

# GEOTHERMAL EXPLORATION IN ETHIOPIA, COUNTRY REPORT

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## ABSTRACT

Geothermal exploration started in Ethiopia in 1969. The study covered 150,000 km<sup>2</sup> in the Ethiopian Rift valley and identified over 500 thermal features. Semi-detailed scientific study including geology, geochemistry and geophysics has been carried out in most parts of the Afar Rift and the Main Ethiopian Rift. Further more, a detailed geoscientific study has been conducted in Aluto - Langano, Tendaho, Corbetti, Abaya, Gedemsa and Tulu Moye areas and the out come of the study indicate a promising result for further feasibility study. Based on the prevailing results follow up feasibility study was carried out in Aluto - Langano Geothermal field and indicated a potential of 30 MWe. Currently a 7.5 MWe pilot plant has been installed and connected to the national grid. In Tendaho geothermal field (Afar Rift) a follow up feasibility study is underway and the present status shows that the field has a potential of 20 MWe.

## 1. INTRODUCTION

### 1.1 Background

Geothermal exploration started in Ethiopia in 1969 jointly by the Ethiopian Government and the United Nations Development Program (UNDP). The main purpose of the work was to study the geology, geochemistry and hydrology of hot springs of the East African Rift System within Ethiopia. The Ethiopian Rift Valley extends from the Ethio - Kenyan border in the south and running in NNE direction to the Red Sea to the north. The study covered 150,000 km<sup>2</sup> area of the Ethiopian Rift including Afar Rift and the Main Ethiopian Rift (MER) and identified more than 500 hydrothermal features (Fig. 1). The study has confirmed that Ethiopia has a potential of about 700 MWe of Geothermal resources in the Ethiopian Rift Valley.

The Ethiopia Government encouraged further exploration works. Geothermal exploration studies were conducted at different levels and their status will be discussed as follow:

## 2. GEOTHERMAL ACTIVITY IN ETHIOPIA

### 2.1. Main Ethiopian Rift

Based on the encouraging results of the 1969 survey a detailed geoscientific study was conducted in Aluto-Langano, Corbetti and Abaya geothermal prospects jointly by Ethiopian Government and UNDP.

#### 2.1.1. Aluto-Langano Geothermal Field

This field has been intensively explored. The exploration work included geological, geochemical and geophysical surveys. Following these detailed investigations, eight deep exploratory wells were drilled in the area between 1981 to 1985. Five of the drilled wells turned out to be productive.

The productive wells have proved a geothermal reservoir having fluids with high enthalpy (1500-1900 kJ/kg) and temperature of 335 °C. Feasibility study shows the Aluto-Langano geothermal field is capable of generating 30 MWe for 30 years. Currently a 7.5 MWe pilot geothermal plant has been constructed. The plant is a binary type supplied with steam and brine from four productive wells. One of the exploratory wells is serving as reinjection well. The plant is connected to the national grid and supply electricity. There is also a continuous program to upgrade the capacity to 30 MWe by drilling additional wells.

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#### 2.1.2. Corbetti Geothermal Prospect

The Corbetti prospect area is one of the most promising geothermal field. A detailed geoscientific investigation including geology, geochemistry and geophysics was carried out. Eight shallow temperature gradient holes were drilled. The results of the temperature gradient wells survey indicate an encouraging result for the drilling of deep exploratory geothermal wells.

#### 2.1.3. Abaya Geothermal Prospect

Abaya prospect has been well studied and has lots of hydrothermal manifestations. A detailed geological (1:20,000) and geochemical investigations were carried out. Currently a detailed geophysical survey is being conducted in the area. The present level of study proves that this field is a promising area for further investigation.

### 2.2. Afar Rift Valley

The Afar rift has been divided into Northern and Southern Afar Rift areas.

#### 2.2.1. Northern Afar Area

##### 2.2.1.1. Dallol Geothermal Prospect

The prospect area is located in the Danakil Depression. This area has been well studied during the 1969 regional survey and it has a good geothermal potential. Regional geological and geophysical surveys had been conducted and there is a future plan to conduct more detailed geoscientific study.

