Hot Springs and Geothermal Areas

This section of the report describes the State's major hot springs and geothermal areas. It consists of summaries of the geology and history of the better known geothermal localities, and is not intended to be a complete listing of data on all thermal springs and wells—Appendix 1 contains the detailed information on water quality, location, spring and well names, etc. The springs, spring clusters, and geothermal areas are organized by county, and in a general way, by the maximum reported temperature within an individual county.

CARSON CITY

Carson (Swift's, Shaw's) Hot Springs [1]

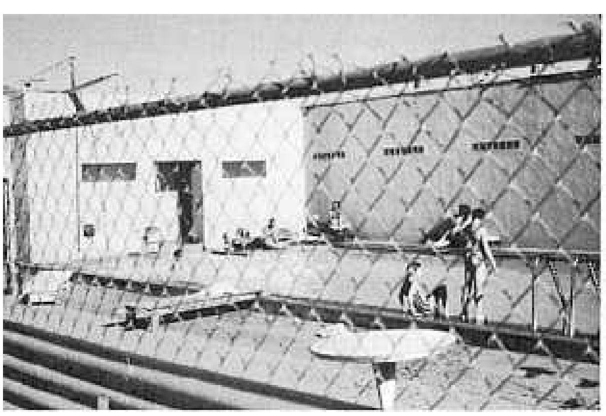
Hot springs on the north edge of the town of Carson City, have temperatures as high as 120°F. These springs, now referred to as Carson Hot Springs, were formerly called Swift's or Shaw's Hot Springs. The water is used in a swimming pool that is open to the public. Water supplied to the pool is pumped, probably from a shallow well near the pumphouse to the north of the pool area.

Nevada State Prison spring [2]

A hot spring is reported from the area of the Nevada State Prison (Waring, 1965). The old State Prison building was used for some of the early meetings of the Nevada Legislature in the early 1860's, and the legislators often used a large bathhouse there, probably Curry's Warm Springs Hotel (letter of Andrew Marsh to the *Sacramento Union*, Sept. 30, 1861, published in Nevada Highways and Parks, Spring, 1974). The Warm Springs Hotel was in operation adjacent to the prison in 1867 (Gillis, 1868).

Pinyon Hills [3]

There are a number of warm water wells in the Pinyon Hills subdivision about 2 miles southeast of the Nevada State Prison. The temperatures are generally 90° to 114°F, and the water is generally of poor quality (Glancy and Katzer, 1975; Center for Water Resources Research, University of Nevada, Reno, unpublished data).



Geothermal swimming pool at Carson Hot Springs, Carson City.

CHURCHILL COUNTY

Brady's (Springer's, Fernley) Hot Springs [10]

The hot springs along U. S. Highway I–80 about 20 miles northeast of Fernley have been referred to as Hot Springs, or Brady's, Springer's or Fernley Hot Springs, and are the Emigrant Springs of the Forty-Mile Desert. Some early travelers called it the Spring of False Hope. Coming across the desert, the oxen of the wagon trains could smell the moisture before reaching the springs. However, when they rushed forward to drink, they found the water scalding. The emigrants collected water in casks to cool, but pushed on to the Truckee River, as there was no forage at the springs (Work Projects Administration, 1940).

In the 1880's Russell (1885) reported that hot boiling water issued from a number of orifices, and when these became obstructed, the steam escaped with a hissing and roaring sound. During this same period there was an unsuccessful attempt to separate boric acid from the waters. In later years the hot water was used in a bathhouse and swimming pool which were located at a service station along U. S. Highway 40. The concrete pool, built in 1929, is all that remains today. The pool was apparently supplied by hot water directly from the springs. The hot springs do not flow at the surface today.

Brady's Hot Springs are located in NE/4 NE/4 SW/4 S12,T22N,R26E. Thermal ground water is found within an area of 6 to 8 square miles centered on this location (fig. 4). The elongate thermal area is parallel to the "Thermal Fault" mapped by Anctil and others (1960). Areas of hydrothermal alteration are aligned along this fault, and its trace has also been outlined by areas of observed snowmelt, indicating warm ground (Olmsted and others, 1975, fig. 37). This fault has had recent movement, as it cuts spring sinter and the alluvial fan deposits in the spring area and to the north. The fault is normal and dips steeply to the west, with the downthrown side to the west; the amount of displacement is unknown (Olmsted and others, 1975). All successful steam wells were collared in the hanging wall of the Brady Thermal Fault (Anctil and others, 1960).

The rocks exposed in the vicinity of Brady's consist of Tertiary basalt and andesite, Tertiary sedimentary rocks, Pleistocene lake sediments, and Quaternary alluvial deposits and siliceous sinter (figs. 5, 6). None of the wells drilled at Brady's (up to 7,275 ft. deep) penetrated the pre-Tertiary rocks, although they are exposed in the northern Hot Springs Mountains and were found in steam wells near Desert Peak (see the following section).

Bailey and Phoenix (1944, p. 51) report the presence of cinnabar and sulfur in S6(?),T22N,R27E about one-quarter mile southeast of U. S. Highway 40 and one-half mile east of the hot springs. The best showings of cinnabar are reported from around an active hot-spring vent. The occurrence is in hydrothermally altered tuff. Soil gas in the vicinity of the main Thermal Fault and around active steam vents at Brady's is anomalous in mercury (John Robbins, Scintrex Limited, written communication, 1973).

The spring sinter at Brady's is predominantly opal, and is quite extensive. It is concentrated along the main Thermal Fault and a small subsidiary fault to the east (Oesterling and Anctil, 1962).

The ground water in Fireball Valley (Hot Springs Flat) to the north probably moves as underflow to Brady's Hot

Springs, and other ground water may move as underflow from the Fernley area (Harrill, 1970). Olmsted and others (1975) suggest that the recharge of the thermal area could be outside the local drainage area.

Ground-water discharge from the thermal area is in part by evapotranspiration and in part by lateral subsurface outflow toward the south. Prior to the drilling of geothermal wells in the late 1950's and early 1960's (but after diversion of the flow to a swimming pool) White (written communication, 1974 *in* Olmsted and others, 1975) estimated a spring flow of about 20.6 gpm. Waring (1965) reported a larger flow (50 gpm), but White believes that this may be too large. The withdrawal of water during drilling may have caused the springs to cease flowing (Harrill, 1970) and at present all discharge is in the subsurface. The original spring was 180°F (Oesterling, 1962). Boiling water reportedly stands at 20 feet below the surface in one well (Willden and Speed, 1974, p. 55).

Twelve major geothermal wells have been drilled at Brady's Hot Springs over the past 20 years, ranging in depth from 341 to 7,275 feet (see Appendix 2 for details). The temperatures encountered during drilling were up to 418°F, (Koenig, 1971). Following the drilling of Magma Power Co. Brady No. 2 well in 1959 thermal activity spread along the 3-mile portion of the main fault. This activity was probably due to steam escaping through the encased portions of the wells and into the fault zone. Olmsted and others (1975) describe this activity in more detail from data in a 1960 unpublished report by Allen. Tests on several wells shortly after drilling indicated 170,000 to 700,000 lbs/hr of fluid. The well head pressure was 9.5 to 18.0 lbs/in^2 gage (psig) (Middleton, undated report). The steam flashover is reported to be 5% (Koenig, 1971). Calcite is reported to form rapidly in the well bores during flow, requiring reaming of the wells after a short period of time. However, the amount of scaling is reported to decrease after the wells have been produced for some time (Oesterling, 1962). The thermal water at Brady's is of the sodium chloride type, with total dissolved solids from some steam wells reported to be over 2,400 ppm. The silica concentration from a steam well near C S12,T22N,R26E (Harrill, 1970) indicates a reservoir temperature of about 360°F (Olmsted and others, 1975). This seems somewhat low in view of the 400°F + temperatures reported during drilling. Geothermal Food Processors, Inc. of Reno, Nevada have received a $2,836,800 Federally guaranteed loan to construct a geothermal food dehydration plant at Brady's. The Federal guarantee will cover 74 percent of the $3.8 million total cost of the project (Nevada State Journal, October 29, 1977).

