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Geothermal Potential of the Cordillera Region, Philippines

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ABSTRACT

Geothermal remains one of the most promising potential of energy source in the Philippines as it ranks second to the United States of America in installed geothermal electric capacity. Its favorable tectonic setting being situated in the Pacific "ring of fire" has endowed her with a large number of geothermal areas widely distributed throughout the country.

The Cordillera Administrative Region (CAR) in Northern Luzon is considered as one of the potential areas for future geothermal development. It has vast resources of indigenous energy that includes geothermal energy, which can be tapped for power and/or non-power applications. Based on the Philippine Energy Plan for 2004-2013, the Region possesses the highest estimated geothermal resource potential in the island of Luzon. Identified geothermal areas with potential for development in CAR include Daklan and Buguias in Benguet, Batong Buhay in Kalinga, Tinoc in Ifugao, and Mainit in Mountain Province. These areas belong to the Luzon Central Cordillera Volcanic Belt consisting of non-active volcanoes hosting several geothermal resources. Except for Daklan, exploration of these areas has not been completed in detail. Further exploration of these prospect areas is recommended to define precisely their resource potential.

1. INTRODUCTION

Geothermal remains to be the most promising potential of energy source, as the Philippines ranks second as a user of geothermal energy for power generation, surpassed only by the United States. Presently, the total geothermal power generating capacity is 1931 MWe accounting for 15% of the total installed generating capacity nationwide.

The Cordillera Region is considered as one of the potential areas for future geothermal development. Identified geothermal areas in CAR include Daklan and Buguias in Benguet, Batong-Buhay in Kalinga, and Mainit in Mountain Province. Based on the PEP for 2004-2013, a maximum total of 590 MWe geothermal energy potential estimates are available in the Region.

This paper summarizes the geothermal potential of the Region based on previous and recent studies made by the Philippine Department of Energy (PDOE) and other private companies. The purpose of which is to assess what works still need to be done in the area and also serve as an investment package for interested potential investors.

1.1 Location and Boundaries

The Cordillera Administrative Region is principally composed of the provinces of Abra, Benguet, Ifugao, Mountain Province, Kalinga and Apayao. The Region is landlocked as shown in Figure 1. It is bounded in the North by the Provinces of Ilocos Norte and Cagayan; the South by the Provinces of Nueva Vizacaya and Ecija; the East by the Provinces of Isabela and Cagayan; and the West by the Provinces of Pangasinan, La Union and Ilocos Sur.

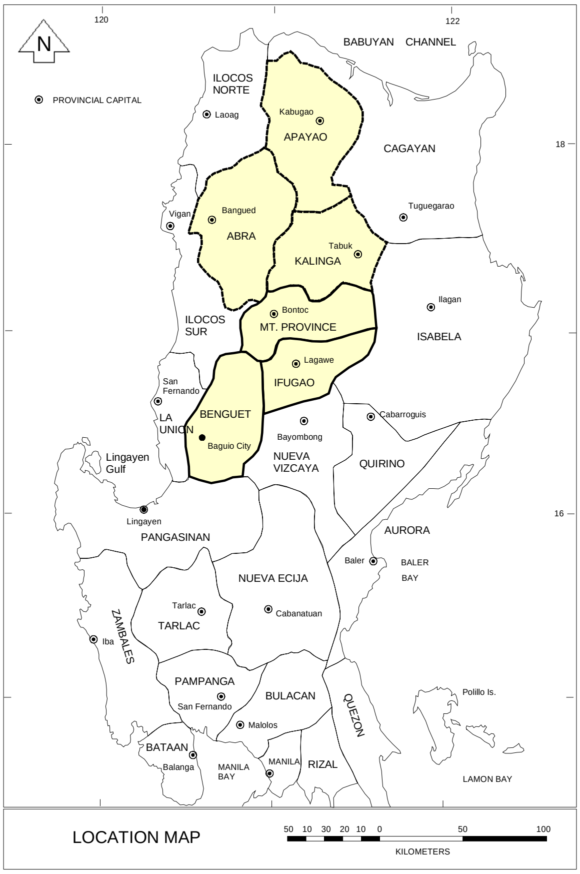

Figure 1: Location Map of Cordillera

1.2 Climate and Vegetation

Most of the moderately elevated to low areas are moderately vegetated. The high-elevated areas are covered by thick vegetation. The region's climate generally falls under Type III and IV, which are characterized by a pronounced dry and wet season. Relatively dry season occurs from November to April while the remaining months are wet with the heaviest downpour observed during the months of August and September.

