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GEOTHERMAL COREHOLE DRILLING AND OPERATIONS, PLATANARES, HONDURAS, CENTRAL AMERICA

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ABSTRACT

Two slim exploration coreholes to depths of 650 m and 428 m, respectively, have been completed at the Platanares geothermal site, Honduras, Central America. A third corehole is now being drilled. These boreholes have provided information on the stratigraphy, temperature variation with depth, nature and compositions of fluids, fracturing, permeability, and hydrothermal alterations associated with the geothermal reservoir. Eruptions of hot water occurred during the drilling of both the first and third boreholes. Recovery of >98% core has been obtained even under difficult superheated conditions.

INTRODUCTION AND OBJECTIVES

The gradient drilling/coring phase of the assessment of the Platanares geothermal area, Honduras, Central America (Fig. 1) was initiated in October 1986 and is continuing into June 1987. This project is part of the Central America Energy Resource Project (CAERP) funded by the U.S. Agency for International Development (AID) and implemented by the Los Alamos National Laboratory in cooperation with Empresa Nacional de Energía Eléctrica (ENEE), Honduras, and the U.S. Geological Survey (USGS). Platanares was selected as the first site for thermal gradient drilling from six sites investigated during a geothermal reconnaissance study of Honduras (Eppler et al., 1986; Heiken et al., 1986; F. Goff et al., 1987a). Coreholes PLTG-1, PLTG-2, and PLTG-3 are the first continuously cored geothermal gradient holes in Honduras.

Figure 1. Location map, Honduras geothermal prospects.

The objectives of these coreholes were to obtain quantitative information on the geothermal gradient, to characterize the site by drilling as deeply as possible with at least 75% core recovery; and to collect fluids associated with the geothermal reservoir.

PROJECT DESCRIPTION

Two boreholes have been drilled and a third is in progress at the Platanares geothermal site. The project plan called for coring the first hole (PLTG-1) to at least 500 m on a site chosen on a major bend in the Quebrada del Agua Caliente (Fig. 2) in a major northwest-trending fracture zone lying between groups of boiling springs (Heiken et al., 1986, F. Goff et al., 1987a). The hydrogeochemical data (F. Goff et al., 1987a) indicated that the reservoir at Platanares equilibrated at temperatures of 220 to 240°C in red beds of the Valle de Angeles Group, which underlies tuffs of the Padre Miguel Group. The total thickness of the Padre Miguel Group in the Platanares area was unknown. Estimates ranged from as little as 300 m to as great as 1000 m (Williams and McBirney, 1969). PLTG-1 penetrated the Valle de Angeles Group at 563.7 m and was completed at a depth of 650.4 m in the red beds.

The site for the second corehole at Platanares, PLTG-2 (Fig. 2) was chosen to assess the hydrology near the southern limits of the reservoir. The site is approximately 500 m southeast of the village of Platanares in a small gully on a Quaternary river terrace. PLTG-2 was located between the boiling springs of the lower Quebrada del Agua Caliente and the mixed thermal springs on the Rio Lara to intersect a possible lateral plume of mixed thermal water moving toward the south in the subsurface. PLTG-2 was cored to 428 m penetrating the Valle de Angeles Group at a depth of 311 m.

The success of the first two coreholes provided the impetus for a joint venture among Los Alamos, ENEE, and USAID Honduras to drill a third

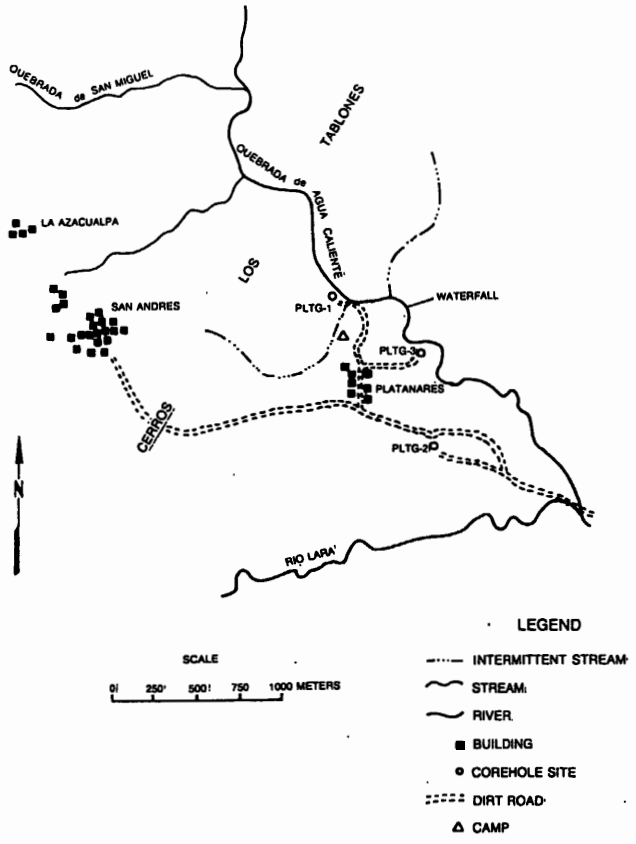

Figure 2. Platanares geothermal site map.

corehole, PLTG-3 (Fig. 2). The location of PLTG-3 was chosen to confirm the high temperature and permeability within the potential heart of the geothermal discharge zone. PLTG-3 was spudded on May 9, 1987.

