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The Unique Challenges of Geothermal Exploration in Papua New Guinea - An Overview

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ABSTRACT

The Mineral Resources Authority (MRA) of Papua New Guinea through its Geological Survey Division (GSD) has been carrying out reconnaissance in a number of active thermal sites and has encountered unique challenges each time. One of the major challenges encountered is Land ownership, which is a big issue that must be resolved prior to any form of investigation and or formal engagement with the locals and the place of interest. Topography, accessibility to site, cultural differences, technical expertise, funding, policy and legal framework are but some of the issues that the Mineral Resources Authority deals with each time a geothermal reconnaissance work is undertaken.

Some of these challenges may be uniform throughout the country and may also have similarities with other developing countries. However unique differences noted within different regions of the country are related to land ownership, cultural practices, illiteracy rate and to a lesser extent topography and accessibility.

Different regions in PNG have unique beliefs and ways of dealing with land and sacred sites that associate with active thermal features, which if not handled properly may bring about undesirable outcome. A top down approach has been adapted in addressing the landownership issue whereby the responsible provincial and local government are notified and consulted and subsequently the local landowner becomes involved, which has proven to be effective. Mutual respect and understanding on the traditional explanations and beliefs of scientific phenomena goes a long way to foster a working relationship between all parties.

The rugged terrain and lack and or debilitating infrastructure makes access to most of the geothermal active sites almost impossible, thus requires detailed plans and a great deal of logistical arrangements. Tough, fully kitted four wheel drive (4WD) vehicle and use of helicopters are an essential component of project planning. This sometimes poses huge strain on budget. Use of boats is also essential in some areas and is more economical than use of helicopters.

High illiteracy rates in rural areas also have a huge bearing on exploration projects. Due to the lack of education, the locals fail to see the big picture hence stall progress due to lack of understanding.

Conflicts and issues must be addressed objectively and it is prudent to double check decisions made the previous day as new developments are likely to happen the next day. Mutual respect and local participation in reconnaissance work has proven to be an important factor to the overall success.

1. INTRODUCTION

Papua New Guinea is an Island Nation in the South Pacific, north of Australia and east of Indonesia. It has a total area of ~463,000 square kilometers and a population of ~7 million people (2012 World Bank estimate) having a vast cultural base with more than 800 languages and ethnic groupings and by far the largest of the Pacific island countries and territories.

PNG is socially divided into four regions with 22 provinces consisting over 600 islands. Cultural practices, beliefs and obligations within these regions vary from each other endowing its unpredictable challenges.

About 90 percent of the populations live in rural areas where landownership is customarily owned, however the national government has jurisdiction over all mineral and energy matters according to the Mining Act 1992, which states that, *"All minerals existing on, in or below the surface of any land in Papua New Guinea, including any minerals contained in any water lying on any land in Papua New Guinea, are the property of the State"*. A lot of mineral and energy reconnaissance has been carried out in PNG and engagement with the local community has always been a challenge.

There is only one geothermal plant in PNG for power generation, currently in operation in Lihir Island, which is just over 900 kilometers north-east of Port Moresby, the capital city of PNG. The 56MW power plant is owned and operated by Newcrest Mining Limited, acquired from its predecessor Lihir Gold Limited. Two other prospective sites noted and recommended for further studies are the West New Britain Province and Ferguson Island in Milne Bay Province (McCoy-West et al., 2009).

Further work and development of geothermal in PNG will be regulated and administered by the policy and legal framework that is currently going through the formal process of being accepted and endorsed by the parliament of PNG.