1.3Topography and Drainage

Dubbed as the "Watershed Cradle of the Philippines", the Cordillera has a mountainous topography characterized by towering peaks, plateaus and intermittent patches of valleys. The complexity of the overall topography of the area resulted from a combination of intermittent uplifts and erosion which started during the Miocene and continued to Pliocene and Quaternary times

The Region is drained mainly by Abra River in Abra, Agno and Bued Rivers in Benguet and Baguio City, Magat River in Ifugao and Apayao, Chico and Pamplona Rivers in Kalinga-Apayao and the Chico and Abra Rivers in Mt. Province. The down cutting and dissecting action of these rivers and their tributaries contributed to the generally steep topographic relief of the area. The result is a vigorous and rugged terrain where deeply incised valleys, steep river gradients and steep slopes.

2. REGIONAL GEOLOGY

Luzon Cordillera is a north south trending geanticlinal mountain chain in the northern part of Luzon. This mountain chain resulted primarily from a Miocene orogenic event accentuated physiographically by a much later Plio-Pleistocene orogeny and tectonism (Pulanco, 1971). The arcuate island of Luzon lies between the Manila Trench and the Philippine Trench, a two oppositely dipping subduction zones responsible for the orogenic and tectonic development of the Central Cordillera since Miocene time.

The Central Cordillera is cut by the northern branch of the Philippine Fault which split into four main branches (Ringenbach et al, 1990) shown in Figure 2. These are the Tebbo Fault, the Tuba Fault, the Pugo Fault, and the Dalton Fault.

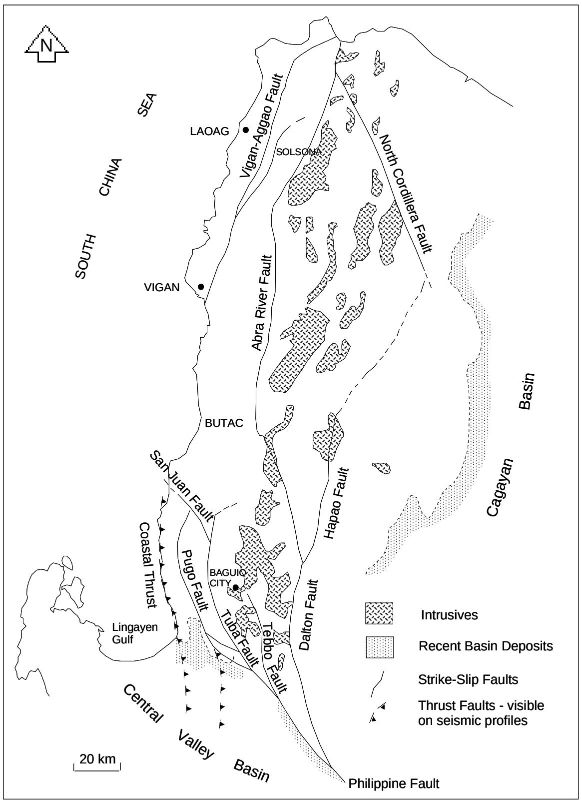

Figure2:Regional Geology (Adapted from Ringenbach, 1990)

The oldest rocks in the region are the undifferentiated metamorphic rocks which are considered part of the Pre-Jurassic Philippine Basement Complex. Overlying this are the more widespread, undifferentiated, partly metamorphosed Cretaceous to Paleogene, ophiolitic volcanic flows with locally intercalated chert, marble and clastic sedimentary rocks. Bordering these rocks are folded Neogene volcaniclastics and sedimentary rocks.

Masses of Late Miocene diorite-granodiorite plutons, elongated along the north-south direction, dominate the core of the Cordillera as shown in Figure 2. These plutons discordantly intruded the above rock sequences and are responsible for some ore mineralization in the region. The known geothermal areas in the region associated with Quaternary volcanism are Batong-Buhay in Kalinga, Mainit in Bontoc, and Daklan, Buguias, Itogon in Benguet.

3. DISTRIBUTION OF GEOTHERMAL AREAS

The Philippine archipelago is a complex assemblage of island arcs, which has been accreting between two opposing major tectonic plates – the Eurasian and the Philippine Sea Plate. The subduction zones have generated a discontinuous belt of Pliocene to Quaternary volcanoes which extends throughout the length of the Philippines, from Northern Luzon to Southern Mindanao.

Many authors, through years of Philippine geothermal energy exploration, development and production agree that the present geothermal systems are related to volcanism, plutonism and tectonism. According to Datuin and Troncales (1987), many of the potential geothermal resource areas in the Philippines are related to young volcanoes; along Philippine Shear System or its nearby branch faults and some are localized along the fringes of large intra-Miocene silicic batholiths.