SUMMARY OF CORING OPERATIONS

The core rig, a Longyear 44 powered by a 4-71 GM diesel engine, and having a 20 ft mast, was mobilized by Swissboring, Guatemala Branch. Mobilization efforts required acquiring permits to cross borders; road improvements; site preparation; and construction of camping and messing facilities, office space, field repair shop, and equipment and core storage areas.

PLTG-1 was spudded on October 19, 1986. Surface conductor pipe was set to 10.2 m. PW casing, which served as a support of the BOP and wellhead stack was set to 70 m. From 70 m, HQ size drill rods were used. On reaching 252 m, a major eruption of hot water occurred (Fig. 3) wedging the core barrel within the HQ rods. Attempts to control the eruption by killing the well were unsuccessful and all the HQ rods were tripped out of the hole under superheated, erupting conditions. Operations resumed with a closed circuit system using loading chambers and continuous cooling with fresh water during nondrilling periods. The core recovery system consisted of a shut-off valve in the drill string, loading chamber for the inner tube and a receiving chamber for the overshot assembly and core barrel

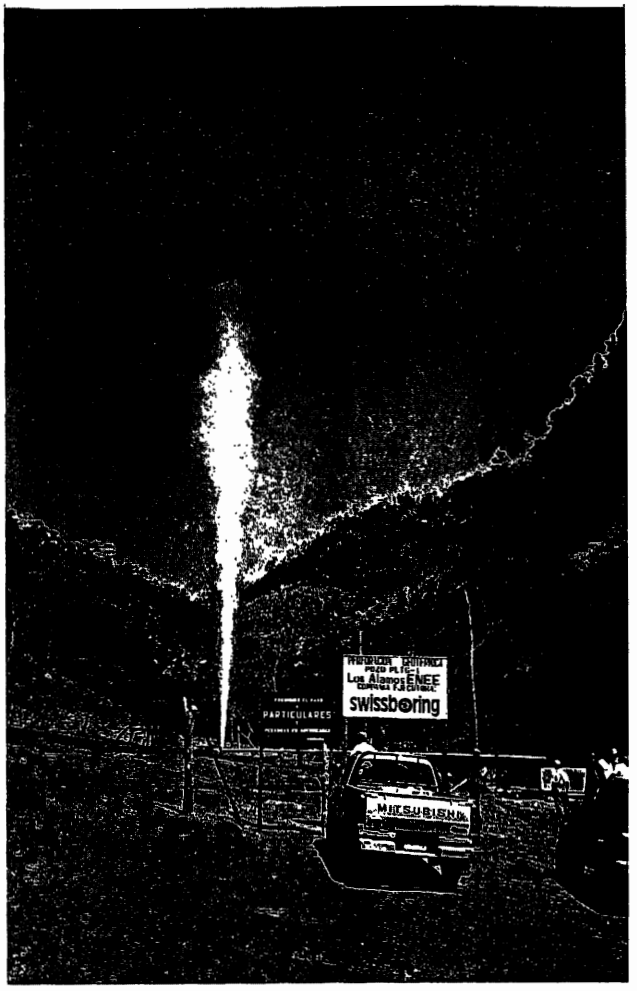

Figure 3. PLTG-1, Platanares, Honduras, Central America.

inner tube. The inner tube head contained a non-return valve as in the Longyear "Q" underground system to allow change of rods and core withdrawal. The core recovery operations through the receiving chamber were done by pumping cooling water through the HQ drill string to pressure up the system to unlatch the inner tube and to avoid uncontrolled rise of the core barrel up through the drill string. The loading of the core barrel inner tube was achieved by closing the system to equalize pressure. This system was used from 252 m to 588 m. Hot water entries occurred at various depths during the drilling but tight control on the system prevented additional eruptions. Lost circulation occurred between 525 to 563 m, where the Valle de Angeles was encountered. Operations were shut down during December at a depth of 588 m. In mid-January an attempt was made to cement the HQ string up from 588 m to seal off the major fluid entry of 160°C water, which was dominating the temperature of the borehole and preventing obtaining a conductive gradient. The cementing job was successful in sealing off lost circulation zones near the bottom of the borehole. Another attempt to seal off the upper fluid entries by pumping cement down the

