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THE GEOTHERMAL POSSIBILITIES OF

THE WESTERN DESERT AREA-UTAH

By: H. Clyde Davis

December 30, 1971

859 East 2730 North
Provo, Utah 84601
December 30, 1971

Thermal Power Company
785 Market Street
San Francisco, California

Dear Sir:

This report is being prepared for Thermal Power Company of San Francisco of its southwestern Utah properties which are held by Coda Corporation in southwestern Utah. The properties consist of 21,000 acres of land under lease by Coda Corporation in Millard, Beaver, and Iron Counties, as indicated by the map.

The region under study is about 50 miles in width and 150 miles in length, in which studies have indicated an abnormal heat flow in the area pertaining to geothermal springs. The area has very few people, approximately 2500, living in two small communities.

CLIMATE: The climate of this area is typical of basin and range province consisting of desert type of climate in the valleys and changes with elevation radically as altitude increases. The valleys are dry lake beds surrounded by sage brush flats. At slightly higher elevations, bench lands afford sufficient rainfall for juniper and pinon pine trees and in the low mountains there is a more temperate climate with increased precipitation and plant growth, in the high mountains there is sufficient moisture to create considerable snowpacks during the winter months to recharge the underground aquifer of the valley grabens. The climate is quite variable and is a function of the altitude and these variations of climate occur within a very few miles.

GENERAL GEOLOGY: The geology of Southwestern Utah offers many contrasts. In this area, the relatively stable Colorado plateau hinges with the relatively chaotic Basin and Range province. This report is a study of the Basin and Range geothermal possibilities in the hinge zone and covers a tract of land approximately 50 miles in width and 150 miles in length. A dominant feature of the region of study is the abnormal heat flow demonstrated by the hot springs, the earthquake activity, the huge faults, volcanism of many kinds, and hydrothermal alterations. The Colorado plateau consists of separate plateaus, mesas, and buttes with intervening canyons, washes and gulleys, and is bordered on the west and south by volcanism, and on the east by the Rocky Mountains. In some places the Basin and Range volcanism extends into the Colorado plateau producing a vague dividing line between the two types of geology.

The granitic stocks are dominant features of the Basin and Range province. They represent the mountain building process going on throughout the area, and are strong indicators of the abnormal heat flow occurring in the continental rifting process. Although they are less dramatic than an active volcano, they evolve in a similar but slower fashion. They represent the same process of upward migration of deeper layers of semimolten rock material toward the surface, and they carry high temperatures with them.

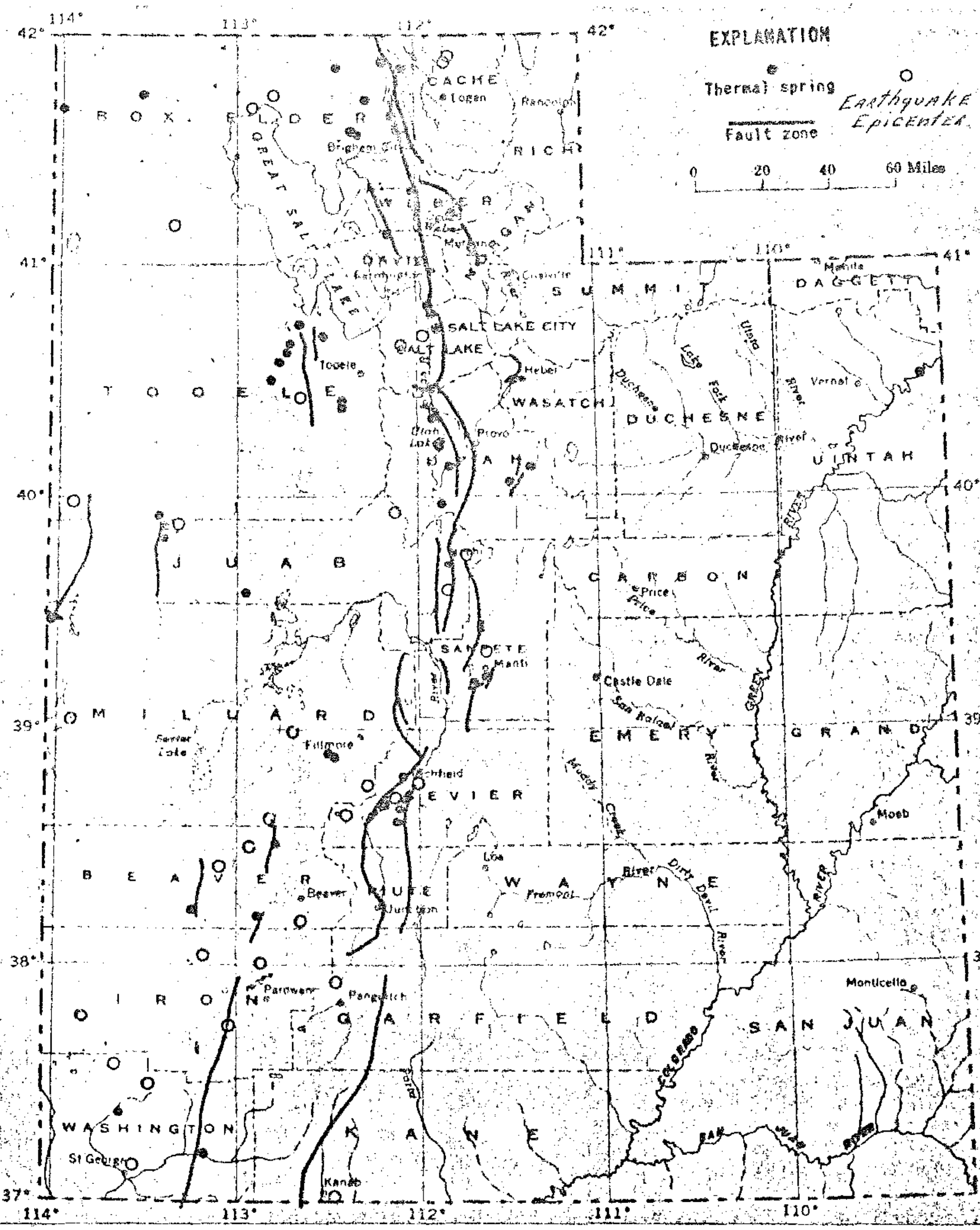
Volcanism is manifested in many ways. There are a few active volcaneos in the world, and there are many inactive or dead volcanic cones. In addition, volcanism is represented by such surface materials as pumice, perlite, obsidian, basalt, ignimbrites, and various igneous flow rocks. These volcanic material originate in the mantle such beneath the crust and make their way to the surface through volcanic cones, massive caldera, and through rifts in the crust. In the area of study along the hinge zone of the Basin and Range province, volcanism has occurred at depth and does not show on the surface. This is in addition to all the volcanism which is apparent on the surface.

