CURRENT STATUS OF THE GEOTHERMAL DEVELOPMENT IN KENYA

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ABSTRACT

Kenya is accelerating the development of geothermal resources to meet the increasing power demand. Power demands now stands at 8% with only about 1 % of the rural population having access to electricity. For a very long time, growth of geothermal was slow as the country relied more on the hydro power production because there was adequate precipitation. With the current changes in climate and the dwindling rainfall, overreliance on hydro power production has proved to be expensive. Geothermal energy capacity ratio does not depend on the weather conditions and therefore it is more reliable. The Government has fasttracked the development of geothermal resources in the country as a source of affordable and clean power. The Government established the Geothermal Development Company with the sole purpose of making available enough steam for electricity generation by Independent Power producers (IPPs) and KenGen.

Key words: Geothermal energy, hydropower.

INTRODUCTION

Kenya is endowed with a huge geothermal resource due to the presence of the Kenya rift which is part of the East African rift system. Geoscientific instigations indicate that the potential is over 7000Mwe if fully exploited. The geothermal activity is attributed to Neogene volcanic activity which has resulted to the presence of near surface heat generating sources. Geothermal fields of the Kenya rift occur in two types of environments, in Quaternary volcanoes or in fissures. The main geothermal fields are associated with Quaternary volcanoes. The second type is associated with fissures that are related to active fault zones. In either case, these fields are dissected by numerous rift faults that give rise to a number of geothermal springs and fumaroles, See Figure1.

Exploration for geothermal resources in Kenya started in 1950's and gained momentum in the 1960's, when two wells were drilled at Olkaria. From 1967, the United Nations Development Programme (UNDP) in collaboration with the Kenya Government and the then East African Power and Lighting Company Ltd., conducted geological and geophysical surveys in the area between Lake Bogoria and Olkaria. The studies identified Olkaria as the most prospective area for further investigations. As a result, more wells were drilled from 1973. The Government and KenGen, and now together with the Geothermal Development Company have undertaken to ramp up the development of geothermal resources in the country especially for electricity generation.