——— 20 ———

line of equal temperature (°C) at a depth of 30 meters

● 30.2

test hole, number is temperature (°C) at a depth of 30 meters

——— — — ? —

fault, dashed where concealed, queried where indefinite

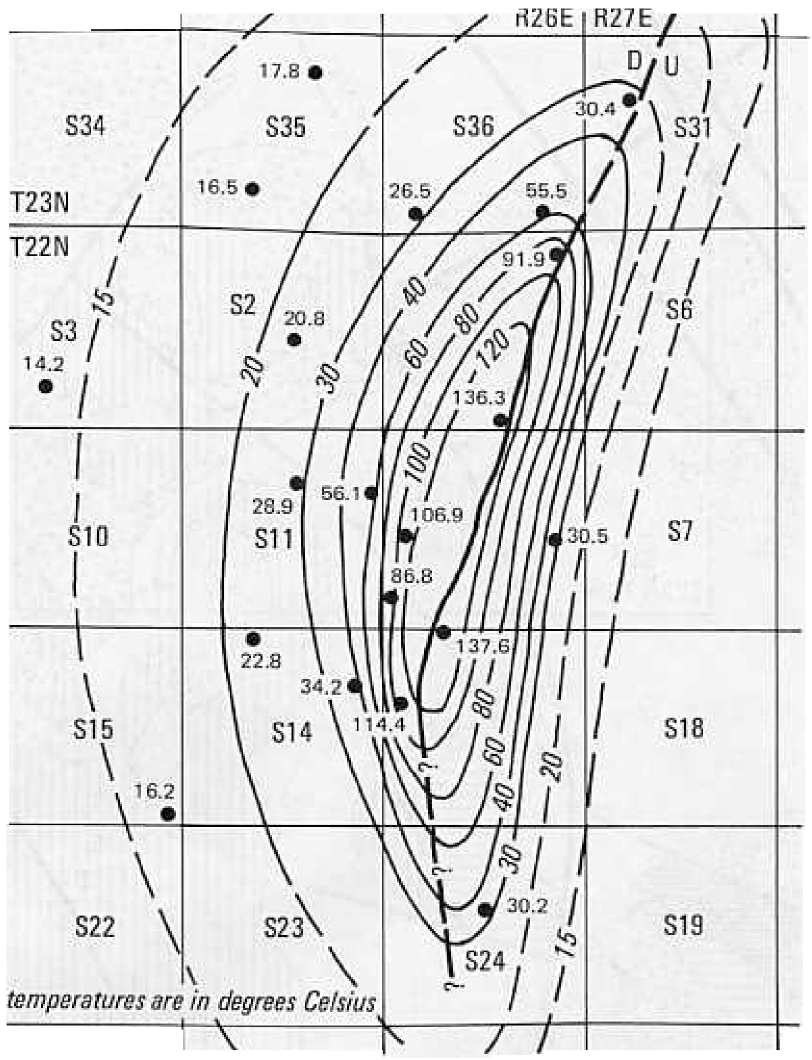


FIGURE 4. Map of Brady's Hot Springs thermal area, Churchill County, showing temperature at depth of 30 meters, 1973 (modified from Olmsted and others, 1975).

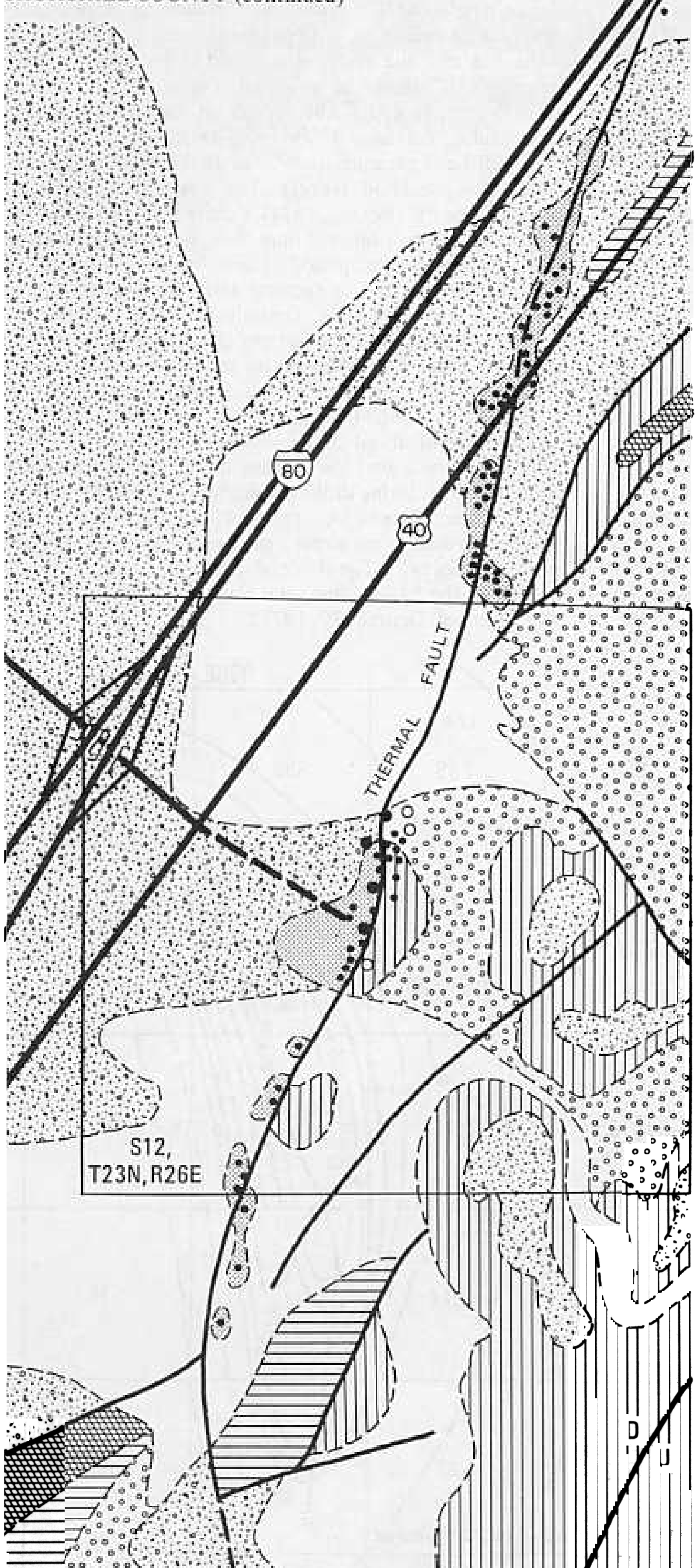


FIGURE 5. Geologic map of Brady's Hot Springs area, Churchill County (thermal activity as of May, 1960).

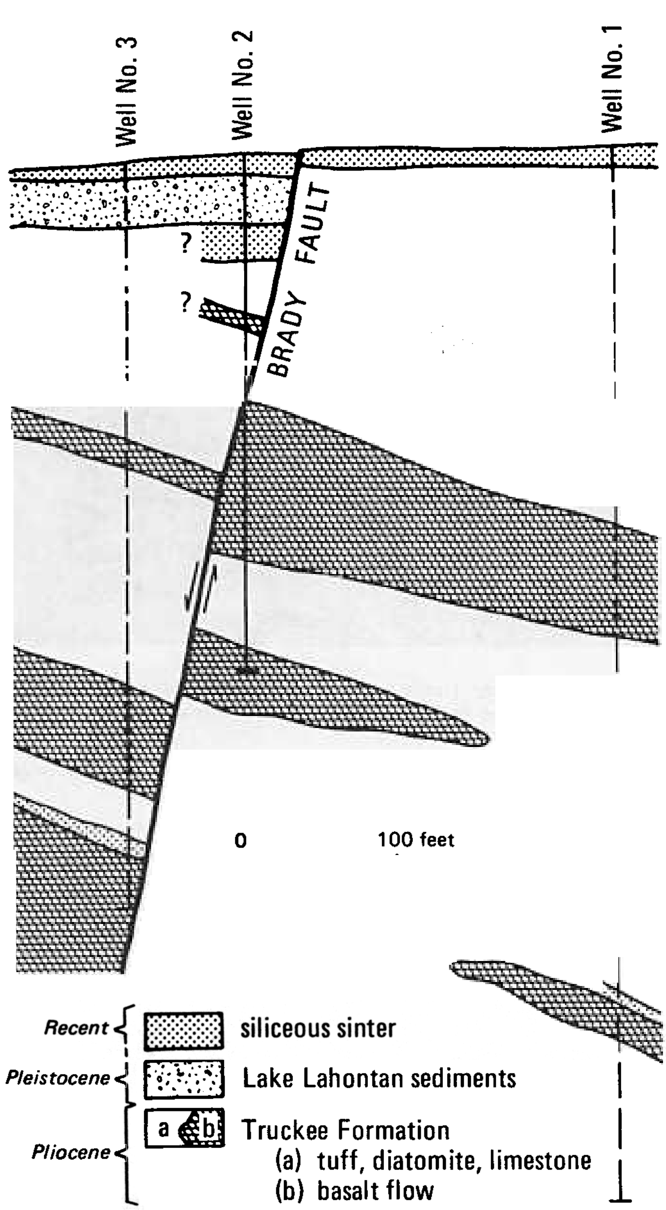


FIGURE 6. Cross section (based on driller's logs), looking north-northeast, at Brady's Hot Springs, Churchill County (after Oesterling and Anctil, 1962).

Desert Peak area [12]

The Desert Peak geothermal prospect is located in the northern part of the Hot Springs Mountains about 4 miles southeast of Brady's Hot Springs, and is named for a prominent peak 2 to 3 miles northwest of the area of the steam wells. The thermal area is apparently centered on S21,29,T22N,R27E (fig. 7). It was discovered by Phillips Petroleum Co. after drilling approximately 50 temperature-gradient holes up to 500 feet in depth. Much of the following information is summarized from data released by Phillips.

