Los Alamos National Laboratory is operated by the University of California for the United States Department of Energy under contract W-7405-ENG-36

TITLE: GEOTHERMAL INITIATIVES IN CENTRAL AMERICA

LA-UR--86-2009

DE86 012374

AUTHOR(S): R. J. Hanold, ESS-DOT
V. W. Loose, ADIII
A. William Laughlin, ESS-1
P. E. Wade, ADIII

SUBMITTED TO: Geothermal Resources Council 1986 Annual Meeting,
29 Sept. - 1 Oct. 1986
Palm Springs, CA

DISCLAIMER

Los Alamos Los Alamos National Laboratory
Los Alamos, New Mexico 87545

FORM NO 836 R4
ST NO 2629 5/81

DISCLAIMER

GEOTHERMAL INITIATIVES IN CENTRAL AMERICA

R. J. Hanold*, V. W. Loose*, A. W. Laughlin*, and P. E. Wade**

*Los Alamos National Laboratory, P.O. Box 1663, Los Alamos, NM 87545
**U. S. Air Force Academy, Colorado Springs, CO 80841

ABSTRACT

The U.S. Agency for International Development is supporting a new project in energy and resources exploitation for Central America. One of the largest components of the project involves exploration and reservoir development investigations directed at enhancing the production of electricity from the region's geothermal resources. An assessment of the geothermal resources of Honduras is in progress, and interesting geothermal regions in the Guanacaste Province of Costa Rica are being explored. Well-logging activities are in progress in the production wells at the Miravalles geothermal field in Costa Rica, and preparations are being made for logging critical wells at Ahuachapán in El Salvador. A self-contained logging truck, complete with high-temperature logging cable and logging tools designed for geothermal service, is being fabricated and will be made available for dedicated use throughout Central America. Geochemical and isotopic analyses of water samples collected in Panama are being evaluated to select a high-priority geothermal site in that country. Application of low- and medium-enthalpy geothermal fluids for industrial and agricultural processes is being investigated in Guatemala.

INTRODUCTION

In 1985, the U.S. Agency for International Development (US AID) announced a new initiative entitled "Central America Energy Resources Project - A Path Toward Economic Security." The countries included are Costa Rica, El Salvador, Guatemala, Honduras, and Panama. The objectives of this multiyear project are to:

1) Increase economic development and employment in Central America.

2) Provide the scientific base for the private sector to develop energy and mineral resources.

3) Provide training to counterpart scientists and engineers in current technology areas.

The project is designed to introduce new technologies into the region that will allow each of the participating countries to better assess their current and future energy needs, to develop nontraditional sources of energy such as geothermal, and to more efficiently utilize the region's rich energy and natural resource endowment. Activities within this project will not undertake resource development, a task left for the private sector. Much of the work on this project will be done by Los Alamos scientists, engineers, and economists. The U.S. Geological Survey (USGS) is contributing to the overall project, particularly in the geothermal and minerals investigations. The following discussion addresses the geothermal activities that are part of this project.

GEOTHERMAL ACTIVITIES IN CENTRAL AMERICA

Honduras Geothermal Reconnaissance

Prior efforts to identify and develop the geothermal potential of Honduras have been minimal compared with activities in several other Central American countries. The Honduran electric utility enterprise, Empresa Nacional de Energía Eléctrica (ENEE), is approaching a decision point on how to meet Honduras' growing electricity demands. To make this decision on future electricity planning, ENEE has requested an assessment of the technical feasibility of geothermal power plants in Honduras and the most desirable locations for development. In response to this request, an extensive geothermal reconnaissance effort is now in progress. This reconnaissance is designed to provide the scientific data necessary to quantify the resource potential of Honduras and provide ENEE with the information required to determine its future policy.

Participants in this project include Los Alamos and the USGS, with funding provided by US AID, and the Italian companies Geotermica Italiana srl and dal in. te. sa. working under a United Nations Development Project (UNDP) grant. The ultimate objective of this cooperative investigation is to determine the scientific and economic feasibility of developing the geothermal energy resources of Honduras for electrical power generation.