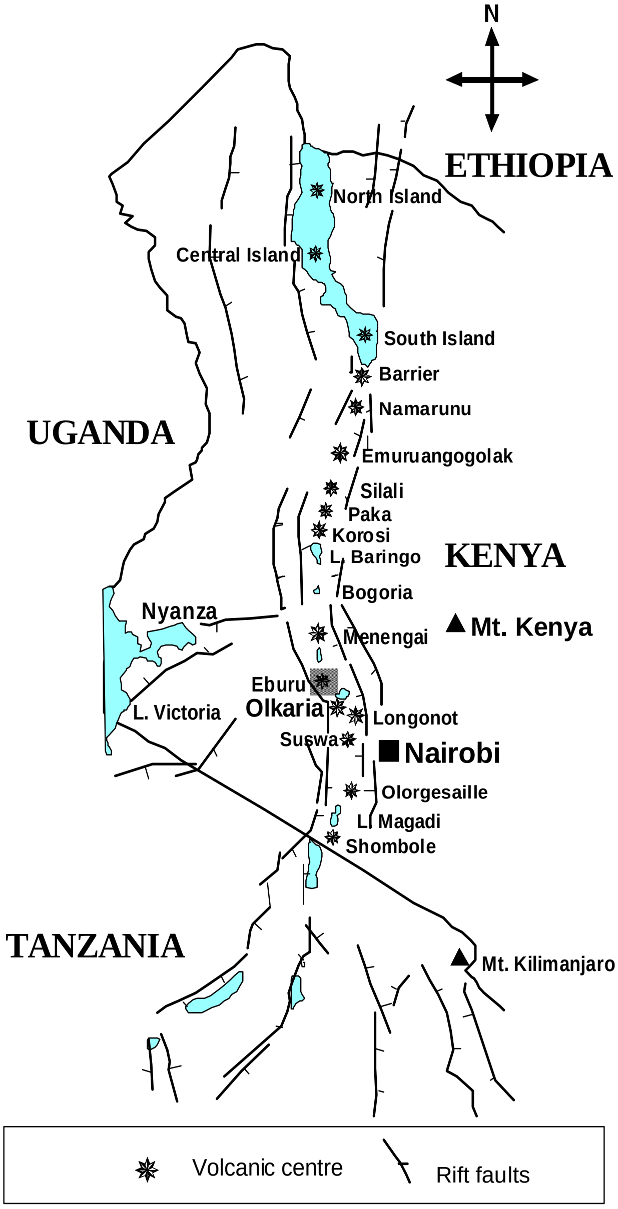

Figure 1: Map showing location of the geothermal fields and the Quaternary volcanoes and Rift faults along the Kenya rift axis.

GREATER OLKARIA GEOTHERMAL AREA

Olkaria 1 Power Plant (45 MW)

The Olkaria 1 Power Plant is the first geothermal power plant in Kenya and in Africa. It was commissioned in 1981 at the time producing 15MW and by 1985, the plant was producing 45MW. The power plant is owned by KenGen has been in operation since then. The power plant is currently using steam from the Olkaria East field.

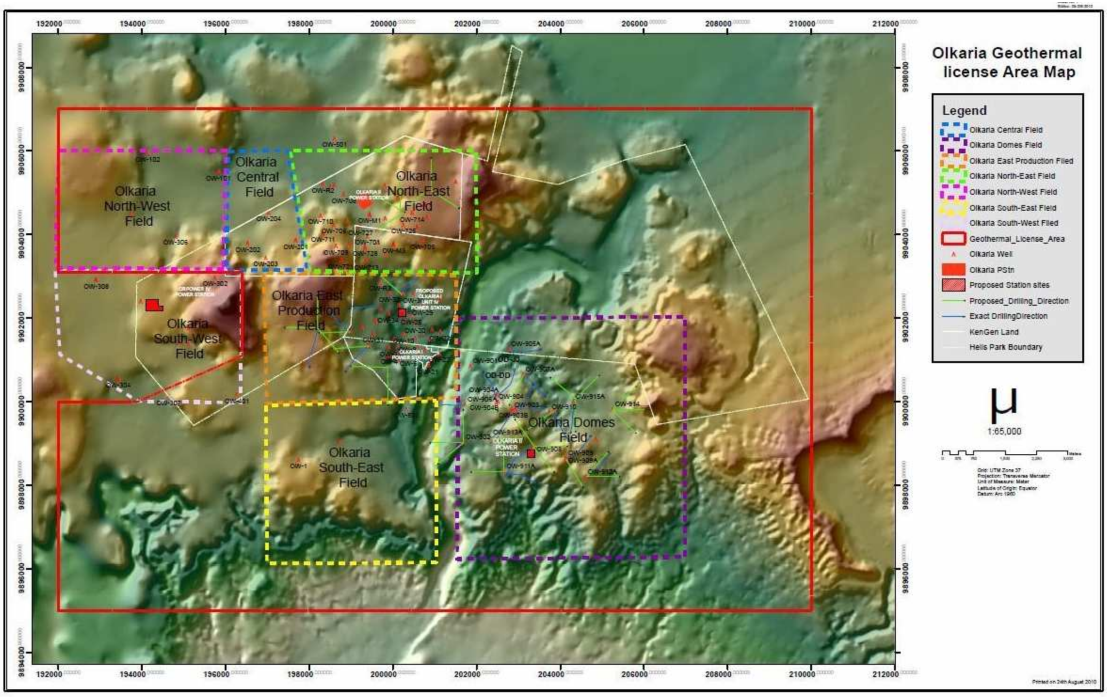

Figure 2: The Greater Olkaria geothermal field showing seven production fields.

Olkaria II Power Plant (105 MW)

More wells were drilled in the Olkaria East geothermal field. This culminated into the construction of a 70 MW power plant, the Olkaria II Power Plant. The Plant was commissioned in 2003. Due to the availability of excess steam, KenGen decided to add a third unit to Olkaria II Power Plant to generate an additional 35 MW. Construction of the unit commenced in 2009 and was completed in May 2010, bringing the total combined output at Olkaria II Power Plant to 105 MW.