There are no surface thermal indications at the area, other than a few small occurrences of siliceous sinter and travertine, probably from springs which are now inactive. The geology of the rocks exposed at the surface has not been helpful in predicting the subsurface geology. The three geothermal wells drilled in the 1974–1976 period encountered Mesozoic metavolcanic and metasedimentary rocks at depths of 3,000 to 4,500 feet, below a sequence of Miocene volcanic rocks (fig. 8). Wells 21–1 and 21–2 produce a mixture of steam and water from fractured meta-andesite. It has been suggested that the Tertiary volcanic rocks may act as a seal for the reservoir.

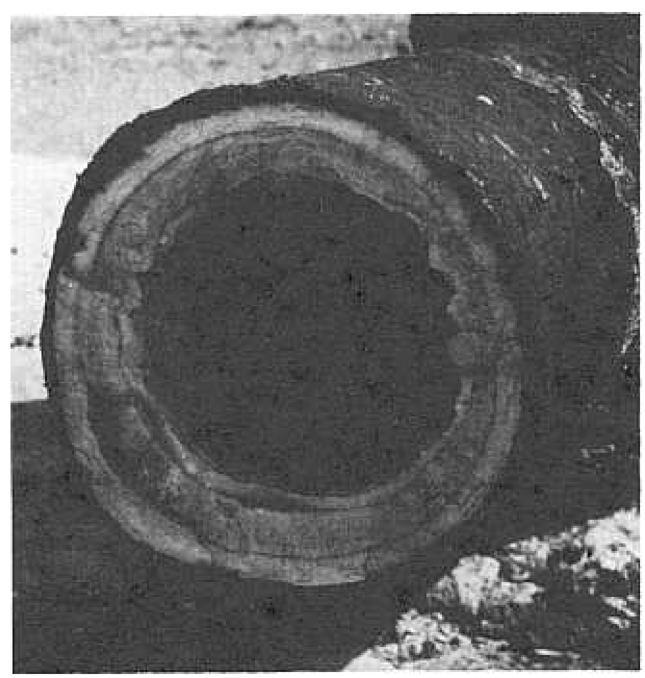
The reservoir is believed to have a temperature of 406°F, and the fluid produced is a sodium chloride type containing about 7,500 ppm total dissolved solids.

Soda Lakes–Upsal Hogback thermal area [13]

The Soda Lakes–Upsal Hogback thermal area is in the west-central part of the Carson Desert, 7 to 8 miles northwest of Fallon (fig. 9). The thermal ground water is mostly present in the central part of T20N,R28E over an area of 7 to 8 mi^2. The area is along the Carson River Route of the Old California Trail; soda was mined from Soda Lakes in the middle to late 1800's.

The presence of hot water in the area was not known until a well drilled in 1903 to supply water for a topographic survey camp for the Truckee–Carson Irrigation Project hit boiling water at about 60 feet. A cinder-block bathhouse was built later to utilize the steam and hot water (Peggy Wheat, oral communication, 1975). The well was still emitting hot steam in 1974, although the bathhouse had been torn down.

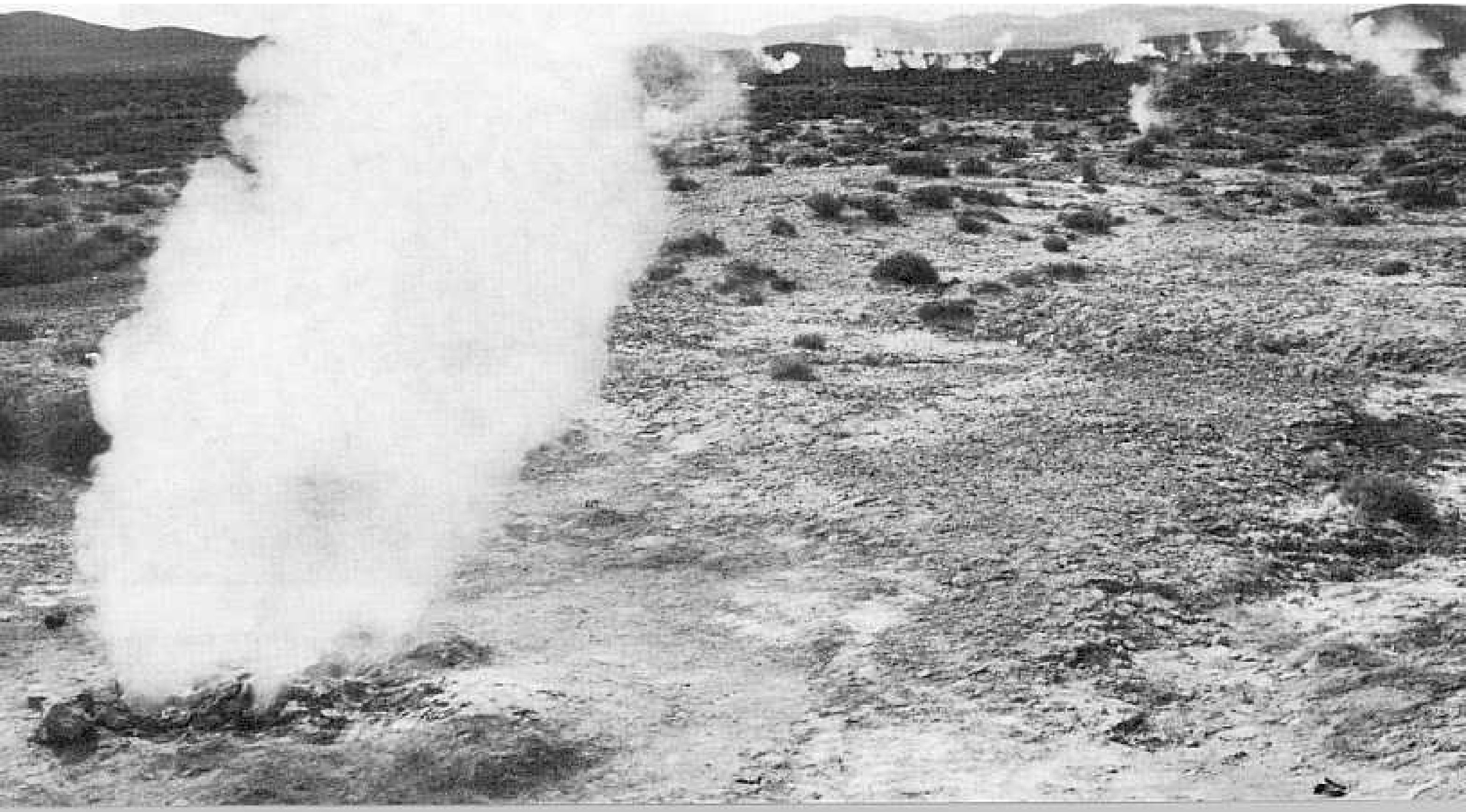
The extent of the thermal anomaly in the shallow subsurface has been outlined by the drilling of temperature-gradient holes (fig. 10) by the U. S. Geological Survey and the U. S. Bureau of Reclamation (Olmsted and others, 1975). Also, warm springs apparently enter the bottom of Big Soda Lake near its center, which is approximately 200 feet deep. Breese (1968), conducted a temperature survey of the lake bottom and reported temperatures up to 86°F. Nearby temperature-gradient drill holes of the U. S. Geological Survey indicate that cool ground water is present

