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Honduras Country Update

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ABSTRACT

Honduras is a country in Central America with a population of 7.1 million people and a demand of 1175 MW. The electrical energy demand has increased considerably in the last 5 years due to the country´s social-economical growth. The use of alternate energy sources using renewable resources has become of great importance due to the fossil fuel dependency for the electrical energy generation. Among the renewable energies, the geothermal energy could supply up to 76 MW in the next five years.

1. INTRODUCTION

Back in early eighties, the DOE of USA funded geothermal studies in Central America's region. In Honduras the temperatures of the fields were not attractive as in other countries, and the ORC technology by then was not well known. For those reasons among others, the geothermal development was stopped and forgotten for more than twenty years.

The main use given to the geothermal resources is mainly touristic at present time, but in the last five years considerable progress has been made in Honduras regarding the Government´s politics on the development of electrical energy projects using renewable resources.

In 2007, an incentive law was approved promoting the generation of electrical energy using renewable energy for projects with an installed capacity less than 50 MW; under this law, these projects would be exempt from the payment of taxes. This has increased the investment of private companies in the energy sector.

Figure 1: Honduras Geothermal sites under studies.

At present time, two private companies are aimed at the geothermal development in the country for the generation of electric energy. These companies are GeoPower which has Pavana and Azacualpa projects under studies and GeoPlatanares which has Platanares project under development.

Studies in Azacualpa and Pavana projects are in a pre-feasibility stage, for this reason GeoPower has hired the services of the New Zealand Company Sinclair, Knight and Merz to collect all the information from the studies performed in the past 15 years in order to determine if the electrical generation could be feasible.

Platanares Geothermal Project is the one with the highest expectations for the generation of electrical energy, and the performed studies show that a potential of 35 MW could be achieved.

GeoPlatanares is ready to start the drilling of three exploratory wells, with a production diameter of 9 5/8 inches and a depth of 1,500 meters. Drillings are expected to be performed by the third quarter of 2009, in order to have a better understanding of the field. After that, a reservoir study has to be completed.

2. GEOLOGY BACKGROUND

The Honduran territory is located in the western portion of the Caribbean plate, which moves eastwards differently with respect to the two larger westwards moving North American and South American plates. The "Bartlett (Cayman) Trench" a sinistral transcurrent zone, represents the northern limit between the Caribbean and the North American plates. To the west, southwest and north of the Galapagos Ridge the Caribbean plate is limited by the "Middle American Trench" where Cocos plate is subducting. The result of this subduction is the active volcanic axes that cross all Central America from Mexico to Costa Rica. South of the Galapagos Ridge, the Caribbean plate is in contact with the Nazca Plate (Figure 2).

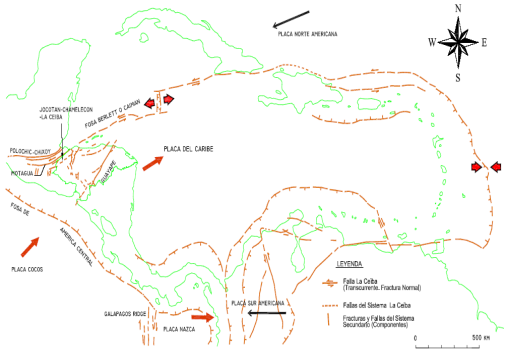

Figure 2: Carribean Plates.

A large part of Central Honduras, up to the Caribbean coast formed by metamorphic and plutonic rocks, emerged in Paleozoic and lower Triassic period (Figure 3).

During Triassic and Jurassic period, shallow marine sediments were deposited. And during Cretaceous period,

regional subsidence created a wide intercontinental trough, south of the emerged basement belt, where the marine limestones of the Yojoa Group and the clastic sequence of the red beds of the Valle de Angeles Group were deposited.

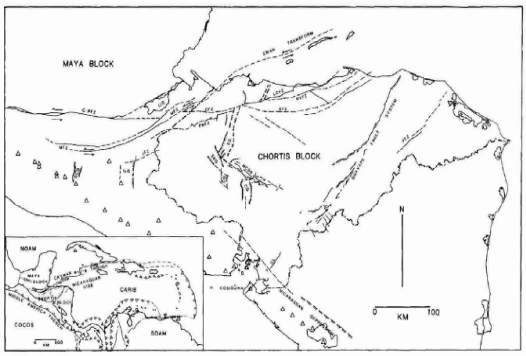

Figure 3: Geological Structures of Honduras.

In Upper Cretaceous, Lower Tertiary (Laramidic Orogenesis) the sedimentary Mesozoic deposits were deeply folded along a nearly E-W axis.