Geothermal areas in CAR which include Acupan, Daklan, and Buguias in Benguet, Batong Buhay in Kalinga, Tinoc in Ifugao, and Mainit in Mountain Province belong to the Luzon Central Cordillera Volcanic Belt. This belt consists of heavy concentrations of active and non-active volcanoes. Most of the potential geothermal prospects in CAR are related to the Plio-Quaternary volcanic centers of andesite to dacite composition which are related and connected to the North Cordillera Quartz Diorite Complex straddling the central region of Northern Luzon.

4. DESCRIPTION OF PROSPECT AREAS

Hot springs abound in the Cordillera Region. Several of these thermal areas possess the potential for geothermal development. Location of the different thermal areas in the Region is shown in Figure 3.

4.1 Abra

Several thermal areas were identified in the province. They are located in the Municipalities of Pilar, Danglas, Boliney, Sal-lapadan, Bucloc and Tubo. Thermal manifestation consists essentially of warm to hot springs occurring along fractures. The springs have discharge temperatures ranging from 38 - 67 ^oC and of neutral pH. The more impressive of which is in Boliney, Sal-lapadan and Tubo with measured temperatures of >50 ^oC. The rest are warm seepages with measured temperatures of <50 ^oC. From 1994 up to 1999, the Department of Energy (DOE) conducted preliminary survey of the thermal manifestations in the province consisting of water sampling and reconnaissance geological mapping.

The geology and chemistry of thermal waters in Boliney, Sal-lapadan, Bucloc and Tubo prospect areas indicate a low temperature system associated with plutonic areas where residual heat remains in the intrusive bodies. Water