Olkaria IV Power Plant (140 MW)

Plans are at advanced stage to construct a 140 MW Olkaria IV Power Plant. KenGen has secured funding for the Power Plant from bilateral donors.

Olkaria I unit 4 & 5 (140 MW)

Funding has also been secured from bilateral donors for construction of units 4 &5 at the Olkaria East Geothermal field with a total capacity of 140 MW. Consultancy services have already been procured for the project, together with that of the Olkaria IV Power Plant.

Wellhead generation

The Company has adopted use of wellhead generation units. These units will generate electricity from single wells before construction of large power plants. The electricity generated will then be transmitted to the national grid. This technology was adopted so that the costs incurred in the drilling of the wells can be offset and funds made available for further development and or construction of the large power plants. This early generation will make available more power to the country thus help mitigate against the effects of drought and resultant high cost of power from diesel generation

Olkaria III

In Africa, the only binary plant in Kenya is OrPower4, which is producing 48 MW. The power plant is located in Olkaria South West (See Figure 2). The Ormat® Energy Converter (OEC) is a modular binary power plant that consists of heat exchangers, turbine/generator, motive fluid, lubrication pumps, valves, controls and instruments. The operation of OEC's is based on the Rankine cycle. Heat is transferred from the geothermal fluid to the organic fluid via heat exchangers (vaporizer and per-heater) where the organic fluid is heated and vaporized. The organic fluid is then expanded in the turbine to a lower pressure and temperature after which it is then condensed in the air cooled condenser. The organic fluid now in the liquid phase is pumped back to the heat exchangers – either vaporizer or pre-heater. After the heat has been extracted from it, the geothermal is reinjected to replenish the aquifer and ensure sustainability *(Mabwa, 2007)*.

Greenhouse heating at Oserian Flower farm

By the year 2000, global statistics on non-electric uses of geothermal energy showed Kenya had a capacity of 1.3 MWt with a capacity factor of 0.25. The annual heat produced then was 10 TJ/yr with 3 GWh/yr of utilization mainly from well OW 101 on the Olkaria field leased to Oserian by KenGen. Lagat (2003) has documented non-electric uses of hot water from well OW-101 at Olkaria Central field in green house heating, soil fumigation and addition of carbon dioxide to green houseplants at Oserian. Steam from the well is used to heat fresh water through heat exchangers and the water is then circulated to heat the greenhouses.

EBURRU PILOT PLANT

The Company has engaged a consultant and contractor for the construction of the Eburru Pilot plant that will initially generate 2.5 MW. The generation capacity will finally be upgraded to 25 MW. The Eburru geothermal field has a greater potential estimated to be more than 50Mw. Figure 3 shows MT resistivity anomaly map at -3000m above sea level with the low resistivity values indicating the geothermal resource.

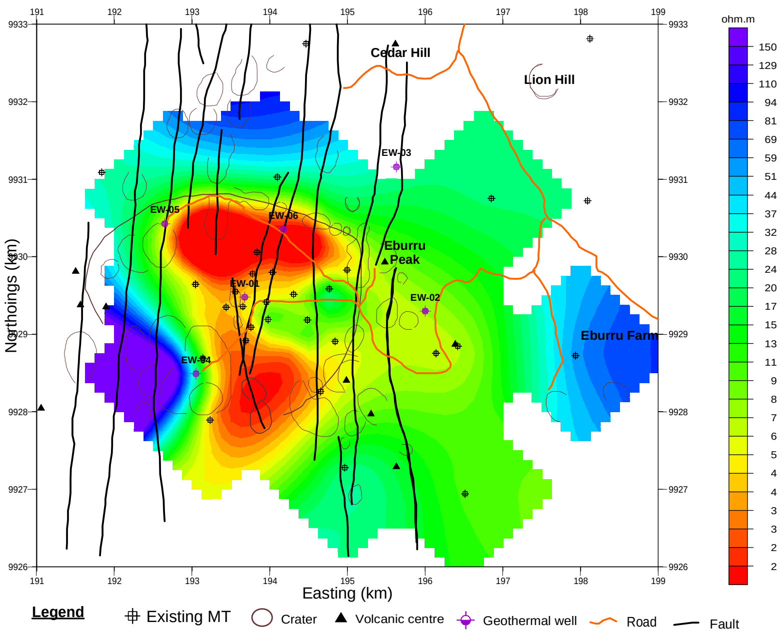

Figure 3: MT Resistivity plot at -3000 meters above sea level of Eburru Geothermal field.