Reconnaissance-scale geological and geochemical investigations were completed at six previously identified geothermal areas: Azacualpa, San Ignacio, Platanares, Pavana, El Olivar, and Sambo Creek (Fig. 1). Emphasis has been directed at geothermal reservoirs that exhibit the greatest potential for electric power generation based on estimates of permeability, fluid temperature, and reservoir magnitude. Evaluation of the reconnaissance results led to the selection of four sites (Azacualpa, San Ignacio, Platanares, and Pavana) for detailed geological and geochemical investigations. Complete results from these investigations are being published as separate geologic reports on each site and a detailed geochemistry report on all sites.

Evaluation of the results of the detailed investigations indicates that Platanares, San Ignacio, and Azacualpa have high potential for geothermal development. To further evaluate this potential, geophysical surveys (detailed gravity and self-potential) have been designed for the Platanares and San Ignacio sites and a 500-m thermal gradient hole has been planned for the Platanares site. Additional detailed fluid geochemical studies were also made at Platanares, San Ignacio, and Azacualpa to examine fluid recharge and seasonal chemical and isotopic variations at these sites (Goff et al., 1986).

Miravalles Geothermal Development

With the Miravalles geothermal field in Costa Rica undergoing active development, the most urgent need of Instituto Costarricense de Electricidad (ICE) is for equipment and technical expertise to perform well logging measurements in the production wells. The measurements that have been given highest priority include well temperature surveys, pressure surveys, flow measurements to determine which formation horizons are producing the geothermal fluids, casing profile measurements to check for casing damage and wellbore scale accumulations, and obtaining downhole samples of the pressurized reservoir fluids for geochemical analyses.

At the present time almost no high-temperature well logging capability exists in Central America. The objective of this effort is to provide ICE with the capability for performing downhole diagnostic measurements in the geothermal wells at Miravalles to collect data for improving the reservoir model of the field and to investigate the existence of any wellbore problems that could lead to future production declines.

Los Alamos personnel have overhauled a trailer-mounted well logging rig for interim use in the Miravalles geothermal wells, and logging activities are in progress. The trailer-mounted rig is equipped with a high-temperature armored 7-conductor geothermal logging cable, a high-temperature cablehead assembly for interfacing with the downhole tools, a modern computer-based data acquisition system, and a selection of downhole logging tools.

Los Alamos engineers and technicians, working in cooperation with ICE personnel, have performed logging measurements in Miravalles wells PGM-3 and PGM-10. Measurements included temperature, pressure, wellbore diameter and

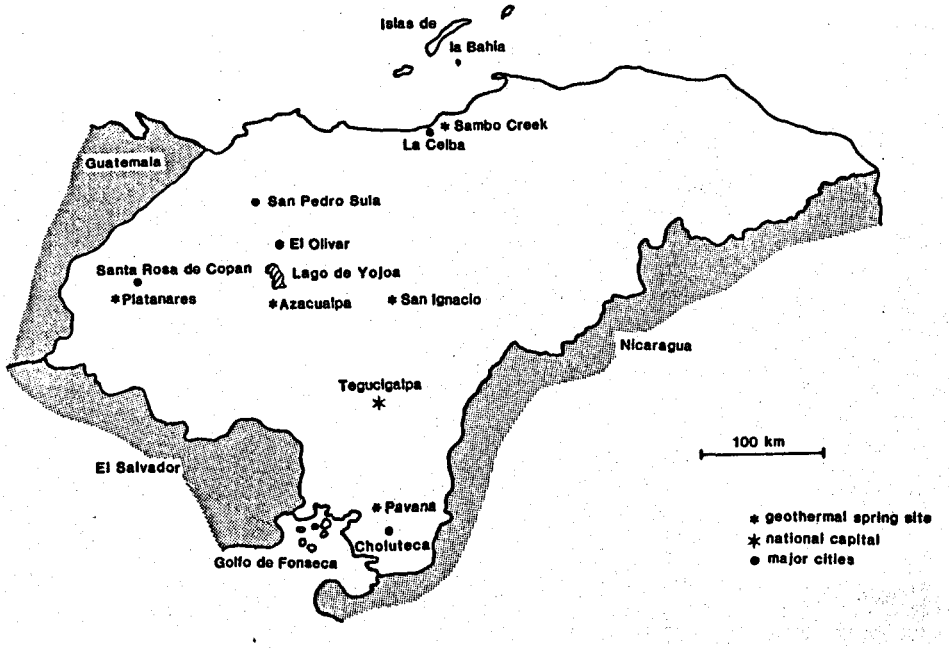

Figure 1. Geothermal sites in Honduras.

