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TITLE: Tecuamburro Volcano, Guatemala: Geothermal Gradient Core Hole Drilling, Operations, and Preliminary Results

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TECUAMBURRO VOLCANO, GUATEMALA
GEOTHERMAL GRADIENT CORE HOLE DRILLING, OPERATIONS, AND PRELIMINARY RESULTS

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ABSTRACT

A geothermal gradient core hole (TCB-1) was drilled to a depth of 700+ m at the Tecuamburro geothermal site, Guatemala during February and March, 1990. The core hole is located low on the northern flank of the Tecuamburro Volcano complex. Preliminary analysis of cores (>98% core recovery) indicates that the hydrothermal system may be centered in the 4-km-diameter Chupadero Crater, which has been proposed as the source of pyroxene pumice deposits in the Tecuamburro area. TCB-1 is located 300 m south of a 300-m-diameter phreatic crater, Laguna Ixpaco; the core hole penetrates the thin edge of a tuff ring surrounding Ixpaco and zones of hydrothermal brecciation within the upper 150 m may be related to the phreatic blast, dated at 2,910 ^{14}C years. At the time of this writing, the unequilibrated temperature at a depth of 570 m was 180°C. Data on fracturing, permeability, hydrothermal alteration, and temperature will be presented.

INTRODUCTION AND PROJECT DESCRIPTION

Prefeasibility studies of the Tecuamburro Volcano geothermal area, Guatemala, Central America have been completed. The results of geological, geophysical, and hydrogeochemical investigations indicate that there is a substantial crustal heat source beneath the Tecuamburro volcanic complex and a large crater (possible caldera) located on the north flank of that complex (Duffield *et al.*, 1989; Goff *et al.*, 1989; Hoover *et al.*, Unpub. Data; and Heiken and Duffield (eds.), 1989).

The gradient drilling/coring phase of the assessment of the Tecuamburro area was initiated in February, 1990 and is in progress at the time of this writing. The purpose of this project is to work with Guatemala's Instituto Nacional de Electrificación (INDE) to train INDE personnel in geothermal exploration and assessment techniques by collaborating with them during actual prefeasibility studies and exploration geothermal gradient drilling. This project is part of the Central American Energy Resource Project (CAERP) and is funded by the U.S. Agency for International Development (USAID); the project has been carried out by the Los Alamos National Laboratory and the U. S. Geological Survey, in collaboration with INDE.

The Tecuamburro Volcano geothermal area (Fig. 1) is located in southeastern Guatemala (48 km south-southeast of Guatemala City), along the Central American volcanic chain. The Tecuamburro volcanic complex, which rises about 800 m above its surroundings, dominates the area. Thermal manifestations, found over an area of nearly 400 km^2, are linked to youthful volcanic activity.

The Tecuamburro volcanic complex has no recorded historic volcanic activity. Radiometric ages obtained during the Los Alamos/USGS/INDE study and reported at GRC last year (Duffield *et al.*, 1989), suggest that the youngest Tecuamburro eruptions are younger than 38,300 years and that phreatic eruptions about 2900 years ago formed a crater that contains Laguna Ixpaco, an acid sulfurous lake (pH<3) 360 m in diameter. Gases from acid sulfate springs near Laguna Ixpaco consistently yield estimated subsurface temperatures of 300°C (Goff *et al.*, 1989). Laguna Ixpaco and other groups of hot springs are located within Chupadero Crater, a 4-km-diameter possible caldera identified in earlier studies as the