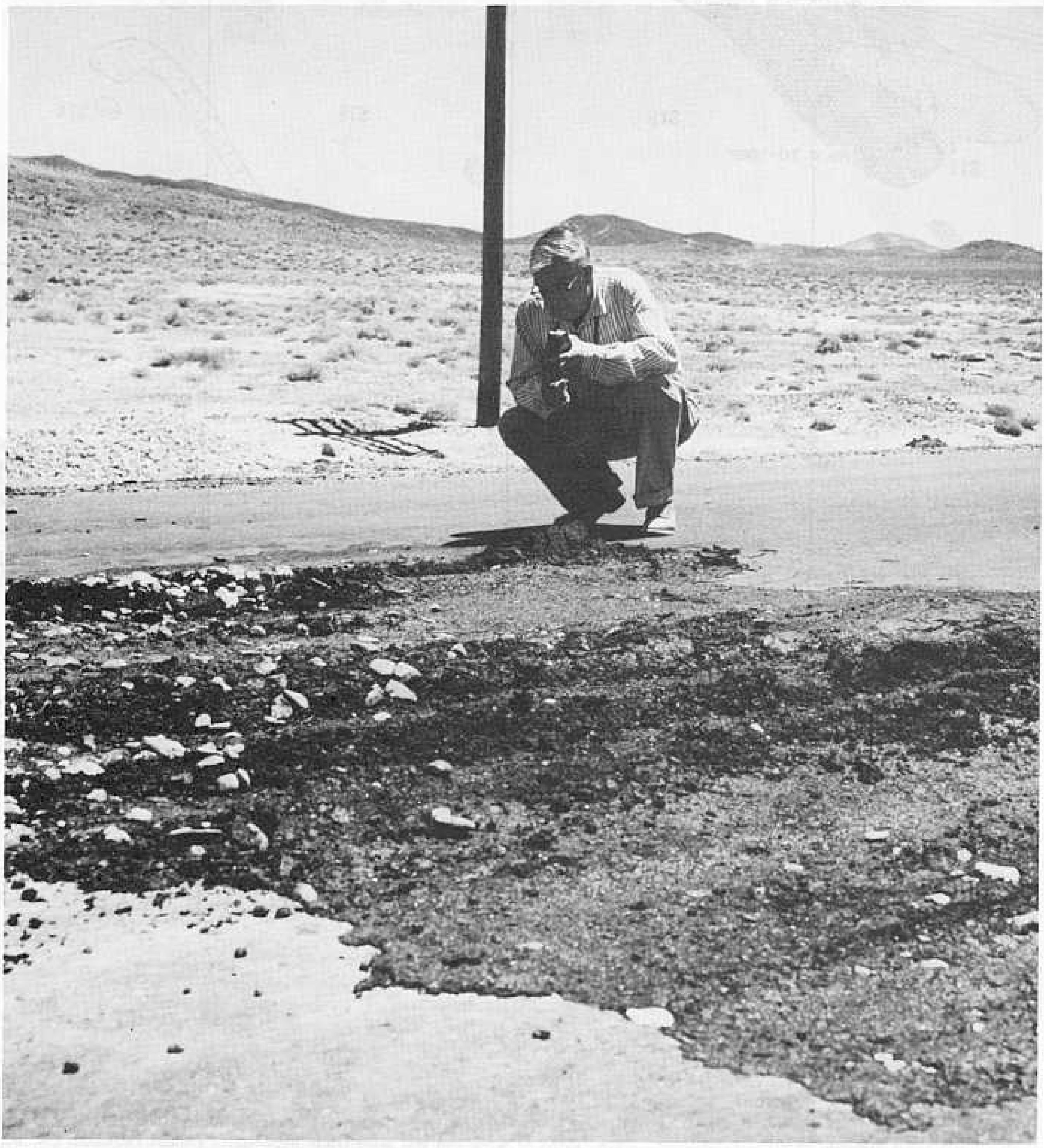


Travertine deposited in the pipe of a geothermal well at Brady's Hot Springs, Churchill County.

Above: Steam escaping from a fault zone which crossed U. S. Highway 40 approximately 1 mile north of Brady's Hot Springs, Churchill County. This unusual geothermal activity resulted from a well blow-out following drilling in 1959 (photo courtesy Nevada State Highway Department).

Below: Close-up of a steam vent which formed after the well blow-out at Brady's Hot Springs. Other new vents can be seen in the background (photo courtesy Nevada State Highway Department).





Resurfaced area of U. S. Highway 40 which was disrupted by geothermal activity following blow-out of a well at Brady's Hot Springs in 1959 (photo courtesy Nevada State Highway Department).

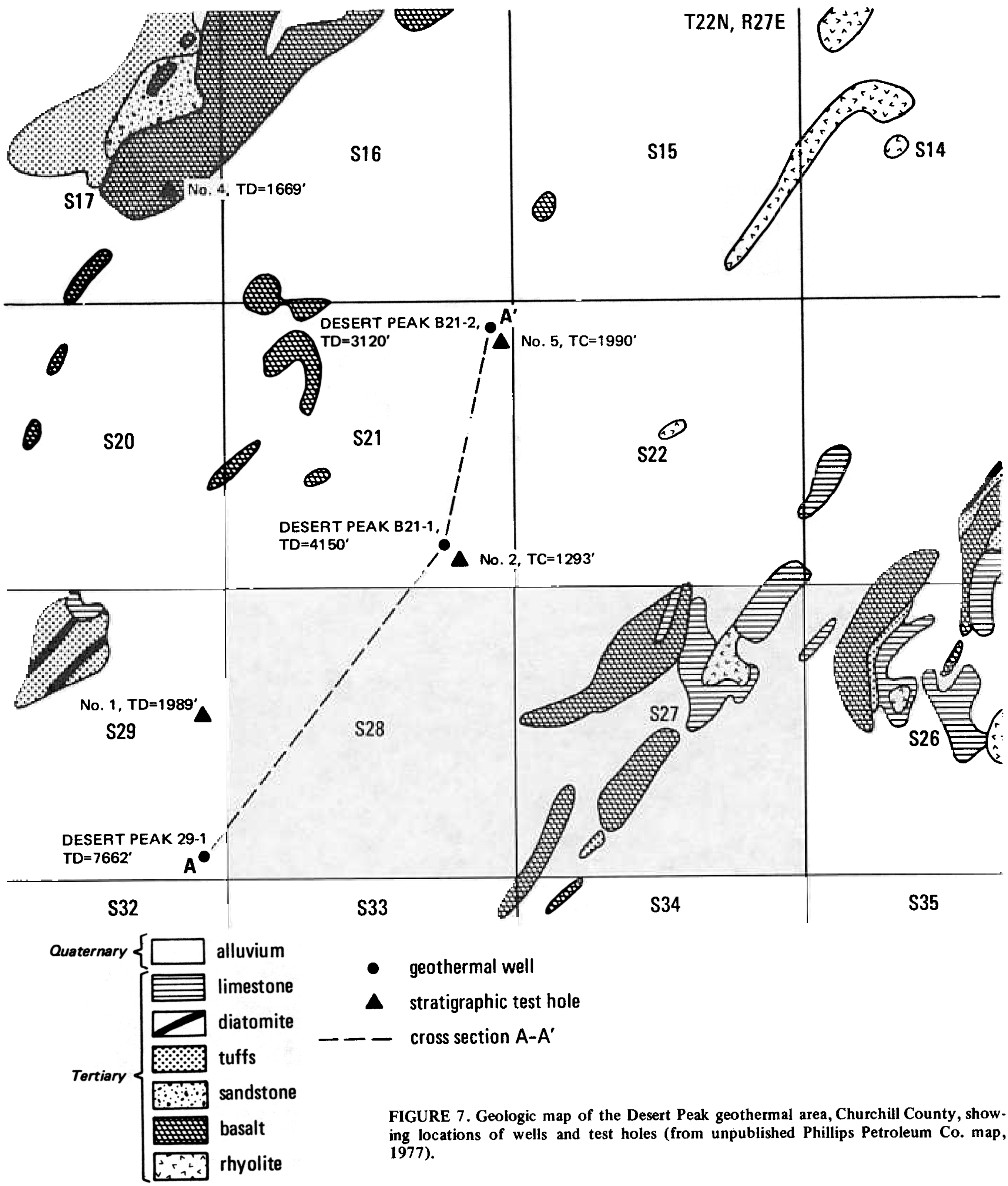


FIGURE 7. Geologic map of the Desert Peak geothermal area, Churchill County, showing locations of wells and test holes (from unpublished Phillips Petroleum Co. map, 1977).

