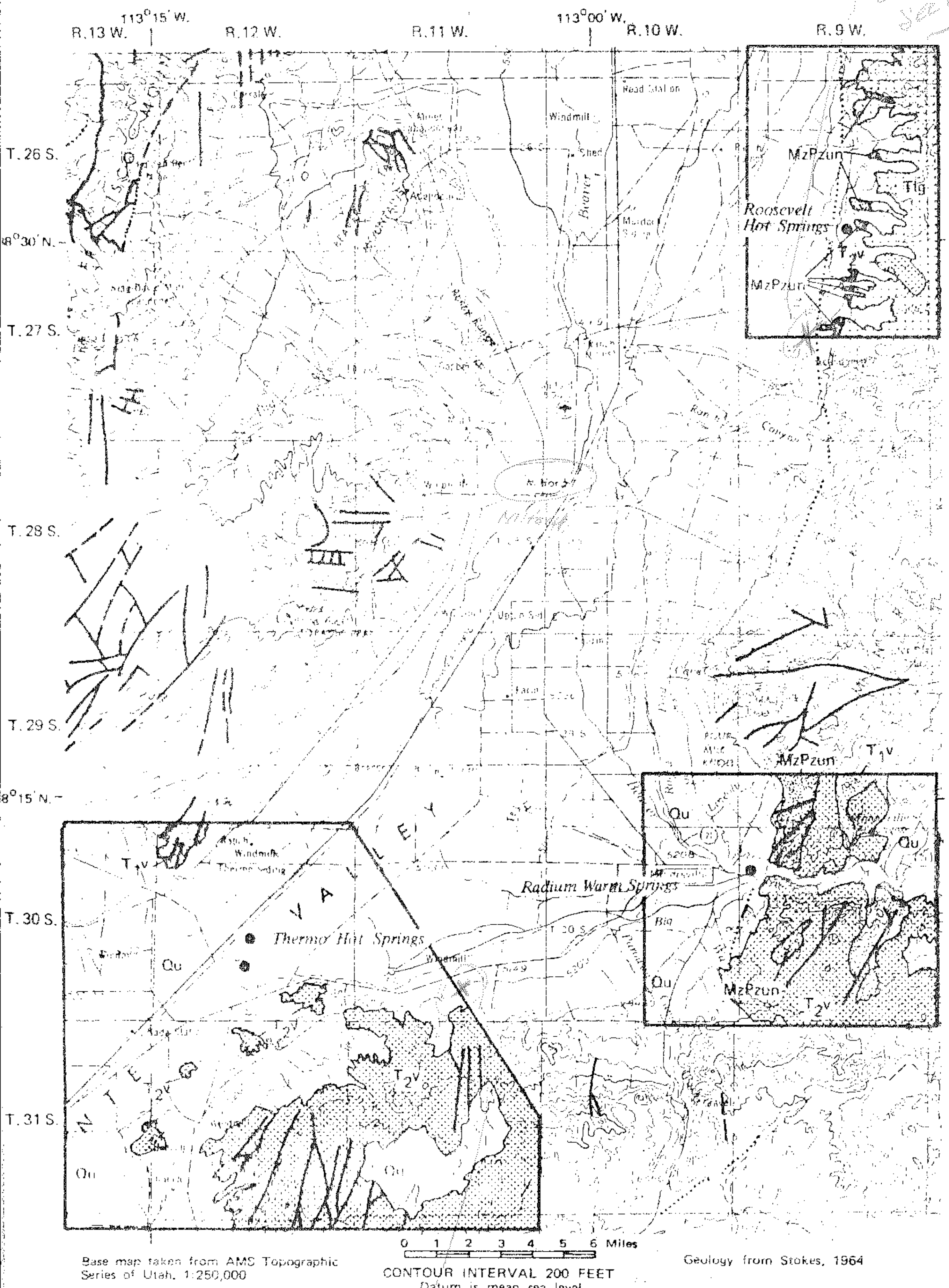
It does appear to this writer that the geologic relations here are quite different, much more challenging to deal with but perhaps excitingly more attractive than the localities that have been drilled in many other places where the indications were limited to hot-springs or mud-pots. The evidence here of some kind of a vent a half mile long that had exuded highly siliceous gases or solutions during a long time before it closed itself off with its own opalitic residue suggest the possibility, if not the probability of a really tremendous heat source beneath the surface in this particular area. It is most certainly a prospect that warrants drilling and if the right people, tools and financing can be assembled to do it it should be a most attractive speculative venture.