OTHER GEOTHERMAL FIELDS

Suswa

The Kenya Electricity Generating Company undertook detailed surface exploration studies in the Suswa prospect. Suswa prospect has a central volcano with an inner and outer caldera. The diameter of the outer caldera is 10 km while that of the inner is 4 km. Surface manifestations in the prospect are fumaroles, steam jets, steaming and hot grounds with temperatures of over 93ºC. Plateau Trachyte Formation comprises flood trachytes that erupted on the developing graben. (Omenda et al, 2000). Suswa is a Quaternary caldera volcano in the southern part of the Kenya rift. The prospect has a central volcano with an outer and inner caldera (Simiyu, 2010). The next phase is for exploratory drilling to be carried out.

Longonot

The Longonot geothermal prospect is a Quaternary caldera volcano in the south of Olkaria prospect and is within the Longonot volcanic complex. The volcano is has summit crater and is largely a central volcano. Detailed surface exploration work in Longonot was carried out in 1998 by KenGen. In 2005, additional geophysical studies were conducted in order to delineate the areal extent of the anomaly. Exploratory drilling is yet to be done in the area to confirm the subsurface conditions.

Menengai

The Menengai prospect is located at Nakuru area and is geologically located at a triple junction of the Kavirondian Rift trending East west and the Major Kenyan Rift which trends North South. Detailed surface exploration was carried out in 2004 by the Kenya Electricity Generating Company Limited and it is one of the most promising prospects with a potential of over 700MW. Menengai volcano caldera is one of the high potential prospects in Kenya. It is Located in Nakuru and therefore is close to high power transmission lines and is situated close to a populated town. Menengai is a major Quaternary caldera volcano located within the axis of the central segment of the Kenya Rift. The volcano is located within an area characterized by a complex tectonic activity characterized by confluence of two tectono-volcanic axes (Molo and the Solai). The volcano has been active since about 0.8 Ma to present. The volcano is built of Trachyte lavas and associated intermediate pyroclastics. Most of the pyroclastics activity accompanied caldera collapse. Post caldera activity (<0.1 Ma) mainly centred on the caldera floor with eruption of thick piles of trachyte lavas from various centre (Simiyu, 2010)

Arus Bogoria

Arus and Lake Bogoria is an area with no observable central volcano. Geothermal manifestations mainly hot springs, geysers, hot grounds, fumaroles and steam jets occur along the shore of Lake Bogoria and at Arus. From the geoscientific work done in the area done in 2006 by KenGen, the prospect is ideal for a binary system as the prospect is considered to have low to intermediate temperature system which can generate to up to 400MW. The prospect is also ideal for direct uses of recreation and within the area a hotel has utilized the hot water for its swimming pools and other local use within the hotel.

Figure 4: Geysers at the Lake Bogoria prospect.

