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GROUND TEMPERATURE SURVEY

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ABSTRACT

Two temperature surveys were carried out in the Hualapai Flat area with measurements taken in 1-meter-deep holes. One survey was made in January, the other in June. Temperature differences of 10°C, caused by seasonal variations in air temperature and the thermal diffusivity of the soil, were observed between the two sets of measurements. An obvious anomaly in temperature was found along a linear zone extending 2 miles (3.2 km) northward from the Fly Ranch hot springs.

INTRODUCTION

Measurement of ground temperature at 1-meter depth has proved to be an effective means of outlining geothermal systems in the central volcanic belt of the north island of New Zealand (Robertson and Dawson 1964; Fisher 1965; Dawson and Fisher 1964). At a depth of 1 meter, diurnal variations in air temperature are effectively damped out by the thermal inertia of soil, but the yearly cycle is attenuated by only about 40 percent (Dawson and Fisher 1964). Thus, in surveying an area in a few days, it would be expected that differences in temperature at 1-meter depth could be used to recognize areas with relatively high heat flow. To test the utility of shallow temperature measurements, two surveys were carried out in the Hualapai Flat area in northwestern Nevada. The first survey was done in January 1975, and the second in June 1975.

FIELD RESULTS

Sixty-seven, 1-meter-deep, ground temperature measurements were made at ½- and 1-mile (0.8 and 1.6 km) spacings in the western half of Hualapai Flat and at 1/10- to 1/4-mile spacings in the vicinity of the Fly Ranch hot springs during the first week of January 1975 (fig. 1). Due to continuous rains which began after 4 days of measurements, coverage is incomplete and the results are inconclusive.

The pattern of temperatures may be divided into four distinct zones. The coldest zone is sandy alluvium which is above the water table by at least 1 meter. The average ground temperature for this soil type is 5.4°C with a standard deviation of 1.2°C for 21 readings.

The next coolest temperatures were observed in silty playa deposits in which the water table is 0.1 to 0.3 meters deep. The average ground temperature for this soil type is 9.1°C with a standard deviation of 1.2°C for nine readings.

The next warmer temperatures were observed in a transition zone from alluvium to playa where the water table was about 1 meter. The average temperature for this soil type is 7.7°C with a standard deviation of 0.8°C for 13 readings.

The warmest temperatures were observed in a circular area centered at Fly Ranch hot springs. The radius at which an elevated temperature was clearly due to the hot spring activity was about ¼ mile. In this zone the depth to water table varied from 0.25 to more than 1 meter. The average ground temperature in this zone was 14.8°C with a standard deviation of 4.6°C.

The January temperature data are shown as a contour map in figure 1. An area of anomalously warm temperature extends in a lobe for almost 2 miles (3.2 km) north from the center of the hot spring anomaly. This direction is up in elevation and up in hydrologic gradient from the hot springs and thus thermal effects of spring flow are not likely to be the cause of elevated temperature. Also, there are no obvious down-drainage effects from the hot spring effluent which drains nearly due east.

During the first 2 weeks of June 1975, 223 one-meter-deep ground temperature measurements were made in the Gerlach-Black Rock Desert-Hualapai Flat area (approximately 420 sq km) (fig. 2). The survey shows definite temperature patterns which may be summarized as indicating low temperature on the playas and at low elevations and high temperature on the bedrock and higher elevations. The temperature range in the vicin-

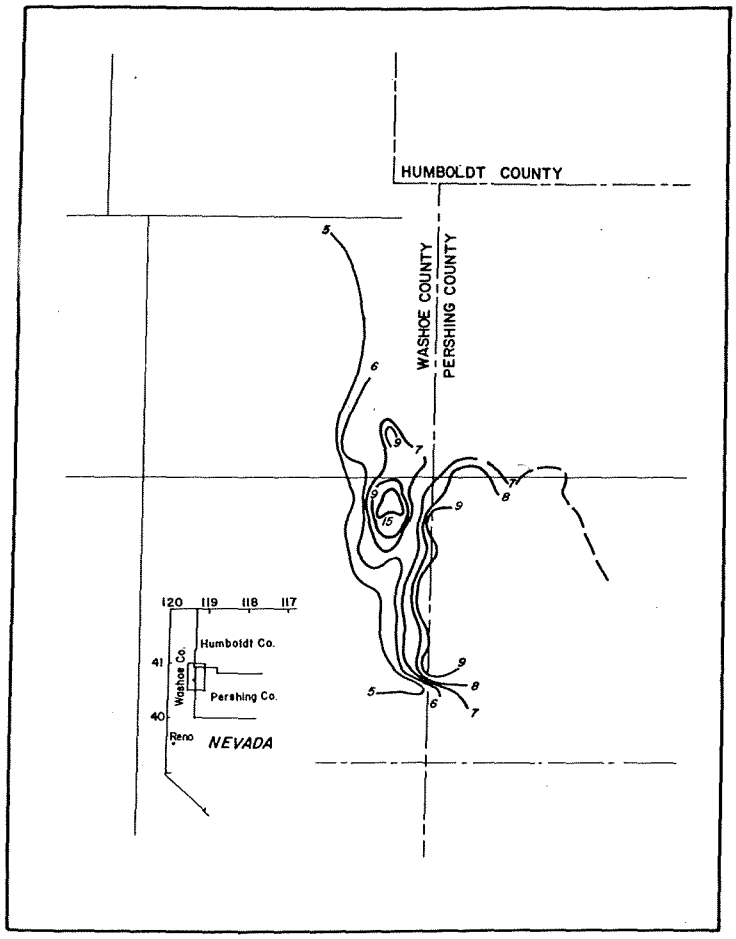

Figure 1.—Ground temperature measured at a depth of 1 meter in January 1975.