##### 2.2.1.2. Tendaho Geothermal Prospect

Tendaho geothermal prospect is located in the Afar Depression which is a crossing point of three rifts, two oceanic (Red Sea and Gulf of Aden Rift) and one continental (East African Rift). This prospect has been well studied and eight temperature gradient wells were drilled by Aquater in 1979.

Prefeasibility study and deep drilling activities were carried out by Aquater. The drilling has been carried out jointly by the Ethiopian government and the technical cooperation of the Italian Government. Three deep exploratory wells (TD-1, TD-2 and TD - 3) have been drilled from 1993 to 1994 TD-1 has low permeability and a fluid with maximum temperature 277°C. The second well (TD-2) has better permeability and a water dominated reservoir having

temperature 241°C. The third well (TD-3) turned out to be non productive.

Based on the results of the three deep wells the permeable zone is observed at shallow level (250 - 350m). Therefore, three additional shallow wells were drilled (TD-4, TD-5 and TD-6) between 1994 and 1998. Feasibility study was carried out and the results have indicated the presence of a shallow reservoir. Currently, the productive wells could supply enough steam to operate a pilot power plant of about 5 MWe. In addition the study has estimated a total potential of 20 MWe.

#### 2.2.2. Southern Afar Area

In the Southern Afar area a coordinated study was carried out as a project by Electroconsult (ELC) in association with Geothermica Italian and the Ethiopian Institute of Geological Surveys in the years 1985 - 1987. The project mainly concentrated on a reconnaissance study of the geothermal sites in the Southern Afar region and parts of the northern MER. The areas included in the study were Gedemsa, Tulu Moye, Kone, Dofan, Fantale, Meteka, Danab, Teo and Abhe geothermal prospects.

Based on the result of the survey and socio - economic aspect four of the prospect areas namely Dofan, Fantale, Gedemsa and Tulu Moye areas were selected for further geoscientific investigations. Gedemsa prospect was given priority and two shallow temperature gradient wells were drilled and encountered cold aquifer. Recently a detailed geological (1:20,000) and geophysical investigation has been carried out in Tulu Moye area. Five shallow temperature gradient holes have been drilled. The results have confirmed that the Tulu Moye area is a promising field. There are also plans to do more geoscientific study in Fantale and Dofan geothermal prospect areas in the coming few years (couple of years).

### 3. CONCLUSIONS

The Ethiopian Rift Valley has a large potential of geothermal energy. Ethiopia could generate about 700 MWe using geothermal resources. The existence of this indigenous energy will satisfy the energy demand of the country. Aluto-Langano and Tendaho geothermal fields will be fully operational in the near future. There is also a plan to do detailed geoscientific

investigations for different geothermal prospects.

Due to the finance limitation as indicated above the studies have been conducted jointly by the assistance of Ethiopian Government and others. Therefore, future development should focus by attracting donating governments, organizations and interested investors to participate.

#### REFERENCES

Aquater (1996): Tendaho Geothermal Project final report, Ethiopian Institute of Geological Surveys, Ethiopia.

Electroconsult (ELC) (1987): Geothermal Reconnaissance study of selected sites of the

Ethiopian Rift System, Milano, Italy.

Electroconsult (ELC) (1986): Exploration of Aluto-Langano Geothermal Resources, feasibility report, Geothermal Exploration Project, Ethiopian Institute of Geological Surveys.

Meseret Teklemariam, Kibret Beyene, Yiheyis Amdeberham and Zewdie Gebregziabher (2000): Geothermal Development in Ethiopia. Proceedings World Geothermal Congress 2000, Kyushu-Tohoku, pg. 475-480.

UNDP (1973): Geology, Geochemistry and Hydrology of hot springs of the East African Rift System within Ethiopia, pp 1-285.