The theory of Continental Drift offers an explanation for the abnormal heat flow in Southwestern Utah. In this theory, it is assumed that the continents are floating on a sea of molten rock. This is recognized in the oceans as a global network of spreading centers, and on the continents as rifting of the continental crust. A spreading center known as the East Pacific Rise enters the North American continent under the Imperial Valley. It is postulated that a rift in the crust extends northward through California, Nevada, Utah, Idaho, and on northward into Canada generally in a northerly and southerly line. This rifting of the continental crust allows the molten mantle to come relatively close to the surface. As a result, the evidence of the abnormal heat flow in the hinge zone is apparent as volcanism, block faults and thrust plates, hot springs, and earthquake epicenters.

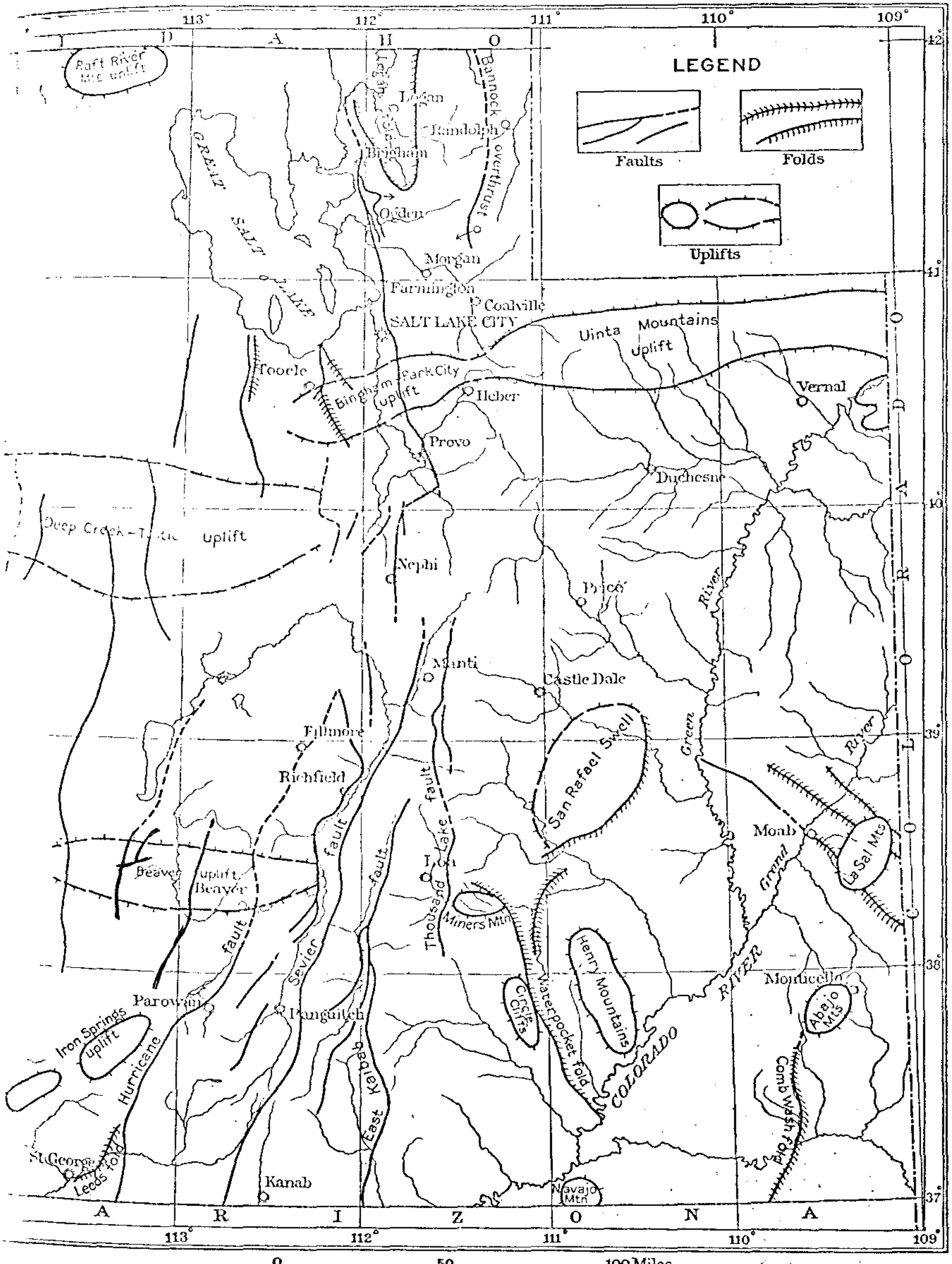
There are three hot springs in Southwestern Utah where the temperature is near the boiling point of water. Water falling as rain or freezing rain or snow gradually percolates through the layers of rock and rock fissures and faults to rock formations of high heat at depth. Some of the heated water may escape to the surface as warm springs or hot springs. Heated water under pressure will carry minerals to the surface and these minerals precipitate on the surface and seal off geothermal fields. Such hydrothermal activity is recognized as deposits of opalite or travertine. Many of these are found in the area of study.

American Institute of Professional Geologists
Certificate Number 2187
AIPG
H. Clyde Davis
Certified Professional Geologist

Figure 1



Adapted from Utah Geological and Mineralogical Survey - Water Resources Bulletin 13, 1970 and from Earthquake Epicenter Map of Utah, Seismicity in Utah by Kenneth L. Cook and Robert B. Smith.



POSITION AND RELATION OF MAJOR STRUCTURAL FEATURES OF UTAH.

