GEOTHERMAL FIELDS ON THE VOLCANIC AXIS OF MEXICO

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INTRODUCTION

At present in Mexico, geothermal energy is receiving a great impulse due to the excellent results obtained in the Cerro Prieto geothermal field, in which a geothermoelectric plant is operated. This plant has four units of 37.5 MW each, with a total capacity of 150 MW, and under program 470 MW more by 1984.

The Government Institution, Comisión Federal de Electricidad, is in charge of the exploration and exploitation of geothermal fields as well as construction and operation of power plants in Mexico. By this time CFE has an extensive program of exploration in the central part of Mexico, in the Eje Neovolcánico. In this area, several fields with hydrothermal alteration are under exploration, like the Michoacán geothermal area, where Los Azufres geothermal field is being developed. Seventeen wells have been drilled and twelve of them presented excellent results, including two dry steam wells. In other areas, such as Araró, Cuitzeo, San Agustín del Maiz, Ixtlán de Los Hervores and Los Negritos, geological, geophysical and geochemical explorations have been accomplished, including shallow well drilling with good results.

Another main geothermal area is in the State of Jalisco with an extension of 5,000 m^2, where La Primavera geothermal field shows a lot of volcanic domes and has an intensive hydrothermal activity. Deep wells have been drilled, one of them with a bottom temperature of 290°C. Other fields in this area, like San Marcos, Hervores de La Vega, La Soledad, Villa Corona, etc., have a good geothermal potential.

A new geothermal area has been explored recently in the eastern part of the country named Los Humeros, Puebla. In this area studies are being made and there are plans for well drilling exploration by the beginning of 1981. Like this one, there are many other areas in the country in which 300 hydrothermal alteration zones are been classified and 100 of them are considered economically exploitable.

EXPLORATION IN LOS AZUFRES, MICH.

This field is located at 200 km West of Mexico City, with an elevation of 2,900 m, 19°47' N Lat. and 100°39'W Long. Studies and drilling in this area started three years ago. The geological and geophysical studies as well as the drilling performed, have proved the existence of a geothermal field of about 25 km^2. The geological

exploration indicates outcrop of volcanic rocks among which acid rocks, silica rocks, basic intermmediate rocks (granitic-rhyolite) diorite, andesite and gabrobasalts are more prominent.

Geophysical studies performed were mainly geoelectric and magnetometric. The geoelectrical studies consisted of more than 100 Schlumberger vertical soundings, with 4000 m of separation AB permitting the identification of well defined zones of low resistivity, which were useful in locating the first exploratory wells.

The magnetometry study was made using a Sharper Magnetometer MF-1-100 of vertical field. The interpretation presented some difficulties requiring detailed geological support.

Geochemical studies, made by analysis and interpretation, indidicated the presence of hot water and dominant steam systems, with temperatures higher than 200°C in several hot springs. Reservoir temperatures of 300°C were calculated with gas thermometry.

The location and drilling of the first well A-1, was performed after these studies. This well has a depth of 2,193 m, with a bottom temperature of 290°C and produces a water-steam mixture of high enthalpy. To date, seventeen wells have been drilled, of which twelve are productive, the most outstanding being well A-2 with a production of 378 ton/hr of water-steam mixture; well A-4 producing 50 ton/hr of steam and 50 ton/hr of water; well A-5 which produces 70 ton/hr of steam and 65 ton/hr of water; well A-6 which produce 50 ton/hr of steam; well A-13 with a production of 65 ton/hr of steam and 15 ton/hr of water; and well A-17 producing 82 ton/hr of dry steam. Some of this wells have 850 psi shut-in pressure at well head. In this field, there are plans for reinjecting the waste brine, having for this purpose, well A-7 with a capacity to receive 100 ton/hr of separated water; well A-10 with 70 ton/hr; well A-15 with 120 ton/hr, etc.

With all these studies several modules have been detected related with the future geothermal exploitation of the area, like Tejamaniles, Agua Fría, El Chino, El Gallo y Laguna Verde. Projects are on line for the installation of five portable units of 5 MW each, with plans for having them into operation by the end of 1981. At the same time, interference well tests have been started in the module of Tejamaniles, to define the reservoir capacity and size of the first installed plant for generation. It is considered feasible that 300 to 600 MW may be installed at the geothermal field of Los Azufres.

CUITZEO, MICHOACAN

This area has several points with hydrothermal manifestations like San Sebastián, Las Arenas, Huandacareo, Nismpo, San Agustín del Maiz, Taratameo, La Mina, Huingo y Araró. The last one being studied in detail, planning to drill two deep wells by next year. The geochemical studies show that reservoir temperatures are higher

than 200°C.

