

## GEOTHERMAL POTENTIAL IN BOLIVIA

Roberto Condoretti Aliaga

Geothermal Institute  
University of Auckland\*

## ABSTRACT

More than 70 areas with thermal surface manifestations have been mapped in Bolivia. A few of them were studied in detail. Some geological and general characteristics of these manifestations show their importance and potential for future development.

At present, available data include geological, geochemical and geophysical studies made for other purposes than geothermal explorations. A pre-feasibility study was carried out in the southwestern part of the Bolivian territory.

United Nations Revolving Fund for Natural Resources ranks Bolivia as being a country with two prospects ready for exploration drilling and a number of prospects ready for pre-feasibility work.

## INTRODUCTION

About 60% of the Bolivian territory lies East of the Andes. The rest of the area is characterised by the Cordillera de Los Andes itself and the Altiplano. The Andes in Bolivia consists of two branches, the Cordillera Occidental (Western Andes) and the Cordillera Oriental (Eastern Andes), both reaching altitudes of about 7000m above sea level. The Altiplano is a high plateau located between the two Andes, with an average altitude of 3900m, where the boiling point of water drops to 90°C. More than 70 areas with geothermal manifestations can be found in the three major physiographic units mentioned above. Surface manifestations include hot pools, mud pools, fumaroles and steaming ground. They are associated with a wide geological range, from faulted Devonian strata to Quaternary deposits overlying Devonian rocks. Fig. 1 shows the areas with active geothermal manifestations.

A recent report prepared by Donovan (1984) mentions the interest of the Bolivian Government in geothermal projects such as exploration drilling and prefeasibility studies.

Geological Framework

Based on available data and literature, a general geology of the involved areas is as follows:

The Western Andes (Cordillera Occidental), on the border with Chile, is composed of Cenozoic volcanic rocks with a thickness exceeding 1000m overlying marine Jurassic sediments. Most of the volcanic mountains in Bolivia belong to this orographic unit which in turn is part of the Pacific Volcanic Belt.

Surface thermal manifestations are found on the Eastern slope of this cordillera made up by a sequence of pyroclastic material, lavas and ignimbrites.

The Eastern Andes (Cordillera Oriental) consists mainly of Devonian and Carboniferous rocks in the North, Cambrian and Ordovician rocks with some intrusive granites present in the south. Both of them constitute the Andean Paleozoic Block where most mining prospects occur. The northern part of this cordillera forms a conspicuously high mountain chain up to approximately 7000m intruded by intermediate plutonic rocks. The southern part of the Paleozoic Block presents many ridges comprising a width of 400 km and altitudes of approximately 6000m. Thermal manifestations in this area are associated with faults and fractures as well as volcanic bodies.

The Altiplano, located between the two Andes, Occidental and Oriental, has an approximate length of 700 km, and a maximum width of 200 km. Quaternary sediments cover continental-type Tertiary beds. In the southern part, volcanoes up to 6000m high are scattered throughout the area, with a strongly folded Paleozoic basement. Thermal manifestations are mainly in the eastern central part; they are related to igneous bodies and probably regional faults.

General Characteristics

Temperatures of many surface manifestations are as high as 85°C, although most of them do not exceed more than 50°C. The largest flow measured occurs at Lanza (No. 15, Fig. 1) with 67 l/sec, according to Donovan (1984). The same source gives 18,608 ppm of total dissolved solids for springs on the shore of Salar de Empexa (No. 65, Fig. 1). Chemically, waters vary from acidic to alkaline, most of them being used for bathing purposes. Some of the hot pools are related to mining areas, where mainly antimony, sulphur, pyrite, gypsum, wolframite, hyalite, realgar and cinnabar are present.

State of geothermal exploration

Up to the present the Ministry of Mines, through the Geological Survey of Bolivia, has the responsibility for geothermal investigations. The presently available data were obtained from other studies than geothermal; these studies were made for mining prospecting, inventories of other natural resources, geological mapping, or research on specific topics such as volcanic investigation (Kussmaul et al., 1976).