At the end of Cretaceous period, most of the Honduran territory was above sea level, likewise, most of the Central American isthmus during Oligocene and Lower Miocene period, when the huge Tertiary volcanic activity began. This activity produced mostly calco-alkaline lava flows with basaltic and andesitic composition and minor pyroclastic layers (Formation Matagalpa). The Matagalpa lavas were emplaced on a sharp deeply eroded morphology and their emplacement was accompanied and followed by intense faulting that produced large blocks that were again faulted and tilted by later tectonic events.

Before the beginning of a second phase of tertiary volcanism an erosional phase occurred whose exact duration is unknown, but which was possibly rather long considering that the land morphology was deeply modelled and most of the territory was near the sea level when great ignimbrite eruptions of the Padre Miguel Group eruption occurred. This second volcanic phase, of Miocene age produced many ignimbritic sheets, with minor pyroclastic fallout deposits and lava flows, and several associated volcanic mud flows.

During Upper Pliocene–Lower Pleistocene period a regional uplift occurred in the central part of Honduras, as well as in sectors of Guatemala, El Salvador, Nicaragua and Costa Rica. In this tectonic phase a series of horst and graben were formed, including the large depressions of Honduras. The eastward motion of the Caribbean plate and the sinistral transcurrent motion of its northern boundary are the primary causes for the origin of these structures that resemble the ¨Basin and Range Province¨ of the western United States.

3. GEOTHERMAL RESOURCES AND POWER GENERATION POTENTIAL

Most hydrothermal systems in Central America are associated with recent volcanic fields. However, the numerous geothermal manifestations scattered throughout central and western Honduras are associated with late Cenozoic faults and crustal extension.

Volcanic activity related to the Central American active volcanic front, occurs in Honduras only in its southernmost part (Gulf of Fonseca) where some volcanic islands developed. Most of the Honduran territory lies in a more internal part of the Caribbean plate and is not affected by the recent volcanism of the subduction zone. The few episodes of Quaternary volcanism are related to extensional structures, probably of “back-arc” origin, forming a series of tectonic depressions. Also, the alkaline nature of the erupted basalts speaks in favour of a mantle provenance of the basic magma that rises along deep reaching faults with a marked extensional character.

As a whole, geology indicates that at present in Honduras there are no magma bodies at shallow depth that could act as the heat source of high-temperature geothermal fields. The silicic ignimbrites of the Padre Miguel Group, that were likely generated by partial melting of the continental crust, are too old to have maintained a significant thermal anomaly at shallow crustal depths. The scarce Quaternary volcanism reflects conditions of rapid uprising along deep fractures of basic magma with negligible heat transfer to the country rocks. Under these conditions, the possibility of finding geothermal resources is linked to deep circulation of meteoric waters infiltrating through deep reaching faults. Water is heated up at depth, rises toward the surface in densely fractured zones, and may infiltrate laterally to produce geothermal reservoirs in zones with high lateral permeability.

These are actually the basic geological conditions of geothermal studies in some promising areas of Honduras, such as Platanares, Azacualpa and Pavana.

Platanares deserves a higher priority with respect to Azacualpa and Pavana projects. This evaluation is based on the somewhat higher temperatures found at shallow depth (160-165°C) proved by the existence of a geothermal resource in the two gradient wells (PLTG-1 and PLTG-3), and on the higher temperatures suggested by geochemical geothermometers, that indicates a high probability of finding at least a medium enthalpy resource of industrial interest (200-225°C).

Updated studies show a potential of 23 MW in Azacualpa with temperatures between (170-180°C) and 18 MW in Pavana with temperatures between (140-150°C).

4. GEOTHERMAL UTILIZATION

In Honduras, the direct use is the only one developed for tourist sites that have as their main sources of attraction thermal swimming pools. These sites are not quantifying the amount of energy used in them.

The use for electrical generation through binary exchange heat cycle plants is in the process of studies. At this moment the most promising site for geothermal development is Platanares. For this reason, the company GeoPlatanares is planning to execute the drilling of three exploratory wells in this site during 2009 to get the feasibility study. The estimated capacity is 35 MW and the expected energy is 297 GWh annually.

5. ENERGY DEMAND

The maximum demand of the National Interconnected System during December 2008 was 1,205 MW. The demand has increased in recent years in the order of 7-10 percent, which means that the growing demand for Honduras is in the order of 85 to 120 MW per year.

Empresa Nacional de Energía Eléctrica (ENEE), which is the National Utility, in order to satisfy the demand of electricity, had an installed capacity in December 2008 of

1,597.1 MW. 34% based on hydroelectric plants, 62% on thermal plants and 4% on plants that use sugarcane bagasse (biomass) as fuel.