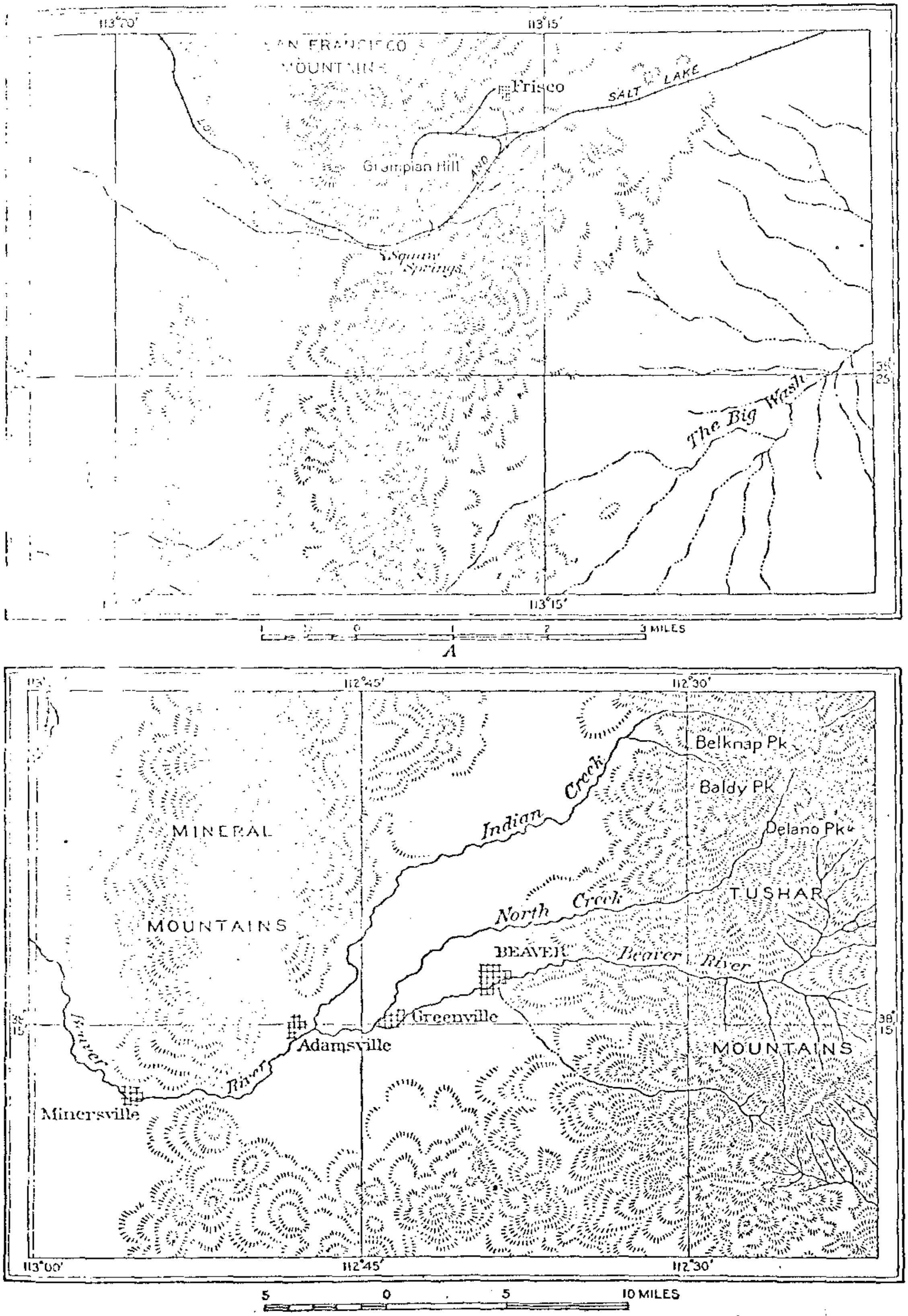


FIGURE 5.—*A*, Squaw Springs Pass. Headwater erosion has developed a valley through the range. (From Frisco special topographic map.) *B*, Beaver Canyon, Mineral Range. The stream has developed a valley through the range and has acquired a large drainage area beyond. (From Beaver topographic map.)

It is considered by some that the streams that pass from the Plateau region to the Basin region are antecedent—that is, that they have maintained their courses while the mountain ranges were rising across their path. If the development of the region has been correctly interpreted in the preceding paragraphs, this seems extremely unlikely. If, at the beginning of the uplift, the drainage was from the Basin Range province to the Plateau, there was, at the time of the reversal, no drainage westward from the Plateau province to maintain itself. It also seems significant that the Canyon Range, the most notable example of a mountain cut directly across by a river, was probably completely buried by early Tertiary sediments[1] and was gradually uncovered as the stream cut its valley. The Beaver River canyon through the Mineral Range has been developed along a line of faulting and is evidently controlled by the weakness of the rock at that locality and has no connection with preuplift drainage. The Squaw Springs Pass through the San Francisco Range has also developed along a line of faulting. The western drainage has pushed through the range and has captured a small drainage area on the east side of the range. Other canyons of the western slope of the San Francisco Range have pushed far inward toward its eastern margin but have not yet cut completely through. Here the western drainage has a much shorter distance to the same base-level (Sevier Lake) than the eastern and has therefore been able to accomplish much more, and the development of a valley across the range plainly can not be attributed to antecedent drainage. (See fig. 5.) Most of the streams crossing a range that have been noted by the writer may be logically accounted for by normal headward erosion.

An unpublished manuscript on the Basin Ranges by Dr. G. K. Gilbert cites evidence to support the idea that a relative uplift of the area east of the Wasatch Range resulted in a reversal of the drainage before the present Wasatch Mountains were formed, and that that drainage was maintained across this range as it was uplifted.

[1] Loughlin, G. F., Reconnaissance in the Canyon Range of west-central Utah: U. S. Geol. Survey Prof. Paper 90, p. 53, 1914.

CORRELATION OF THE GREAT BASIN WITH THE OTHER PROVINCES.