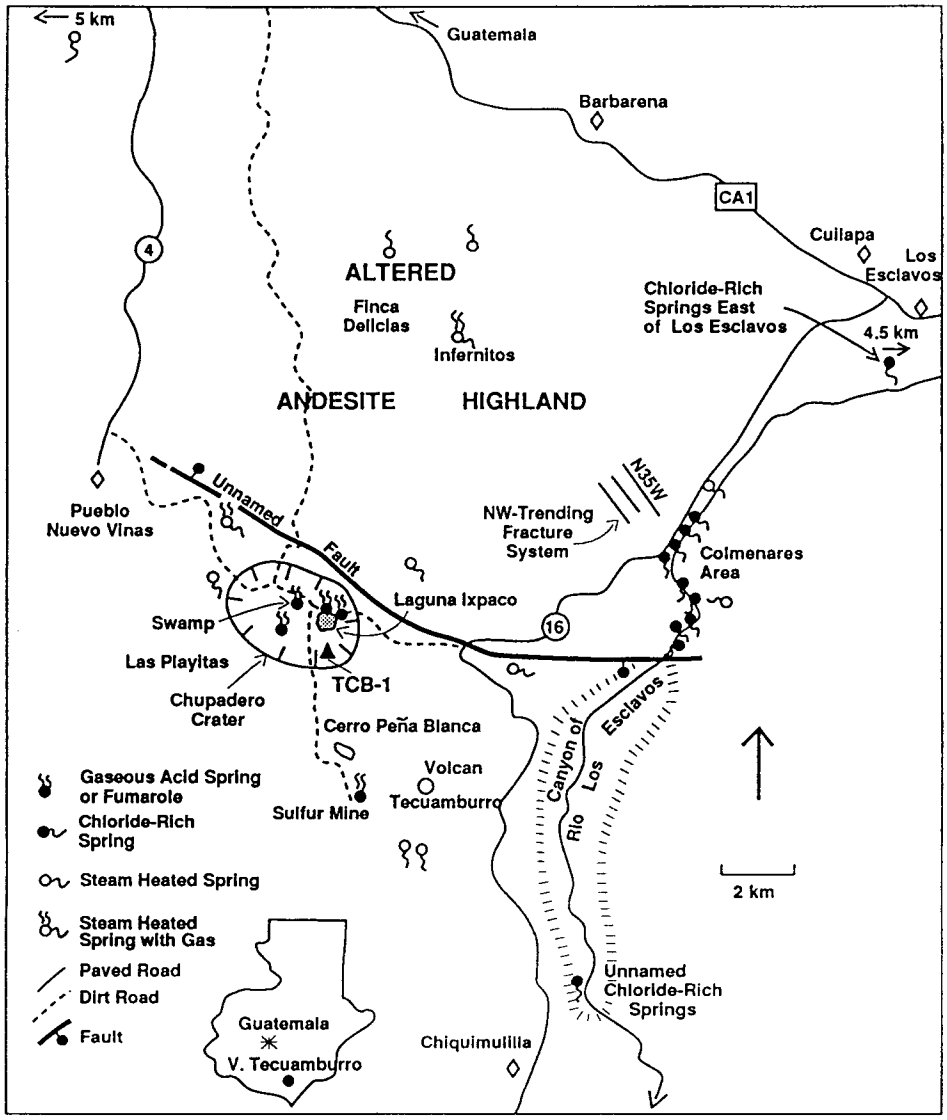

Figure 1. Location map for the Tecuamburro geothermal area, showing the TCB-1 site.

probable source for a widespread pyroxene pumice deposit in the area. The site for exploration core hole TCB-1 (Fig. 1) is within the Chupadero Crater, 300 m south and 55 m above the southern margin of Laguna Ixpaco. The purpose of the core hole is to determine the temperature gradient, study the stratigraphic section (to verify the proposed Chupadero Crater), and to sample hydrothermal fluids. The core hole TCB-1 has been drilled to our initial goal of 700 m. We are presently deepening the core hole in an attempt to gain additional information about the composition of fluids in this hydrothermal system.

CORING OPERATIONS

The coring rig is a Longyear 44, with a 20 foot mast, and powered by a 4-71 GM diesel engine. It was mobilized by the Guatemala office of Swissboring.