William G. Kane

May 15, 1968

William G. Kane

Site of Dr Davis' Steam Well. See W. G. Kane Report



EXPLANATION

●	Spring
Qu	Unconsolidated deposits of Quaternary age
T_2v	Volcanic rocks of late Tertiary age
T_1v	Volcanic rocks of early Tertiary age
MzPzun	Granitoid rocks of Tertiary age
Tig	Sedimentary and metamorphic rocks of Mesozoic and Paleozoic age
	Contact
	Fault: Dashed where inferred; dotted where concealed

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Figure 18. Map showing generalized geology in the areas surrounding Roosevelt (McKeans), Radium (Dotsons), and Thermo Springs.

Measured 7°F temperature rise between surface & 125' Depth 1973

Radium (Dotsons) Warm Springs

Radium (Dotsons) Warm Springs (C-30-9) 7aca-S1, issue from a seepage zone about 300 feet long along the south bank of the Beaver River about one mile east of Minersville in Beaver County. The springs issue from alluvium, but the source of the water probably is the faulted sedimentary rocks of Paleozoic age immediately northeast of the springs. Large areas of pyroclastic rocks of late Tertiary age are within one mile of the springs (figure 18).

Lee (1908, p. 21) reported that the discharge of the springs was 57 gpm and the temperature of the water was 97° F. On July 11, 1967, U. S. Geological Survey personnel measured a water temperature of 89° F and estimated that the total discharge from the spring zone was 100 gpm.

Chemical data obtained during 1963-67 show that the dissolved-solids content ranged from 956 to 1,020 ppm, that the water was of the sodium calcium sulfate type, that fluoride concentrations were moderately high, and that silica concentrations were low.

The altitude of the faulted mountains within a few miles of the springs is 1,000-3,000 feet higher than that of the springs. The presence of volcanic rocks of late Tertiary age in the vicinity of the springs suggests that the source of heat may be either volcanic or an abnormally high geothermal gradient in the zone of faulted sedimentary rocks adjacent to the volcanics. The spring discharge undoubtedly is meteoric water that infiltrates the faulted or porous rocks at higher altitudes a few miles from teh springs; the water descends 2,000-3,000 feet through these rocks, is warmed, and issues along a fault zone in the immediate vicinity of the springs.

Thermo Hot Springs*

Gilbert (*in* Howell, 1975, p. 257) stated that "Another group of hot springs, . . . is located . . . sixteen miles west of Minersville [Beaver County]. These springs, [(C-30-12)21-S and (C-30-12)28-S], are situated in the open desert, on two parallel ridges have a north and south trend, placed *en echelon,* about twenty rods apart, each eight ot ten rods in width and 20 feet high, with a total length of about one and a half miles. These ridges have been formed mainly by the drifting sand, held together by the moisture and consequent vegetation, as no sinter nor tufa seems to be deposited by the springs. The highest temperature noted was 185° [F]." In contrast to Gilbert's report of sand ridges and the absence of tufa, Lee (1908, p. 22) reported that "The springs occur in two conspicuous mounds built up from the surface of the plain by silica deposited from the spring waters." U. S. Geological Survey personnel reported in July 1967 that the springs issue along the sides and top of calcareous travertine mounds. The southern mound, which was the most active spring, is about half a mile long, 200-250 feet wide, and 10-20 feet higher than the desert floor. The southern mound is mainly clay covered and has travertine along the sides. The hottest spring was on the south mound and had a temperature of 170° F. The two sets of observations, which were made nearly a century apart, indicate that the sand ridges observed by Gilbert have become partly indurated by calcium carbonate or silica that precipitated from the spring water. The observations of Lee (1908), however, indicate that appreciable chemical precipitation must have occurred by 1908. Perhaps older travertine deposits had been buried by drifting sand shortly before Gilbert's observations.

The springs issue from the alluvium in Escalante Valley, but the source of the water probably is rainfall on the faulted mountains northwest or southeast of the springs. A fault buried beneath the alluvium may control the location of the springs. Volcanic rocks of late Tertiary age crop out in the mountains within a few miles south of the springs (figure 18). The source of the heat probably is an abnormally high geothermal gradient that results from late Tertiary volcanism.

The dissolved-solids content of the water ranged from 1,470 to 1,500 ppm. The water is sodium sulfate in type although both bicarbonate and chloride anions are present in significant amounts. Silica concentration was fairly high 100 to 108 ppm. Results of spectrographic analyses were somewhat erratic; one sample showed unusual concentrations of aluminum, copper, and lead, but another sample obtained a year later at the same spring showed nothing unusual.