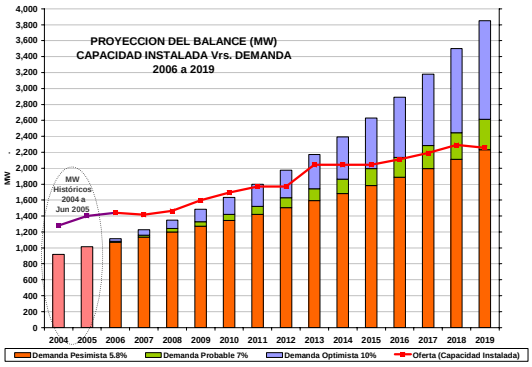

Figure 4: Electric Demand in Honduras.

6. FUTURE DEVELOPMENT

From the tables attached bellow, it can be seen that, at present time, the geothermal projects are in their study phase and the most ambitious project could be generating by the middle of the year 2012.

The electrical energy generation with renewable resources is being incentivized by the Government. Decrees No. 85-98 and 267-98 were approved in 1998 by the Honduras Congress in order to increase the development of renewable energy generating plants in the country. The new legislation includes tax breaks to developers and a secure buyer arrangement for energy at prices equivalent to the system's short-term marginal cost. ENEE, which is the default buyer, must pay a premium (10 percent of the same short-run marginal cost) for the electricity generated when the installed capacity is below 50 MW. This framework has facilitated the negotiation of about 30 Power Purchase Agreement with ENEE for small renewable energy plants. In addition, Decree No. 85-98 also establishes tax exemptions in favor of developers: import and sales taxes on equipment, and a five-year income tax holiday. The contracts have a nominal duration of 20 years with an option for a renovation.

There is a new law in the Congress that could be approved during the second quarter of 2009, which will give more incentives to the developers in order to add more renewable projects to the interconnected system.

The geothermal Project with very high probabilities of development is Platanares, located in the municipality of La Union Copan. So far there have been several studies such as geological, geochemical, geophysical and three 600 meters gradient wells drilled at this site, which show that it is a good field to be developed.

The most important conclusions of the studies made, suggest two reservoirs in the area. One at a depth of between 450-650 meters with a temperature characteristic of between 160-165°C and a second one at a depth of between 1.2-1.5 km with a characteristic temperature in the range 200-225°C. The temperature of the reservoir may have been defined by methods of thermometry geochemistry including both liquid and gas phases.

The data obtained from these gradient wells and water sources, have provided enough information on the nature of the fluid reservoir, the potential for escalation, pH and content of each gas.

The salinity degree of the reservoir in Platanares is relatively low; it is in the order of 1200 parts per million solids. The fraction of gas dissolved in the water reservoir is also low, in the order of 0.5% or less. The pH of the water is almost neutral but increases to 8.4 during flashing. This means that the flashing must be controlled to prevent the escalation in drilling wells.

In figure 5, we can see the integration of the geophysical studies and the gradient wells drilled in the geothermal area of Platanares.

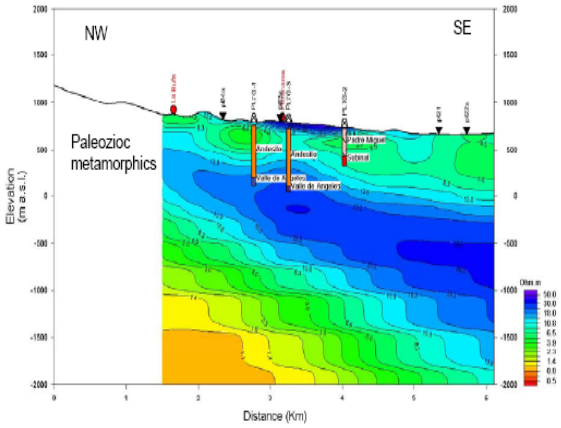

Figure 5: Platanares Profile.

With the preliminary findings obtained, the next stage would be the one of exploration, which includes the drilling of three exploratory wells with production diameter.

The annual energy generation expected by Platanares is 297.40 GWh, with an installed capacity of 35 MW, with a base operating system and a factor of 97% availability and 99% reliability.

Drilling in the geothermal field has been delayed in part by bureaucracy in obtaining permits and environmental licenses from the actual government.

7. CONCLUSIONS

The development of geothermal projects in Honduras will be quite different from the other countries in the region, because the source of heat is not magmatic and the temperature is quite low.

The geothermal private power companies have to be aware that the cost of the development of the geothermal fields in Honduras will be higher than in other countries of the region.