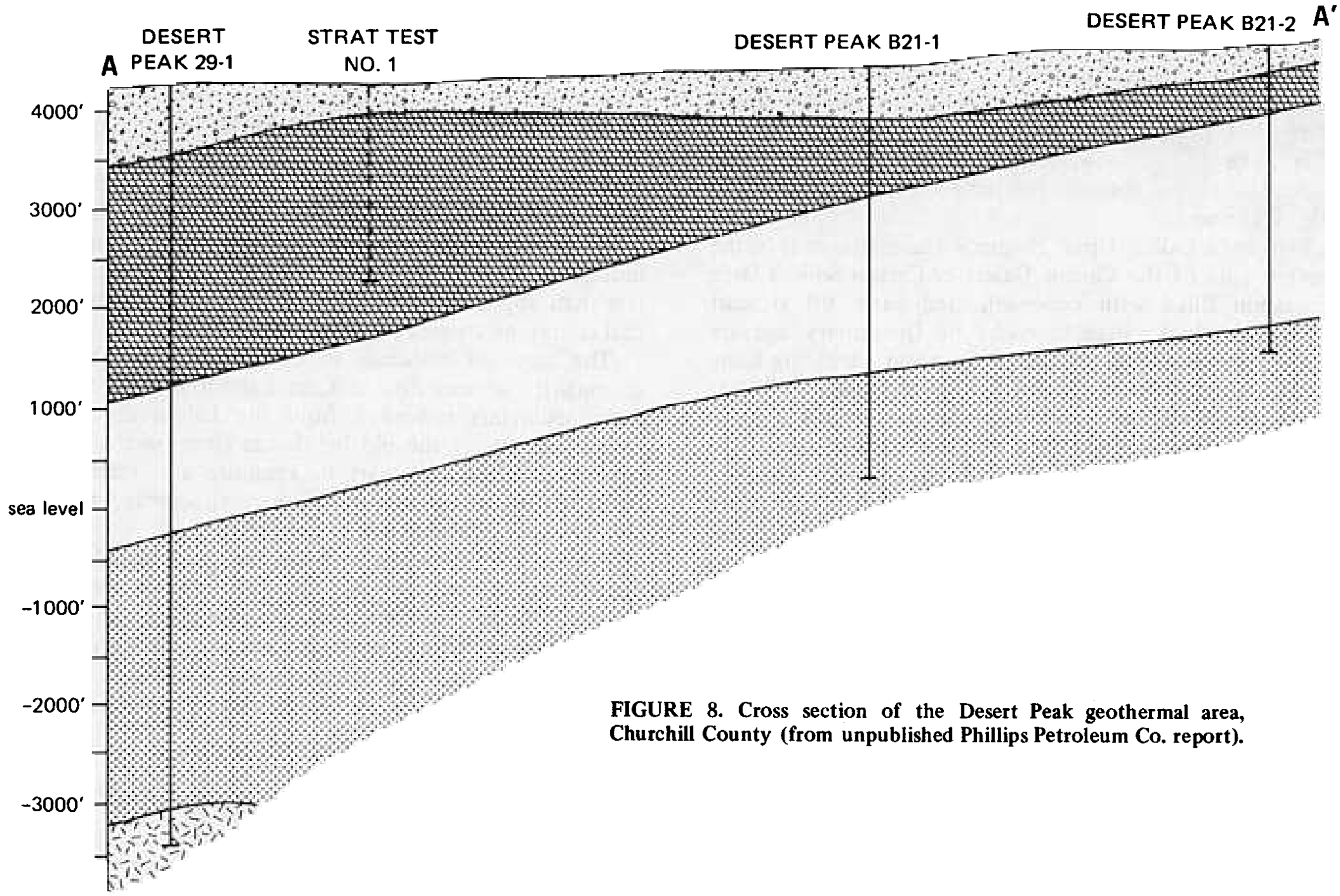
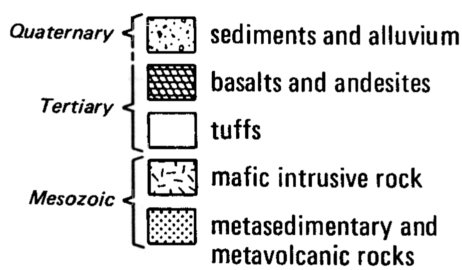
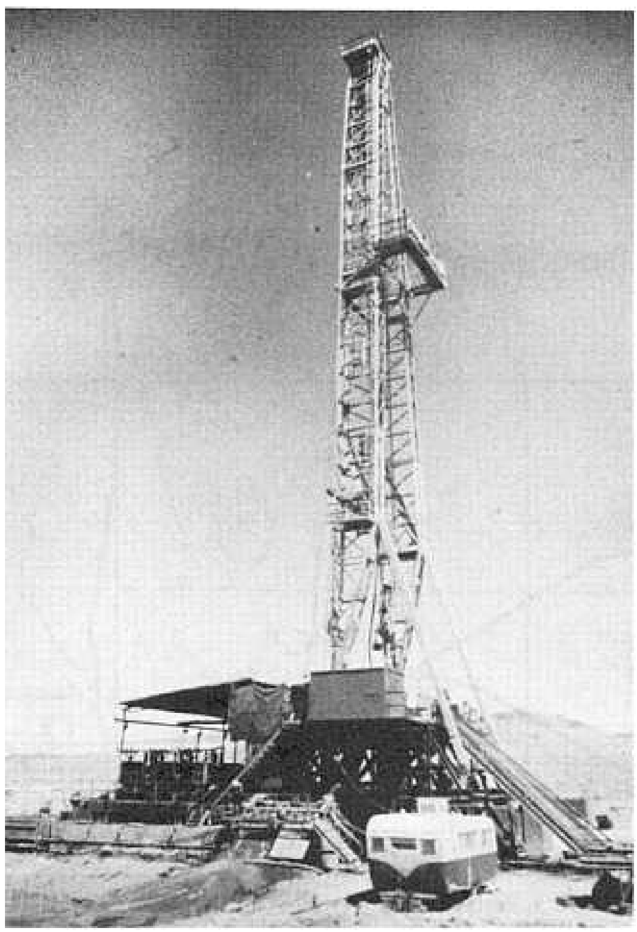


FIGURE 8. Cross section of the Desert Peak geothermal area, Churchill County (from unpublished Phillips Petroleum Co. report).





Drilling rig at the Phillips Petroleum Co. Desert Peak No. 29–1 well in 1974 (photo by Patricia Garside).

between Big Soda Lake and the thermal anomaly approximately 3 miles to the northeast. A geothermal well drilled in C SE/4 SE/4 S29,T20N,R28E (The Chevron–Phillips Soda Lake 1–29) to 4,306 feet reportedly encountered gabbro? near the bottom. No temperature data are available on the well.

The Soda Lakes–Upsal Hogback thermal area is in the western part of the Carson Desert or Carson Sink, a large depression filled with unconsolidated basin fill at least 6,000 feet thick. Basalitc rocks of Quaternary age are exposed at several places within the basin, including Lone Rock in the northeast Carson Sink, Rattlesnake Hill near Fallon, and Soda Lakes and Upsal Hogback (fig. 11). Lone Rock may be a remnant of a volcanic plug or neck, and Rattlesnake Mountain consists of basalt flows and the eruptive vent, which is now filled with agglomerate (Morrison, 1964). Upsal Hogback is a cluster of several basaltic cones, and Soda and Little Soda Lakes are craters or maars which are rimmed by a mixture of basaltic and nonvolcanic debris blown out by repeated gaseous eruptions (Olmsted and others, 1975). The eruptions that formed the craters may be phreatic in part.

The eruptions that formed the cones at Upsal Hogback occurred chiefly during an interpluvial time in the late Pleistocene when Lake Lahontan was dry (Morrison, 1964). Upsal basaltic tephra is found in the lower Sehoo Formation, which is probably about 25,000 to 30,000 years old (Jonathan Davis, oral communication, 1977). The earliest eruptions at Soda Lakes may have been as early as or earlier than those at Upsal Hogback (Morrison, 1964), but the rim of Soda Lake (elevation 4,000 ft.) has not been cut by any Pleistocene lakes. Since the last lake above 4,000 feet elevation was in the lowermost upper Sehoo, this would indicate that the present maar at Soda Lake was formed less than approximately 6,900 years ago (Jonathan Davis, oral communication, 1977).

The exposed materials in the thermal area are predominantly unconsolidated Lake Lahontan sediments and some sediments reworked from the Lahontan deposits. In the vicinity of the old bathhouse steam well the sands have been altered in part to kaolinite and various iron oxides or hydroxides by hydrothermal activity, probably chiefly vapor (Olmsted and others, 1975).

Exposed faults in the area are rare, although Morrison (1964) has mapped several northeast-trending faults (see fig. 11). The general alignment of Soda Lakes, the thermal anomaly, and Upsal Hogback along a north-northeast trend suggests faults at depth, possibly along a zone of rupture in the Tertiary or pre-Tertiary consolidated rocks (Olmsted and others, 1975).

