AMERICAN THERMAL RESOURCES, INC

SOUTHERN SURPRISE VALLEY

GEOTHERMAL PROSPECT

Modoc and Lassen Counties

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INTRODUCTION

The potential for a geothermal energy supply in Surprise Valley has been investigated by exploratory drilling to depth of 7000 feet to date. Drilling is expected to resume especially after the Lake City KGRA competitive lease sale which is being prepared for a 1975 date. Recent published comments on geothermal features in Surprise Valley by the California Division of Mines and Geology and the U.S. Geological Survey are cited first in the attached list of selected references..

A suitable geothermal energy discovery within the Surprise Valley should prompt consideration for use in geothermal electric power systems. Pacific Power & Light Company (PPL), which owns a 69 kv transmission line into Surprise Valley, has contemplated a large nuclear or coal-fired electric generating plant in its big, pivotal service area immediately northwest of Surprise Valley. In addition to PPL, Sierra Pacific Power Company and the Water and Electric Board of the City of Eugene, Oregon are interested in the possible rewards from the geothermal exploration continuing in Surprise Valley.

GEOLOGY

The topography and geologic structure of Surprise Valley is of the Basin and Range type; the long, narrow valley being down-faulted between linear mountainous uplifts. This area has been a volcanic province since Miocene times and the Warner Mountains, upthrown on the west side of Surprise Valley, contain young volcanic features that may point to shallow

magmatic intrusions as primary heat sources. Water supply for thermal energy transport and reservoir capacities at depth appear to be favorably related to an optimal heat supply along the Surprise Valley fault.

Structure and Heat Source

The most important structural feature, relative to the geothermal potential, is the Surprise Valley fault which separates the Warner Mountain horst from the Surprise Valley graben. Late in 1974, drilling operations in a 4512-foot test encountered well bore temperatures above 400°F at a northern point in the Surprise Valley fault zone. This major fault is represented by extreme gravity gradients (15 milligals or more per mile) as shown on the Alturas Sheet of the Bouguer Gravity Map of California. The steep eastern face of the Warner Mountains, rising to crestal elevations of more than 9000 feet, contrasts with the relatively flat valley floor at approximately 4500-foot elevation. The amplitudes of gravity minima under the valley floor were previously interpreted as sedimentary basins of 3000 to 5000-foot depth. However, drilling has demonstrated 7000 feet of shales and volcanic sediments under the valley floor. The vertical displacement across the Surprise Valley fault may substantially exceed 12,000 feet. Given this major fault displacement, the west dip of the Warner Mountains horst in its southern part and the presence of younger volcanic eruptive centers west of the Surprise Valley fault, it is reasonable to think of the structural high under the Warner crest as a favored site where young magmatic intrusions or heat sources may reach shallow positions in the crust. The hot, hidden intrusions could be in or immediately west of the Surprise Valley fault zone as demonstrated by the volcanic plug of

rhyolite immediately west of Menlo Baths in Section 7-T39N-R17E (see enclosed copy of Plate 21 from California Department of Water Resources Bulletin 98).

ATR leaseholds are situated along the Surprise Valley fault, both north and south of the Menlo Baths (MB) intrusive. Certain facts and aspects of the MB volcanic plug are interesting:

1. The MB plug not only intruded the high eastern edge of the Warner horst but broached a mere 5 miles from Eagle Peak, the southernmost and highest crestal point in the Warner Mountains. This geometry suggests the MB plug originated from a deep and large magma body extending northward under the eastern Warner scarp and Surprise Valley fault. The profound gravity minima (structural basin) immediately eastward could be the sinking relative of the hot rising magma mass.
2. The MB plug is situated in a curved gathering of a subordinate fault family which intersects the Surprise Valley fault. This places the MB plug at the northern apex of a normal faulted terrain covered with Plio-Pleistocene basalt that seemingly issued from the MB volcanic vent. This young and structurally distinctive terrain seems to reflect a volcanic disruption or magmatic displacement at depth. However, the geophysical data presently available to ATR makes no contribution to understanding any prospective heat source that might be present.

Hydrology

Investigations by the California Department of Water Resources have not demonstrated any subsurface outlet for Surprise Valley ground waters other than by evapotranspiration from the seasonal lakes, wetlands and irrigated crop lands. Annual precipitation of approximately 30" along the crest of the Warner Mountains provides a runoff from the steep east face and the southern end of the mountains. A portion of this runoff probably drops in cool, dense flows to great depths in the Surprise Valley fault fracture planes. Subsequently heated, such water would rise in convection plumes and appear in the hot to warm springs on both sides of Surprise Valley. The west side thermal fluid belt, north of Lake City Hot Springs, has revealed the highest subsurface temperature (+400^{o}F) encountered in drilling to date. This fluid belt tracing north 12 miles along the Surprise Valley fault to Fort Bidwell is identified by surface fluid temperatures of 128^{o} to 190^{o}F and total dissolved solids of 1000 ppm. An east side thermal fluid belt extending north 13 miles from Section 6-T42N-R17E has comparable temperatures and salinities.

Against the hydrologic and thermal background presented above, the southern thermal fluid belt, commencing at Menlo Baths Hot Springs and extending seven miles southeastward to Bare Ranch, has a modest profile of lower temperatures and salinites.. However, this profile should not be minimized in its implications as Duffield & Fournier apparently have done in their reconnaissance study (Reference 2). Bare Creek, its several tributaries, and Barber Creek have relatively large watersheds. They transport greater volumes of surface water runoff into Surprise Valley (Bare Creek flow on 12 April 1974 measured 25 cubic feet per second at 38^{o}F.). Such inputs of cold, fresh waters must substantially

dilute the termal fluids escaping between Menlo Baths and Bare Ranch. Duffield and Fournier recognize the mixing of surface and thermal waters evident in Surprise Valley, but a possible underestimation of the greater degree of mixing at the south end of the Valley is raised by the 180°F temperature measured at Menlo Baths in August 1967 (California Department of Water Resources). August, the dry and low water point of the year in the Lower Lake area, could be the time when deeper thermal fluids might attain their strongest surface expression. The 180°F recording is to be compared with the 122° to 136°F temperature range recorded in June 1958 at Menlo Baths and the 59°C or 138°F temperature reported by Duffield and Fournier.

PROPOSED EXPLORATORY GEOTHERMAL WELL

To properly evaluate the evident higher temperatures at the MB volcanic plug and the expected porosity and thermal fluids in the Surprise Valley fault zone, American Thermal Resources proposes to drill a 7000-foot exploratory geothermal well in the northwest quarter of Section 20-T39N-R17E (see enclosed topographic map). This location may also afford a determination of the thickness and possible interflow porosity of the young Plio-Pleistocene basalt series. ATR has prepared drilling programs and cost estimates of approximately $225,000 to drill and evaluate at 7000 feet. Completion with 5000 feet of 7" casing is estimated to cost an additional $65,000. ATR anticipates all preparations for actual drilling can be completed by April 8th. The cost estimate figures cited are based on the use of a National 50A rig and crews experienced in geothermal drilling operations.

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