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GEOLOGY OF THE PLATANARES GEOTHERMAL AREA, COPÁN, HONDURAS

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ABSTRACT

The Platanares, Copán (Honduras) geothermal area is located in a highly faulted terrain of Paleozoic(?) metamorphic rocks, Cretaceous clastic sedimentary rocks, and Tertiary volcanic rocks. All thermal manifestations are located along faults. The volcanic rocks are probably too old to represent the surface expression of an active crustal magma body. Thus, the thermal water is interpreted to be heated during deep circulation in a regime of elevated heat flow. The water chemistry suggests that the geothermal reservoir originates within the Cretaceous sedimentary sequence and that the reservoir temperature may be as high as 240° C. Two exploration coreholes penetrated the volcanic sequence and bottomed within Cretaceous redbeds. Well PLTG-1 is 650 m deep and flows at 3 Mw thermal from a 160° C permeable zone. Well PLTG-2 is 401 m deep and has a thermal gradient of 139° C/km. Exploration drilling is continuing, with a third corehole to be drilled in May, 1987.

INTRODUCTION

The Platanares geothermal area in the Department of Copán is located in west-central Honduras, about 30 km from the Guatemalan border (Fig. 1). Many boiling springs are present in the area, most of which occur along the Quebrada de Agua Caliente; these thermal manifestations have prompted several geothermal investigations (Flores, 1980; Heiken et al., 1986), the most recent of which is our current program of geology, geophysics, hydrogeochemistry, and drilling. The hydrogeochemical studies to date indicate that the reservoir rocks likely are a sequence of Cretaceous redbeds and that the reservoir temperature may be as high as 240° C (Goff et al., 1987). Two thermal gradient core holes have been drilled into the redbeds; PLTG-1 was drilled to 650 m and PLTG-2 to 428 m. Permeable zones in PLTG-1 produce 160° C water at about 3 Mw thermal and the less permeable rocks of PLTG-2 have a conductive gradient of 139° C/km. Geologic studies have produced a geologic map of about 25 km^2 of the Platanares area and are now focusing on radiometric-age determinations for the volcanic rocks and lithologic and geochemical studies of cores from both wells. Planned electrical resistivity surveys are as yet unfinished.

STRATIGRAPHY

The oldest rocks in the area are Paleozoic(?)-age schists, phyllites, and quartzites, which form a highland north of the thermal area. Contacts between metamorphic rocks and the younger Cretaceous and Tertiary rocks are faults (Fig. 3). The metamorphic rocks form a high mountainous terrain along the northern and northwestern margins of the geothermal area, and this highland apparently has been a major source of metamorphic clasts found in Cretaceous and Tertiary sedimentary and pyroclastic units. Stream and terrace gravels within the Quebrada de Agua Caliente also are composed of mostly metamorphic clasts.

The next younger unit is a redbed sequence, the Valle de Angeles Group of Cretaceous age. At Platanares, this Group consists of moderately- to poorly-bedded siltstone, pebbly coarse sandstone, coarse immature sandstone, and conglomerate. Most of the rocks are red, but locally the color is

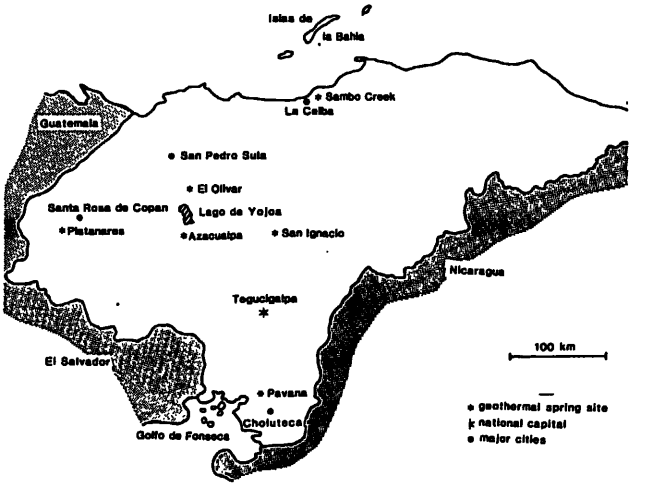

Figure 1. Map of Honduras, showing principal cities (dots and a star) and geothermal areas investigated during the first phases of the Honduras geothermal project.