Discharge from the entire spring area was estimated to be about 200 gpm in July 1967.

Veyo Hot Spring

Veyo Hot Spring, (C-40-16)6cdb-S1, is about 18 miles north-northwest of St. George in Washington County. This spring is no longer accessible to direct observation; a swimming pool has been constructed over the spring. In July 1967, the owner reported that the spring discharge was 120 gpm and the water temperature was 98° F. He also reported that when

* Thermo Hot Springs – local residents report a geyser at Thermo in early 1900's. We have found geyserite in area of one of the mounds.

Johnson Warm Spring issues along the Sevier fault about two miles south of Monroe Hot Springs. Richardson (1907, p. 58) reported a flow of 180 gpm and a temperature of 80° F. In April 1967, U.S. Geological Survey personnel reported a flow of 10 gpm and a temperature of 77° F.

Both Monroe and Red Hill Hot Springs have dissolved-solids contents ranging from about 2,600 to 2,900 ppm and are of the sodium sulfate chloride type. Johnson Warm Spring has a much lower dissolved-solids content and is of the calcium sulfate type. One of the small springs in the Monroe Hot Springs showed a high manganese content (346 $\mu g/1$). Johnson Warm Spring had one of the highest molybdenum contents (18 $\mu g/l$) of all thermal springs in Utah.

Joseph Hot Springs issue from tufa deposited by the springs over the Dry Wash fault. Extensive areas of volcanic rocks crop out immediately east of the fault. Water temperatures of 145° and 148° F were measured in 1966 and 1967. Discharge of the springs probably averages 30 gpm. Dissolved-solids content of Joseph Hot Springs ranges between about 5,000 and 5,200 ppm—nearly double that of Monroe and Red Hill Hot Springs. The water is of the sodium chloride type. The concentration of calcium is about the same for Monroe, Red Hill, and Joseph Hot Springs; sulfate is somewhat greater in Joseph Hot Springs than in Monroe and Red Hill Hot Springs. In Joseph Hot Springs, chloride (in equivalents per million) is nearly double that of sulfate; but in Monroe and Red Hill Hot Springs, chloride and sulfate are about equal (in equivalents per million).

The presence of volcanic rocks of late Tertiary age along the faults from which Monroe, Red Hill and Joseph Hot Springs issue indicates that these rocks probably contribute to the heating of the water. They may be a direct source of heat for some of the water, and the volcanic activity that resulted in these rocks may have resulted in an abnormally high geothermal gradient. The depth of circulation and the amount of dilution by cool shallow ground water are not known. The major faults certainly furnish the avenues of escape for the water that enters the earth's surface at altitudes much higher than those of the springs, but the depth of circulation in the fault zone is unknown.

Roosevelt (McKeans) Hot Springs

Roosevelt (McKeans) Hot Springs, (C-26-9)34dcb-S1, are in Beaver County, about 12 miles northeast of Milford and about 20 miles northwest of Beaver. Lee (1908, p. 20) reported that the largest of the Springs in Roosevelt Hot Springs had a discharge of about 10 gpm, and that the temperature at the pipe leading from the spring was 190° F. He also stated that much of the silica contained in solution as the boiling water issued from the rocks was deposited as the water cooled. U. S. Geological Survey personnel reported a discharge of 1 gpm and a temperature of 185° F in November 1950 and reported a temperature of 131° F in September 1957. In May 1966 the spring was dry and appeared not to have discharged for several years.

Intrusive rocks of Tertiary age crop out immediately east of the former springs, and volcanic rocks of late Tertiary age crop out less than two miles southeast of the springs (figure 18). The springs issued from a fault zone along the west side of the Mineral Mountains. The heating of the water, probably of meteoric origin, may have been caused by contact with volcanic rocks or by an abnormally high geothermal gradient in the area where both intrusive and extrusive rocks of Tertiary age are common.

Lee (1908, p. 20 and 50) reported a dissolved-solids content of only 645 ppm and a discharge of 10 gpm. In 1950 the dissolved-solids content was 7,040 ppm at a measured discharge of 1 gpm. In 1957 the dissolved-solids content was 7,800 ppm. Lee's data show that the water was of the sodium sulfate chloride type; silica concentration (101 ppm) exceeded that of any single ion. In 1950 and 1957, the highly mineralized water was sodium chloride in type; silica content was very high (405 and 313 ppm). The analysis of a sample obtained in 1957 shows fairly high concentrations of boron and fluoride. The source of the dissolved solids is not known. If Lee's data are reliable, the spring discharge showed about a tenfold decrease in discharge during a 50-year period. Lee (1908, p. 20) states that "the water contains a large amount of mineral in solution, as shown by the analysis in table 9"; but the data in table 9 of Lee's report do not show an especially "large amount of mineral in solution."