Up today, the development of geothermal energy for electricity generation relies in the private sector and it will continuous in this way due to the high cost of development and the focus of Honduran government in other sectors, such as health, education, hydroelectricity, etc.

The future of the geothermal development for electric generation in Honduras will be determined depending of the results of the feasibility study of Platanares project as this is the most promising one.

REFERENCES

G Heiken, D. Eppler, K. Wohletz, W. Flores, N. Ramos, A. Ritchie: Geology of the Platanares Geothermal Site

Departamento de Copan, Honduras, Central America. Los Alamos National Laboratory. 1987

Geosystem Team: Adquisition & Interpretation of Geophysical Data, Platanares, Honduras, August 1995.

TABLE 1. PRESENT AND PLANNED PRODUCTION OF ELECTRICITY

	Geothermal		Fossil Fuels *1	Fossil Fuels *2	Hydro *1	Hydro *2	Nuclear		Other Renewables Biomasa *1	Other Renewables Biomasa *3	Total	
	Capac-ity MWe	Gross Prod. GWh/yr	Capac-ity MWe	Gross Prod. GWh/yr	Capac-ity MWe	Gross Prod. GWh/yr	Capac-ity MWe	Gross Prod. GWh/yr	Capac-ity MWe	Gross Prod. GWh/yr	Capac-ity MWe	Gross Prod. GWh/yr
In operation in December 2009	0	0	993	4015.5	522	2290.4	NA	NA	81.8	184.8	1597	6533.3
Under construction in December 2009	0	0	94	378.78	5.8	25.4	NA	NA	10.8	23.6	110.6	427.78
Funds committed, but not yet under construction in December 2009	35	290	167	672.9	289.9	1269.76	NA	NA	100	219	591.9	2451.6
Total projected use by 2015	35	290	1072.4	4321.3	557.8	2447.48	NA	NA	192.6	421.79	1715.9	7019.71

Reference: National Electric Power Company Statistics (ENEE)
*1 Installed capacity February 2009
*2 Power generation 2008

TABLE 2. UTILIZATION OF GEOTHERMAL ENERGY FOR ELECTRIC POWER GENERATION AS OF 31 DECEMBER 2009

1) N = Not operating (temporary), R = Retired. Otherwise leave blank if presently operating.

2) 1F = Single Flash; 2F = Double Flash; 3F = Triple Flash; D = Dry Steam; B = Binary (Rankine Cycle); H = Hybrid (explain); O = Other (please specify)

3) Data for 2009 if available, otherwise for 2008. Please specify which.

Locality	Power Plant Name	Year Com-missioned	No. of Units	Status[1)]	Type of Unit[2)]	Total Installed Capacity MWe*	Total Running Capacity MWe*	Annual Energy Produced 2009[3)] GWh/yr	Total under Constr. or Planned MWe
Platanares	GeoPlatanares	2011	-	N	B	-	-	-	35
Total									

* Installed capacity is maximum gross output of the plant; running capacity is the actual gross being produced.

TABLE 6. WELLS DRILLED FOR ELECTRICAL, DIRECT AND COMBINED USE OF GEOTHERMAL RESOURCES FROM JANUARY 1, 2005 TO DECEMBER 31, 2009 (excluding heat pump wells)

[1] Include thermal gradient wells, but not ones less than 100 m deep

Purpose	Wellhead Temperature	Number of Wells Drilled				Total Depth (km)
		Electric Power	Direct Use	Combined	Other (specify)	
Exploration[1]	(all)	3	0	0	0	4.5
Production	>150° C	0	0	0	0	-
	150-100° C	0	0	0	0	-
	<100° C	0	0	0	0	-
Injection	(all)	0	0	0	0	-
Total		3	0	0	0	4.5

TABLE 7. ALLOCATION OF PROFESSIONAL PERSONNEL TO GEOTHERMAL ACTIVITIES (Restricted to personnel with University degrees)

(1) Government
(2) Public Utilities
(3) Universities
(4) Paid Foreign Consultants
(5) Contributed Through Foreign Aid Programs
(6) Private Industry

Year	Professional Person-Years of Effort					
	(1)	(2)	(3)	(4)	(5)	(6)
2005	2					2
2006	1			1		3
2007	1			2		7
2008	2			1		7
2009	2			1		7
Total						

TABLE 8. TOTAL INVESTMENTS IN GEOTHERMAL IN (2009) US$

Period	Research & Development Incl. Surface Explor. & Exploration Drilling	Field Development Including Production Drilling & Surface Equipment	Utilization		Funding Type	
			Direct	Electrical	Private	Public
	Million US$	Million US$	Million US$	Million US$	%	%
1995-1999						
2000-2004						
2005-2009	16				100	