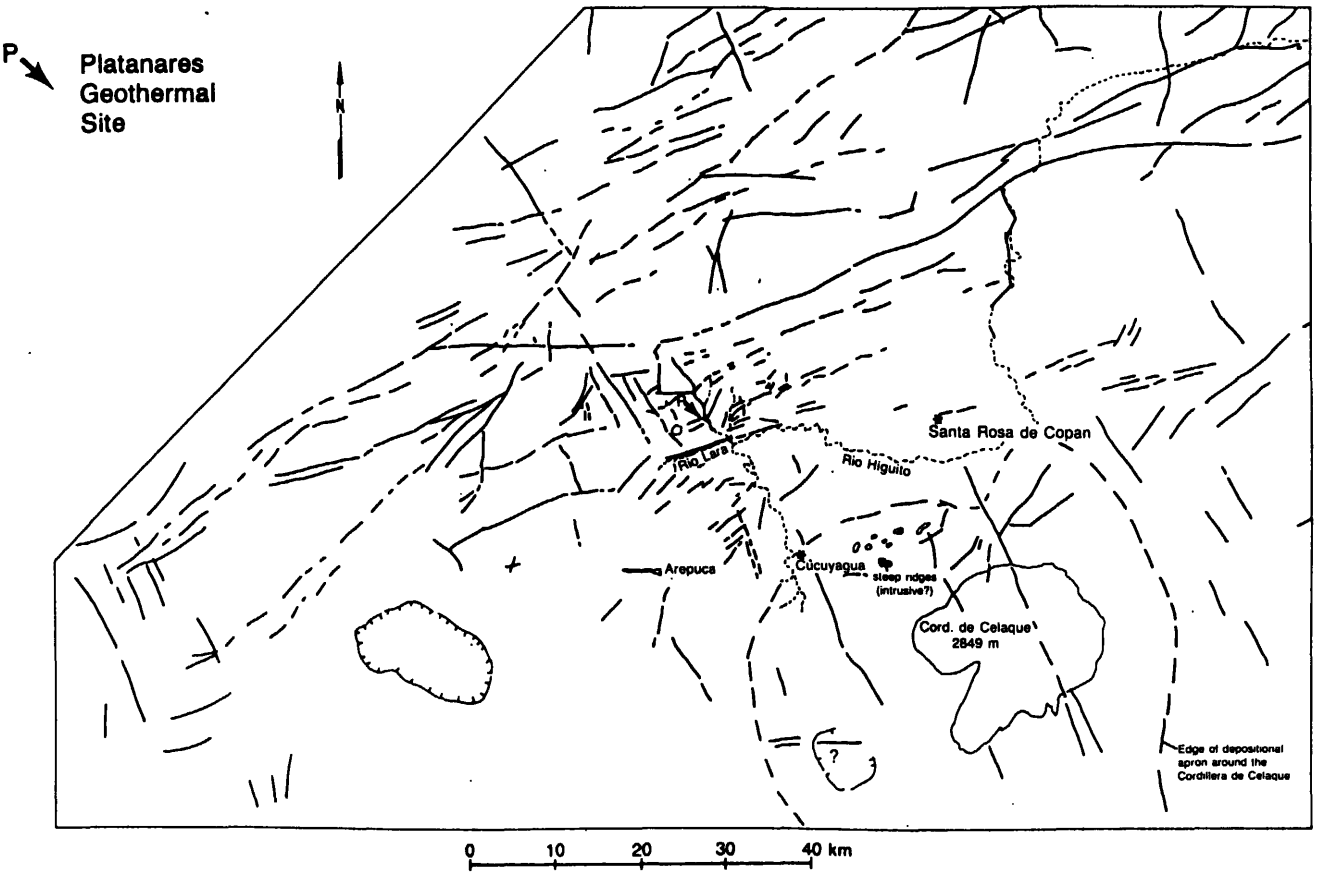

Figure 2. Fault and lineament sketch map of northwestern Honduras, eastern Guatemala, and northwestern Salvador. The Platanares geothermal area is marked with the letter "P".

