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**EFFECTS OF THE 1983 IDAHO EARTHQUAKE ON THE
LITTLE ANTELOPE FLAT WARM SPRING**

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ABSTRACT

The Mt. Borah Earthquake of October 28, 1983 caused rather abrupt changes in the water flow system on the Little Antelope Flats Warm Spring in central Idaho.

A group of warm springs that had been flowing at 6 cfs completely ceased for a period of 8 days after the earthquake. The springs have since been increasing in flow and were measured at 57 cfs in March, 1984.

Mechanisms which could account for the change in spring flowage are postulated to be one or more of the following: regional tilting increasing hydrostatic head, increase in permeability produced by fracturing produced by pressure pulses, or reservoir dilation from internal stresses.

Studies are planned during the spring and summer months to gather the needed data to help understand the earthquake induced mechanisms responsible for the drastic changes in flow of the geothermal system.

The Mt. Borah earthquake of magnitude 7.3, which shook Idaho and surrounding states on October 28, 1983 at 8:06 a.m., caused rather abrupt changes in the geothermal flow system in the Little Antelope Flats area of central Idaho (see Figure 1).

A warm spring located approximately 23 miles north of the Mt. Borah earthquake epicenter had been flowing 6 ft³/sec for a period of at least eighty years (Ingram, personal communication) and completely ceased to flow for a period of eight days after the earthquake. The spring has since recovered and was measured 57.2 ft³/sec on March 17, 1983.

The warm spring located in R20E, T12N, Section 10, is owned by the Ingram family and was used to irrigate 1300 acres of land for hay production. Ingrams were seriously investigating the feasibility of commercial agriculture in the 95°F temperature of the spring prior to the earthquake.

At 10:20 on October 28, two hours after the quake, Mr. Ingram went to inspect the area where the spring is located. He observed that the main springs were completely dry. Another smaller, 94°F spring located approximately ¼ of a mile northwest of the main springs and approximately 10 feet lower in elevation was flowing about 0.2 ft³/sec compared to its normal 1.6 ft³/sec flow rate. This spring completely dried up by the morning of October 29, 1983. This

smaller spring was observed to be flowing at approximately 0.3 ft³/sec at 12:00 p.m. on November 4, 7 days after the earthquake. On the following day, November 5, 1983 the major spring started to flow and increased in flow to 57.2 ft³/sec by March 17, 1984 (Figure 2). Recent observations indicate the flow is continuing to increase although spring runoff conditions may be influencing stream flow. The flow is being monitored to detect any further changes in discharge.

The thermal springs are located at the base of the Lost River Mountains north of the Snake River Plain of Idaho. The Lost River Range trends north-northwest and is the most prominent range in the area. The range has been postulated to be a Borah Peak, at an elevation of 12,665 feet is the highest point in Idaho and comprises the prominent component of the Lost River Range. The area of the warm springs is bounded by the Lost River Fault to the east and the Lone Pine Fault to the west. The springs emanate from a north trending spur of the Lost River Fault which exposes a Devonian quartzite ridge interlayered with dolomite. The heat source is postulated to be the Tertiary Challis Volcanics which outcrop over much of the surrounding area (Figure 3).

An east-west transect was conducted across the quartzite ridge face of the north trending fault above the warm springs. The fractures are of varied orientation but the most frequently occurring are with a NE strike and NW dip. The purpose of the transect was to ascertain if fracture density is greatest nearest the springs. Our data will be gathered this field season to make the transect more complete.

Preliminary chemical analysis of the water indicates there has been no significant change in chemical or physical parameters except flow. This indicates there may be some new fractures opened in the reservoir rock but the system still has a very similar flow path.

Several theories have been proposed to explain the strange behavior of the spring. The northern portion of the Mt. Borah earthquake fault indicates the north side of the fault block on which the warm springs are located was shifted upward to the South. This regional tilting may have increased the head with a resultant increase in flow. The increase in flow could also be caused by compressibility of the thermal aquifer due to tectonic stresses in the area of the warm springs or through the increase in permeability due to opening

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of new fracture systems caused by pressure pulses from the earthquake.

The cessation of flow could have been caused by debris from the fault clogging the fracture openings. Aftershocks and differential settling could have re-opened pathways.

Yet another possibility is that surface flow could have stopped as a result of increased fracturing in the reservoir rock which (1) caused increased void space to be filled with fluid before surface flow resumed and (2) results in an increased flow volume because of fracture connections with more of the reservoir.

Aquifer dilation could also account for the behavior of the system. Initial release of pressure due to the earthquake and fracture in the southern part of the Lost River Fault could have caused the spring flow to cease. This was then followed by a gradual increase of stress in the northern part of the Lost River Fault, which did not show surface rupture causing the increase in flow we now observe.

Any one or a combination of factors could be responsible for the strange behavior of the warm spring. Because winter conditions forced the field effort to be discontinued until Spring, the answers have not been obtained. Studies are planned this Summer season to gather more information on the hydrology and structure of the area to help understand the mechanisms responsible for both the cessation of flow and the tremendous increase in flow which is occurring at this time. This information will be compiled and reported in the final paper.

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