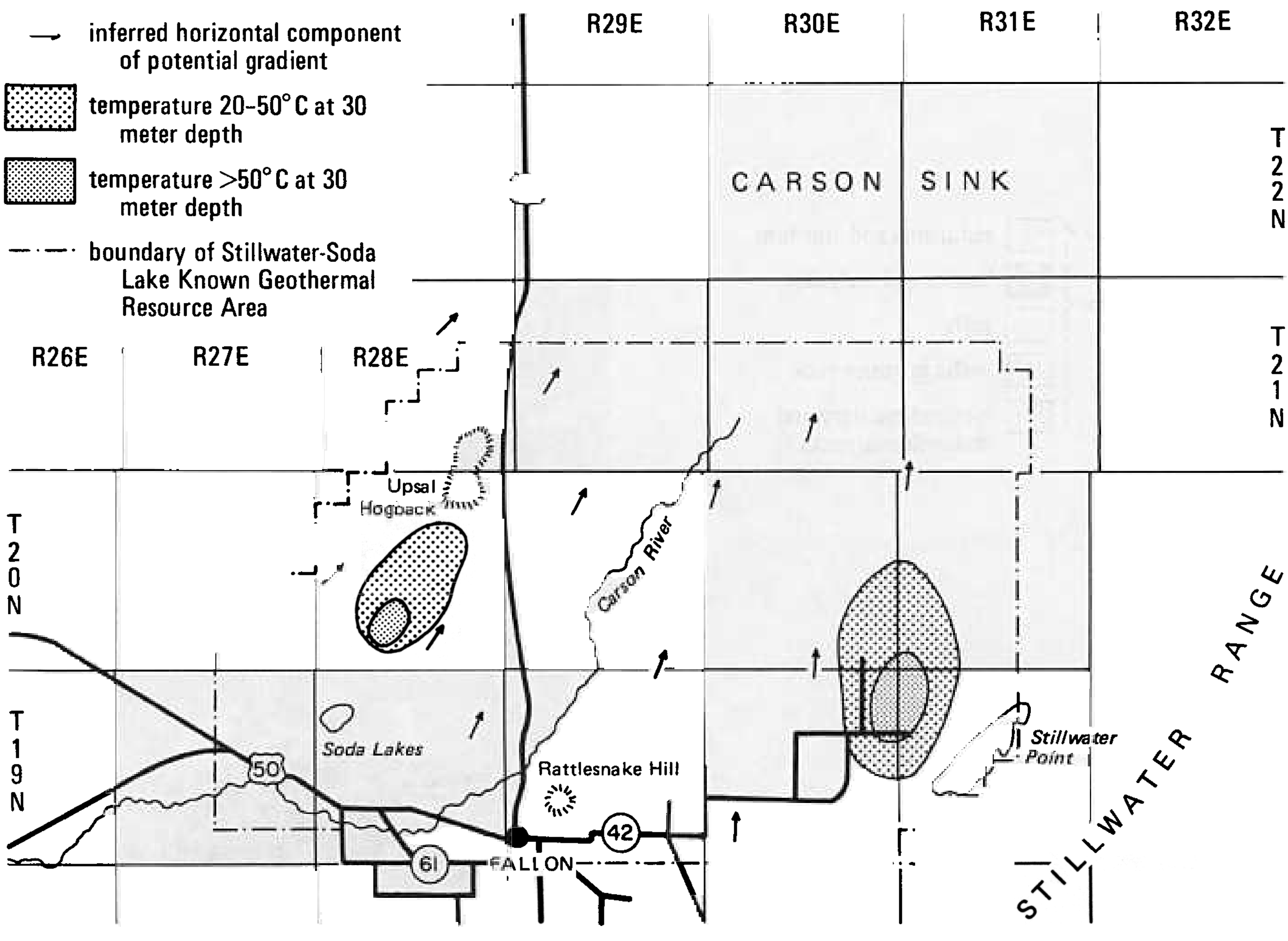
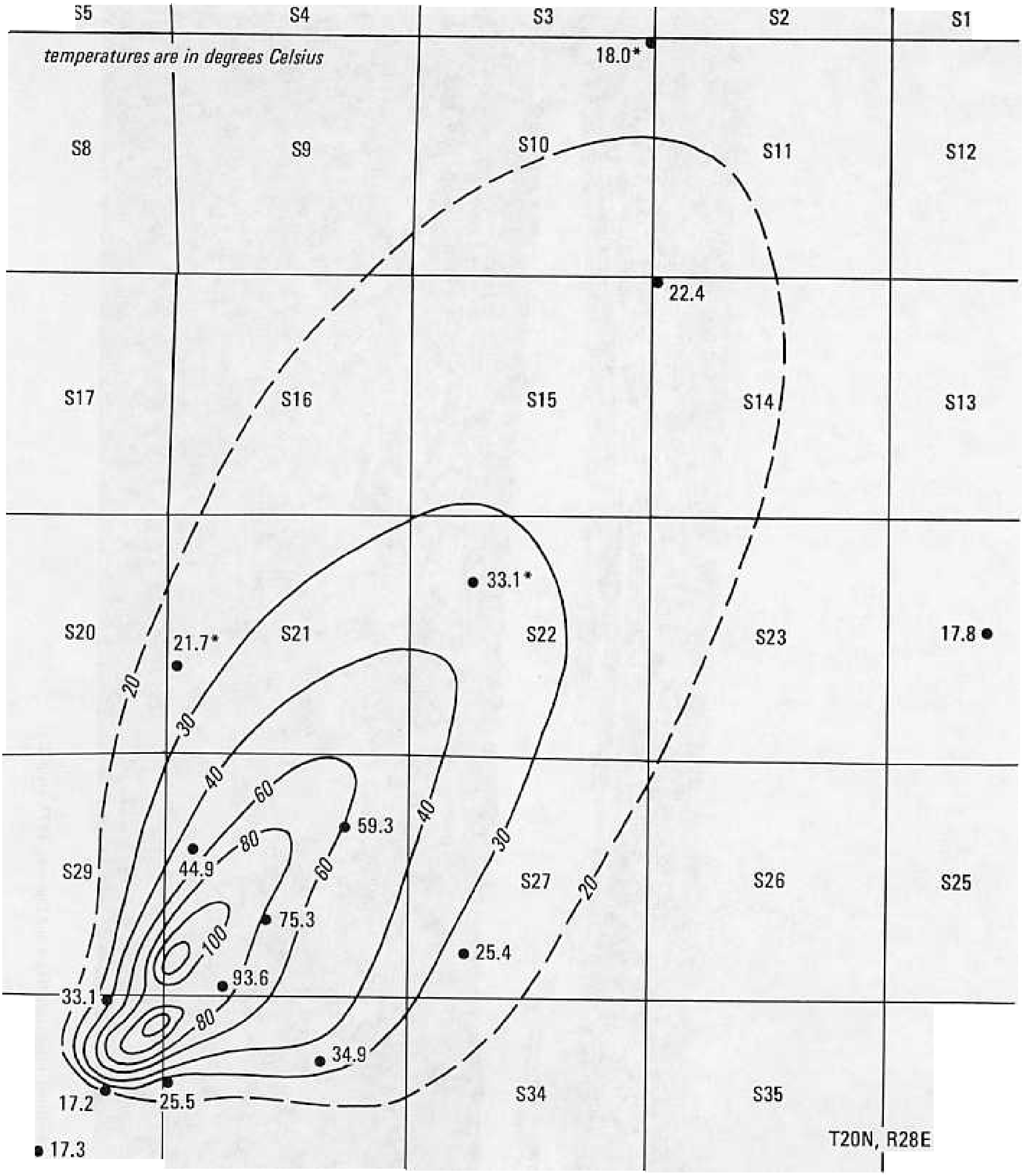


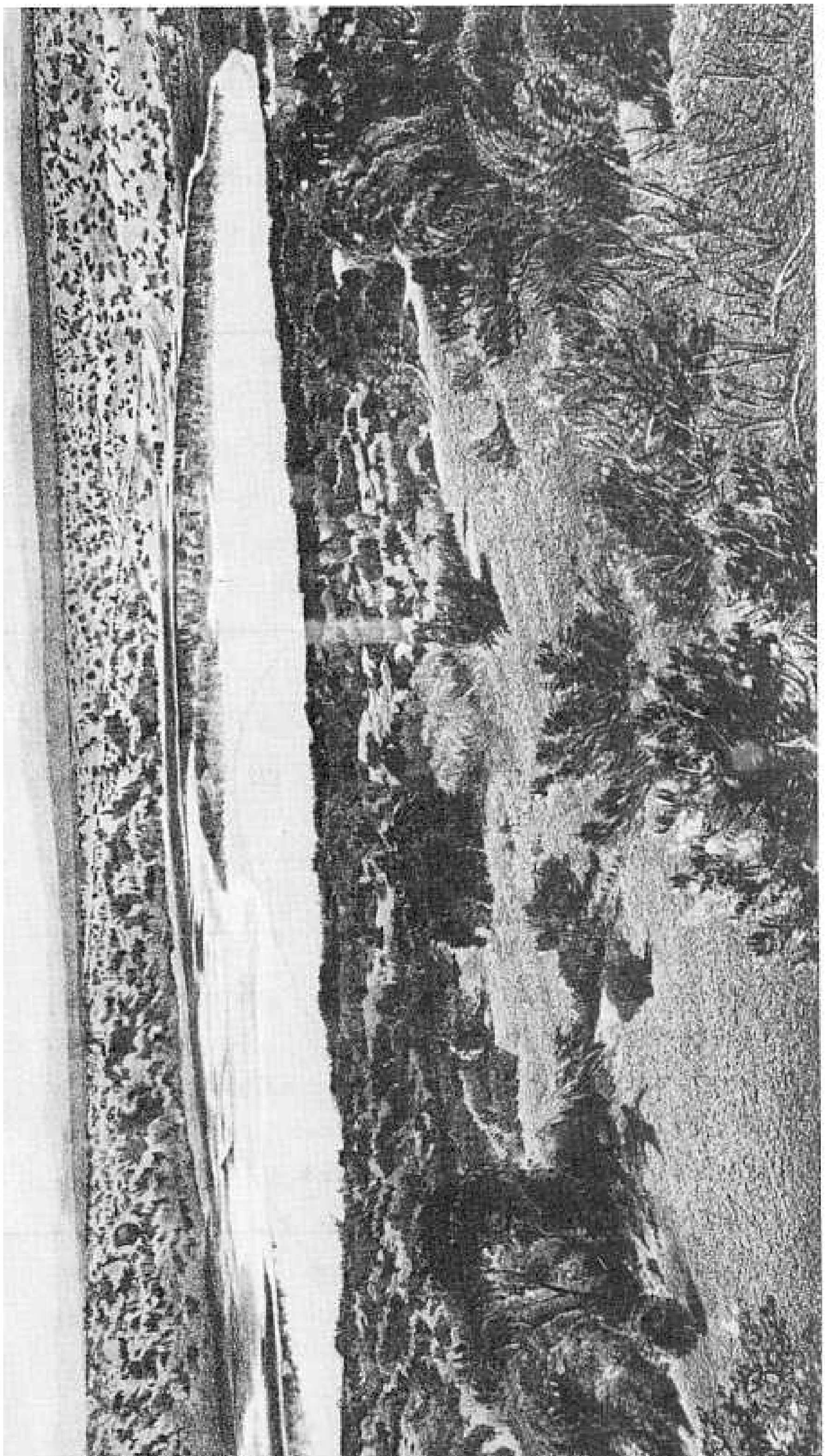
FIGURE 9. Portion of the Carson Sink showing locations of Stillwater and Soda Lakes–Upsal Hogback thermal areas (from Olmsted and others, 1975).