A report prepared by the Technical Adviser of the United Nations Revolving Fund for Natural Resources (Donovan, 1984) listed Bolivia as a country with

\*Present address: Universidad Mayor de San Andres  
Facultad de Ciencias Geologicas  
La Paz, Bolivia

CONDORETTI ALIAGA

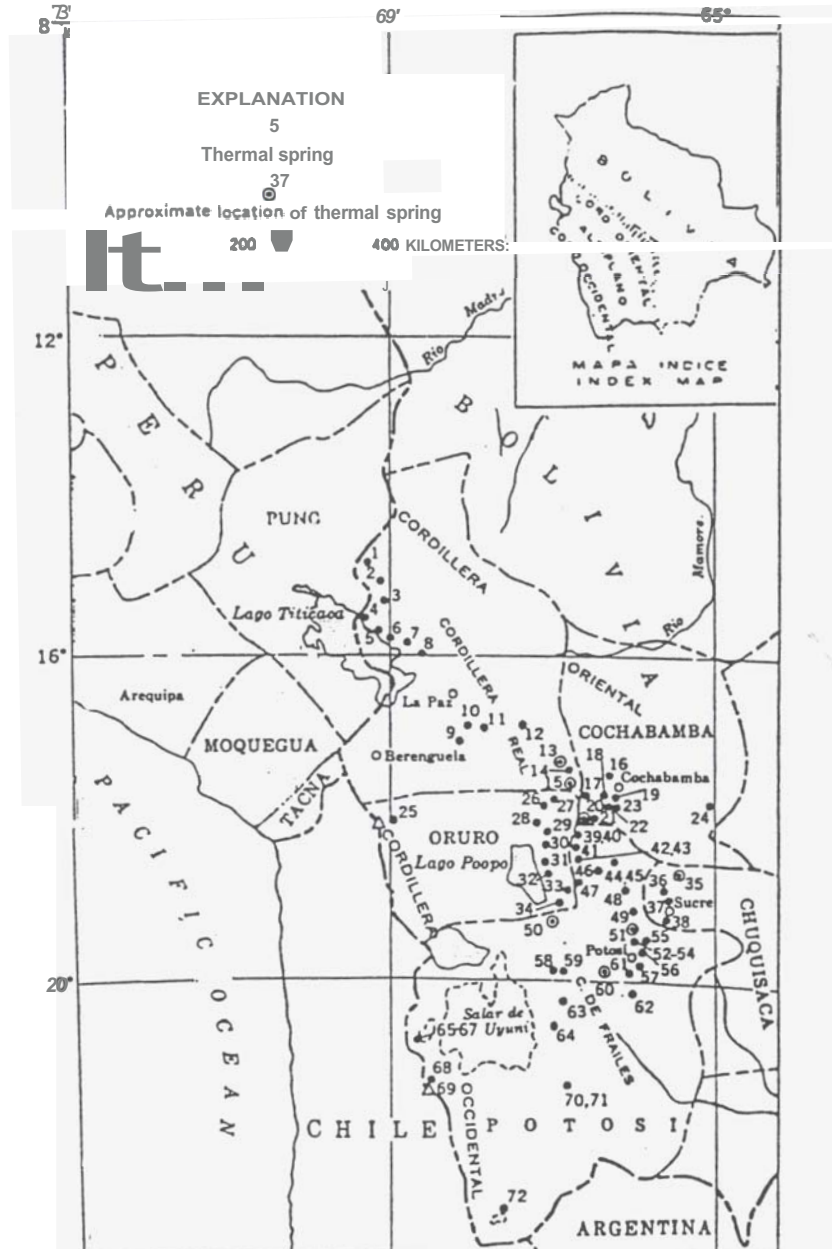


Figure 1: Location of thermal springs in Bolivia.  
(From Waring, 1965)

geothermal prospects defined by prefeasibility study and also a number of prospects where geothermal reconnaissance studies have indicated areas for prefeasibility studies. These areas are: Laguna Colorada and Salar de Empexa (Nos. 65, 67, 68, Fig. 1) located in the southwestern part of Bolivia (Carrasco, 1975). The other prospects are located on the Central Altiplano at Oruro, Poopo (Fig. 1), and Chaqui (57, Fig. 1). According to Donovan's report, the Government of Bolivia has expressed its interest in these geothermal projects. The University of La Paz, through the Faculty of Geology, is interested in preparing qualified personnel for such projects.

#### Conclusions

An evaluation of the existing information suggests that the geothermal potential of Bolivia is significant. Based on the necessary high temperature reservoirs which are likely to occur within the described areas, geothermal energy might be an excellent alternative for an extensive development planning based on an appropriate utilization

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