Core hole TCB-1 was spudded on February 7, 1990 and surface conductor pipe was set to a depth of 38.2 m. PW casing was set to 84.55 m. Lost circulation zones at 83 and 84.55 m depths are associated with hydrothermally fractured, silicified zones, a few

cm to dm thick, in a dacitic tuff-breccia. The lost circulation zones at these depths were plugged after pumping cement (42 bags) downhole.

Drilling continued to a depth of 87.45 m, with PQ-size and was cased to that depth with HW casing. At 87.45 m the blow-out preventer was installed and tested. From a depth of 87.45 m to a t.d. of 700 m, HQ size drill rods were used. The coring operations to t.d. were relatively uneventful and recovery of >98% core was made at an average rate of 20 m per day.

The thin edge of the Ixpaco phreatic tuff ring, dated at 2900 years, was reached at a depth of 65 m. Overlying the ring is a lobe of an avalanche breccia from the nearby Peña Blanca dacite dome. Below the tuff ring, from a depth of 66.5 m to 144.6 m, is a section of tuff-breccia with pumiceous dacite clasts, believed to be from an eruption that preceded the emplacement of the Peña Blanca dome; this deposit is hydrothermally fractured and intensely altered at three levels (Fig. 2), possibly by the phreatic explosions that formed the nearby Laguna Ixpaco crater.

From depths of 144.6 m to a fault contact at 253.75 m is a massive tuff unit. The tuff unit is welded in part, with chloritic and hematitic alteration. We believe this tuff to be pyroxene andesite ignimbrite, which is correlated with the Qai tuff deposits of Duffield *et al.* (1989) and dated at 38,300 years.

Below 253.75 m, to a depth of 600 m (at the time of this writing), are interbedded andesitic lavas, scoria, thin tuff beds, and laharic breccias of the Miraflores composite cone (Qam unit of Duffield *et al.*, 1989) (Fig. 2). This andesitic sequence, mostly lavas, is intensely chloritized, with very low permeability; nearly all pore space is filled with hydrothermal minerals. At the time of this writing, the last rocks penetrated were faulted, with some open veins present.

