

THERMAL MANIFESTATIONS IN NICARAGUA

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INTRODUCTION

In the Cordillera de los Marrabios, an active Quaternary volcanic range in western Nicaragua (Figure 1), several geothermal areas have been identified and characterized. In addition, field studies and scientific investigations have shown that significant thermal anomalies and permeable formations exist in the Nicaraguan Depression, a large NW-SE trending graben in the central part of the country. Exploration surveys, including drilling, have confirmed the presence of several thermal aquifers at different depths.

A number of articles, the latest in the July-August 2003 issue of the *Geothermal Resources Council Bulletin*, discuss Nicaragua's high-enthalpy geothermal fields that produce, or have the potential to produce, fluids appropriate for electricity generation. Here, we describe some of the lower temperature areas. They are associated with surface manifestations (i.e., hot springs, mud pots, gas discharges, zone of rock alteration, etc.) so abundant in the Nicaraguan Depression.

MASAYA-GRANADA-NANDAIME

The center of the Masaya-Granada-Nandaime area is in the southern portion of the Nicaraguan Depression, near the city of Diriomo, 45 km southeast of Managua (Figures 1 and 2). It is an active volcanic area that presents important surface manifestations and includes the Masaya Calera, the Apoyo Caldera (Laguna de Apoyo), and the Mombacho Volcano. Abundant hot springs and fumaroles are found north and south of the volcano; some are discussed below.

LA CALERA

Located north of the Mombacho Volcano, the La Calera hot springs produces 34°C, Ca-SO₄ type waters that have minor amounts of chlorides. Several dispersed fumaroles are also found in this area. The springs flow at a rate greater than 1000 L/min. The waters are near saturation with respect to amorphous silica. Their sulfate content (470 ppm) suggest that the La Calera waters have mixed with condensed steam. The spring waters, however, are not acid. They have a pH of 7.6.

RIO MANARES RIVER - MELCATEPE

The Rio Manares-Mecatepe area is southeast of the Mombacho Volcano (Figure 2). There are several thermal springs in a zone with several swamps and small lakes. The springs are fed by the Manares River flowing from the northeast. Temperature of the waters varies between 38 and 48°C.

The north-western shores of the Laguna Blanca in this area, shows some weak thermal springs. The temperature of the water is 36 - 38°C. North of that lake, the Aguas Calientes springs have temperatures of 38 to 40°C. However, at the bottom of this swampy zone, 60°C have been measured. Calcium is the main cation, and SO₄ and HCO₃ are the main anions in these thermal waters. There is some evidence that the waters mix with gases ascending from depth.

LAGUNA APOYO

Fluids from the Apoyo Caldera are discharging along a 4-km long track on the west and south-western banks of the Laguna Apoyo (Figure 2). The sodium-chloride waters have salinities of about 4000 ppm and temperatures of up to 97°C. The observed correlation between chloride concentrations and temperatures, indicate that the fluids are a mixture of hot Na-Cl and cold diluted waters. Geothermometric data suggest that the hot waters originate at depth at a temperature of at least 220°C.

The waters in the Laguna Apoyo are, in fact, equivalent to the thermal waters that surge along the banks of the lake, but they have been cooled and diluted to about half their original chloride concentrations. Probably, there is thermal upwelling at the bottom of the lake.

TIPITAPA

The Tipitapa area (Figure 3) is on the south-western shores of Lake Managua (also known as Lake Xolotlán), in the central part of the Nicaraguan Depression. It presents several thermal manifestations and some wells have encountered hot waters. A flow of andesitic lavas 12 km southwest of Tipitapa is the closest volcanic feature; the Masaya and Apoyo Calderas are 25-30 km to the southwest. Therefore, the origin of these manifestations is thought to be related to the NW-SE trending fractures of the Cofradía system.

At a place called Baños Termales ("thermal baths") close to the town of Tipitapa, a resort has been constructed. It has several hot water swimming pools and a restaurant to provide recreation as well as benefits from the waters' medicinal properties.