The very high silica concentrations indicate a possibility of marked increase in temperature with depth. The lack of spring flow during the past 10 years and the lack of information on the possible presence of a reservoir rock indicate that the geothermal potential of the area can be evaluated only by intensive subsurface exploration.

general area of the springs. Water from a well about five miles northeast of the springs has a dissolved-solids content of 6,970 ppm. water from two wells about three miles southwest of the springs has dissolved-solids contents of 4,430 and 4,490 ppm, and water from a well about three miles south of the springs has a dissolved-solids content of 8,050 ppm. The depths of these wells range from 100 to 527 feet. If ground water similar to that found in the described wells were in contact with the volcanic flows or were in contact with the volcanic flows or were circulated to a depth of 3,000 feet, water having the chemical and thermal characteristics of the hot springs would result.

Despite the proximity of volcanic rocks of late Teririary and Quaternary age, the immediate area of the springs appears to be of questionable geothermal potential. The relatively low temperature of the spring water, the low silica content, and the similarity in chemical quality of the spring water and the ground water in a fairly large surrounding area are not favorable indicators of a large increase in temperature at fairly shallow depth.

Richfield Warm Springs

Richfield Warm Springs, (C-23-3)26aca-S1, are about half a mile west of Richfield in Sevier County. These springs issue at a fault contact between alluvium and sandstones of Tertiary age in the Elsinore fault zone along the west side of the Sevier River valley (figure 17). Numerous faults occur in the eastern part of the Pavat Range, which is immediately west of the springs. Volcanic rocks of late Tertiary age crop out about two miles southwestward along the west side of the Sevier River valley; similar outcrops are common along the east side of the valley.

Richardson (1907, p. 58) reported that spring discharge was 1,440 gpm and that water temperature was 74° F. Dissolved-solids content of the springs is low–about 300 ppm; the water is of the magnesium calcium bicarbonate type.

The presence of numerous faults in the mountains one to five miles west of the springs, the large discharge of the springs and the low dissolved-solids content indicate that the spring discharge is meteoric water that descends not more than 2,000-3,000 feet and is heated slightly by the geothermal gradient. The altitude in some areas of possible infiltration is more than 2,000 feet higher than that of the springs. The geothermal gradient within the mountains is sufficient to raise the temperature of the water 15°-20° F. The springs probably issue where water moving out of the mountain mass is intercepted by the Elsinore fault zone. The springs are a main source of municipal water supply for the city of Richfield.

Central Sevier Valley Group

The central Sevier Valley group of springs issue along the east side of the Sevier River valley, about 10 miles south of Richfield in Sevier County. Monroe (Cooper) Hot Springs, (C-25-3)10dda-S1 and (C-25-3)15a-S; Red Hill Hot Spring, (C-25-3) 11cac-S1; Johnson Warm Spring, (C-25-3)27a-S; and Joseph Hot Springs (C-25-4)23-S, are included in the central Sevier Valley group in this report. Monroe and Red Hill Hot Springs and Johnson Hot Springs issue from the Dry Wash fault about five miles west of the Sevier fault (figure 17). Volcanic rocks of late Tertiary age occur within one mile of all except Johnson Warm Spring.