annulus succeeded only for the upper zones (70-252 m). Drilling resumed with NQ drill rods with the goal of obtaining an additional 50 m of hole into the Valle de Angeles. On reaching 625 m another major eruption occurred, which was immediately controlled by switching to the closed circuit system with cooling as described above. The temperature of this fluid was 160°C and its flow rate about 90 gallons/min (F. Goff et al., 1987b). The borehole was completed to a TD of 650.4 m on January 21, 1987. Figure 4 presents the corehole configuration for PLTG-1. A summary of significant rig activities by percentage of total rig operating time are shown in Figure 5. Actual coring operations occupied 52.5% of the total time. A significant percentage of "other" time (13.4%) was spent developing the methodology for continuing the borehole during the eruption, which occurred when the hole reached a depth of 252 m.

The core rig was relocated to the PLTG-2 site on January 21, 1987, and spudded in PQ size on January 22. On reaching a depth of 77 m, the hole was reamed, PW casing was set, and the BOP installed. Coring continued rapidly in HQ to 397.7 m penetrating the Valle de Angeles at 311 m. On February 5, 1987, the core barrel threads stripped leaving inner tube in the corehole. A fishing operation recovered the inner tube and drilling resumed for fifteen hours. On February 6, when drilling at a depth of 428.4 m,

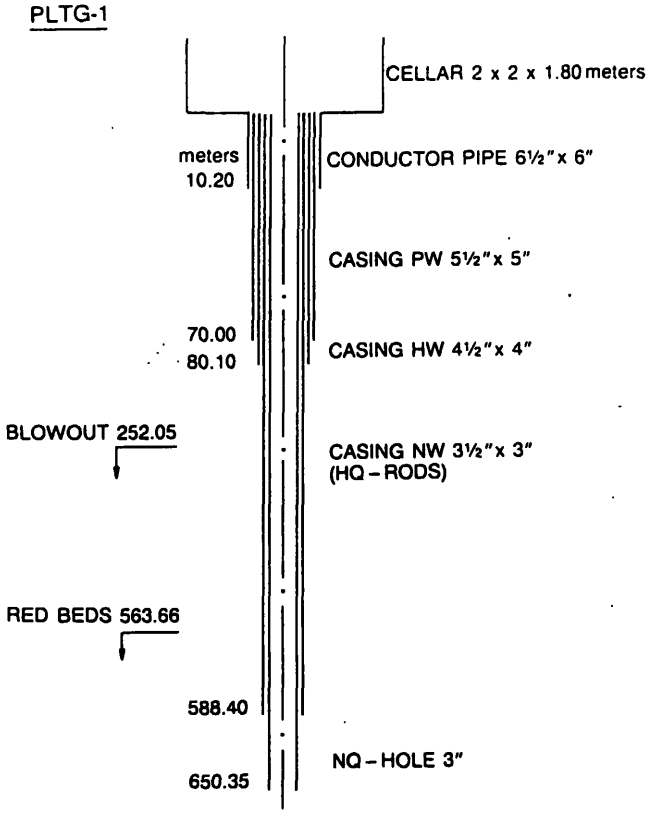

Figure 4. Actual (as-built) configuration, PLTG-1.

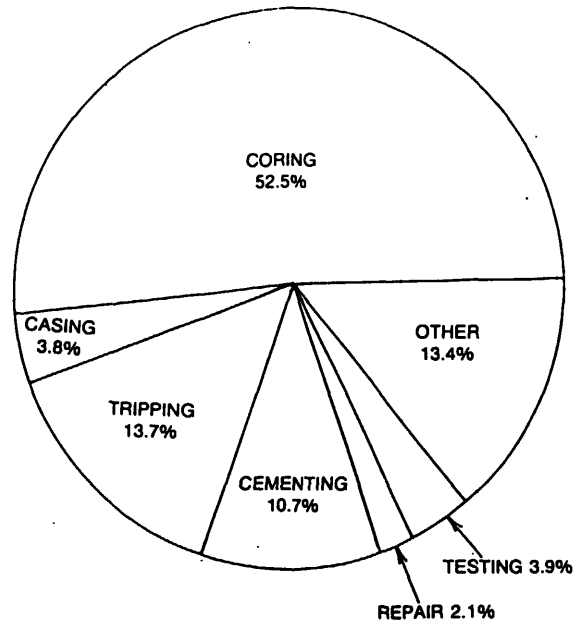

Figure 5. Activities by percentage of total rig time, PLTG-1.