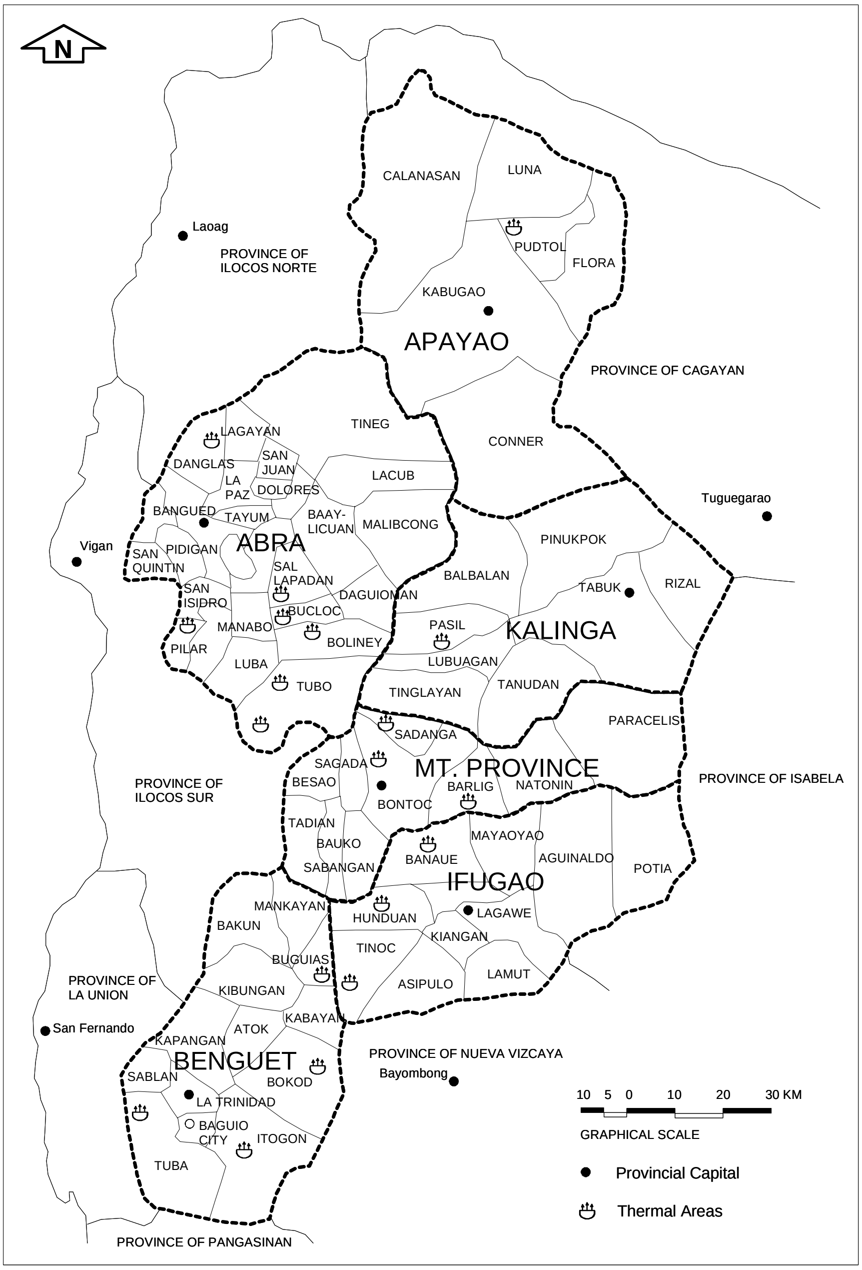

Figure3: Location Map of Thermal Areas in CAR

movement is largely structurally controlled, fault playing a dominant role. Geothermometers and saturation index diagrams suggest a subsurface temperature of 90-120 °C. Resistivity survey is recommended to establish the relationship of each thermal area and determine the size and depth of the geothermal system. Based on the estimated subsurface temperatures, the thermal waters are not suitable for power generation but could be utilized for direct use such as bathing and crop drying.

The underlying lithology in Danglas consisting of conglomerate-greywacke and shale may have an effect on the relatively higher ionic contents of the thermal water of Danglas compared with that of Boliney, Sal-lapadan, Bucloc and Tubo. The warm spring in Pilar is neutral Na-Cl water. Chemistry suggests that Cl may not be coming from a geothermal reservoir but from other sources. The low calculated subsurface temperature for Danglas and Pilar would imply that the thermal waters could be products of normal terrestrial heat flow. The use of these thermal waters seems limited for bathing and no further study is recommended.

4.2 Benguet

4.2.1 Acupan Geothermal Prospect

The Acupan Geothermal Prospect in Itogon is located within the gold mineral property of Benguet Consolidated, Inc. Various geoscientific studies have been carried out in the area under the Bureau of Energy Development (BED)-Japan International Cooperation Agency (JICA) from 1982 to 1985. These studies consisted of reconnaissance to semi-detailed geological, geochemical and geophysical surveys, drilling of shallow thermal gradient holes and drilling of a 2000-meter depth exploratory well (AC-1D).

The geologic setting of the Acupan area is characterized by subvolcanic rocks, which may be rendered relatively permeable at depth by the northeastern-southeastern structural features. Thermal manifestation consists of hot springs and abundant discharges of hot water and steam in the underground working of the Acupan Mine. The distribution and occurrence of the thermal features reflect a pronounced structural control. Measured temperature of hot springs ranges from 42-78 ^oC. Reservoir temperature estimated from silica contents and alkali ratio of the thermal fluids are 229 and 236 ^oC, respectively. These estimates are further substantiated by exploratory well AC-1D's bottom temperature of 220 ^oC.

The drilling of AC-1D revealed that the rocks have interacted with neutral to weak alkali thermal fluids. Semi-permeable zones were also present but were insufficient to sustain continuous discharge. These results seem to indicate the presence of an active heat source and a structurally controlled potential reservoir in the prospect area.

The Acupan-Itogon thermal area is interpreted to cover an area of 3.5 km^2 stretching ellipsoidally NE-SW from the Balatoc plug to the Itogon plug at –1000 meters s.l. This area is defined by temperature of 200 ^oC and fracture controlled secondary permeability, which allows for the upflow of thermal fluids. Additional survey was recommended which include the drilling of additional test well to test the geothermal model obtained from the survey and confirm the resource potential of the area.

4.2.2 Asin, Tuba

The prospect area is located in Brgy. Asin in the Municipality of Tuba. The Commission on Volcanology (COMVOL) initially explored the area in 1979 for possible power application. A follow-up study was conducted by the then Office of Energy Affairs now the Philippine Department of Energy (PDOE) in 1987. Thermal features include several bubbling warm to hot springs with discharge temperature ranging from 35 to 76 ^oC. Faint H_2S emission is also common. The thermal area is presently utilized as a tourist resort.

Geochemical analysis suggests that the area is an outflow of possible low temperature reservoir. Additional geoscientific studies are recommended to further evaluate the potential of the prospect.

4.2.3 Buguias Geothermal Prospect

Geoscientific investigation of Buguias prospect area in Benguet Province was done in 1981 as part of the First Phase of the joint BED-JICA Technical Cooperation in Geothermics. The survey consists of geological, geochemical and geophysical exploration survey to verify the existence and extent of a geothermal reservoir, as well as to select the most promising drill sites for a possible next phase of the survey.

The geological structure of the area is characterized by uplifted zones in both the east and the west of the survey area, a N-S trend graben near Buguias Central, and their combined block movements. A semi-basin structure plunging towards the east, with its center around Buguias Central is believed to exist at depth and maybe indicative of a structure of a geothermal reservoir.

