Reconnaissance of Campbell Hot Springs and Surrounding Area, Sierra County, CA

INTRODUCTION

The geologic setting of Campbell Hot Springs and the adjacent area was examined on June 7, 1980 by the author, a staff member of the Earth Science Laboratory/University of Utah Research Institute. The area is located in T20N, R15E on the Sierraville, California 15-minute quadrangle.

The purpose of this examination was to assess the geologic controls of Campbell Hot Springs and if possible to determine the continuation of these controls onto adjoining land. An 80-acre lease to the southeast of Campbell Hot Springs to Steve Benner of Sierraville and two partners is now under consideration by the U.S. Bureau of Land Management. Benner requested this on-site examination through the User Assistance Program administered by the Earth Science Lab. This Department of Energy funded program is designed to give potential users of geothermal energy technical assistance in the assessment of their resource. This assistance is meant to be a preliminary first step; responsibility for development and utilization of the geothermal resource rests with the user.

One complete day was spent examining an area which included the eastern half of Section 19, all of Section 20, and the northwest corner of Section 29. Emphasis was placed on recognizing faults which might act as conduits for geothermal fluids. Particular attention was given to a northwest trending drainage passing through the center of Section 20 (see the accompanying map). Prominent northwest trending faults are described in this part of California (Hannah, 1975) and this drainage may be a manifestation of that fault system. Rock types and any hydrothermal alteration were noted. Geologic data and the locations of known thermal and non-thermal springs were plotted on 1:24000 aerial photographs and transferred to a topographic base map of the same scale.

GEOLOGY

Rock Units: Unconsolidated alluvial sediments and two types of volcanic rocks were found in the area around Campbell Hot Springs. The majority of the outcrops in the area are composed of a gray andesite. Textures in the andesite are highly variable ranging from fine-grained equigranular to porphyritic. The porphyritic andesite contains 1-3 mm plagioclase phenocrysts which compose 30% of the rock. Flow laminations are common and they often give outcrops a layered appearance. Individual laminations vary in thickness and are generally oriented on a northwest strike with dips to the northeast.

In the southwest corner of Section 20, a fine-grained rhyolite was found. The rock is dense, and occasionally appears to be welded. The only identifiable mineral was 1-2 mm quartz phenocrysts. Flow laminations also appear in this rock type with the same general orientation as the andesite.

Much of the bedrock geology in the proposed lease area is hidden by recent gravels and sediment. This geologic unit is relevant only because it may obscure geologic features necessary to evaluate the geothermal potential of the lease area.

Structure: Two faults may exist in the vicinity of Campbell Hot Springs. The boundary between the Sierra Valley and the mountains to the south is almost certainly marked by a fault, although its orientation is conjectural. It is shown on the accompanying map as an east-west trending structure which has largely been obscured by alluvium from the surrounding drainages.

The existence of a northwest trending fault through the Campbell Hot Springs and the Benner lease could not be conclusively proven by field examination. A minor drainage in the area displays a pronounced southeast trend for 1½ miles from the least site. In the extreme southeast corner of Section 20, however, the drainage forks in divergent directions. If a fault exists in this area it is probably not the long linear feature shown by the California Department of Water Resources (1973, page 146).

As shown on the enclosed maps, the volcanic rocks on both sides of the drainage are largely andesites. This, plus the fact that flow laminations in rocks on both sides are oriented in similar directions, is further evidence against a fault with large scale displacement. More field work would be necessary to confirm this general observation, however.

Alteration: Altered rocks result from several geologic processes, one of which is prolonged contact with hot water. Particular attention was paid to this feature of the rocks in the hypothesized fault area. One outcrop of highly friable, argillized rock was found (see map) but other than that, the volcanic rocks were generally unaltered.

GEOTHERMAL CONSIDERATIONS

Water Chemistry: No water samples were taken during this examination since the thermal water at Campbell Hot Springs have already been thoroughly analyzed (Hannah, 1975; Reed, 1975). The subsurface geothermometers calculated by the author from the data provided in the California Department of Water Resources (1973) report and by Reed (1975) are given below:

Chalcedony	Quartz (conductive)	Na-K-Ca	Source
98.7°C	126.4°C	75.6°C	Reed (1975)
104.1°C	128.0°C	85.0°C	CDWR (1973)
70.9°C			CDWR (1973)

These geothermometers should be viewed with caution; they represent the maximum (temperature) that might be found at depth. The actual temperatures encountered in a test well would probably be less. The chalcedony and Na-K-Ca geothermometers are probably the most accurate.