pale green or tan where hydrothermally altered. The total thickness of redbeds in this area is not known, but is minimally 200 m; elsewhere it can reach thicknesses of 3300 m (Mills et al., 1967). Chemical characteristics of the thermal waters suggest that these redbeds may be the main reservoir rock (Goff et al., 1987). The youngest rock unit is called the Padre Miguel Group and consists of mostly pyroclastic rocks, including massive nonwelded and welded rhyolitic tuffs, pumice fall deposits, and interbedded volcaniclastic sandstones. The thickness is highly variable in the Platanares area, reaching a maximum of 700 m. The most voluminous volcanic rocks are silicic pyroclastic flows, characterized by fine ash matrix with a few to several per cent of lithic and pumice clasts that rarely exceed 5 cm in diameter. Individual flows are many meters thick, although contacts between flows are usually obscure. Other tuffs include pumice falls and surge deposits. Locally, thin redbeds are interbedded with the tuffs; these may be correlative with the Subinal Formation as described by Williams and McBirney (1969). Padre Miguel Rocks elsewhere range in age from 5 to 17 m.y. (Williams and McBirney, 1969; Duffield et al., 1987). Vents for the volcanic rocks have not been identified, although one might be implied for a local 350-m-thick section of andesitic lavas encountered in PLTG-1. The pyroclastic flows may be from the Montana de Celaque, which is possibly a large resurgent caldera, located 30 km south of the site. The tuffs and lavas are silicified near many faults and in corehole PLTG-1.

For simplicity we have omitted deposits of stream terrace gravels from the map (Fig. 3). They form an irregular wedge, up to 60 m thick, along the boundary of the main spring area, near the confluence with the Rio Higuito.

STRUCTURE

Stratification in the volcanic rocks dips 15° to 30° to the S or SW; attitudes diverge from this regional dip near faults and landslides. Bedding in the redbeds is generally to the S or SW, with dips of 15° to vertical.

The Platanares area is highly disrupted by normal faults over an area of about 5 km^2. The Padre Miguel Group of volcanic rocks is downfaulted against Cretaceous redbeds on the NE and SW, thus defining a NW-trending graben. The