20 line of equal temperature (°C) at a depth of 30 meters

18.0* ● test hole, number is temperature (°C) at a depth of 30 meters
*temperature extrapolated from thermal gradient above 30 meters

FIGURE 10. Soda Lakes–Upsal Hogback thermal area, Churchill County, showing temperature at a depth of 30 meters, December, 1973 (after Olmsted and others, 1975).



Soda Lake, Churchill County (from lithograph, Hague and Emmons, 1877, plate 22).

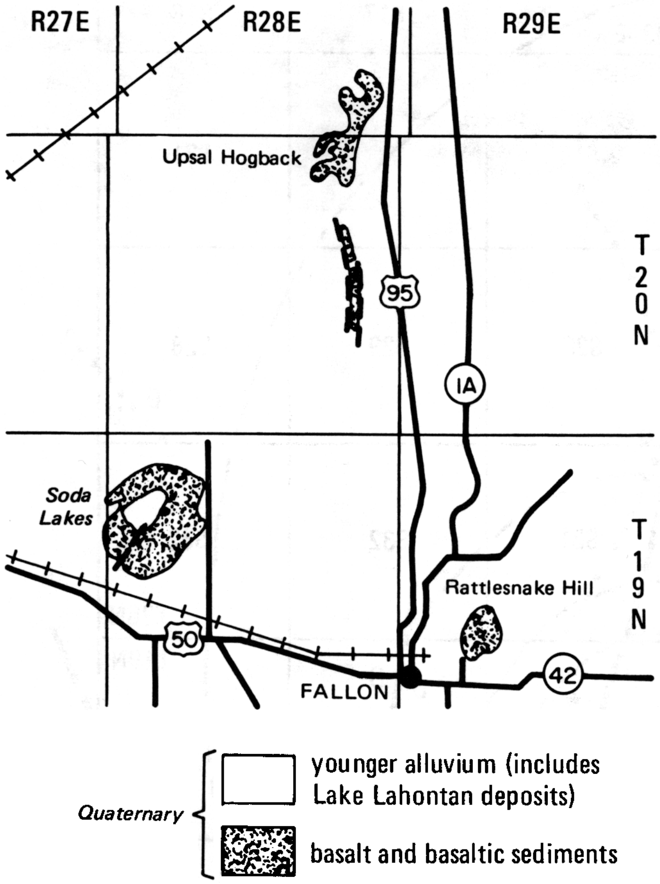


FIGURE 11. Geologic map of the Soda Lakes–Upsal Hogback area, Churchill County (after Willden and Speed, 1974, plate 1).

Since the early 1900's irrigation has raised the water table throughout the area. The thermal water rises from depth, mixes with the shallow nonthermal water, and moves laterally to the north-northeast (fig. 9). The extent of the zone of mixing is not known (Olmsted and others, 1975).

Stillwater thermal area [14]

The Stillwater area, like Desert Peak and Soda Lakes–Upsal Hogback, is a "hidden" geothermal area, its presence being discovered in 1919 when Charles Kent hit hot water in a shallow well. Shortly thereafter, W. W. Wheeler and a man named Freeman struck hot water in a well drilled for oil near the picnic grove. The well reportedly geysered about once a minute, shooting water into the air to a height of over 30 feet. This phenomenon continued until some very brave souls capped off the well (de Braga, 1964, p. 30–31). This well was the first of many hot artesian wells in the area. The well at Greenwood's store in the small community of Stillwater was used to heat the store in 1947. The well is 230 feet deep and has a temperature of 190°F (Morrison, 1964, p. 117). The community of Stillwater in S7,T19N,R31E is near the center of a thermal ground-water anomaly covering 20–25 mi^2 (fig. 12). The high water temperatures are believed to be due to flow from much greater depth along faults (figs. 12 and 13) and into shallower aquifers (Morrison, 1964). The Stillwater thermal area appears to be in a portion of the Carson Sink that has had recurrent Quaternary faulting (Morrison, 1964) and to lie along the extension of a fault bordering the west side of Rainbow Mountain a few miles to the south. Olmsted and others (1975) suggest that the velocity of upflow of the thermal water rising along the fault near Stillwater is sufficient to maintain the water temperature near that of the deep source, which is inferred to be close to 320°F on the basis of geochemical data (Mariner and others, 1974). The source of thermal water probably lies at a depth of several kilometers, well within the pre-Tertiary basement (Olmsted and others, 1975).

Several geothermal wells have been drilled in the Stillwater area (see Appendix 1), but data are available only for the O'Neill Geothermal Inc. (Oliphant) Reynolds No. 1 well which was drilled to a depth of 4,237 feet in 1964. The maximum temperature recorded was 277°F. Three other wells were drilled to approximately 4,000 feet in 1976 and 1977 by Union Oil Co. in several sections about 1 mile north of Stillwater.

Other wells in the Carson Desert [15–19]

Several wells in various parts of the Carson Desert (Carson Sink) have temperatures over 70°F. Some of these are heat-flow drill holes, and probably indicate the regional heat flow. A 3,758-foot-deep oil well (S15,T22N,R30E) is reported to flow hot water (R. Forest, oral communication, 1974), and a water well in S7,T17N,R30E has a reported temperature of 158°C (C. W. Klein, oral communication, 1977).

Lee Hot Springs [21]

Lee Hot Springs are in the NW/4 S34,T16N,R29E. In the past these springs may have been called Allen's Hot Springs (Miller and others, 1953), although Allen's Springs are located about one-quarter of a mile northwest of Lee Hot Springs and are not reported to be warm. However, spring deposits are found at Allen's Springs.

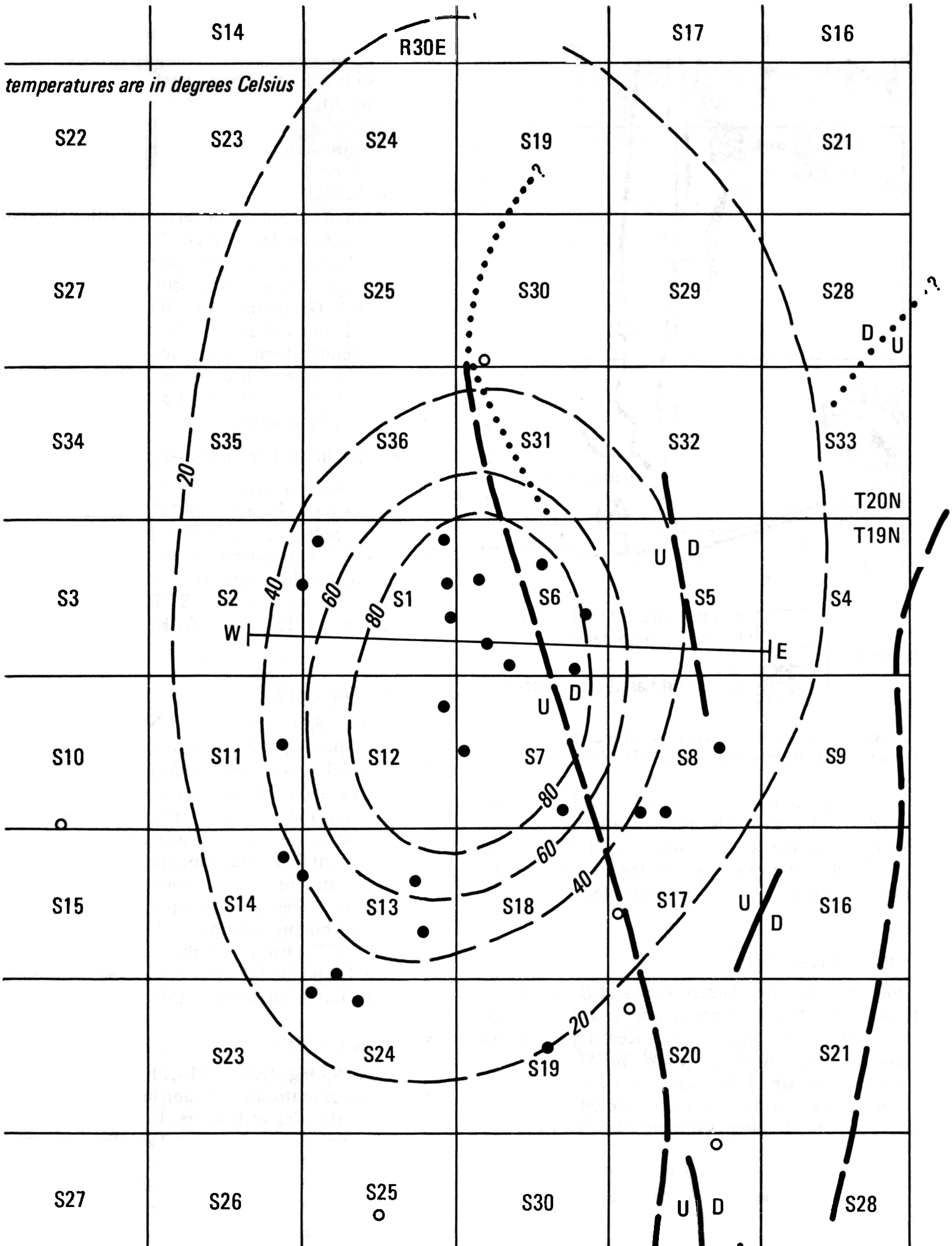
The present flow at Lee Hot Springs is from a well located in a small area of siliceous spring sinter: this well is probably 56 feet deep, and has reported temperatures between 190°F and boiling (Mariner and others, 1974; Glancy and Katzer, 1975). Estimated thermal reservoir temperatures are 323°F and 343°F, using the silica and Na-K-Ca geothermometers, respectively (Mariner and others, 1974).