EXPLORATIONS IN LA PRIMAVERA, JALISCO

La Primavera geothermal field is located only 5 km West of the City of Guadalajara, in a mountainous zone with many volcanic domes which are part of a caldera of big dimensions. This area has many hot springs of great volume, as well as large fumaroles and steam vents. The hot springs area is located 20°40'N Lat. and 103°35' W Long., covering an area of 3 km^2. At the emanation point of these springs, deposits of calcite and silica are found on the rhyolitic rocks. The resulting streams (400 liter/seconds), some of which are Arroyo Nuevo, Arroyo Verde, Agua Brava y Río Caliente, have a characteristic green color in the bottom due to the presence of thermophilic algae, which grow at a temperature of 50°C. In the central highest part of La Caldera, there is the graven named El Colorado, which has a big number of fumaroles and steam emanation which together with the manifestations of La Azufrera and Las Barrancas, indicate the existence of great geothermal potential. Drilling has already been started in this area, as a result, there is well PR-1 with a depth of 1159 m and a bottom temperature of 290°, near its completion and testing stage. Well PR-2, under drilling, with a depth of 650 m, presents very similar conditions. In one of the extreme sites of the field, in the hot spring area named Río Caliente, a well of 1,900 m, of geological support was drilled, but no high temperature condition was found.

LA SOLEDAD, JALISCO

La Soledad geothermal field is located on 20°52'N Lat. and 103°25'W Long., North of Guadalajara City on the banks of Río Santiago, at 1000 m above sea level. Large emanations of water-steam mixtures are found in this place, with an extension of 4 km^2 and two types of water, high salinity brine and low salinity brine.

SAN MARCOS Y EL PANTANO, JALISCO

This field is located at 20°36' N Lat. and 103°30'W Long., with an elevation of 1,350 m, West of Lago de Chapala. It has an extension of 11 km^2. Several manifestations like hot springs, fumaroles, hot water lagoons, mud volcanos, etc., are found in this zone. The water is of medium salinity brine and the geothermometers like Na-K-Ca and the ones obtained by gases show temperatures higher than 200°C. In this area several shallow wells were drilled and used for thermal gradient measurement and to obtain fluid samples.

OTHER GEOTHERMAL AREAS OF JALISCO

At the Chapala geothermal area (Jalisco State), sites like Hervores de La Vega, Agua Caliente, Villa Corona, Mazatepec, Cosalá, Jocotepec, Colimilla, Cacaluta and Verdía are in exploration at the present time. The high thermal activity of the zone is caused by the intersection of the faults system of Mexico's Eje Neovolcánico with the Colima's Trench; the extension of this area is more than 5,000 km^2.

IXTLAN DE LOS HERVORES, MICH.

This field is located East of Lago de Chapala, at an altitude of 1,535 m (a.s.l.). In this area there are thermal manifestations of high intensity in more than 2 km^2, mainly hot springs which have a temperature of 90°C, boiling mud lagoons, fumaroles and steam vents. Geological, geochemical and geophysical studies have been made in this area. Three wells of large diameter have been drilled with one of them discharging a low entalphy steam-water mixture for more than 20 years. To determine the potential of this area, deep drilling is planned.

LOS NEGRITOS, MICH.

This field is located at the intersection of La Sierra Madre Oriental and the Eje Neovolcánico. It is East of Lago de Chapala, 27 km of the Ixtlán de Los Hervores field, at an altitude of 1,535 m (a.s.l.). This is a flat area characterized by a great number of thermal manifestations such as mud volcanos and bubbling ponds with temperatures of 40 to 90°C. Geological, geochemical and geophysical studies have been performed in this area. Twenty wells of 100 to 400 m deep were drilled to measure thermal gradients obtaining in some of them low pressure, water steam discharges. One well of 700 m deep was drilled obtaining a flow of low enthalpy.

EXPLORATIONS IN LOS HUMEROS, PUEBLA

This field is located in the State of Puebla, 30 km West of Ciudad Perote, Ver. Studies have been made in an area of 7,000 km^2. According to these studies, this area is very promising for commercial exploitation. Los Humeros, El Xalapazco and Las Derrumbadas are the most outstanding for their geothermal activity. At present, it is planned to start exploratory drilling in the first months of 1981.

GOALS OF GEOTHERMAL ENERGY IN MEXICO FOR THE NEAR FUTURE

The geothermal resources that are being developed in Mexico, have the goal of exploiting commercially this alternative source of energy. The Comisión Federal de Electricidad has supported the use of this energy source along with the utilization of coal, hydroelectricity, nuclear and solar energy. As far as geothermal energy is concerned, the goal to be reached by the year 2000 is to generate a total of 20 millions of KW every year. This will be feasible with the exploitation of the geothermal fields located in the Northwestern part of the country, in the Eje Neovolcánico and in the Southestern part in the Chiapas State.