The Baños Termales waters have a Na-Cl-SO₄-HCO₃ composition and are relatively diluted, with approximately 285 mg/L of alkalinity (as HCO₃). The available data suggest that these 93°C waters are stable in terms of their chemistry and temperature. They do not show evidence of mixing.

VALLE DEL RIO OBRAJE

The Obraje River valley area (Figure 3), about 10 km northwest of the Momotombo geothermal field, presents numerous thermal manifestations. Several wells show temperatures of about 40°C. The river, at its headwaters, has a temperature of around 50°C. It discharges into Lake Managua at an average rate of 90 L/s. In other words, some $2.84 \times 10^6 \text{ m}^3$ of thermal, highly saline, Na-SO₄ type water flow into the lake every year.

SAN FRANCISCO LIBRE

On the northern banks of Lake Managua, at the San Francisco Libre area (Figure 3), there is a more than 2-km long zone of thermal manifestations (i.e., hot springs, geysers, hydrothermal alteration deposits, etc.). The temperatures of these manifestations varies between 45 and 89°C. Along the shore of the lake, a shallow hot water table exists. It emerges at ground level; where, the rocks are fractured. Several fish kills have been observed near this area. It is quite possible, they were caused by hot fluids discharges from manifestations at the bottom of the lake.

To take advantage of the healing properties of the hot waters and muds, a Medicinal Center of Hydro and Mud Therapy has been built at San Francisco Libre with international financial support. The purpose of the center is to provide treatment to people of limited resources that suffer from illness like arthritis, migraines, rheumatism, muscular pains, obesity, scabies and allergies (Figure 2).

THERMAL SPA “AGUAS CLARAS”

The best thermal spa in Nicaragua is at “Aguas Claras.” The facilities are being managed with tourism in mind. The owners have made improvements so that visitors can enjoy relaxing in the warm water baths. The spa is located at kilometer 69 on the Managua-Boaco highway (Figure 3).

The Na-SO₄ spring waters have a temperature of about 50°C and a pH of 8.1. The Aguas Claras spa has six pools with natural thermal waters. A 6-in. diameter pipeline carries the spring’s sulfurous waters directly to the pools by gravity flow. Besides the attraction of the hot pools, there are cold water pools, a restaurant, a bar, small ranch houses, as well as air-conditioned rooms. This make the place a required road stop when traveling between Managua, Boaco and Juigalpa.

FINAL REMARKS

Until recently, the development of Nicaragua’s high-enthalpy geothermal resources for electricity generation has been the main focus of interest of the government and private sector. Lately, and because of health aspects associated with hot springs and their economic potential as tourist sites, some of the interest has shifted toward the development of a few surface manifestation areas. Some investments by government agencies and private groups have already been made, but much could be done considering the country’s abundant low-temperature geothermal zones.



Figure 1. Volcanoes of the Cordillera de los Murrabios.