With the data at present available it is not possible closely to correlate the later physiographic development of the Basin province of Utah with that of the provinces to the east. The several striking stages of erosional development that have been recognized to the east are either absent in the Basin province or if present are so modified that they have not been recognized. A careful determination and correlation of the late physiographic developments within and without the Basin [illegible] promises most interesting and important results. The rather meager observations of the writer suggest that development has been very different within and without the Basin. Outside the Basin every elevation or depression of the region has changed the elevation relative to the base-level, and the consequent renewal or retardation of the work of the streams has found expression in the physiography. Inside the Basin such elevations and depressions have not changed the elevation relative to the base-level; the streams have therefore not been rejuvenated, and the physiographic development has been more uniform. The [illegible] to climatic changes both within [illegible] the Basin [illegible] nearly [illegible] more elevated portions. The results in the lower portions, however, are mark[illegible] ent; outside [illegible] a change in [illegible] simply affected [illegible] size of the str[illegible] flowed freely to the sea; whereas [illegible] Basin it affected [illegible] areas of the lakes.

GEOLOGY.

STRATIGRAPHY.

The stratigraphy of Utah is so com[illegible] its complete dis[illegible] would requi[illegible] far in excess of [illegible] available. The [illegible] here is merely to outline the major features [illegible] prepare a general setting for the more detail[illegible] discussions devoted to the several di[illegible]

GEOLOGIC MAP.

The topographic [illegible] map (Pl. I), [illegible] the geology has been plotted, was [illegible] for the most part from the older topo[illegible]

There is little doubt that the extensive fields of lava extending westward from the High Plateau into Nevada are essentially contemporaneous with those of the plateaus, and the flows in other parts of the State are probably also of essentially the same age, though the evidence is less conclusive. Several of the intrusive bodies of the State are contemporaneous with the flows (see p. 99), and it is believed that this is true for all those lying along the eastern margin of the Great Basin. Whether it is true of the intrusive bodies near the western border of the State is not known.

Volcanic activity, therefore, apparently broke out in early Tertiary time, and both extrusion and intrusion continued through middle and late Tertiary into recent time, the latest basaltic eruptions having taken place only a few hundred years ago.

STRUCTURE.

Archean rocks are exposed in only relatively small areas, and data are not available for the discussion of their complex structural history. The following description of the structure is, therefore, confined to rocks younger than Archean. The positions and relations of the major structural features are shown in Plate XI.

FOLDS.

Folding, though less conspicuous than faulting in most parts of Utah, is yet of importance. It appears to be greatest in a north-south zone that extends across the State, along the boundary of the Basin and Plateau provinces. In this zone the pre-Tertiary rocks have been thrown into a series of folds, most of which strike north-south but some of which strike from nearly northwest-southeast to considerably east of north.

In southeastern Idaho[1] and southwestern Wyoming,[2] in the northern continuation of this belt, the folds are close, in many places overturned, and are associated with extensive thrust faulting. To the south the folds are more open and the thrust faulting is less important, and south of the southern Wasatch both folds and faults have largely died out, though open folding is recognized much farther to the south. It is probable that the folds that antedate the Tertiary rocks of the High Plateau[3] were produced at the same time as these folds. In the southern part of the State, over a width of several miles, from St. George nearly to Cedar City, a series of north-south open anticlines and synclines, with local overturning of the folds,[4] is conspicuous.

DOMICAL UPLIFTS.

Broad uplifts consisting of an anticlinal folding or doming of the rocks are of prime importance in Utah. These uplifts may be separated into those that show a distinct trend and those that show no marked trend. Among those with a distinct trend are the great east-west Uinta uplift and its westward extension through the Wasatch and Oquirrh ranges, the similar but lesser uplift of the Raft River Range in the northwestern part of the State, and the less clearly defined east-west uplift in the latitude of the Tintic and Deep Creek ranges, in which pre-Cambrian rocks have been raised above the present erosion surface in numerous localities, though not exposed in the adjacent regions either to the north or south. (See Pl. XI.) This structure apparently flattens out before reaching the Tintic Range. Farther south a similar structural feature extends [illegible] the Tushar, Mineral, Star, San Francisco, and Wah Wah ranges, and still farther south [illegible] series of domical uplifts, associated with [illegible]ns, extends northeast and southwest [illegible] the Iron Springs-Bull Valley region.

In the southeastern part of the State the San Rafael Swell, Henry Mountains, Abajo Mountains, and Navajo Mountain show less definite trends. The La Sal Mountains, however, form the central portion of a series of northwest-southeast [illegible] several miles long. The Water Pocket [illegible] consists of an unsymmetrical uplift, of which the eastern limb dips steeply and the western limb gently, and along which the Circle Cliff (Burr Flats) and Miners Mountain [illegible] subsidiary domes. The great Monument [illegible]y uplift east of Colorado River trends [illegible]ly west of south from the region of the A[illegible] Mountains into Arizona.

[1] Richards, R. W., and Mansfield, G. R., The Bannock overthrust; a major fault in southeastern Idaho and northeastern Utah: Jour. Geology, vol. 20, p. 704, 1912.

[2] Veatch, A. C., Geography and geology of a portion of southwestern Wyoming: U. S. Geol. Survey Prof. Paper 56, p. 108, 1907.

[3] Dutton, C. E., Geology [illegible] Plateaus of Utah, p. 44, U. S. Geog. and Geol. Survey Rocky M[illegible], 1880.

[4] The Hurricane fault in the [illegible]ville district, Utah: Harvard Coll. Mus. Comp. Zool. Bull., vol. [illegible], 1914.

Water is essential to the occurrence of a steam field. It is almost entirely meteoric in origin, and the high mountains of the area serve as excellent structures for the collection and transmission of water to the underground heated rock layers. All of the laws governing the use of water will apply to the use of water in a steam field.

The criteria for a geothermal field include an inexhaustible heat source relatively close to the surface, a rock structure sufficiently porous to create a reservoir, sufficient meteoric waters to recharge the reservoir, and sufficient heat and pressure of the steam or fluids to operate a commercial plant.