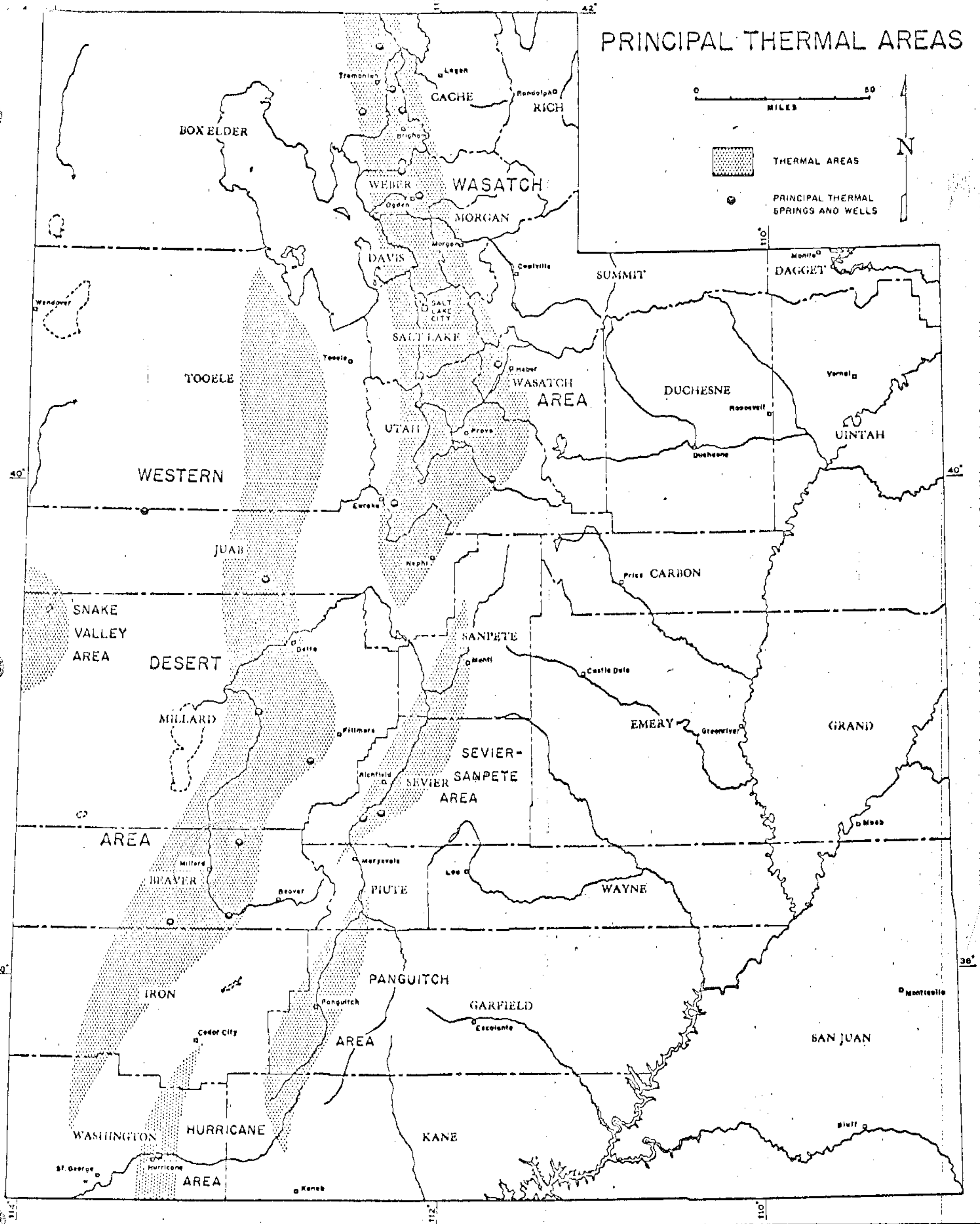
Monroe Hot Springs issue from a single tufa mound that extends for about half a mile along the mountain front; the width of the mound is about 600 feet from the mountain front to the base, and the height is 75-100 feet. The springs issue from seepage zones and from fissures and cracks that have been enlarged by local residents to increase the spring yield. Discharge is at two major points–one near the center of the mound and the other at the base. The largest spring on the mound discharges about 50 gpm; water temperature was 148° F on February 13, 1967. The other large spring discharges about 40 gpm from the base of the mound; water temperature was 106° F. Several small springs discharge from the surface of the mound. The total discharge of Monroe Hot Springs was about 150-200 gpm on February 13, 1967. In addition to the visible discharge from the springs, some water evaporates directly from the mound surface; saturated area high on the mound above the spring areas and extending to the mountain front indicate that artesian pressure is forcing water to the surface of the mound.

Red Hill Hot Spring issues from a tufa mound about 600 feet long, 200-300 feet wide, and about 50 feet high. The only spring that issues from the mount discharges as much as 150 gpm from a crevice in the north-central part of the mound. The water temperature was 167° F on February 13, 1967; a temperature of 169° F was reported for "Monroe Hot Springs" (Carpenter and Young, 1963, p. 17), but this temperature actually was for Red Hill Hot Spring.

Solid black shows areas of current geothermal resources that have been withdrawn.

Grey areas are considered less valuable for geothermal resources, and are not withdrawn.