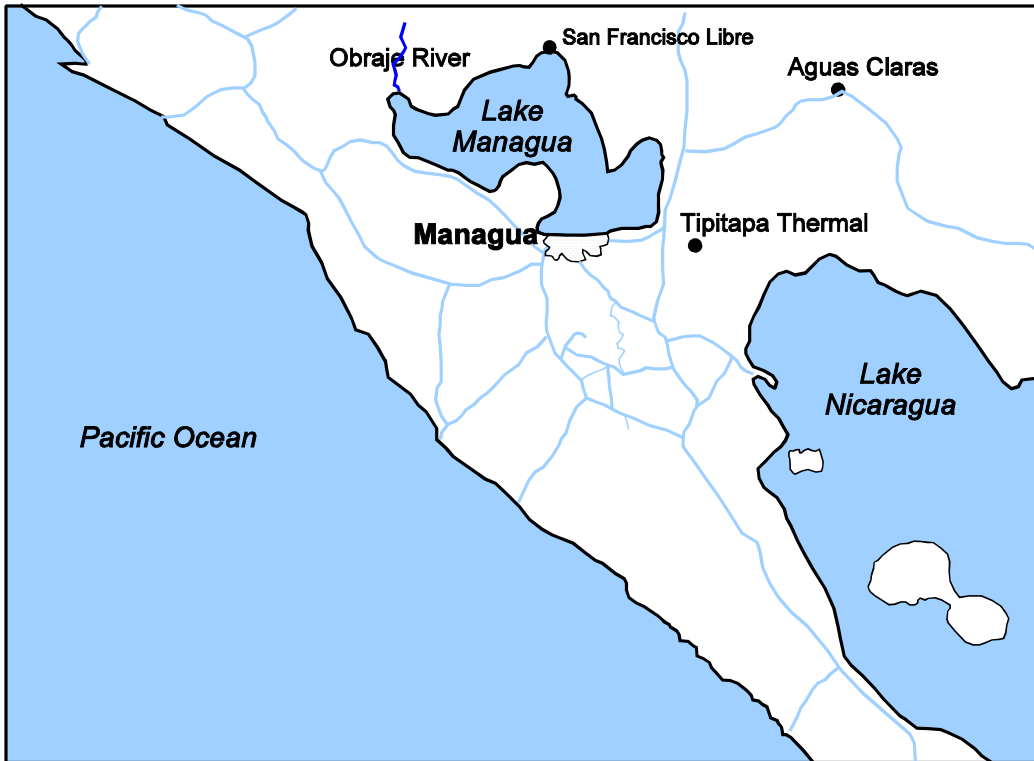


Figure 2. Details of the Masaya-Granada-Nandaime area.

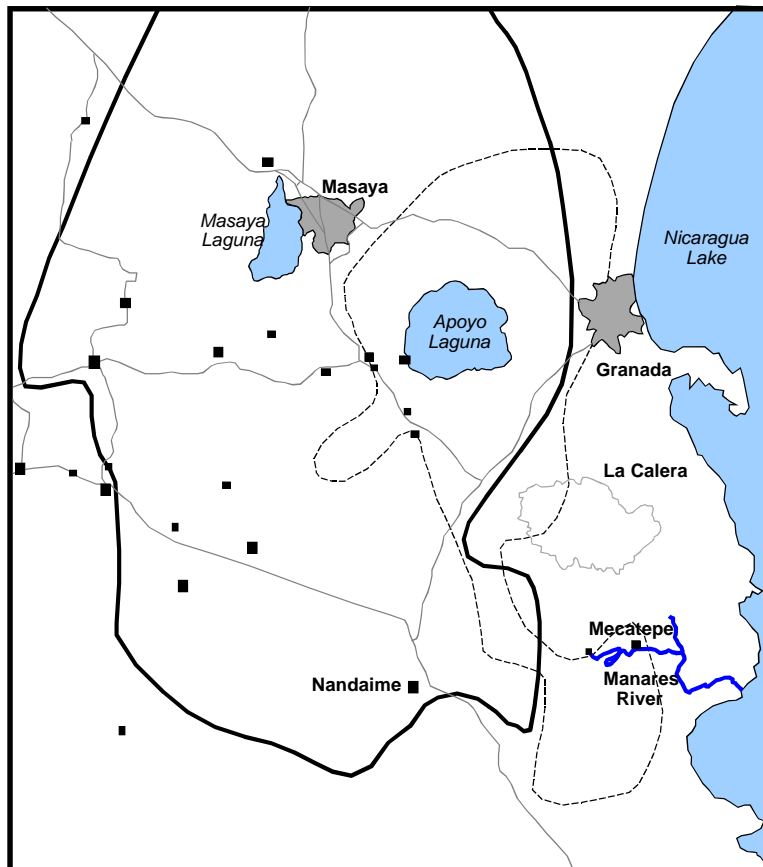


Figure 3. Location of other thermal areas mentioned in the text.