the core barrel threads again stripped and parted. The wireline broke near the surface and the overshot assembly sent down the hole to retrieve the inner barrel was lost. Although the next two days were spent fishing, the overshot and inner core barrel could not be recovered. On February 9 the decision was made to reduce to NQ and try to "kick around" the lost core barrel. While tripping HQ rods to be used as casing for the NW rods a depth of only 424 m could be reached. Before grouting, the NW casing (HQ rods) was withdrawn to 394 m to allow sufficient length for the "kick off" attempt. Three "kick off" attempts failed due to caving and swelling of clays in the Valle de Angeles. Various mud mixes were tried with no success. After the third attempt, the decision was made to stop drilling on February 16. Figure 6 presents the corehole configuration for PLTG-2. The summary of significant rig activities by percentage of total rig operating time is shown in Figure 7. Coincidentally, the same percentage time (52.5%) was spent in coring PLTG-2 as PLTG-1. The relatively long time (20.90%) spent tripping is directly related to trying to continue the borehole during the operations described above.

PLTG-3 was spudded on May 9. A hot water eruption occurred on reaching a depth of 25 m, propelling the inner tube to the height of the eruption column, at the top of the mast. Drilling continued cautiously to 26.75 m when the decision was made to set the BOP to the PW casing. A 128°C temperature was measured at 25 m. Coring continued with HQ size rods and the Valle de Angeles contact was encountered at a depth of 289 m. On May 22, PLTG-3 was at a depth of 353 m.

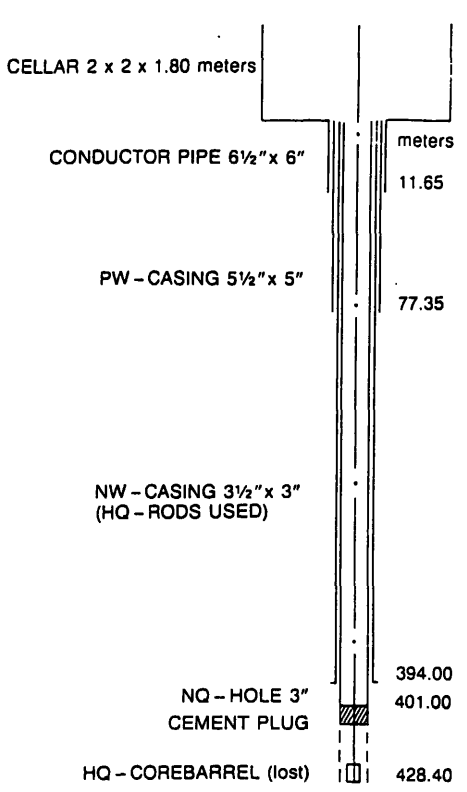

Figure 6. Actual (as-built) configuration, PLTG-2.

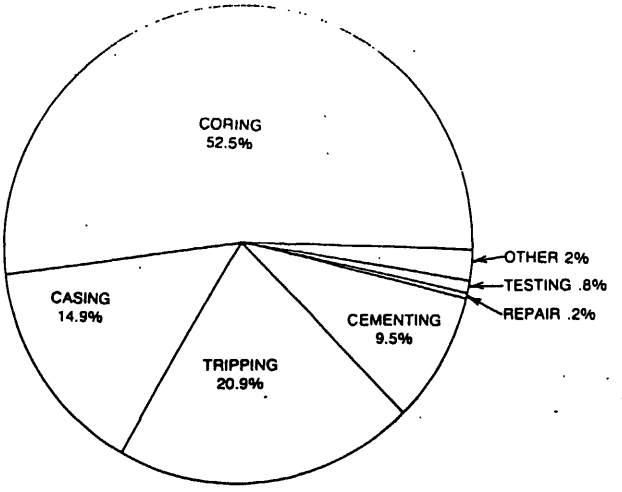

Figure 7. Activities by percentage of total rig time, PLTG-2.

CORE RECOVERY

The amount and quality of the core recovered were consistently high throughout the entire operation. Low initial core recovery occurred in PLTG-1 in the first 7.2 m of drilling in the fine sand and clay of the river deposits and in PLTG-2 in the first 13.25 m of unconsolidated terrace gravel material. After the Quaternary gravel/ Padre Miguel contact core recovery averaged 98%. Core was curated on site by Los Alamos and ENEE geologists following procedures modified from those developed at Los Alamos (S. Goff, 1986).

SUMMARY

The first two geothermal gradient coreholes in Honduras have been successfully completed and the third is in progress at the time of writing. Core recovery from the three coreholes has exceeded 98% and the recovered samples have been used to determine the depth to the top of the potential geothermal reservoir rocks, the stratigraphy, and the nature of permeability and alteration at the Platanares site. Temperature measurements have been made and fluid samples collected for chemical analysis. Results of the investigations of the core (Heiken et al., 1987) and fluid samples (F. Goff et al., 1987b) will be integrated with other results from Platanares and to generate a conceptual model of the Platanares geothermal system.

This work will provide the Honduras government with the information needed for planning the next phase in the assessment of the Platanares site.

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