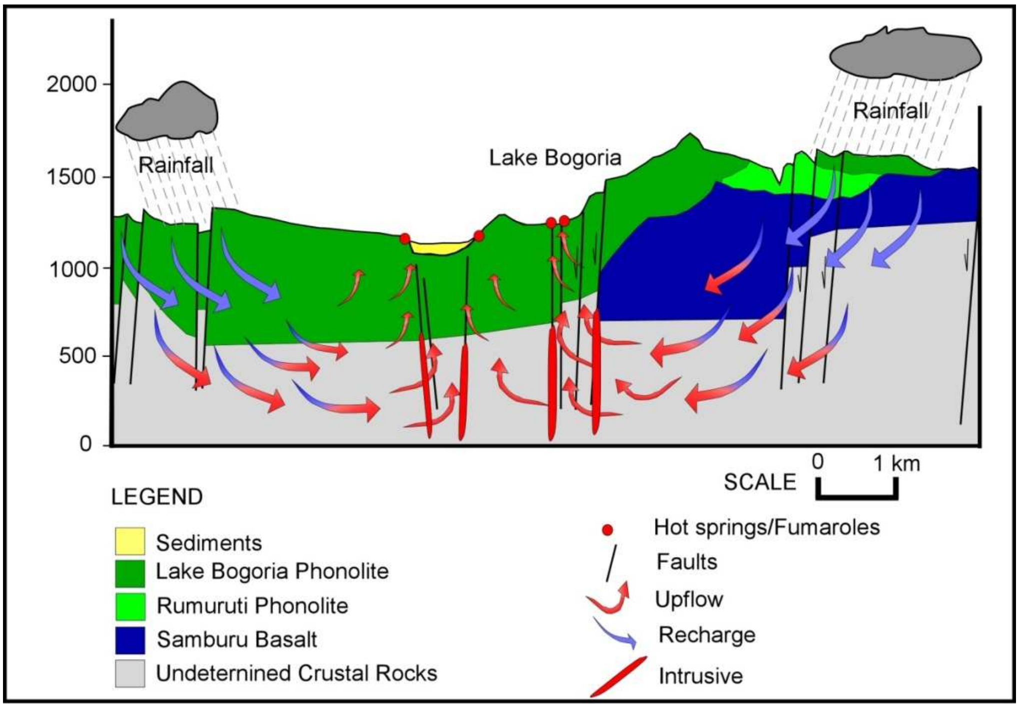

Figure 5: Conceptual model of the Arus- Bogoria prospect.

Paka

Detailed surface investigations to determine the geothermal potential of Paka was carried out between 2006 and 2007 by Kengen in collaboration with the Ministry of Energy. Paka volcano is one of the localities in the Kenya Rift endowed with geothermal resource potential. Occurrence of a geothermal system at Paka is manifested by the widespread fumarolic activity, hot grounds and hydro thermally altered rocks.