THE SOURCE OF GEOTHERMAL HEAT: In the Status Report for April, 1971, for Geothermal Resource Investigations in the Imperial Valley, Ellis Armstrong discusses the continental drift theory. He states, "a relatively new hypothesis in global tectonics relates high crustal heat flow to the occurrence of a global network of spreading centers that largely traverse the ocean floors. Heat flow approaching the earth's surface along these spreading centers is often five to ten times the crustal average. The earth's crust is a series of continental and oceanic plates that are being rafted about on the liquid mantle of the interior. In areas of fluidic convergence or downsinking, buoyant crustal plates are plunged into the liquid mantle and resorbed. In areas of upwelling, the crustal plates are spread apart and oceanic ridges are formed. Geologists believe that oceanic ridges mark the alignments where continents split and began to drift. The mid-Atlantic ridge marks such a line of departure for the westward drift of North and South America and conversely the eastward drift of Europe and Africa. The Island of Iceland lies athwart the mid-Atlantic ridge".

This report is concerned with the Basin and Range Geothermal Province which is directly related to the crustal spreading of a feature known as the East Pacific Rise. Utah has long been known to lie along an active belt of seismicity that extends northward from the Gulf of California, through Arizona, Utah, Idaho, Wyoming, Montana, and into British Columbia. This belt of seismicity is presumed to be an extension of the East Pacific Rise into the North American continent. The significant feature of the gross tectonic relations is that most of Utah's earthquakes have occurred along boundary zone between the Basin and Range Province and the Colorado Plateau. The earthquake activity is interpreted as directly related to abnormal heat flow from the continental rifting of the East Pacific Rise.

GEOTHERMAL GROUND WATERS: Water falling as rain, freezing rain or snow gradually percolates down along fault systems created by the mountain building process to rock formations containing large amounts of heat. Temperatures may increase rapidly in some formations. In one shallow well drilled to a depth of 270 feet, temperatures of 270° F were recorded at the mouth of the well, and this temperature was maintained at the same level after the well had been allowed to flow for three months. In four other wells drilled along the structure live steam was encountered at shallow depths of 40 feet to

80 feet. These test holes were placed along the structure over a distance of three miles. Heated waters may escape into relatively shallow underground water strata heating them to higher temperatures than the atmosphere. Reports of wells drilled for agricultural purposes show temperatures of 72° F in many such farm wells. Some of these same wells are still in production after a century of use, and still show a temperature of 72° F. There are three hot springs in the area of study which show temperatures near the boiling point of water. The maximum recorded temperatures of these springs range from 185° to 189° F. All three of these springs are in or near late Tertiary or Quaternary volcanism.

J. C. Mundorff, hydrologist, U. S. Geological Survey has prepared a report entitled the 'Major Thermal Springs of Utah'. In this report he makes the following remarks, "the normal thermal equilibrium of an area may be affected by (1) the presence of an intrusive magma rising sufficiently close to the surface to heat the surrounding rock and the interstitial water, (2) the extrusion of igneous rocks (volcanism), (3) heat from radio-active elements, and (4) heat that may be generated by the friction along faults. Of the probable sources of geothermal heat, intrusive or extrusive masses of magma are a requirement for hyperthermal conditions having economic value. Fault friction may be a minor source of heat for all springs shown in the vicinity of faults or for springs described as being in the vicinity of known or inferred faults.

Thermal discharges having temperatures at or near the boiling point of water indicate prospective areas in which to drill wells in exploration for geothermal energy. In Utah, three springs - Thermo, Abraham, and Roosevelt - have temperatures near the boiling point of water. The boiling point at the altitude of these springs is about 205° F. All three springs have temperatures between 185° and 189° F and all three springs are in or near late Tertiary or Quaternary volcanism. During the past ten years, Roosevelt Hot Springs have had little or no discharge, although abnormal geothermal conditions are evident in the vicinity of the springs.

The possibilities of producing natural steam depend on the existence of a source of heat, on the presence of a permeable bed, and generally on the presence of an impermeable caprock. Detailed geologic, gravimetric, electrical, seismic, and hydrological reconnaissances are recommended before drilling. The preliminary objective is to drill test wells to confirm the inferences from these surveys and to supply detailed information about the formations present. Such detailed information should include their most important physical properties (porosity, permeability, and density) and existing physical conditions (temperature and pressure of the fluids and nature of the percolating fluids). Figure 1 is a map showing major faults, earthquake epicenters, and major thermal springs of Utah.

<u>GEOTHERMAL POWER FOR COMMERCIAL USE:</u> In a report entitled "Geothermal Power Goes Commercial", published in SEVENTY SIX, November/December, 1971, by Union Oil Company, the following comments are made.

"We (United States) continue to demand electricity in unprecedented amounts. The market doubles every eight to ten years with no letup in sight. Coal, oil, and natural gas produce most of our electric power, far exceeding the output of hydroelectric dams and nuclear energy. Natural gas is in short supply. There are ample reserves of coal and oil available, yet much of the coal and oil has a high sulfur content, and their use for making more electricity is under attack. Coal has its own problems: sulfur, fly ash, strip mining, safety rules. Nuclear power meets opposition due to potential radiation hazards."

As a supplement, Dr. Carel Otte, a geologist, who heads Union Oil's Geothermal Division, has indicated electric power made from natural steam. Next to hydropower, it is the lowest cost electricity available. It is more than competitive with fossil fuels, and there are no combustion products emitted into the atmosphere. For many years geothermal progress was slow, regarded by many outsiders as an interesting oddity. There were many hurdles to overcome and pioneers in geothermal energy wore many hats: specialists were required in geology, economics, law, engineering, real estate and the environment. Two breakthroughs helped turn geothermal energy into a commercial success. One of these was the acceptance by Pacific Gas and Electric management of the principles of reservoir engineering, widely used in the petroleum industry. Coincident to breaking the technical barrier was a legal breakthrough in geothermal leasing. In 1970, President Nixon signed into law a bill that permits geothermal prospectors to lease federal lands.

Geothermal power has proven to be a commercial success at the Big Geysers, 90 miles north of San Francisco. The costs of electric power generated at the Big Geysers compares favorably with the cost of power from PG & E's most modern steam power plants. Union Oil is the operator of the steam project for its partners, Magma Power Company of Los Angeles, and Thermal Power Company of San Francisco. Pacific Gas and Electric Company makes electricity from the steam.

RECOMMENDATIONS AND CONCLUSIONS:

1. Because of heat sources from the granitic stock and graben basin with areas metamorphism, it is apparent this area is favorable for an exploration program to determine a geothermal field. Many studies have indicated this area has the potential similar to Geyserville, California.