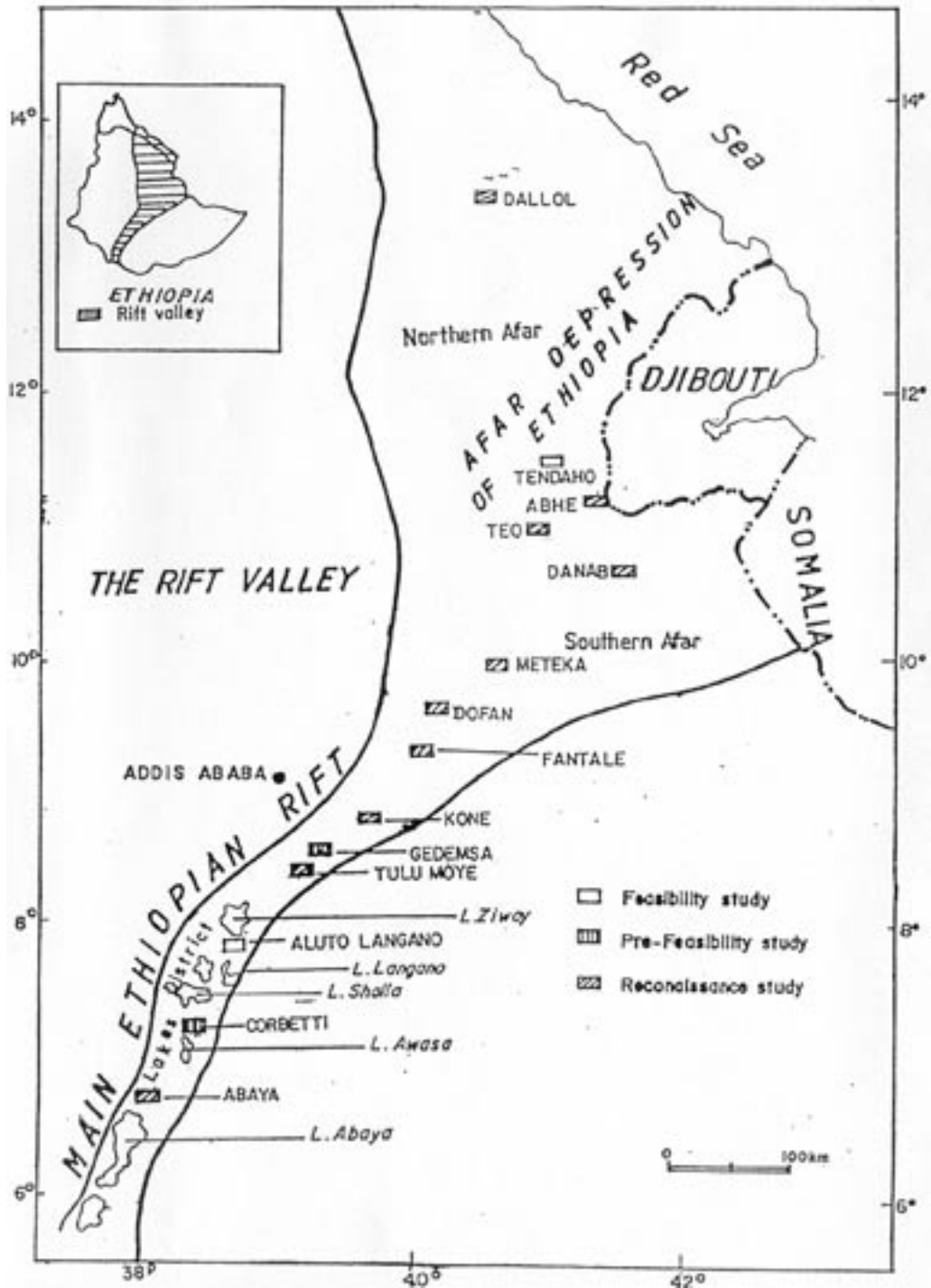


Fig. 1 Location map of the Ethiopian rift valley and the Afar depression showing the explored and geothermal prospective areas.