2. GEOLOGICAL BACKGROUND

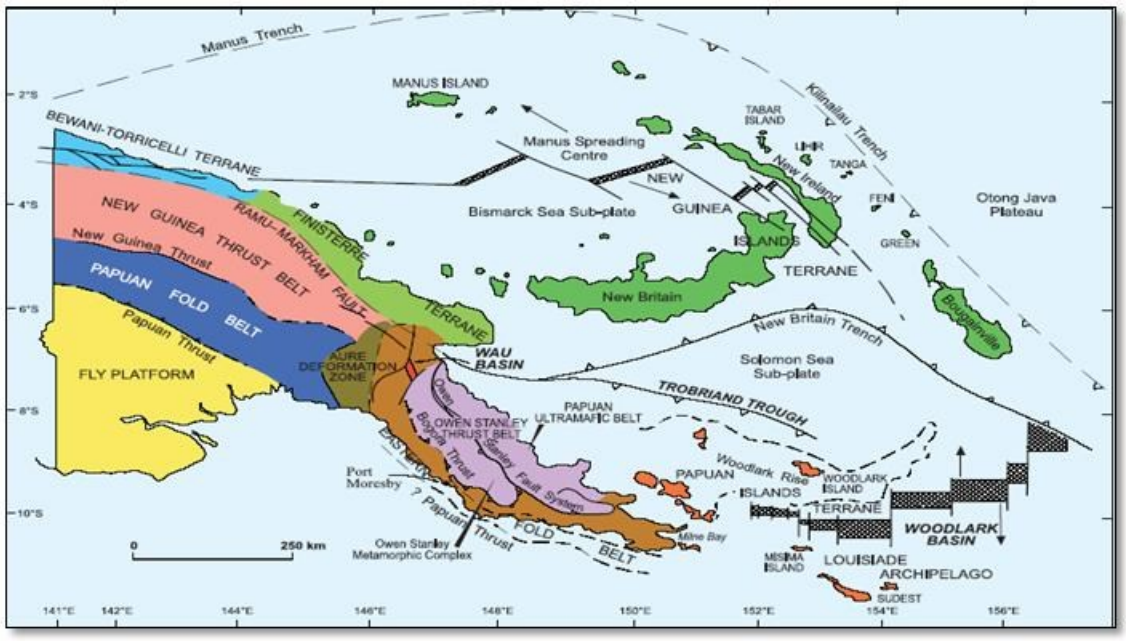

Figure 1: Geology and tectonic setting of PNG

The unique geology of Papua New Guinea (PNG) and its considerable mineral resources and geothermal potential is a result of its location on the "Pacific Ring of Fire". PNG is located on an active tectonic region or a collision zone between three major plates; the north-ward moving Indo-Australian plate, the west-northwest moving Pacific plate and the eastward moving Caroline plate. A number of micro-plates occur between the Indo-Australian and Pacific Plates; the Solomon plate to the southeast and North and South Bismarck plates in the north. These micro-plates located offshore are bounded by spreading ridges, deep sea trenches and trans-form faults while those onshore are represented by thrusts, extensional and strike-slip faults and folds (Johnson and Molnar, 1972).

The geological framework of PNG comprises a series of geological terranes that are commonly separated by geological elements or structures as shown in Figure 1. Detailed descriptions of the geological terranes can be found in references found in the Geology and Mineral Potential of PNG booklet. The components that define the tectonic setting of PNG include;

(1) The Australian Craton, which underlies the Fly Platform and much of PNG as a rigid continental block extending to the south. The Fly Platform comprises the Australian Cratonic (Proterozoic–Permian) basement that is overlain by the Triassic–Neogene sediments of the Papuan Basin. The platform is essentially unaffected by the Cainozoic deformation that is apparent in the terranes to the north.

(2) The New Guinea Orogen is characterized by the mountainous spine of PNG which was formed by the collision of the major plates as discussed earlier. Most of mainland PNG Figure 1 is part of the New Guinea Orogen including the Papuan Islands and excluding the Finisterre Terrane. It is composed of metamorphosed sediments that have undergone fold thrust belt deformation, island arc magmatic extrusive and intrusive rocks and obducted oceanic crust. The oldest rock type found in this terrane are the Ultramafic rocks of Eocene-Oligocene or older.

(3) The Melanesian Arc consists of now dismembered islands to the north-northeast of the New Guinea Orogen within the segmented oceanic Pacific Plate margin. The islands of the Melanesian Arc were formed by subduction-related island arc magmatism beginning in the Eocene.

(4) The Pacific and Caroline Plates have been subducted in the Manus and Kilinailau Trenches respectively and are locally obducted onto the Orogen.

3. GEOTHERMAL RESOURCE POTENTIAL OF PNG

Papua New Guinea (PNG) has up to 55 known geothermal occurrences which are found within distinct geological settings and are commonly clustered within the Melanesian Arc. According to R.F. Heming, geothermal occurrences in PNG can be classified into two types; those related to volcanism and those resulting from a regional heat flow most likely caused by radiogenic sources like those found in the Wau-Bulolo area of Morobe Province. Examples of pre-dominant geothermal activities are those due to volcanism which include, Lihir, New Britain Islands and other islands along the volcanic arc including the D'Entrecasteaux Islands, particularly Ferguson Island in Milne Bay Province. A number of field investigations have been carried out on thermal waters in the region with further geochemical analysis carried out in Lihir Island and the most recent ones in West New Britain and Ferguson Island to ascertain the source and viability of thermal anomalies.