2. From the study made of the area, five targets for exploration have been identified, as indicated on the attached map.

3. It is deemed advisable to acquire by lease or otherwise approximately 20,000 acres in each of the above target areas.

4. When the acquisition of any given area has been completed, an exploratory program is recommended. This should consist of a detailed geological, geophysical, and geochemical studies and investigations. Based on the results of these studies, a concurrent shallow drilling program can be determined. This drilling program can be contemporous while other target areas are studied. The drilling should consists of twenty or more shallow

holes 50 to 600 feet in depth, depending on the surface geology and the findings of any given drill hole. After the shallow wells and target areas are completed, one or two deep holes should be drilled from 2,000 to 8,000 feet deep, depending on thermal gradent and results of the shallow holes.

Successful development of geothermal resources in this area would allow a technical base for the development of industries and possibilities of new communities for the State.

Sincerely,

H. Clyde Davis
Consulting Geologist

HCD:pn

G L O S S A R Y

Heat flow is the movement of heat through any given media. Heat flow rates vary with the conductivity of the media through which the heat is being transferred.

Spreading centers refers to a geological feature in the form of a sea floor ridge thousands of miles in length. It is caused by the circulating pattern of the molten rock in the mantle just below the crust of the earth. The upwelling of molten rock causes spreading or rifting of the crust, thus creating movement of large masses of land. There is believed to be a network of spreading centers covering the entire earth but occurring mostly under the oceans.

Thermal Anomaly is an area of high heat flow as indicated by contouring thermal gradients.

Thermal gradient is the rate of change of temperature with depth. It is normally expressed as 'degrees Fahrenheit per 100 feet'.

Temperature recovery is the return of a well to equilibrium with the various temperatures of the formations that were penetrated. Circulation of drilling mud cools the formations immediately adjacent to the drill hole and from one to three weeks to equilibrate is required for the test hole.

Anticlinal dome consists of upfolded strata opening downward in all directions and thus taking the shape of a dome, usually elongate in form.

East Pacific Rise is a branch of the world-wide network of oceanic spreading centers. The East Pacific Rise has been traced as running along the axis of the Gulf of California, and entering the United States under the Imperial Valley. Its route after that is postulated as traveling northward through California, Nevada, Utah, Idaho, and on to the north.

Geothermal resource is the heat generated from the interior of the earth and recoverable in some medium such as hot ground water or existing as steam.

Hot pots are small pools of warm or hot water occupying shallow craters in the tops of conical or hemispherical mounds of tufa.

Hot springs are springs whose waters have temperatures higher than 100 degrees Fahrenheit.

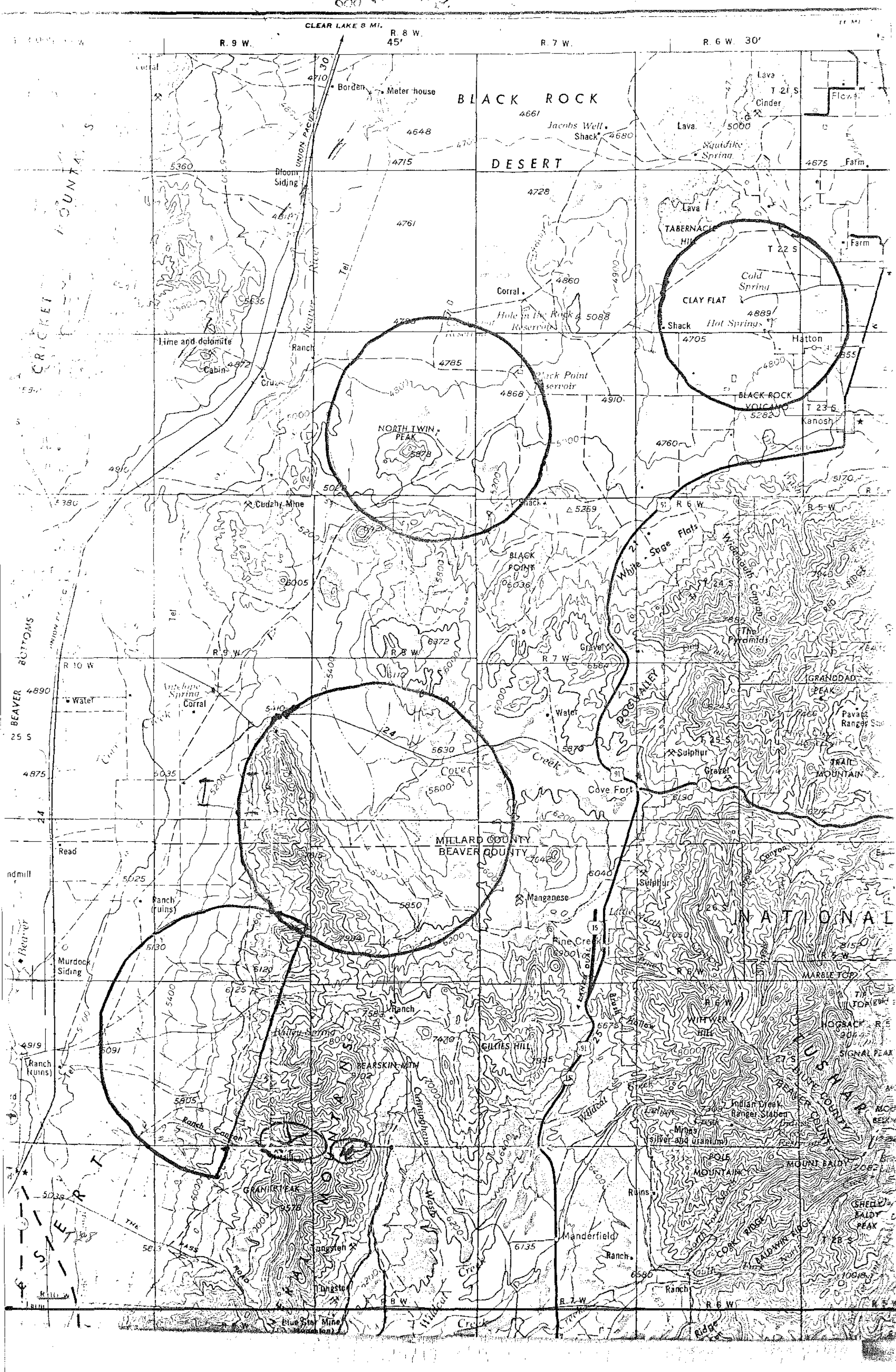
Magma is naturally occurring mobile rock material, generated within the earth and capable of intrusion or extrusion, from which igneous rocks are considered to have been derived by solidification.