contour, and fluid velocity (spinner) in the wellbore, all as functions of depth. Downhole reservoir fluid samples were also obtained, and chemical and isotopic analyses of these samples are in progress. To minimize the number of entries required into the high-pressure Miravalles wells, the temperature, pressure, and spinner functions were combined into a single tool (Kolar, 1986). Typical results from this tool during a logging run in PGM-10 are shown in Fig. 2. Temperatures up to 240°C were measured, and the flowing bottom-hole pressure was greater than 50 bars. The trace from the spinner tool detects the onset of two-phase flow and clearly shows the transition from the production liner to the cemented-in casing string.

The presence of wellbore scaling in one production well, which was suspected by ICE engineers, was verified by the multiarm caliper tool (Corrales, 1985). Preparations are being made for logging additional production wells at Miravalles.

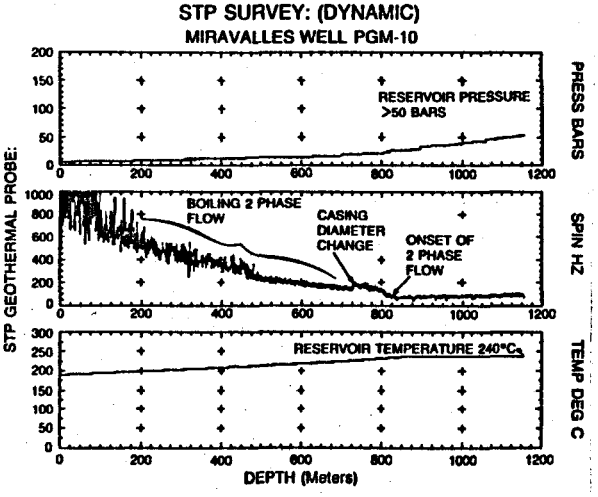

Figure 2. Well PGM-10 dynamic logging data.

Costa Rica Geothermal Reconnaissance

Costa Rican geothermal development will also be assisted by a geothermal reconnaissance in the Cordillera de Guanacaste. This reconnaissance will build on work completed earlier by ICE and allow a decision to be made on the next site for a geothermal prefeasibility study. The prefeasibility work is now in the planning stages and will likely be applied to areas near either Volcan Rincon de la Vieja or Volcan Tenorio, located just to the north and south of Miravalles respectively.

The reconnaissance phase of work in the Guanacaste Province was mostly completed in the late 1970s by ICE and identified Rincon de la Vieja as a promising geothermal site along with Miravalles. Recently though, observations of geothermal manifestations on the slopes of Volcan Tenorio have also indicated a significant resource there. New hydrogeochemical and geovolcanological data are required for the Tenorio region to completely reflect the potential of the Guanacaste Province. These data will support a decision on whether to follow Miravalles with detailed work at Rincon de la Vieja or Tenorio and will provide a more regional understanding.

The Costa Rican prefeasibility study will concentrate on the hydrogeochemistry and geophysical character of tuffaceous rocks on the west slopes of the Cordillera de Guanacaste. These tuffs apparently form widespread geothermal reservoir rocks underlying both the Rincon de la Vieja and Miravalles areas. In addition, detailed geologic mapping and geovolcanological analysis are required to identify major structural controls of hot springs and fumaroles. A well-exposed caldera is of great importance to the Miravalles system, and an older, less apparent caldera might be buried under the flanks of Rincon de la Vieja. Hence, the prefeasibility study should provide a detailed picture of the volcanic framework (which has allowed development of the geothermal system) and quantitative models of the depth, extent, temperatures, and productive capabilities of reservoir rocks contained within the framework.