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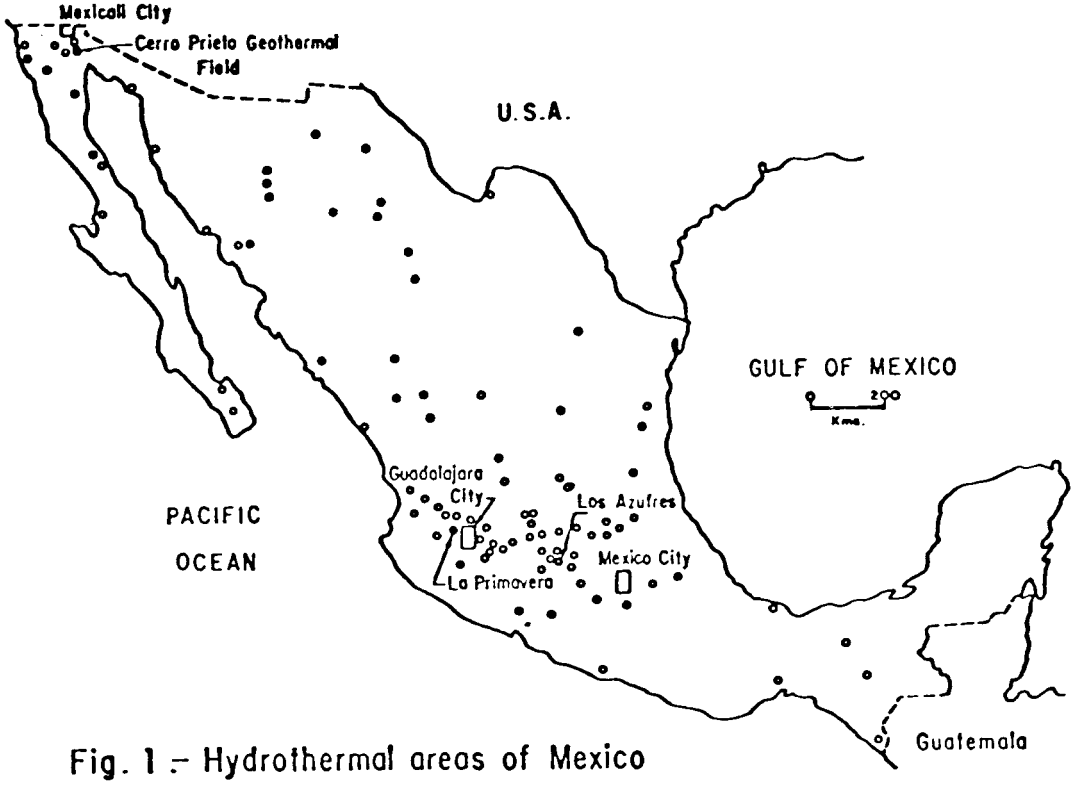
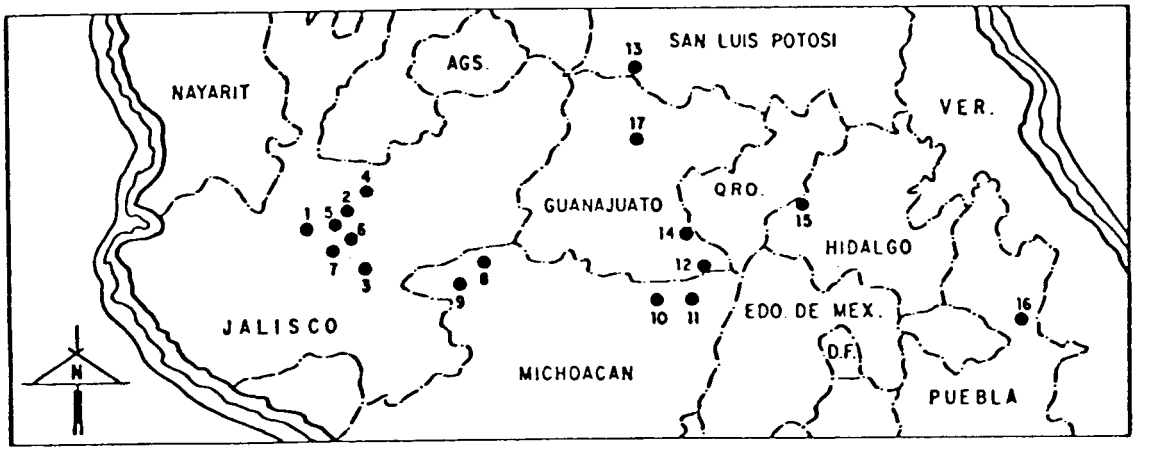
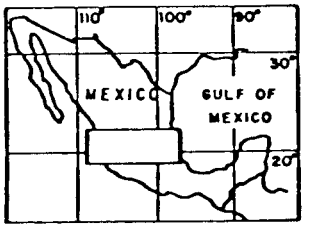


Fig. 1 :- Hydrothermal areas of Mexico





1 :- Hervores de la Vega, Jal.
2 :- La Primavera, Jal.
3 :- San Marcos, Jal.
4 :- La Soledad, Jal.
5 :- Agua Caliente, Jal.
6 :- San Isidro Mazatepec, Jal.
7 :- Villa Corona, Jal.
8 :- Los Negritos, Mich.
9 :- Ixtlan de los Hervores, Mich.
10 :- Lago de Cuitzeo y Araro, Mich.
11 :- Los Azufres, Mich.
12 :- Puruagüita, Gto.
13 :- El Gogorron, S.L.P.
14 :- San Bartolome, Gto.
15 :- Pathe, Hgo.
16 :- Los Humeros, Pue.
17 :- Comanjilla, Gto.

Fig. 2 :- Location of most important Geothermal fields of Volcanic Axis.