Magmatic water is water that is in, or is derived from magma.

Meteoric water is water that was derived from the atmosphere.

Thermal spring is any spring whose temperature is significantly higher than the mean annual air temperature of the surrounding area.

Warm springs are springs whose waters have temperatures higher (10° F) than the local mean annual temperatures of the atmosphere but lower than 100° F.


CLEAR LAKE 8 MI.
R. 9 W.
R. 8 W.
45'
R. 7 W.
R. 6 W. 30'
BLACK ROCK
DESERT
CRICKET MOUNTAINS
BEAVER BOTTOMS
UNION PACIFIC
Borden
Meter house
Jacobs Well
Shack
Lava
Cinder
Squawfoot Spring
Farm
Bloom Siding
TABERNACLE HILL
CLAY FLAT
Cold Spring
Hot Springs
Hatton
Corral
Hole in the Rock Reservoir
Black Point Reservoir
Lime and dolomite
Cabin
Ranch
NORTH TWIN PEAK
5878
BLACK ROCK VOLCANO
5282
Kanosh
Cudahy Mine
BLACK POINT
White Sage Flats
Antelope Spring
Corral
Water
Read
Murdock Siding
Ranch (ruins)
DOG VALLEY
Cove Fort
Cove Creek
MILLARD COUNTY
BEAVER COUNTY
Manganese
Pine Creek
Sulphur
NATIONAL
The Pyramids
GRANDDAD PEAK
Pavant Ranger Sta
TRAIL MOUNTAIN
RED RIDGE
MARBLE TOP
HOGBACK
SIGNAL PEAK
WITTWER HILL
Indian Creek Ranger Station
Mines (silver and uranium)
POLE MOUNTAIN
MOUNT BALDY
SHELLY BALDY PEAK
CORK RIDGE
BALDWIN RIDGE
BEAVER COUNTY
PIUTE COUNTY
Ranch
GILLIES HILL
BEARSKIN MTN
MOUNTAINS
GRANITE PEAK
9578
Tungsten
Blue Star Mine
Manderfield
Ranch
Ruins
Wildcat Creek
Cunningham Wash
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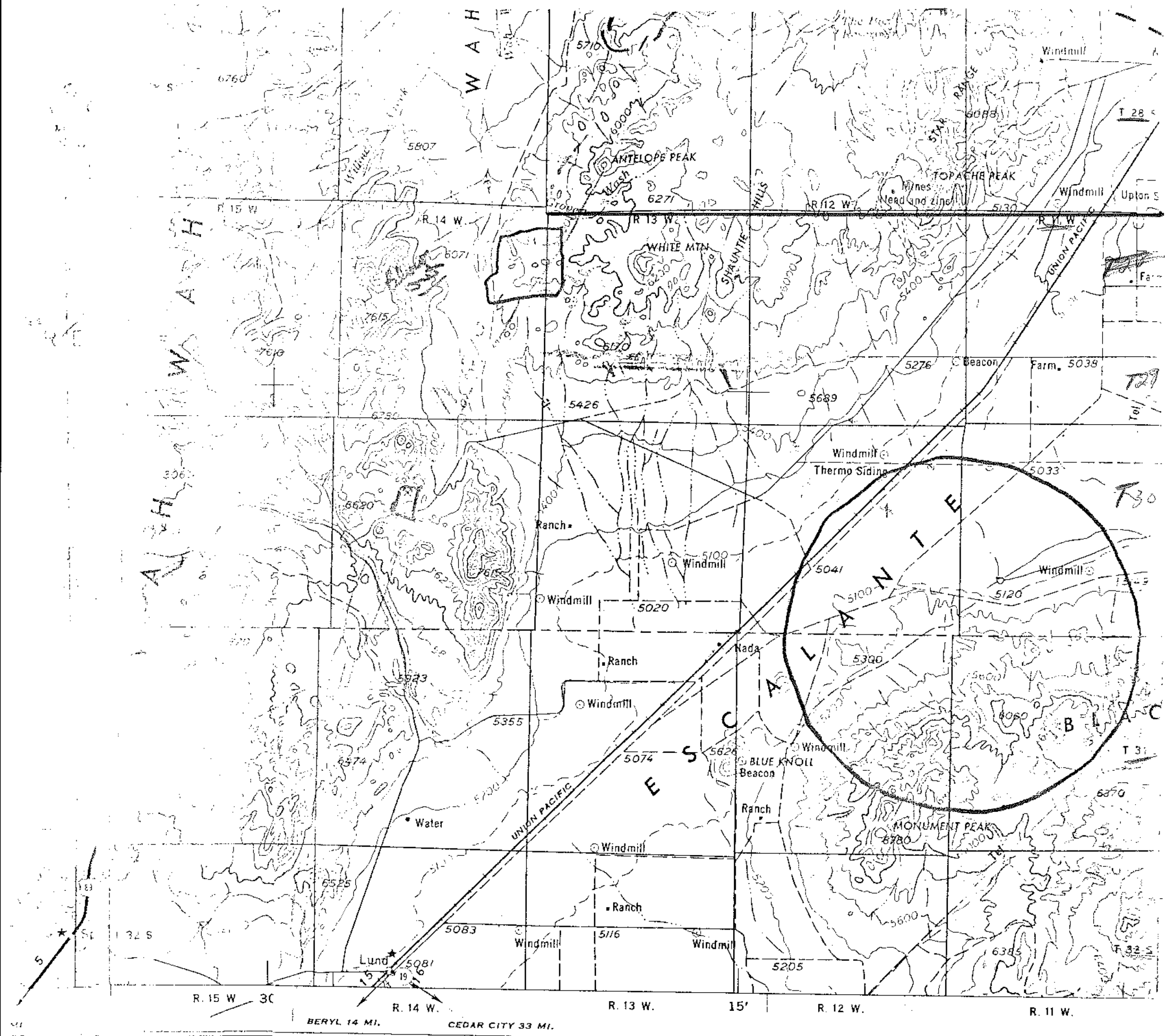