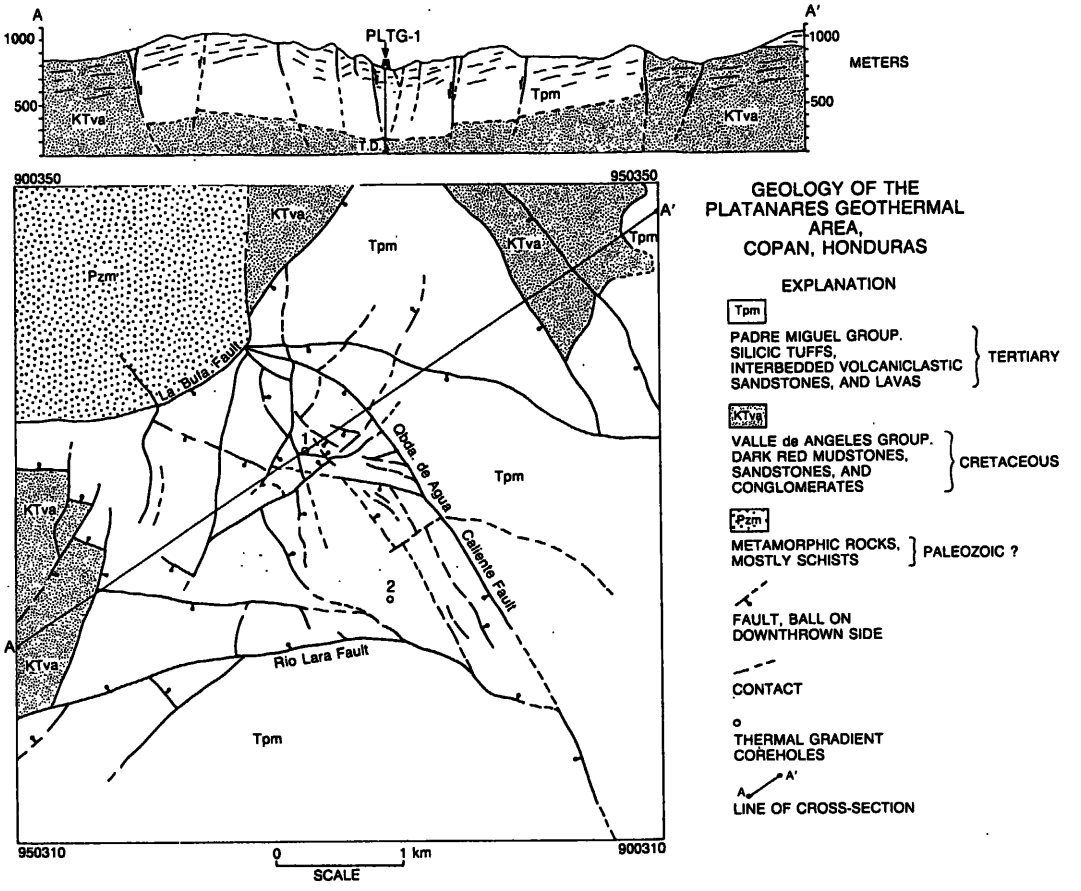

Figure 3. Simplified geologic map and cross-section of the Platanares geothermal site.

graben is terminated on the N by a NE-trending fault that places Paleozoic(?) metamorphic rocks and Cretaceous redbeds against the younger volcanic sequence. To the SE, outcrops of Tertiary volcanic rocks are continuous to the Montaña de Celaque, 30 km from Platanares.

Most of the thermal springs and all of the boiling springs are located along a NW-trending fault zone that bisects the graben; the Quebrada de Agua Caliente is eroded along this fault zone. Many of these springs are depositing sinter that locally cements stream gravels to form resistant beds and banks. Inactive sinter terraces are present at several locations along the Quebrada, some as much as 20 m above the present stream. Two warm springs are located about 1.5 km SW of the main thermal area, along the E-W-trending faults that coincide with the course of the Rio Lara. No thermal manifestations are known north of the fault termination at the north end of the graben or south of the Rio Lara.

The main trace of the fault along Quebrada de Agua Caliente has strong physiographic expression, including escarpments in river-terrace gravels near the confluence with the Rio Higuito. A zone, 0.5 km wide, to the W of this main trace is complexly and highly faulted. The fault that coincides with the Rio Lara is part of an E-W zone of strong lineation that is readily apparent on satellite images and extends well beyond the project area both to the east and west. Rio Higuito makes a right angle turn at its confluence with the Quebrada de Agua Caliente and follows this zone to the east. Well PLTG-2 is located about 200 m north of the main trace of this zone; abundant shears and clastic dikes seen in core from this hole may reflect its proximity to the Rio Lara fault. Similarly, highly fractured core from PLTG-1, located along the Quebrada de Agua Caliente, reflects the degree of faulting there.

CONCLUSIONS

The geologic framework of the Platanares area consists of a basement sequence of highly deformed Paleozoic(?) metamorphic rocks that are overlain by Cretaceous redbeds and Tertiary volcanic rocks. Although the age of the volcanic sequence is not yet known, the degree of weathering, erosion, and faulting suggests that these rocks are too old to reflect the presence of an underlying magma reservoir in the crust. Thermal manifestations are localized along faults that cut the entire bedrock section, and thus the general geothermal character is somewhat akin to a typical hydrothermal system of the Basin and Range province of the United States.

The principal reservoir for the Platanares geothermal system is believed to be within redbeds of the Cretaceous Valle de Angeles Group, the top of which is at least 400-600 m beneath the surface cover of Tertiary volcanic rocks and younger river-terrace gravels. Reservoir permeability is tentatively interpreted as fracture permeability, caused by fracturing along major fault zones. Geothermometry applied to the thermal water suggests a reservoir temperature as high as 240° (Goff et al., 1987). The thermal water likely is heated during deep circulation in an environment of high crustal heat flow. The two recently drilled coreholes hold promise of a commercial-grade resource at Platanares. Additional thermal gradient drilling and studies are planned before a recommendation for deep production wells are considered.

ACKNOWLEDGMENTS

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