Support Equipment for Central America

In order to support the geothermal development activities in Central America, specialized technical equipment is required that is not typically available within the region. Although such equipment does exist in the United States, its availability is limited because of programmatic commitments. To ensure the success of the proposed geothermal development activities, it is essential that certain equipment items be available on demand for use in Central America. The following items have been identified as the highest priority needs of the region:

1) Self-contained, commercially fabricated logging truck equipped with a high-temperature 7-conductor geothermal logging cable, modern computer-based data acquisition system, and necessary equipment for logging geothermal wells in remote areas.

2) Logging tools capable of operating at 275°C in a flowing geothermal well. Measurement capabilities will include temperature, pressure, spinner, multiarm caliper, and a casing collar locator. A downhole fluid sampling tool will also be provided.

3) High-current, high-voltage dc resistivity transmitter and power supply for conducting deep resistivity profile experiments.

The objective of this project is to provide equipment for dedicated use in the geothermal fields of Central America. Los Alamos engineers and technicians will provide on-site training to

appropriate counterpart personnel on operation and maintenance of this equipment. The interim logging rig being used in Costa Rica will be returned to Los Alamos, and future logging operations in the region will be performed with the new self-contained truck.

Geothermal Support to El Salvador and Panama

At the beginning of the decade, the geothermal power plant at Ahuachapán was producing over 40% of the electricity required by El Salvador. Production from this plant, however, has been steadily declining during recent years (Vides, 1985). The most urgent need of Comisión Ejecutiva Hidroelectrica del Rio Lempa (CEL) is for equipment and technical expertise to perform logging measurements in selected production wells at Ahuachapán to investigate the characteristics of the reservoir and the wells responsible for the production decline. Results from the logging are desired to:

1) Identify damaged wells or damaged production horizons in the reservoir formations that restrict the flow of geothermal fluids, and

2) Upgrade the models of the Ahuachapán reservoir to assist in the development of a spent brine reinjection plan that could stabilize the pressure decline in the field.

As depicted in Fig. 3, production from the Ahuachapán field is concentrated in a small area. Step-out drilling to the south is yielding some success, but the dynamics of the reservoir and recharge system are not completely understood. Initial target wells for the logging program are Ah-22, 24, 27, 31, and 32, and the same logs will be obtained as were performed at Miravalles.

The geothermal support to Panama responds to requests from the Instituto de Recursos Hidráulicos y Electrificación (IRHE) for assistance in the reconnaissance and pre-feasibility efforts in Panama. Geothermal manifestations in Panama are less obvious than in other Central American countries. The volcanic sequence responsible for geothermal resources in Costa Rica extends into western Panama, however, and exploitable resources could be present. In regions of the country where chemical geothermometer temperature estimates are sufficiently high, further exploration and development are being pursued. Activities are focused on the chemical analysis of water samples collected in Panama by IRHE and shipped to Los Alamos. This includes the calculation of geothermometer temperatures, interpretation of the chemistry data, and recommendations for further work in the most promising areas. At the present time, the most promising geothermal development site in Panama is the caldera of El Valle de Anton.

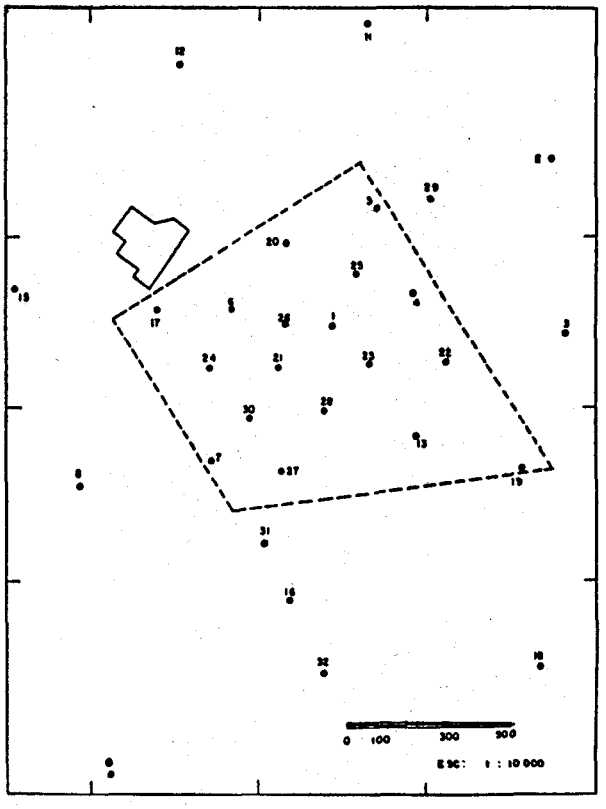

Figure 3. Ahuachapán exploitation area (Vides, 1985).