LEGEND

ROAD DATA 1953 PARTIALL REVISED 1962

Interstate approximate distances in miles between stars

ROAD

ANGELES

OMAHA

GALVESTON

Laramie

Grand Coulee

Sun Valley

Hard surface, heavy duty

More than two lanes wide — 3 LANES | 4 LANES

Two lanes wide; Federal route marker — 15

Hard surface, medium duty

More than two lanes wide — 3 LANES | 4 LANES

Two lanes wide; State, Interstate route markers — 10 15

Improved light duty

Unimproved dirt

Trail

Landplane airport

Landing area

Seaplane airport

Seaplane anchorage

Woods-brushwood

Approximate road alinement

Landmarks: School; Church; Other

Horizontal control point

Spot elevation in feet — 221

Marsh or swamp

Intermittent or dry stream

Power line

CONTOUR

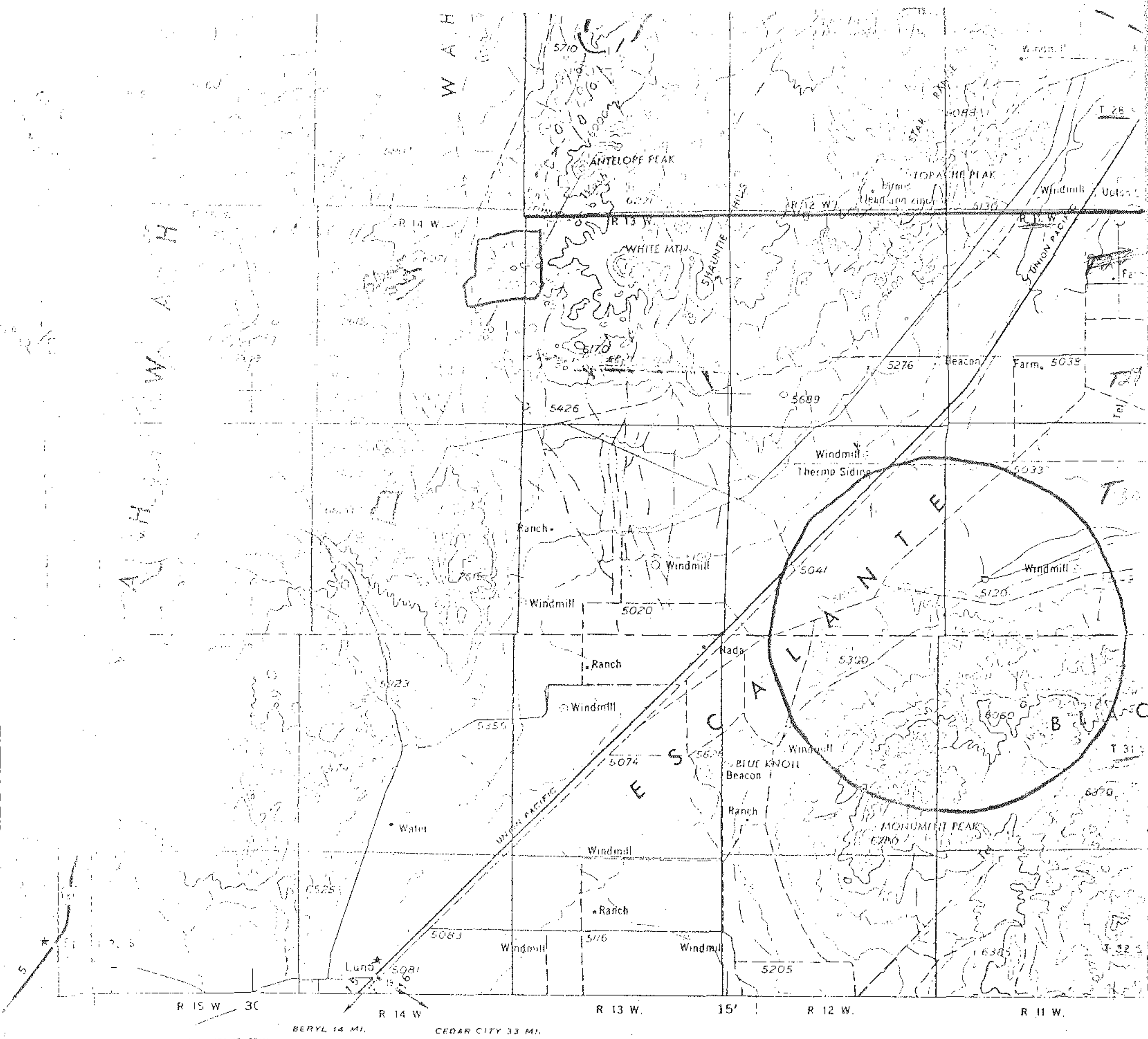
WITH SUPPLEMENTARY

TRANSVERSE

1955 MAGNETIC DECLINATION FOR THIS SHEET

EDGE TO 15°45′ EASTERLY FOR THE CENTER

FOR SALE BY U. S. GEOLOGICAL SURVEY,



LEGEND

... 1953 PARTIALLY REVISED 1962

... approximate distances in miles between stars

ROAD

ANGELES — Hard surface, heavy duty: More than two lanes wide — 3 LANES | 4 LANES

OMAHA — ... lanes wide; Federal route marker

GALVESTON — Hard surface, medium duty: More than two lanes wide — 3 LANES | 4 LANES

Loramie — Two lanes wide; State, Interstate route markers

Grand Coulee — Improved light duty

Sun Valley — Unimproved dirt

Trail

Landplane airport — Landmarks: School; Church; Other

Landing area — Horizontal control point

Seaplane airport — Spot elevation in feet — 221

Seaplane anchorage — Marsh or swamp

Woods-brushwood — Intermittent or dry stream

Power line

Approximate road alinement

CONTOU...

WITH SUPPLEMENTARY ...

TRANSVERS...

1955 MAGNETIC DECLINATION FOR THIS SHE...

EDGE TO 15°45' EASTERLY FOR THE CENTER

FOR SALE BY U. S. GEOLOGICAL SURVEY,