Thermal manifestations are distributed at the east and west bank of the Agno River around Buguias Central and are characterized by hot water flow and gas bubbling pools. Sinter deposits mainly composed of carbonates are also found around the areas of manifestations. Hot water temperatures range from 40 ^oC to 70 ^oC. Based on the analysis of the geochemical survey, hot springs belong to the NaCl type, and the assumed temperature calculated from the chemical analysis is more than 200 ^oC, which shows a good potential of high temperature geothermal fluid that can be used for geothermal electric generation.

The heat source in this area is inferred to come from the magma chamber under the Quaternary dacite lava dome in the eastern side of this area. The survey area of this phase is confined within the western side of the above-mentioned dacite lava dome, which is considered to be the heat source of this area. Prominent geothermal manifestations are confined within the eastern side, which is in Tinoc, Ifugao, of this dacite lava dome.

In order to delineate the geothermal reservoir of the area, resistivity surveys should be conducted mainly in the eastern part of this survey area. It is recommended that boreholes be drilled to measure the thermal gradient in order to conceptualize the geothermal fluid movement. The drilling depths must be deep enough to penetrate the geothermal aquifer.

4.2.4 Daklan Geothermal Prospect

The Daklan Geothermal Prospect lies in the Municipality of Bokod in Benguet Province. A preliminary assessment, geological, geochemical, geophysical, hydrogelogical investigations, drilling of gradient holes, and drilling of five deep exploratory drilling wells were conducted by the then Bureau of Energy Development (BED) and Electro-Consult (ELC) joint venture from 1978-1981 to determine the geothermal potential of Daklan. In 1982, PNOC-Energy Development Corporation (PNOC-EDC) and BED conducted a reconnaissance to detailed survey to study the structural-volcanological aspect of the area.

Thermal manifestations include fumaroles and solfataric activity in Balukbok shown in Picture 1 and warm/hot springs scattered around the solfataric field and along the fault controlled valleys in Asin and Abyang. Exploratory drilling in Daklan has proven that high temperature exists which is probably exploitable. All deep wells showed measured temperature of more than 200 ^oC. Though short-lived only well DK-1A discharged while others failed. Measured temperature of this well is 293 ^oC at a depth of 2400 m. The major problem lies mainly on lack of permeability.