The source of the geothermal heat is probably conduction in deep fault zones. The California Department of Water Resources (1973) report speculates that the thermal waters are magmatic in origin. Reed (1975) does not agree and his oxygen-deuterium isotope data clearly indicate the water is meteoric (see Figure 1).

Hot Springs: The four hot springs which collectively are known as Campbell Hot Springs are shown as solid dots on the accompanying map. The four have similar temperatures (approximately 100°F) and similar low flow rates. This suggests a common source for the hot water.

Hot springs are often found at the junction of two faults. The two hot springs found near the boundary between Section 18 and 19 could be controlled by the intersection of the two faults discussed in this report. This does not explain the presence of the two hot springs to the southeast. In fact the northwest-southeast array of the four hot springs suggests that the fault running in this direction may be the dominant control of the system.

Potential for development: As mentioned above, the Benner, et al. lease area is located on the same structural trend as the Campbell Hot Springs system. The lack of surface geothermal manifestations, however, makes this a "blind" target for any exploratory drilling. There are several ways to further evaluate the property's potential. Some geophysical work should be considered. A resistivity survey might give a clue about the presence of subsurface water while a gravity survey could help define the fault in the lease area. Further mapping in the area might clarify the geologic and hydrologic controls of the hot water at Campbell Hot Springs.

REFERENCES CITED

California Department of Water Resources, 1973, An interagency multidisciplinary investigation of the natural resources of the Sierra Valley study area, Sierra and Plumas County.

Hannah, J. L., 1975, The potential of low temperature resources in northern California: California Division of Oil and Gas Report No. TR13.

Reed, M. J., 1975, Chemistry of thermal water in selected geothermal areas of California: California Division of Oil & Gas Report No. TR15.

