Pilot Project
For
Energy and Mining Economic Beneficiation from Assal (Djibouti)
Geothermal and Mineral Resources

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ABSTRACT

Djibouti is very small country (23 200km2) in the horn of east Africa.

It is stable, politically neutral, democratically regime country. Its mining and investment policies encourage investments.

The policy of the government is to provide facilities any local and foreigner investors to obtain permits/ concessions for geothermal and mining exploration and then to evaluate and develop the potentiality of the geothermal and mineral resources of the country in general and particularly in Assal area.

The republic of Djibouti is located on the triple junction of the red sea, Gulf of Aden and east Africa rift.

The economy up to day depends on the strategically position of Djibouti port as a centre between Europe, Africa and Asia as well as the principal railway to link Ethiopia to the sea.

This exceptional geological condition of the country, as located on one of the world's hot spot, contains numerous active hot springs and several areas favourable for geothermal energy and geothermal mineralization systems.
Some of these hydrothermal systems have investigated as potential en energy and gold and base metals sources, especially in Assal area.

Up to now Djibouti electric power generation depends only on the imported petroleum products and the price fluctuation in the international oil market.

Exploration for geothermal energy in the Assal rift has been underway since 1970.
Several deep wells were drilled and met high temperature and high enthalpy fluid production containing valuable minerals.
Epithermal gold deposits with high grade near the surface are discovered in the Assal area.

The Government policy is to develop energy and mineral resources of Assal as a new economic pool of the country and encourage foreigner interested investors to come and develop these resources as a complex industry for energy and minerals production.
As a lot of effort and money has been spent on the geothermal exploration work at Assal, it will be our best interest to plan and build a pilot complex plant there to provide electric power and water to the region.
This pilot project could also be used as a tool to train local staff for larger geothermal plants in the future.

Introduction

The government of Djibouti, in its desire to promote the realisation of economic development in the lake Assal region has undertaken a technical economic feasibility study of an industrial complex of pilot project of this area. The aim of this pilot project is to demonstrate the socio-economic profitability of putting in place the necessary basic infrastructures as energy, acces and water in order to attract investors to the lake Assal region to explore, exploit and add value to the different natural resources from geothermal and mineral resources of the region.

The unavailability of reliable and affordable domestic energy resources is identified as the key barrier to socio-economic development in Djibouti.

Djibouti has no coal, oil, gaz and surface water to produce electricity.
The government target is to develop all alternative renewable energy and the priority goes to the geothermal.

This pilot project will determine the ways to produce electricity and to extract valuable minerals in the geothermal process to bring down the cost of geothermal power and make it and other minerals of the area more attractive.

Potential impact of geothermal resources in Assal region

Impact of geothermal development will enable the availability of secure, reliable, adequate, clean and low cost energy resources.
This will create economic growth in the region as it located in the centre of the country by encouraging the development of industry and commerce and provide clean water and other essential social services wich are actuallly rare.

Previous geothermal project in Assal area.

The different geothermal works including field studies and exploration by drillings between 1970 and 1990, revealed the deep Assal geothermal reservoir as a high regional thermal flux with high salinity and an intermediate reservoir with lower temperature and lower salinity.

Assal deep reservoir first phase exploration:

Assal deep reservoir was explored (BRGM, 1975) by two well, A1 and A2, respectively with depths of 1554 and 1146,5m.
No evidence of permeability appeared in Assal 2 but Assal 1 encountered a fracture zone at 1137m depth and was discovered the Assal deep geothermal reservoir.

The production test on Assal 1 showed a fluid flow with 20% vapor fraction at 6 bars at the well head and high salinity of 110g/l.
Long term production results showed a complex deposit of silica and in the well head and the production lines.

Polymetallic sulphides deposits occur inside the borehole mainly in the form of lead and zinc sulphides (BRGM, 1980).
Four new wells were drilled in the second phase of the exploration (aquater 1989) and reached respectively the following depths: A3:1316m; A4:2013m; A5:2105m; A6:1716m.

Assal 3 and Assal 6 have similar temperature profile and show one intermediate and one deep reservoir. While the later does not appear in assal 4 and Assal 5.

The deep reservoir has been tapped by Assal 3 and Assal 6.
The bottom hole temperatures are respectively 263, 5°c and 280°c.

Scale samples and analysis showed sulphide (Pbs, Zns) deposits at high presure and amorphous silica with Mn and Fe at low presure.

Assal intermediate reservoir:

As the objective of the past geothermal drilling exploration was target only the deep high anthalpy reservoir, the intermediate reservoir in the Assal rift zone was negleted.
Assal rift is between goubhet (sea level) and Assal Lake (155m below sea level) thus an important underground flux of sea water occurs in the upper part of the recent volcanic series toward Lake Assal mainly through open fractures.

Between this superficial cold water zone and the deep high enthalpy reservoir all six wells in Assal encountered the intermediate reservoir.

A thermal study on the surperficial underground flow from goubhet to lake Assal and the thermal leaching, and the comparison to the spring's temperatures at the lake Assal result in a substancial balance between the removed heat and the geothermal flow (Enel 1990)

From this it follows that the lower intermediate reservoir with temperature ranges of 140°c to 190°c must be thermally protected.

Chemical analysis of the reservoir fluid showed total dissolved solids of about 50g/l which is less than half of the concentrated in the deep reservoir.