Picture 1: Balukbok Thermal Area

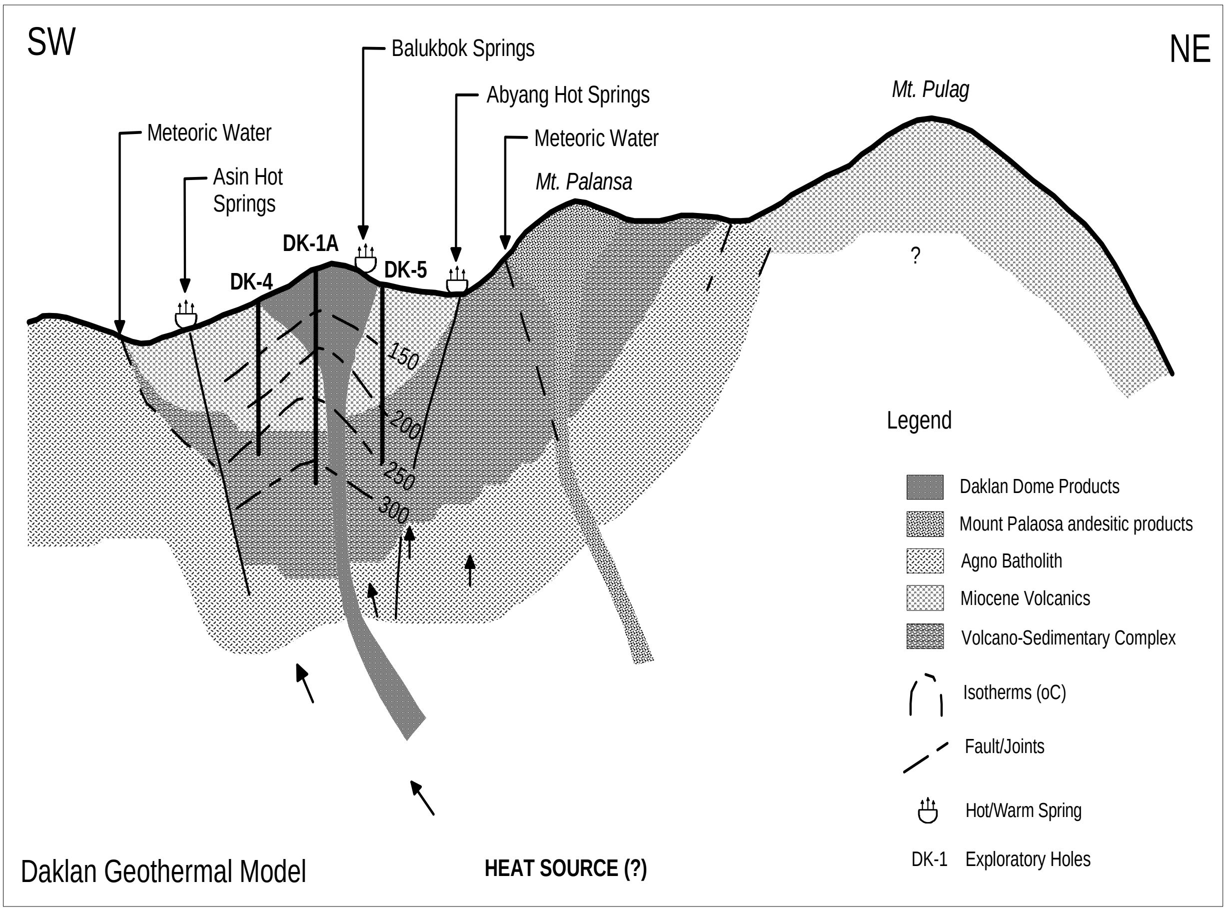

Figure 4: Daklan Geothermal Model (Adapted from PNOC-EDC, 1982)

A hypothetical geothermal model shown in Figure 4 for Daklan and vicinity shows that the system is confined in a subsurface depression hosted by Agno Batholith. This volcano-tectonic depression formed during and after the Plio-Pleistocene volcanic activity might represent a structural control for the lateral extent of the field. The young volcanic centers in Palansa and Daklan probably originated from a shallow seated magma which has been evolving since the Miocene. It appears that the upflow of hot water is confined to a narrow zone around Daklan domes.

In spite of the negative production characteristics shown by the deep exploratory wells drilled, the existence of high temperature at depth calls for a continuation of the study over a wide area around Daklan preferably northeast towards Palansa area, with the hope of detecting a zone with both a high anomalous thermal regime and an appropriate permeability necessary conditions for a commercial geothermal field.

Additional geoscientific works that include geological investigation, geochemical and geophysical survey is proposed with the aim of locating three (3) new deep exploratory wells in the area. The result of this further exploration will result to a definitive evaluation of the feasibility of a geothermal project in the area.

4.3 Ifugao

4.3.1 Ducligan, Banaue

The Geothermal Division of the Department of Energy conducted reconnaissance geological and geochemical surveys in Ducligan in Banaue from 1994 to 1995 to determine the geothermal potential of the area. The area is basically underlain by basic igneous rocks consisting of basalt and diabase with gabbroic phases. Thermal manifestation consists of cluster of warm springs with the highest temperature at 48 ^oC. Chemistry of the thermal waters is typical of low temperature systems. The presence of numerous volcanic plugs could be the heat source for the occurrence of thermal manifestations. The area has low potential for power generation and does not warrant further investigation.

4.3.2 Hunduan Geothermal Prospect

The Hunduan Geothermal Prospect in Ifugao lies north of Tinoc Geothermal Prospect. The Geothermal Division of the Department of Energy conducted reconnaissance geological and geochemical surveys in Hunduan from 1994 to 1995 to determine the geothermal potential of the area.

The prospect area is underlain from oldest to youngest by basic igneous rocks consisting of basalt and diabase with minor gabbroic phases, marine clastic sedimentary unit of interlayered beds of conglomerate, sandstone and siltstone, basaltic conglomerate and breccias and quaternary alluvium.

The NE trending Hapao Fault and its NNW and NNE splays dominates the prospect and control the occurrence of the warm/hot springs in the area.

Chemistry of the thermal waters is typical of low temperature systems in areas with large-scale faults having and estimated reservoir temperature of 148 ^oC. The area has low potential for power generation and does not warrant further investigation.

4.3.3 Tinoc Geothermal Prospect

The Tinoc Geothermal Prospect located in Brgy. Tukucan lies close to the western boundary between Ifugao and Benguet Provinces and east of the Buguias Geothermal Prospect. The Geothermal Division of the Department of Energy conducted reconnaissance geological and geochemical surveys in Tinoc, Ifugao from 1994 to 1995 to determine the geothermal potential of the area. Schlumberger Resistiviy Traversing (SRT) survey was conducted in 2003 to complement the earlier surveys.