Direct Use of Geothermal Heat in Guatemala

The use of low- and medium-enthalpy geothermal heat for industrial and agricultural processes is being investigated in Guatemala. The investigation is a joint effort of Los Alamos, the Guatemalan Ministry of Energy and Mines (MEM), and the Guatemalan Instituto Nacional de Electrificacion (INDE). The object of the project is to demonstrate the use of lower grade heat and to determine the economic viability of specific applications. Existing industries that could utilize the direct heat have been identified based on location and process heat requirements. New industries that could use such heat are also being investigated.

A demonstration plant for drying agricultural products is being designed and is scheduled to be completed by the end of 1986. At present the products to be dried are being selected and product suppliers are being identified. The plant will be constructed at the Zunil geothermal field near Quetzaltenango and will utilize heat from a slim-hole well. In addition, a feasibility study for a commercial-scale agricultural processing center, utilizing geothermal heat, is being initiated. This

center will include drying, cooking, blanching, and freezing operations. Interest has also been expressed in using geothermal process heat in industries near the Amatitlan geothermal field.

NONGEOTHERMAL ACTIVITIES IN CENTRAL AMERICA

Peat Development

Peat is an organic-rich sediment produced in swamps and marshes from partially decayed plant material. If found in suitable quality and thickness, peat can be converted to gaseous or liquid fuels. Peat can also be burned directly and is a source of many valuable organic chemicals such as waxes, resins, and medicinals. During preliminary resource reconnaissance work, peat deposits were located in Panama and Costa Rica. Analysis of samples from several of the deposits and estimates of deposit volumes indicate that each country has large quantities of good quality peat. At the present time, experience with the peats of Central America is very limited. Technical assistance being provided to Panama and Costa Rica includes:

1) Training of appropriate in-country personnel.

2) Assisting with peat resource evaluations.

3) Demonstrating the feasibility of peat end-use applications.

Mineral Reconnaissance in Costa Rica

A mineral reconnaissance program is being implemented that provides a methodical approach to identifying mineral resources and areas containing potential mineralization. The objective of this project is to identify areas in Costa Rica that have good potential for mineral resources that could eventually be mined. This will be accomplished by creating a mineral database that will consist of previously documented data, new site-specific information, and stream sediment geochemical information collected and compiled as part of this study.

Regional Energy Situation Analysis

At the request of US AID, an update of the regional energy situation has been performed. The information has been put into energy/economic databases that have been transferred to each of the Central American countries. Counterpart personnel from each country have been trained in the use of these databases. Los Alamos will continue to support each country in updating the databases and in specific energy-planning areas. In addition, an energy atlas for the region is being prepared. This atlas will include information on energy usage, resources, production, and distribution.

ACKNOWLEDGEMENT

The Central American activities described herein are sponsored by the U.S. Agency for International Development.

REFERENCES

Corrales, M. F., 1985. Costa Rica: Country Update Report, Geothermal Resources Council, International Symposium on Geothermal Energy, International Volume, p. 57-63.

Goff, F., Shevenell, L., Truesdell, A., Janik, C., Grigsby, C., and Paredes, R., 1986. Hydrogeochemistry and preliminary reservoir model of the Platanares geothermal system, Honduras, Central America, Geothermal Resources Council Transactions, v. 10.

Kolar, J., Chavez, P., and Garcia, B., 1986. Passive electronic systems for logging and characterization of geothermal wells in the Miravalles geothermal field, Costa Rica, Geothermal Resources Council Transactions, v. 10.

Vides-Ramos, A., 1985. Ahuachapan, El Salvador, Field Management, Geothermal Resources Council, International Symposium on Geothermal Energy, International Volume, p. 397-404.