Potentiality of Mineral Resources in Assal Region

Industrial Minerals

Perlite

As perlite outcrops have been identified in numerous places in the territory of Djibouti, the Egeralayta deposit at Assal area was partially studied.
The surface geological study showed that the deposit itself, which is sub circular (with a diameter of about 2km) and of the flow-dome type, forms only a small part of a large (about 15km) siliceous massif.

Geological and mine assessment studies (BRGM;1988-1989) of the deposit has shown the industrial significance of the deposit, due to the quantity of the reserve that puts it among the top world –wide deposits, and to the quality of the ore that it contains

The Persian Gulf, East Africa, India and South-East Asia are the priority market to sell this perlite production.

Salt

Lake Assal located at 155m below sea level is surrounded by a deposit of solid salt Saumur containing about 340gr/l of salt.

The solid salt has a variable thickness up to 60m at some places and total surface of 60 km2

The pickling brine lake cover a 50 Km² surface with 25m deep.

The reserve represents several billons of tons and is considered inexhaustible source because of input from salted brines and sea water permanent flow.
Salt production will be sold primarily in the following markets: Ethiopia, Somalia and other African countries members of Comesa market, as well as the Middle East and Europe. In lake Assal region exist also a lot of useful minerals among theme: gypsium, pumice, diatomite, zeolite…
Analysis and industrial test of gypsium and diatomite have confirmed the high quality of these minerals.

- Epithermal precious and base metals.

The unique exceptional geological structure of triple junction of extensive rifts, combined by the intensive recent volcanism, and tectonic and hydrothermal manifestations and high mineralized geothermal fluid were the pathfinder to discover the geothermal mineralized system in Assal region.

The tenor up to 11g/t (Green River 2005) of gold from samples taken on the surface and the presence of the considerably extends of different potential zones near Assal lake confirme the very attractive gold mineralization of the area.
In comparison with other Epithermal gold deposits of the geothermal mineralization system let us to believe that base metals deposits must also be present beneath gold

Implementation of necessary basic infrastructures

The government of Djibouti, in its intention to promote amongst the international financial institutions and international private sector, the realisation of an economic development pool in the lake Assal region, has undertaken a technical-economic feasibility study (Tecsult and SAJE Canada, 2003).

This feasibility study was aimed to demonstrate the economic profitability of putting in place the necessary basic infrastructures in order to attract companies to the region to exploit and add value to the different natural resources.

The study concludes that it is economically profitable for the State of Djibouti to proceed with the implementation of a dock, mineral or storage and handling equipments, building and necessary accesses, a desalination plant and a thermal power station.

Proposed pilot project for Energy and Mining economic beneficiation from Assal Geothermal resource:

The proposed project will have the following components;

Assal Intermediate Geothermal reservoir

-Review of geophysical data and other data available
-Using the full advantage of the existing geological, geophysical information for well siting

-Drill 5 development wells up to 600m

-Testing, analysis, reservoir engineering and modelling and resource evaluation

-Study of environment impact

-Feasibility of Assal Intermediate geothermal exploitation and design power pilot plant of about 2,5 to 5 Mw by binary system.

Existing productive wells A3 and A6 of deep reservoir

-Review the current status of the wells

-Clean the wells and equipments and do the necessary works in case of obstruction.

-Put again the wells in production and carry new testing analysis of the fluid.

-Mineral resources study.

-Feasibility study and design a pilote power plant 2,5 to 5 Mw.

This pilot project for deep reservoir will be designed to harvest minerals from high-Temperature geothermal brine.

The minerals recovery program will make the geothermal electricity more cost effective and tap valuable minerals from the fluid we bring to the surface for power production.

Our target is to evaluate potentiality of polymetallic minerals and silica from deep reservoir of Lake Assal region and their economic impact in the project.

We belive the extraction of valuable minerals from the deep reservoir helps to bring down the cost of the geothermal power of Assal deep geothermal resources and make it more attractive.

The energy produced from this pilot project will be consumed locally, supplying the necessary electricity to the different industrial and base infrastructures installations of the future Pool economic of Assal region.

SCOPE OF WORK

Shallow reservoir
Review of geophysical and geological data available.
Drill 5 new wells up 600m
Testing and analysis of fluid, reservoir engineering and modeling
EIA (environment impact assessment)

Deep reservoir
Review the status of A3 and A6 wells
Clean the wells and equipments
Do the necessary work in case of obstruction
Put again the productive wells in production
Carry new testing and analysis of the fluid
Appropriate technology study to recover mineral resources
Seismic risk study
EIA

Power development for 5-10Mw pilot plant
Feasibility study and design of the power plant
Local distribution line study

CONCLUSION

It is clear that Energy is considered as the key, the motor and the base of all economical, social well being and development for any country of the world.

The availability and access, sufficient and low cost energy contribute largely to the economic growth, the reinforcement of the competitiveness of the country, the upgrading of the daily life of the population and of course the reduction of the poverty.

With the creation of pool economic in Assal, there will be growing market demand for power to provide all business services development for the establishment of different mineral plants and water desalination unit as well as tourism activities (lake Assal has a high potential for tourism).

By this pilot project, the government policy is to initiate:
The development of Assal natural resources;
The production of electricity from existing geothermal sources;
The recovery of minerals from geothermal fluid;
To provide the necessary base infrastructures which facilitate the exploitation of other mineral resource of the region
To prove to the international private sector that Assal geothermal and mineral resources are attractive and constitute reel profitable business opportunities to invest