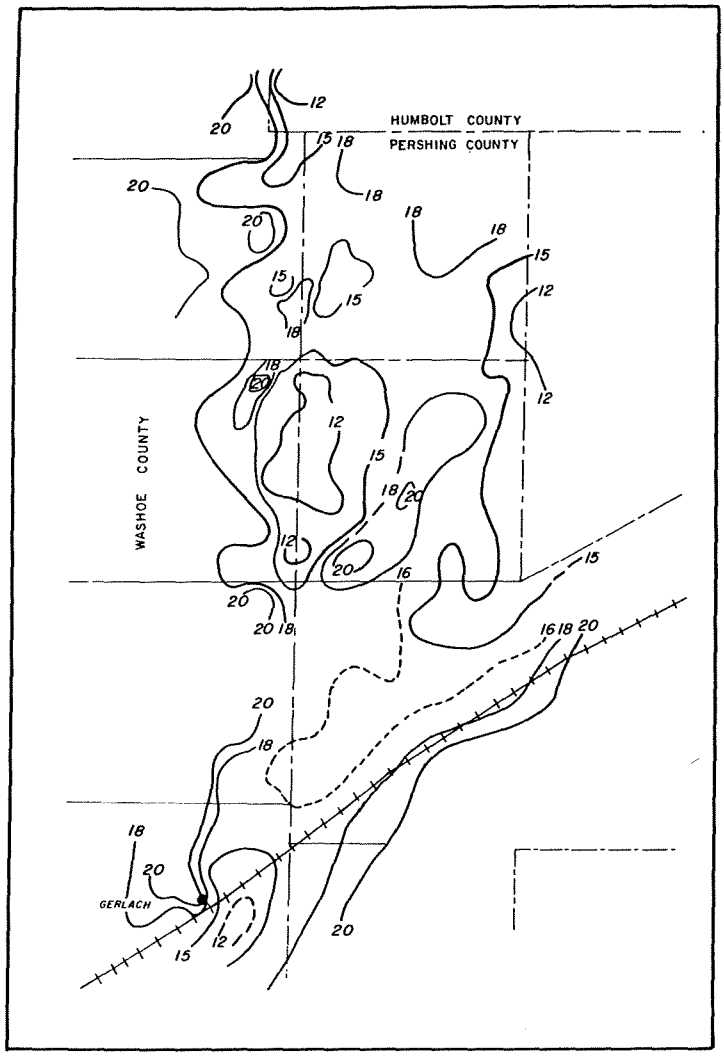

Figure 2.—Ground temperature measured at a depth of 1 meter in June 1975.

ity of the Fly Ranch hot springs is 18.6 to 33.8°C; the temperature range over the rest of the area is 10.1 to 22.8°C. The temperature range on the playas is 12 to 15°C. The higher alluvial and bedrock areas increase from 16°C near the playas to 18 to 21°C farther away.

When the results of this survey are compared to January 1975, it becomes clear that there is a strong effect due to seasonal temperature changes and perhaps groundwater flow. The playa temperatures have warmed only 2.5°C from January to June (from 9° to 11.5°C), while the alluvial areas have warmed 12°C in the same time (from 5 to 6°C to 17 to 18°C). The Fly Ranch hot springs area shows about an 8°C warming from a range of 9 to 15°C to 18 to 23°C.

Lachenbruch and Sass (1977) demonstrate that at a depth of 1 meter, diurnal fluctuations are negligible and that annual fluctuations due to seasonal warming and cooling will be considerable. The increase in temperatures at 1-meter depth in the study area reflects seasonal temperature rise. The differences in rates of temperature rise across the area are caused primarily by the differing water content in various materials. The very high thermal diffusivity of water causes water-saturated sediments to have smaller changes in temperature than partially saturated materials for the same solar irradiance. Unconsolidated, completely unsaturated alluvial sediments exhibit the greatest temperature fluctuation. For this reason, the water-saturated playa sediments show the smallest increase in temperature between January and June of any surficial material in the study area.

The observed increase in temperature with increase in elevation away from the playas is interpreted to be the effect of decreasing water content in shallow soil and rock.

There are two features in the data taken in June in north Hualapai Flat that deserve attention. A zone, 2 km in width, extending northward 1.6 to 5 km from Fly Ranch hot springs, is cold (15°C) relative to what is normal (18 to 20°C) on the basis of distance from the playa (5 to 6 km), elevation (30 m above the playa), and depth to water table (5 m). This may be caused by irrigation. Nevertheless, within this zone, an area of elevated temperature (18°C) is present which closely coincides with part of an area of unusually low resistivity (Morris 1978, this volume; Keller and Crewdson 1978, this volume).

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