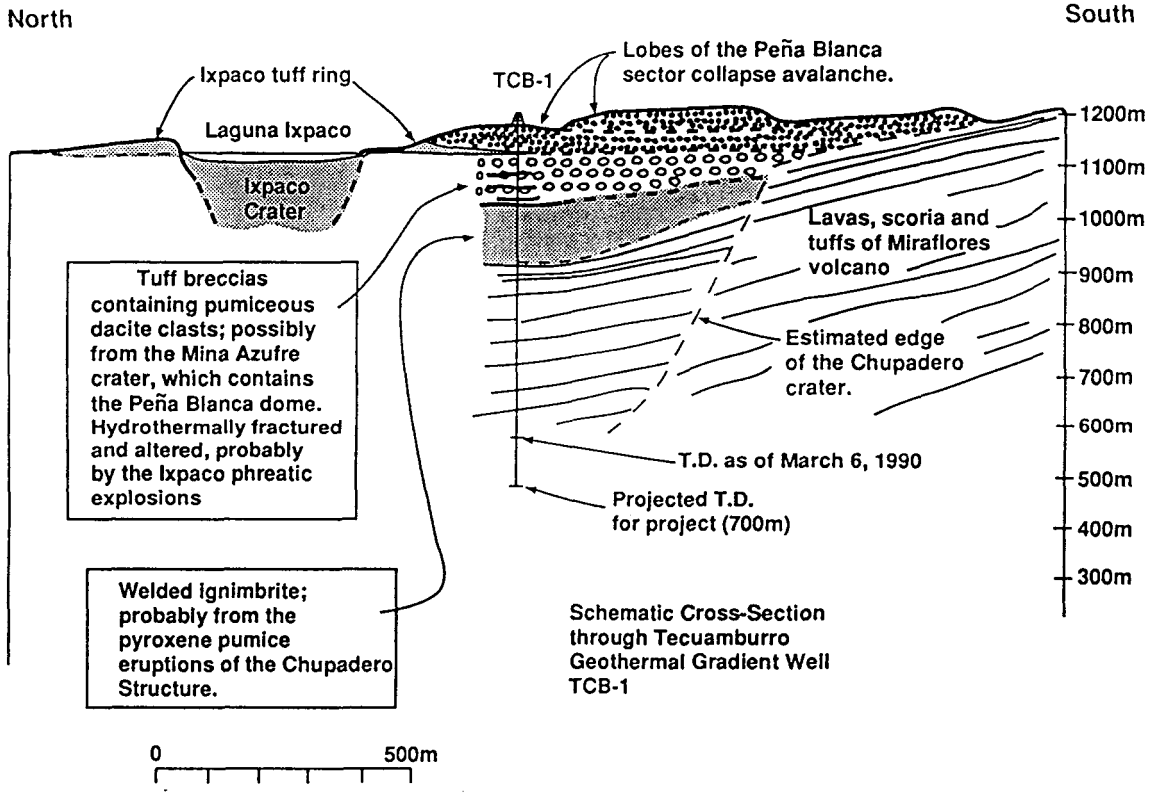

Figure 2. Schematic north-south cross-section through Tecuamburro geothermal area geothermal gradient well TCB-1. Elevations are above mean sea level. No vertical exaggeration.

TEMPERATURE GRADIENT

At a depth of 400 m, a temperature log was made with a Kuster[tm] tool. Below that depth, measurements with maximum-reading thermometers were made every 50 m. The unequilibrated thermal gradient is 38.4°/100 m (Fig. 3). The core hole will be logged one week after this paper is due and the results will be presented at the GRC meeting in August, 1990.

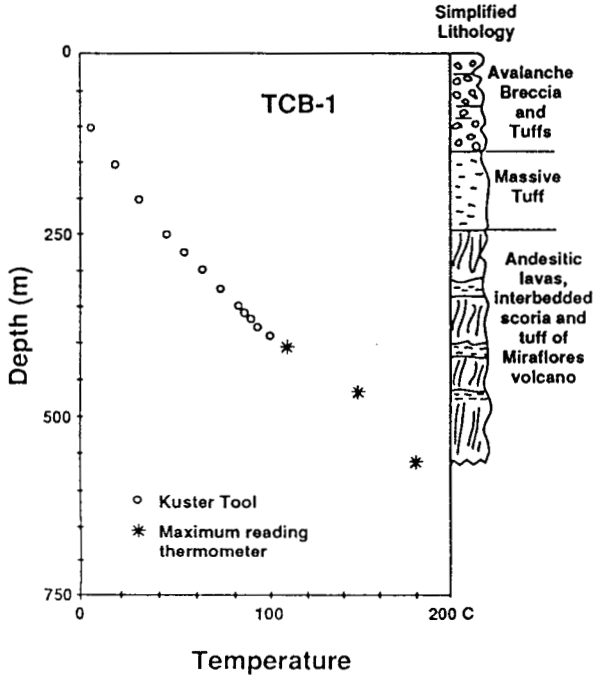

Figure 3. Unequilibrated temperature log of geothermal gradient well TCB-1.

CONCLUSIONS

The first geothermal gradient core hole, TCB-1, in the Tecuamburro geothermal area, Guatemala has been drilled to test hypotheses developed during the prefeasibility studies (Duffield *et al.*, 1989; Goff *et al.*, 1989): (1) The presence of a massive, partly-welded 110-m-thick tuff sequence at depth is partial confirmation of the existence of the 4-km-diameter Chupadero crater, which, as a small caldera, could be an excellent heat source. The tuff sequence may also serve as a caprock. (2) An unequilibrated thermal gradient of 35°/100 m supports the gas geothermometer temperatures of about 300°, determined at the nearby Laguna Ixpaco phreatic crater and acid lake.

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