Studies carried out by various experts have shown that PNG has huge geothermal resource potential, with an estimate of producing 3000 – 4000 MW of geothermal power (Hairai, 2004). Lihir's 56MW geothermal power plant is the only one in production in PNG and is a testament to the potential PNG may have in geothermal energy production.

Though there is limited data to ascertain the capacity of other areas; the recent geochemical sampling in West New Britian Province and Ferguson Island in the Milne Bay Province has indicated high reservoir temperatures of more than 250 degree Celsius (Mroczek & Rae, 2013)

At the time of this document, resistivity and ground magnetics survey has been carried out respectively in the two areas and preliminary results has indicated a great extent of the resource. More geophysical and geochemical studies are planned for these areas and it is anticipated that more insights will be gained as more of the subsurface is understood.

4. MAIN CHALLENGES

Some of the challenges listed here are experienced in most developing nations with geothermal potential; however the first four are unique to PNG.

4.1 Land Ownership

Land ownership issue is one of the significant challenges that are faced in PNG when engaging with the locals for any form of reconnaissance and or other development initiatives. Up to 90 percent of the land in PNG is customarily owned and only 10 percent owned by the state, with the later concentrated in urban centers.

Land in PNG is not regarded as a commodity but as an integral part of a village or community. The way customary land is owned, distributed and managed in PNG also varies with different cultures with respect to the different regions within PNG. Customary land-ownership and boundaries are not legally documented but are passed down and inherited through generations by word of mouth and placing of significant traditional landmarks to demarcate boundaries of different clans and or individuals. These boundaries are strictly observed to ensure others don't trespass. However, over the last 10-15 years, due to the influx of investment especially in the extractive mineral industry, customary land-owners started forming incorporated land groups (ILG) to formally participate in the spin-off benefits.

The Mineral Resources Authority of PNG through its Geological Survey Division has utilized a top down approach to mitigate land ownership issues which has proven to be effective. Prior to any form of engagement with the locals, a notice of intention to carry out a survey in an area of interest is circulated to the Provincial and Local Level government representatives of the area. A team of MRA personnel do a follow up on the respective government officials with maps and other relevant information to further discuss details of proposed work. The local government representatives are primarily tasked to liaise with the local landowners and custodian of the area of interest of the proposed work, and engage some of the locals as paid field assistants and guides. The local-hire's then provide security and further liaise with the locals' as the team continues to carry out its work.

4.2 Cultural Differences within PNG

As mentioned earlier, PNG's diverse culture has a significant impact on reconnaissance programs. PNG is the most heterogeneous country in the world with more than 700 cultural practices, more than 800 languages and divided into four (4) major regions consisting of 22 provinces. The approaches taken to engage with locals in the four different regions vary greatly. For instance, the Islands region is a matrilineal society hence most of the land decisions are made by the womenfolk while other community obligations and important decisions are made by the men. In the Southern region, land is owned by the paramount chief and locals seek his permission for all land issues whilst land ownership in the Highlands and Momase region is owned by clans and individuals.

It is, however, considered disrespectful to engage directly with the womenfolk regarding land issues. All negotiations must be done with the menfolk in the presence of the women and the women are at liberty to have their say especially in matrilineal societies. In areas where the paramount chief has ultimate control over land, all negotiations must be made directly with the chief or his appointed spokesperson and whatever is agreed therein is often considered as final.

It is also well noted that most of the geothermal sites are considered sacred sites with unique legends. Beliefs of the spirit world are prominent in PNG culture and thermal features are highly revered by the locals. Any form of sampling or visit by outsiders requires certain rituals or special permission.

Mineral Resources Authority in its engagement with the locals during reconnaissance work has always taken note of the legends and beliefs' upheld by the locals and always strive to act and carry out its work in a manner that is not disrespectful to their beliefs. Such gestures go a long way to building a working and mutual understanding with the locals thus preventing unnecessary conflicts during the course of the work.

4.3 Topography and Accessibility

Papua New Guinea is a very rugged country, with mountainous terrain and big rivers. Most of the geothermal occurrences are located in very remote areas, often isolated, where access is often difficult due to poor or lack of infrastructure. The few existing infrastructure are not maintained leaving them in debilitating conditions.

This makes access to most of the geothermal active sites almost impossible, and thus requires a great deal of logistics and planning. Tough fully kitted four wheel drive (4WD) vehicles and use of helicopters are an essential component of project planning. This sometimes poses huge strain on the budget. Use of boats is also essential in some areas and is more economical than use of helicopters.