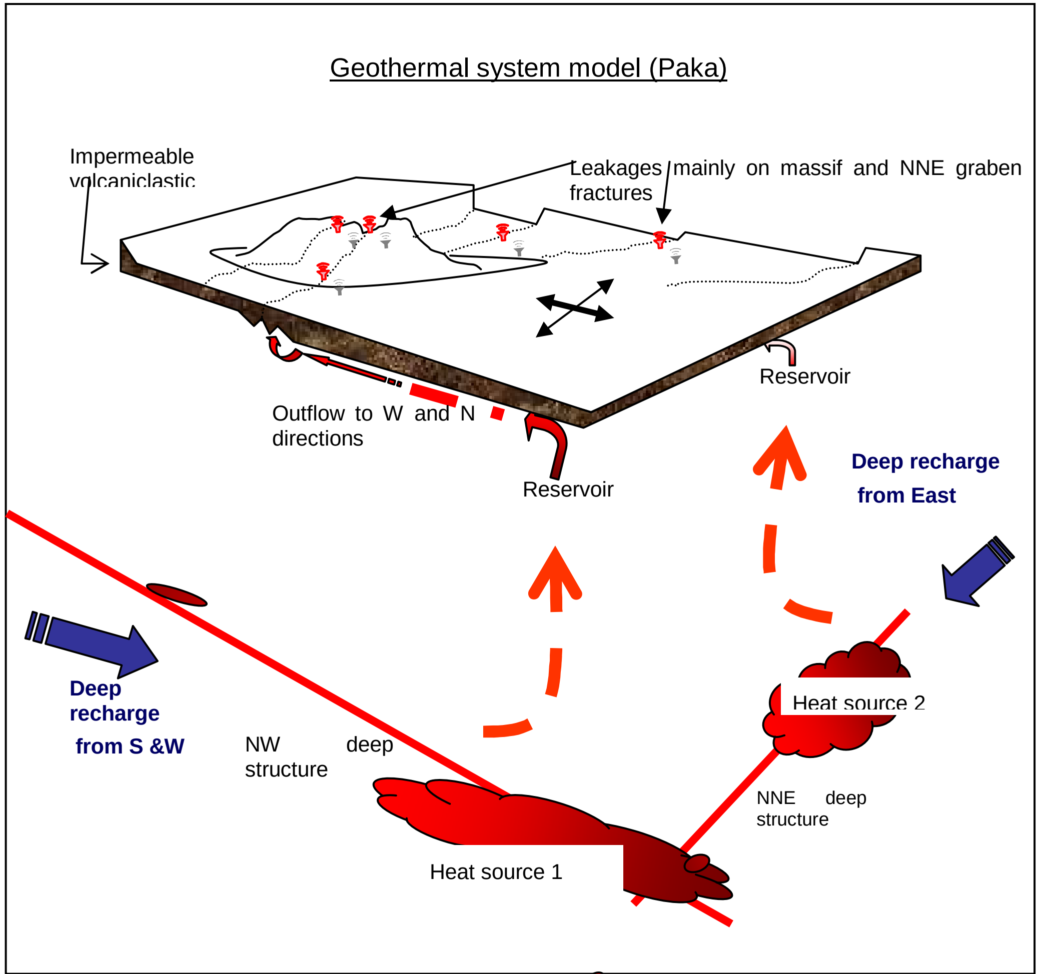

Figure 6: Conceptual model of the geothermal systems at Paka (after KenGen and MOE assessment report.)

Exploratory wells to confirm the geothermal reservoir have been sited. Estimated potential of the prospect is >500 MWe.

LAKE BARINGO PROSPECT

Lake Baringo geothermal prospect located in the North of the Menengai prospect and is characterized by hot springs, fumaroles and highly altered grounds. Surface manifestations include fumaroles, hot springs, thermally altered hot grounds and anomalous ground water boreholes. The Kenya Government and KenGen carried out detailed surface studies in 2004 (Mungania et al, 2005).

The geology of this area can be summarized culmination of trachytes, trachy-phonolites, basalts and alluvial and fluvial deposits on the lower parts. There is no evidence of a centralized volcano or a caldera in this prospect. The temperatures for this prospect are low and hence due to this it is ideal for a binary cycle generation. Exploration drilling is recommended to confirm the viability of the prospect.

Korosi-Chepchuk

KenGen carried out detailed surface exploration in Korosi-Chepchuk prospect in 2006. The geology of Korosi is mainly dominated by the intermediate lavas mainly trachytes and trachy-andesite, which cover the central and eastern sectors of the prospect area and basalts dominating the south, northland western sectors. The southwestern plain is, however, dominated by fluvial and alluvial deposits whereas the pumice deposits dominate the western plains. Chepchuk volcanic complex consists of a sequence of flows of trachyte with inter-layering of basaltic lavas of various ages and pyroclastics. The geothermal manifestations in Korosi are seen in the elevated surface temperatures, steaming grounds and fumaroles. Hydrothermal alteration is associated with the Korosi volcano with reservoir temperatures in excess of 300°C as deduced from gas geothermometry. Exploration studies indicate that the power potential for the prospect is over 450 MWe. In the North of the Rift there are other geothermally active areas which little exploration work has been done. These are Emuruangogolak, Namarunu, Barrier.

CONCLUSION

Kenya has a great potential in geothermal resources when exploited would generate over 7000Mw. In Olkaria it has been a success story and Kengen is optimizing this field with incorporation of new technologies to ensure maximum output from the steam from the field. Of all the fields in the Kenyan Rift only Olkaria is being exploited and that is why the government has given priority to the geothermal by incorporating the Geothermal Development Company to ensure that the exploitation is achieved. Geothermal development is a very expensive affair and therefore to ensure the fast growth in this sector is to ensure that funding is secured early and the proper planning of the projects to ensure money is not lost in delays. Kengen has a fine track record ensuring that project are completed ahead of schedule and hence has enabled to ensure addition of Megawatts to the national grid. There is need to do more geoscientific work on the other fields outside of Olkaria to ensure the realization of vision 2030 of achieving 4000Mw of electricity from geothermal.

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