Eightmile Flat [20]

Borax Spring (NE/4 S14,T17N,R30E) on Eightmile Flat 18 miles southeast of Fallon has a reported temperature of 178°F (Stearns and others, 1937; Russell, 1885, pl. 8). Also an exploration drill hole for saline minerals in NW/4 NW/4 S12,T17N,R30E reportedly hit very hot water at 400 feet. The drill hole is in playa and lake sediments to a total depth of 500 feet (Nevada Bureau of Mines and Geology unpublished data). The Fourmile Flat section of Salt Wells Basin, a playa area to the southeast of Eightmile Flat also has a reported hot spring in S6,T16N,R32E (Waring, 1965, no. 75).

Dixie Hot Springs [6]

Numerous hot springs are located in SE/4 S5 and NE/4 S8,T22N,R35E along the west side of Dixie Valley. Cold springs are present about 1 mile to the south in S17,T22N, R35E (Dixie Valley 15-minute topographic quadrangle).



20 line of equal temperature (°C) at a depth of 30 meters

○ ● test hole (open circle) or well (solid circle) for which temperature data are available

fault, dashed where concealed, dotted where inferred

FIGURE 12. Stillwater thermal area, Churchill County, showing temperature at a depth of 30 meters and location of fig. 13 (after Olmsted and others, 1959).

The springs seem to be along a northeast-trending line which may be the continuation of a range-front fault present to the north at the Dixie Comstock Mine (see the following description). Movement was reported along this fault in the 1954 Dixie Valley earthquake (Willden and Speed, 1974). The estimated thermal reservoir temperature is 291–293°F, using the silica and Na-K-Ca geothermometers (Mariner and others, 1974).

Eight to ten miles south of Dixie Hot Springs (T21N, R34E and 35E) a number of flowing wells are found in the central part of southern Dixie Valley. These wells, with slightly anomalous temperatures of 70° to 76°F, may be related to the same thermal system active elsewhere along the west side of Dixie Valley.

Senator Fumaroles [4]

Cinnabar, metacinnabar, sulfur, and minor pyrite are present in siliceous sinter at the Senator Mine (Senator Fumaroles) in the northern end of Dixie Valley. The mine is located along the N30°E fault which bounds the eastern edge of the Stillwater Range (Lawrence, 1971). The location of the mine is reported to be 1 mile north of the Boyer Ranch at the mouth of Cottonwood Canyon, probably in the vicinity of SW/4 S31,T25N,R37E. The deposit was discovered in 1968.

No hot springs are present at the site, as it is approximately 60 feet to the water table. Cinnabar appears to be depositing at the present time around two main fumaroles which are 300 feet east of the main deposit. Small amounts of sulfur and pyrite have also been deposited, and considerable solfataric alteration has taken place. Small volumes of steam with some hydrogen sulfide are being emitted at the vents, and preliminary work indicates that the cinnabar was being deposited from a vapor phase at the surface (Lawrence, 1971).

Dixie Comstock Mine [5]

Vanderburg (1940, p. 48) reports that mining in the Dixie Comstock Mine was hindered by the intense heat and a large volume of hot water in the mine workings less than 75 feet from the surface. These workings referred to by Vanderburg are probably in S14,T23N,R35E near the major range-front fault which had movement in the 1954 Dixie Valley earthquake (Willden and Speed, 1974). This fault and related parallel faults continue south 5.5 miles to the Dixie Hot Springs area, and north to Senator Fumaroles. Waring (1965) reports a small spring in T23N,R35E, which may possibly be near the Dixie Comstock Mine.

Cottonwood Canyon sinter deposit [4]

Ransome (1909b, p. 57) described an extinct hot spring located 2 or 3 miles above Boyer's Ranch and about half a mile below the Nickel Mine in Cottonwood Canyon (approximately SE/4 S35,T25N,R36E). A large mound of siliceous sinter is surmounted by a craterlike orifice, about 200 feet above the present stream, which has cut deeply into the mound. The deposit rests on diorite. The relationship of the sinter deposit to the nearby Senator Fumaroles (about 2 miles to the southeast) is not known.

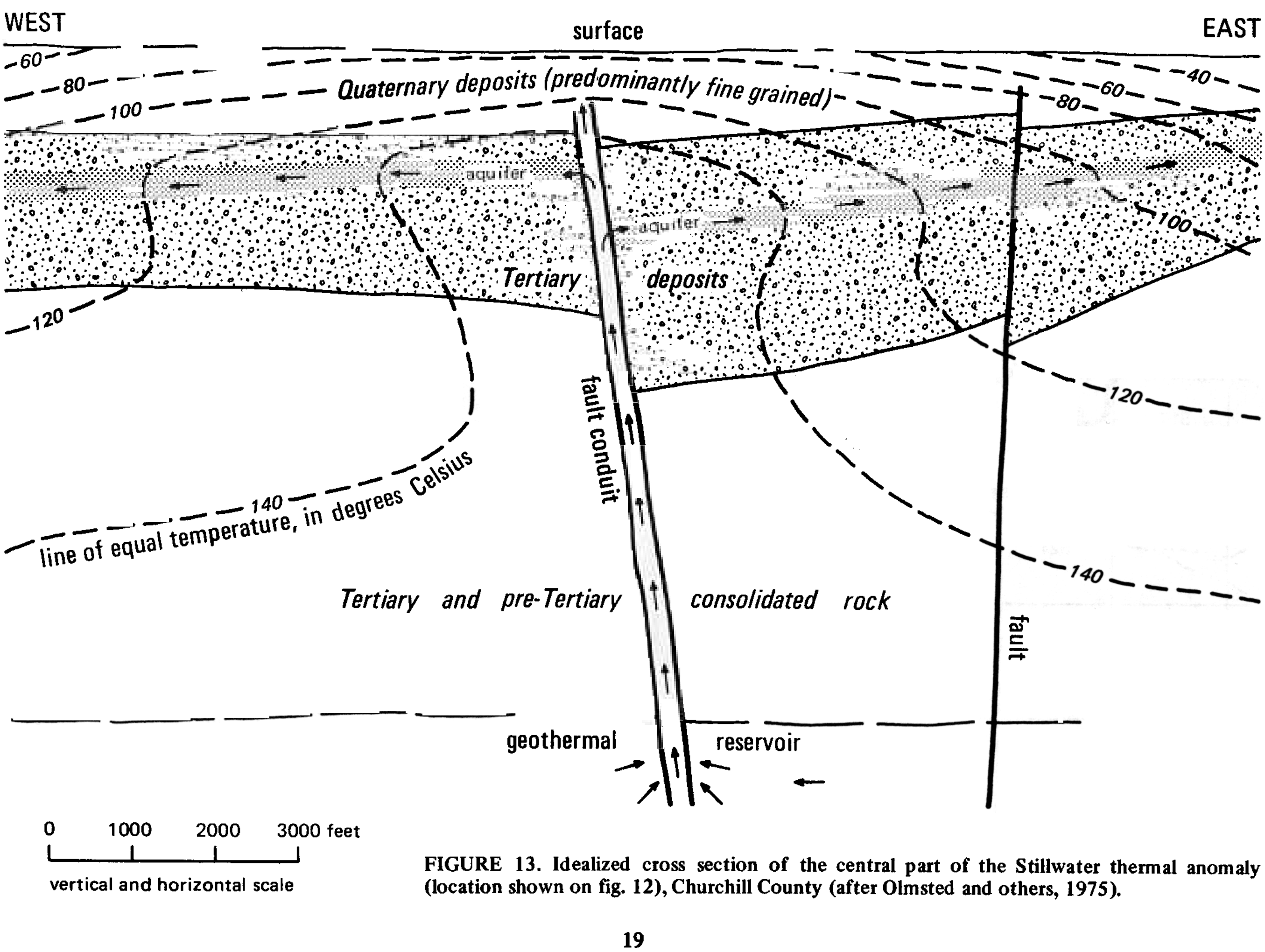


FIGURE 13. Idealized cross section of the central part of the Stillwater thermal anomaly (location shown on fig. 12), Churchill County (after Olmsted and others, 1975).