MRA personnel have always gone out prepared to camp out for up to 5 days in the field. Some of the field experiences include, crossing over fast flowing rivers on single tight-roped bridges, swimming across rivers, taking a whole day to climb over one ridge, and so on.

4.4 Illiteracy Rate

The high illiteracy rates in rural PNG due to lack of government services such as schools, and debilitating infrastructure as mentioned above (4.3), has significantly contributed to peoples' level of understanding and their ability to perceive the bigger picture. Most of the decisions made by the locals are subjective and are bound to change with changes in circumstances. Their ability to trust foreigners is subject to their previous experience and/or influence from others who have a better relationship with foreigners of certain ethnicity or nationality. Most have preconceived preferences therefore it becomes more difficult to convince and foster a good relationship if one is in their "bad" books.

4.5 Funding

The lack of funding and incentive from the PNG government is a direct result of the lack of awareness and understanding on geothermal energy and its application in PNG; which is a major disadvantage in the drive for geothermal energy development. However with more policy makers and planners becoming aware of the industry, more attention is now being given. It is anticipated that more government funding will be made available for the purpose of geothermal exploration. To date MRA has sought all it's funding for geothermal exploration and studies in PNG through foreign aid. The main foreign donor agencies supporting PNG geothermal exploration and studies are the World Bank Technical Assistance 2 (WBTA2), and the Iceland Government through the United Nations University Geothermal Training Program (UNU-GTP). It is MRA's hope that the support will continue to be there to allow for more work to be carried out.

4.6 Legal and Policy

A geothermal Bill was tabled in PNG National Parliament in 2011 but the policy has a lot of disconnect with the realities of geothermal industry because of the lack of experience and or exposure to the industry. The Bill has been put aside until recently, and a team of technical experts have been engaged to review the bill.

At the time of this document, draft policy and legal framework of geothermal exploitation and development in PNG is before the parliament of PNG, the highest legislative body of PNG for formal debates and endorsement.

4.7 Technical Expertise

Papua New Guinea has very little technical expertise and exposure on geothermal exploitation and development due to the very recent introduction of the industry in the country.

The few professionals who are exposed to the industry are those working at Lihir Gold Mine's 56 MW geothermal power plant and more recently by MRA GSD staff. The former concentrate more on the production and maintenance of geothermal power and have attended short courses and training in the areas of well testing, geosciences and reservoir management facilitated mostly by GNS Science, NZ, MB Century NZ and Auckland University.

The later focusses more on reconnaissance work and MRA personnel's have attended short courses run by GNS Science, NZ and UNU-GTP in Iceland. The cost of sponsorship has always been a problem however as more scholarships become available; more personnel can be trained therein.

So far, three GSD staff from MRA have been given Fellowships by the Iceland Government for 6 months intensive training in Geothermal Sciences at the UNU-GTP in Iceland and have successfully completed the program. MRA also anticipates sending more personnel to UNU-GTP Iceland as well as University of Auckland, NZ as more funding become available.

5. SUMMARY AND CONCLUSION

The construction and successful operation of the 56MW geothermal power plant in Lihir Island has demonstrated the potential of this technology in PNG and has opened up opportunities for geothermal power development in other parts of PNG. This will not only see PNG contributing to the reduction of greenhouse effect but is an opportunity to substantially reduce the cost of power generation.

Though PNG has demonstrated promising potential of the industry, much work needs to be done to collect geoscientific information to fully substantiate the viability of the industry. MRA in its capacity has carried out geochemical and geophysical surveys (DC Resistivity and ground magnetics) in a number of sites in West New Britian Province and Ferguson Island of Milne Bay Province. The results from these surveys have indicated deep reservoir temperatures, and preliminary reports suggest more work needs to be done to gain a better understanding of the reservoirs.

The challenges encountered in exploration work in PNG are unique due to many contributing factors. Land ownership is the main challenge that must be addressed delicately prior to any work. Land in PNG is not seen as a commodity that is tradable but as an integral part of the community. Different regions in PNG address land issues differently therefore due attention must be given when dealing with different regions. Cultural differences, beliefs and practices regarding sacred sites must be respected and given due honor.

The rugged terrain and debilitating infrastructure has always impeded progress and places constraints on the budget. Logistical arrangements and costs are high, especially with the use of helicopters to access project sites. All these compounded with the high illiteracy rates in rural PNG is deemed as one of the biggest setbacks. People's lack of understanding of the big picture and their suspicious perception of foreigners sometimes contribute to a slow start of work.

Despite these, mutual respect and local participation in reconnaissance work has proven to be an important factor to achieving the overall success of geothermal exploration projects.

6. ACKNOWLEDGMENTS

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