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July 10, 1980

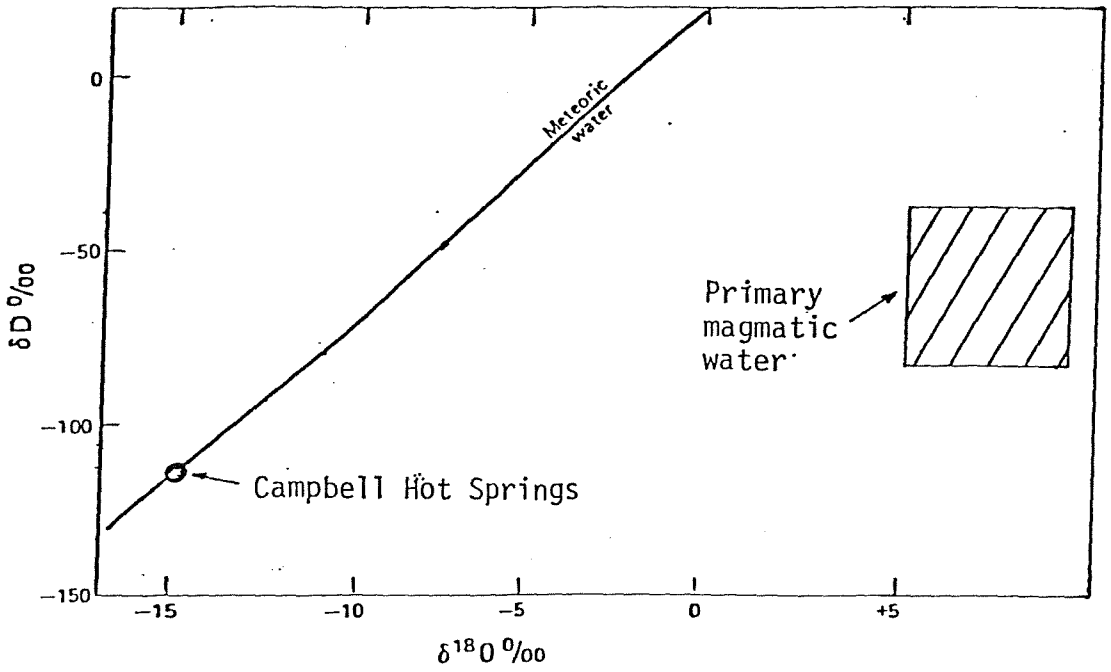
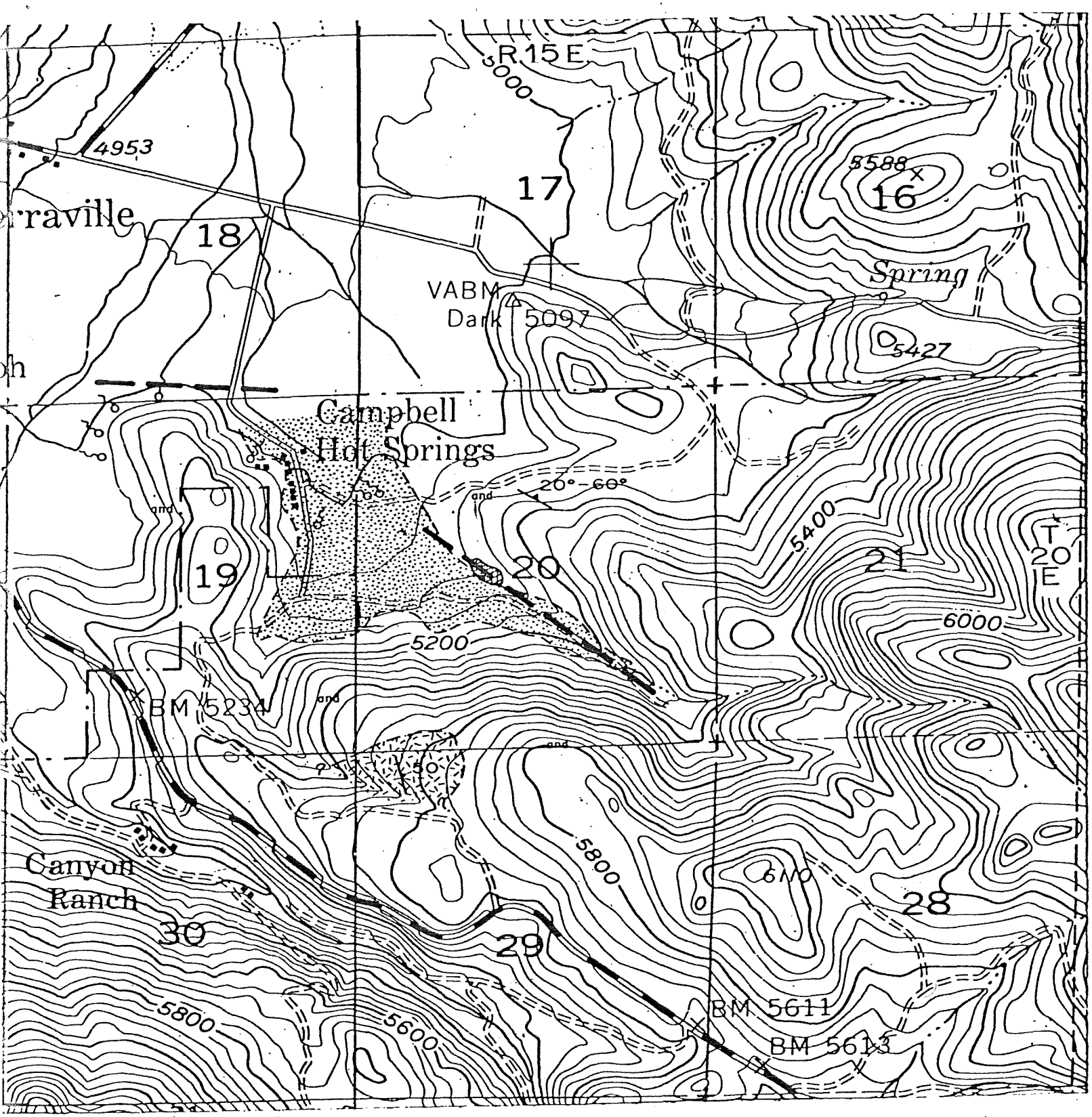


Figure 1. O^{18}-Deuterium diagram showing data from Campbell Hot Springs (Reed, 1975) and the field of primary magmatic water.