Tinoc Geothermal Prospect possess the characteristics of a promising geothermal potential as shown by occurrences of young dacitic domes, solfataras as shown in Picture 2, cold gas seeps, altered grounds and warm to hot springs with field temperatures ranging from 32-60 ^oC. Four (4) lithologic units were identified in Tinoc, i.e. dacitic lava flows, pyroclastic rocks, diorite and meta-sedimentary rocks. Major structural features dominating the area are the NE-SW and N-S trending faults. A neutral pH Na-Cl water type with high chloride content characterizes the hot springs in Tinoc.

Picture 2: Tinoc Thermal Area

Results of geoscientific studies suggest the existence of a geothermal resource in the area. Chemistry of the waters however does not indicate the presence of a mature geothermal system. Evaluation of the Tinoc waters together with those sampled in Buguias during the RP-JICA First Phase Survey in 1980 revealed that these waters likely originated from the same source. The heat source could be related to the Quaternary dacite lava dome (Mt. Tebeyo). Geothermometers indicate an intermediate subsurface temperature of about 160 ^oC. A more saline parent water possibly at higher temperatures exists at depth though tends to be sulfate rich. A much deeper geophysical exploration studies and additional geological mapping and geochemical sampling is recommended to determine the resource potential of the area.

4.4 Mountain Province

4.4.1 Barlig

Barlig Geothermal Prospect is located at the southeastern rim of Mt. Province. The Geothermal Division of the Department of Energy conducted a combined reconnaissance geological and geochemical survey in 1999 to verify the reported thermal occurrences in the area. Thermal manifestations are in the form of warm to hot springs coming out from fractures of basaltic lava flows with temperature ranging from 35-50 ^oC.

Geological evidences shows that these springs are structurally controlled and apparently related to the NE-SW trending major faults traversing the area. The heat source could either be related to the Pliocene-Quaternary volcanism of Mt. Puquis (andesitic to dacitic in composition), or to the waning heat associated with the Neogene Quartz Diorite intrusive. Chemistry of the thermal waters are dominated by Na and Cl with appreciable quantity of Ca and minor amounts of boron. Geothermometry suggest a reservoir temperature of about 160 ^oC. Recommended for further geoscientific studies.

4.4.2 Mainit, Bontoc-Sadanga

The Mainit-Sadanga geothermal prospect had been the subject of geological and geochemical investigations in the late 1978 and early 1979 in connection with the Stage II of the Philippine Italian Technical Cooperation on Geothermics. Brgy. Mainit in Bontoc hosted the more impressive thermal manifestations in the form of hot springs/pools with temperatures ranging from 42-96 ^oC shown in Picture 3 and altered/mineralized grounds. Warm to hot springs with temperatures ranging from 46-55 ^oC are present in Sadanga. In 1994-1995, the Geothermal Division of the Department of Energy conducted reconnaissance geological and geochemical surveys and public information campaign.

Picture 3: Mainit, Bontoc Thermal Area

The geothermal system at Mainit-Sadanga is believed to be driven by a cooling body of igneous rock centered beneath the andesite eruptive center of Mt. Patoc. The prospect area appears to be located and probably confined to a north-south trending graben formed by the intrusion of diorite bodies and uplift movements. Surface thermal manifestations occur along both boundary fault zones, but are sparse within the graben.

Chemistry suggests that the waters of the Mainit-Sadanga could be separate systems. The fluid compositions of the Mainit hot springs are of Na-Cl type with amounts of K while that of Sadanga are of $Na\text{-}HCO_3\text{-}Cl\text{-}SO_4$ type. Geothermometry suggests reservoir temperatures of 259 ^oC and 200 ^oC for Mainit and Sadanga, respectively. Recommended for additional geoscientific studies.

4.5 Kalinga

4.5.1 Batong-Buhay

The geothermal prospect is located around the Batong-Buhay Mining Camp covering the municipalities of Pasil and Tinglayan in the southern part of the Kalinga province. The area was first explored by COMVOL in 1976 noting several thermal manifestations consisting of hot springs and fumaroles along Caigutan Creek, south of the Batong-Buhay mining camp and along the inner gorge of the Pasil River. In 1982-1983 Caltex conducted reconnaissance to semi-detailed geological, geochemical and geophysical surveys and drilling of five (5) temperature-gradient holes.

Results of investigation postulated the existence of a geothermal reservoir with a temperature in excess of 200°C with potential of about 100 MWe. The heat source is the young igneous body beneath the dacite and andesite vents located south of the Pasil River.

Results of the geology and the geochemistry of the Batong-Buhay area points out a good geothermal potential. The type of volcanism and the widespread nature of the thermal manifestations are indicative of a large and active heat source. The stratigraphic/structural setting is favorable for the existence of a reservoir at not too great a depth. Recommended for detailed geoscientific exploration.