U.S. GEOLOGICAL SURVEY


PRINCIPAL THERMAL AREAS
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JUAB
CARBON
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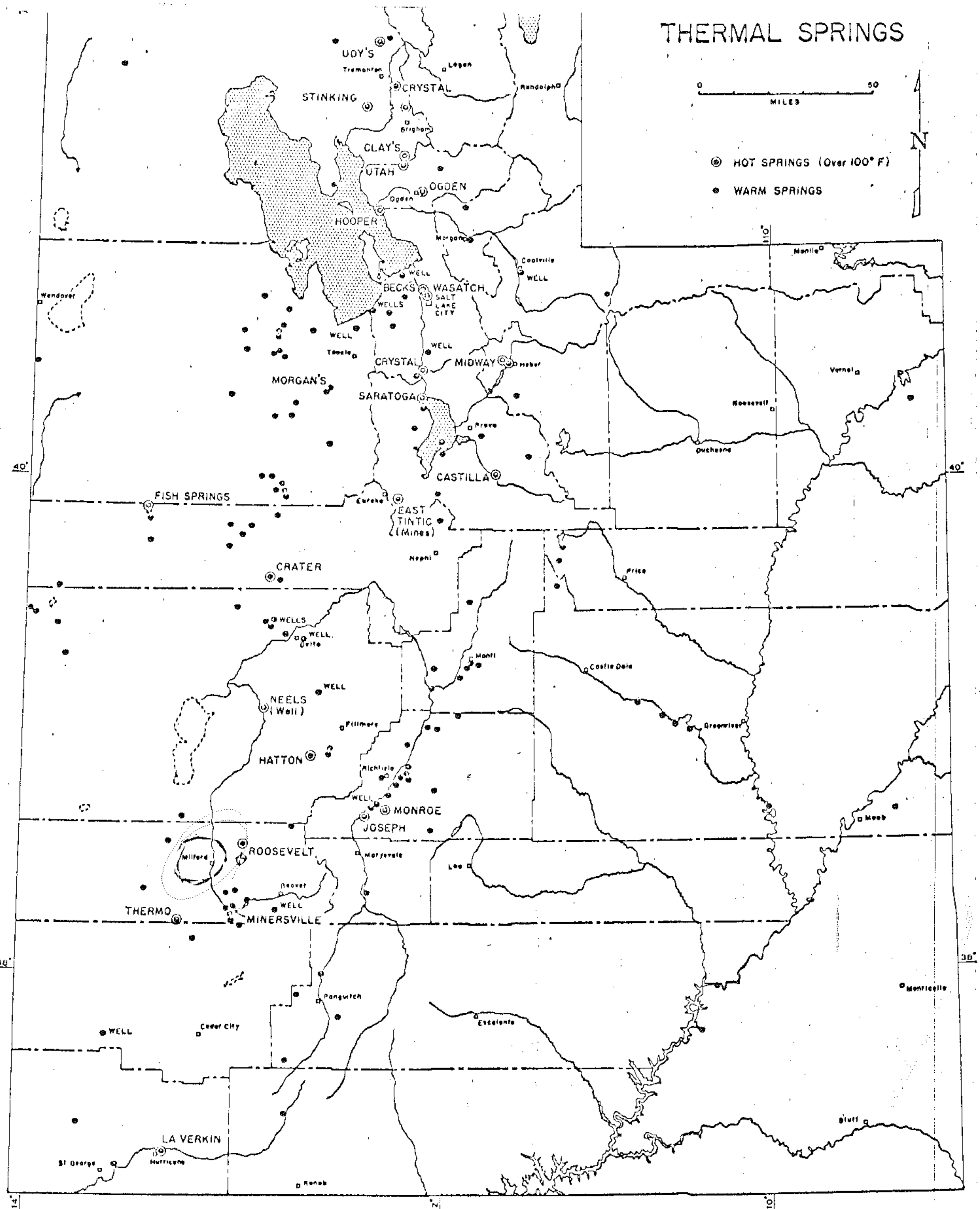
Figure 1.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MILES
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HOT SPRINGS (Over 100° F)
WARM SPRINGS
UDY'S
STINKING
CRYSTAL
CLAY'S
UTAH
OGDEN
HOOPER
BECKS
WASATCH
CRYSTAL
MIDWAY
MORGAN'S
SARATOGA
CASTILLA
FISH SPRINGS
EAST
TINTIC
(Mines)
CRATER
WELLS
NEELS
(Well)
HATTON
MONROE
JOSEPH
ROOSEVELT
THERMO
MINERSVILLE
LA VERKIN
WELL
40°
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Figure 2.