EXPLANATION

ROCK UNITS:

- alluvium
- rhyolite
- andesite
- altered rock
- 50 foliation
- fault
- contact

GEOLOGY OF THE CAMPBELL HOT SPRINGS AREA SIERRA COUNTY, CALIFORNIA

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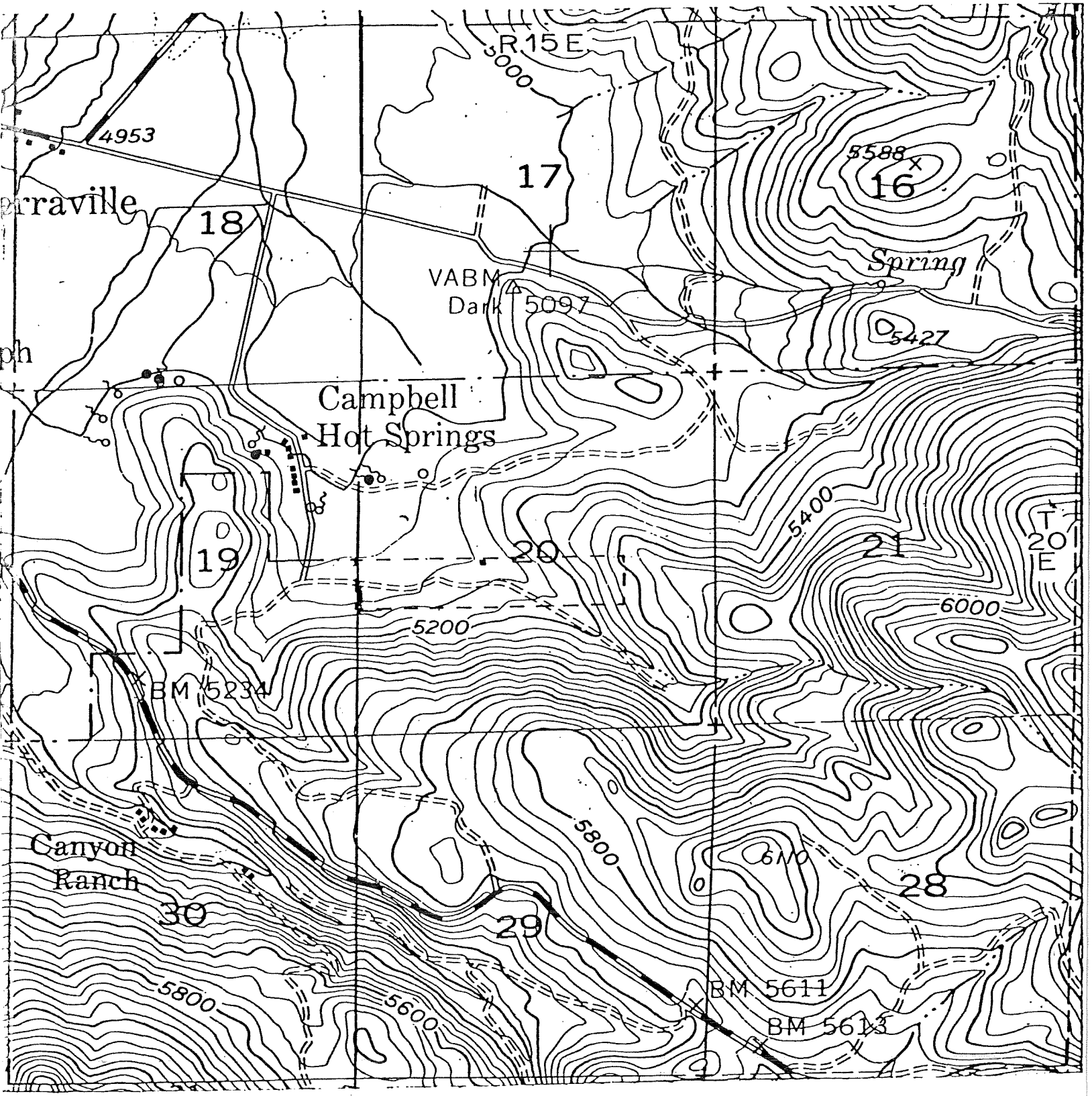
0 .5 1

SCALE 1:24,000



EXPLANATION

- lease boundary
- cold spring
- warm spring

LOCATION OF BENNER LEASE AND SPRINGS
CAMPBELL HOT SPRINGS AREA
SIERRA COUNTY, CALIFORNIA

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0 .5 1

SCALE 1:24,000