4.6 Apayao

The lone geothermal prospect area in Apayao is located in Paco Valley, Brgy. Aurora in the Municipality of Pudtol. The Geothermal Division of the Department of Energy conducted a combined reconnaissance geological and geochemical survey in 1999 to assess the geothermal potential of the area. Thermal manifestations are in the form of neutral warm to hot springs with surface temperature ranging from 49-50 °C. The area is underlained by moderate to steeply dipping sandstone beds with alternation of shale and conglomerate and limestone cap in some places. The north trending Dinataan River Fault controls the existence of thermal springs. Postulated heat source is the massive diorite exposed in Kabugao area. Chemistry of the thermal waters reveals a Na-SO_4 water type. Silica geothermometry indicate a subsurface temperature of about 96 °C. Additional sampling of other reported hot springs in the area is recommended together with geological mapping to determine volcano-geologic setting of the area.

5. RESOURCE POTENTIAL

Many of the geothermal potential sites for development in Luzon are located in CAR. Based on the Philippine Energy Plan (PEP) for 2004-2013, a maximum total of 590 MWe geothermal energy potential estimates are available in the Region out of a total of 2169.59 MWe for Luzon. These are broken down as follows as shown in Table 1:

Table 1: Geothermal Resource Potential of the Cordillera Region

Province	Area	Resource Potential (MWe) High	Resource Potential (MWe) Low
Benguet	Acupan	20	15
	Daklan	60	60
Benguet/Ifugao	Buguias-Tinoc	190	120
Kalinga	Batong-Buhay	200	120
Mt. Province	Bontoc	120	80
Total		590	395

These values were obtained using the volumetric method. This method involves the calculation of the thermal energy contained in a given volume of rock and water and then the estimation of how much of this energy might be recoverable. It must be noted that several assumptions are used in the estimate and this should be accordingly modified and improved as more data are evolved.

Based on the PEP, a total of 140 MWe is available from the Region shown in Table 2 as indicative capacity additions in Luzon.

Table 2: Indicative Capacity Addition in Luzon

Province	Area	Potential Capacity (MWe)	Year Available
Benguet	Daklan	20	2011
Benguet/Ifugao	Buguias-Tinoc	60	2010
Kalinga	Batong-Buhay	60	2009

6. CHALLENGES AND PROBLEMS

The DOE believes that opportunities in the Philippines for geothermal resource exploration and development still abound for both power and nonpower use which includes the prospects in the Cordillera Region. To fully realize the geothermal potential of the Cordillera Region two (2) basic problems among others need to be addressed. First, there is lack of awareness and interest on investment opportunities in the Philippine geothermal resource industry. The DOE as the government agency in energy should encourage the conduct of international and local promotion of investment opportunities in geothermal resource exploration, development and production in the Philippines. The DOE should also support the conduct of geoscientific surveys and research activities in the Region. These will be the inputs for the investment promotion campaign. Second, with the advent of laws for the preservation of the environment and empowerment of the cultural minorities, environmental and socio-cultural concerns are now considered critical factors in geothermal resource development. This is especially true for the Cordillera Region where most of the prospects are located within protected areas and inhabited by indigenous people. Proper coordination with concerned agencies and public information campaign to the local people is recommended to be able to pursue geothermal projects.

7. CONCLUSION

Several authors have estimated the over-all geothermal reserve in the Philippines, which is viable for electric power generation in the range of 3,000 (probable) to 4,000 (potential) MWe. With an installed capacity of 1,931 MWe, we have only reached 50% of our discovered resources. The results show that there is still a considerable geothermal resource available for development. Geothermal capacity addition for the next ten years range from 820 - 1,200 MWe. This will come from development and expansion of new and existing fields and power plant optimization.

Of the various geothermal prospects in the Region, the geothermal areas in Daklan, Benguet, Batong-Buhay, Kalinga, Buguias-Tinoc, Benguet/Ifugao and Bontoc, Mt. Province seem to be the more impressive that warrants additional studies. Luzon’s energy requirements are seen to steadily increase during the planning period. A total of 5,215 MWe of installed capacity is needed in Luzon to meet the projected power demand. The indicative capacity additions are envisioned to be supplied by indigenous energy resources such as natural gas, geothermal and hydropower. A total of 380 MWe is expected to be supplied by geothermal energy, 140 MWe of which is expected to come from the Cordillera Region.

To realize this, the DOE will promote through an investment promotion campaign the geothermal potential areas of the country including the Cordillera Region. It will promote and encourage exploration programs over selected geothermal prospects to provide sufficient information on geothermal priority areas.

It should be noted that the Cordillera Region is home to various natural parks, protected areas and indigenous communities. Environmental protection and social acceptance are crucial factors for the further exploration and development of the geothermal prospect areas in the Region.

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