NEW PHASES OF RECURRENT GEOTHERMAL EXPLORATION FOR ELECTRICITY GENERATION IN THAILAND

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ABSTRACT

Many geothermal hot springs in Thailand are located along Thai-Malay plate, western part from North to South, and almost associated with granitic rocks. The exploration of geothermal energy in Thailand was commenced in 1978 by collaborating between Department of Mineral Resources (DMR), Chiang Mai University (CMU), Department of Energy Development and Promotion (DEDP) and Electricity Generation Authority of Thailand (EGAT) as a Working Group in geothermal research. The crucially detailed studies during 1980-1990 were comprised of geological survey, geophysical investigation, geochemical analysis and borehole drilling. Finally, the first small-scale of geothermal electricity power plant was constructed and produced electricity with a capacity of 0.3 MW by binary cycle system until nowadays. Subsequently, the policy of further intensive exploration has been terminated from consideration due to lack of financial support, expertise and technology. However, the expected demand of electricity energy in the nation in 2021 would be raised up to 39 percent of current status and 21 percent of this figure anticipated from renewable energy such as solar power, wind power, hydropower, biogas and biomass, and also geothermal power. Due to highly demand on electricity because of continuously economic growth in Thailand, and unlike restricted site location of high potential electricity energy development such as hydropower or nuclear power, hence, geothermal electricity is one of the most alternative energy, which friendly and sustainable to global environment. In 2011, a new partnership or new Working Group has been formed comprising of Petroleum Authority of Thailand (PTT), Department of Alternative Energy Development and Efficiency (DEDE) and Department of Groundwater Resources (DGR) under Memorandum of Understanding (MOU) in order to cooperate in exploration and development of geothermal resources for electricity generation by setting a target plant with a capacity of 5 -10 MW and an initial budget for only preliminary exploration is more than US$ 10 million. Hopefully, recent technological advances would be an extremely important role to be fruitful in exploration and development, particularly in Hot Dry Rock (HDR) that should be appropriated for Thailand geological conditions or non-volcanic zone.

Keywords: geothermal hot springs, recurrent geothermal exploration, MOU, HDR, HSB

1. INTRODUCTION

Due to continually economic growth in Thailand, the demands of electricity energy are increased in every year and would be more than 39 percent of current situation in 2021. The total installed electricity power capacity was 31,773 MW (DEDE, 2012), which of them were 16,470 MW or 51.8 percent from state/public power utilities and 15,303 MW or 48.2 percent were from private power producers. The main energy resources come from: natural gas 71.1%, coal and lignite 21.4%, hydropower 5.9% and oils 1.6% (Fig.1). In terms of renewable energy were only 927 MW from biomass, biogas, solar, rubbish, hydro, geothermal and wind powers and have to be targeted up to 9,198 MW in 2021. Geothermal electricity is an alternative power that can be developed even though much investment than the others but it is reliable, sustainable and friendly global

environment whereas fossil resources are restricted and going to extinct in the next few decades. Compare to solar farms which are increasingly an important role in nowadays but not suitable for long- term developing in Thailand due to an agriculture country that has to keep for crop areas.

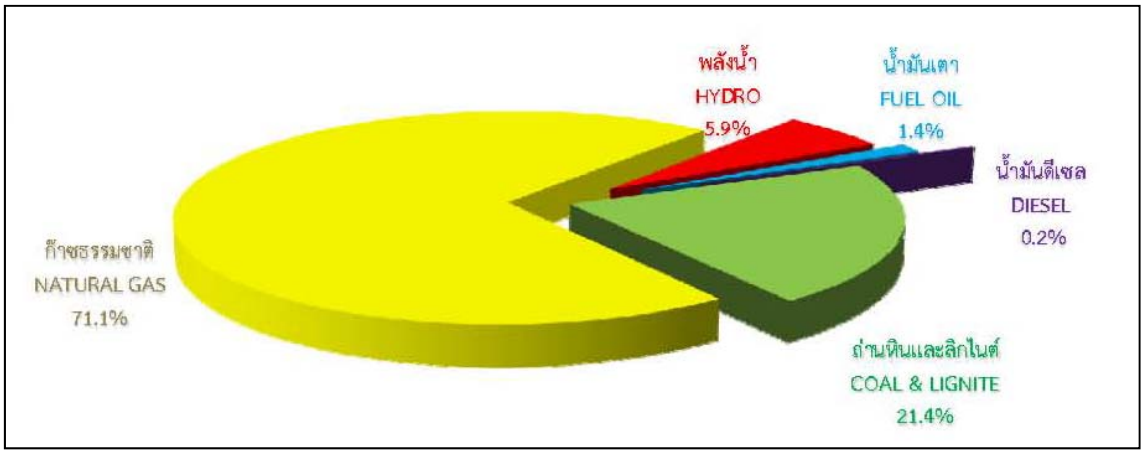

Figure 1. The main energy resources of Thailand.

Geothermal resources, as many hot springs manifestation, are located like spotted hot or boiled water pools or even geysers along western part from north to south of Thailand with surface temperatures ranging from 40^{o} to 100^{o} C. A total of 112 hot springs (Fig.2) has already discovered (DEDE, 2005) and almost associated with granitic rocks, particularly in the northern part (Fig.3). Geologically, these geothermal resources are involved with non-volcanic activity. Hence, two geothermal systems may occur from radiogenic heat in crystalline rocks and the other is from hot sedimentary basin that water percolates deeply to contact them and emerge to surface along faults or fractured rocks. However, the most of hot springs manifest along Thai-Malay plate, which are connected to the western part of Kunming in China, and having the same conditions but less volcanic concerns.

The aim of this paper would like to emphasis about the new framework in recurrent geothermal exploration under MOU between PTT, DEDE and DGR by having Department of Mineral Resources (DMR) supporting in some geophysical investigation as sub-MOU. Each agency will be having an independent responsibility for working in authority concerns in order to achieve a successful holistic geothermal assessment and finally making prototypes of an appropriate geothermal power plant.

2. PREVIOUS GEOTHERMAL EXPLORATION AND DEVELOPMENT

The principal of geothermal energy exploration and utilization was warranted by the National Energy Administration (NEA) of Thailand and Kingston Reynolds Thom & Allardice Ltd. of New Zealand in 1973. However, the studies and exploration were crucially done after 1979. There were many working groups and organizations both state and private sectors collaborating in various aspects during the past more than 30 years as summarized in the table1 (modified from Ramingwong, 2000 and Korjedee, 2002).

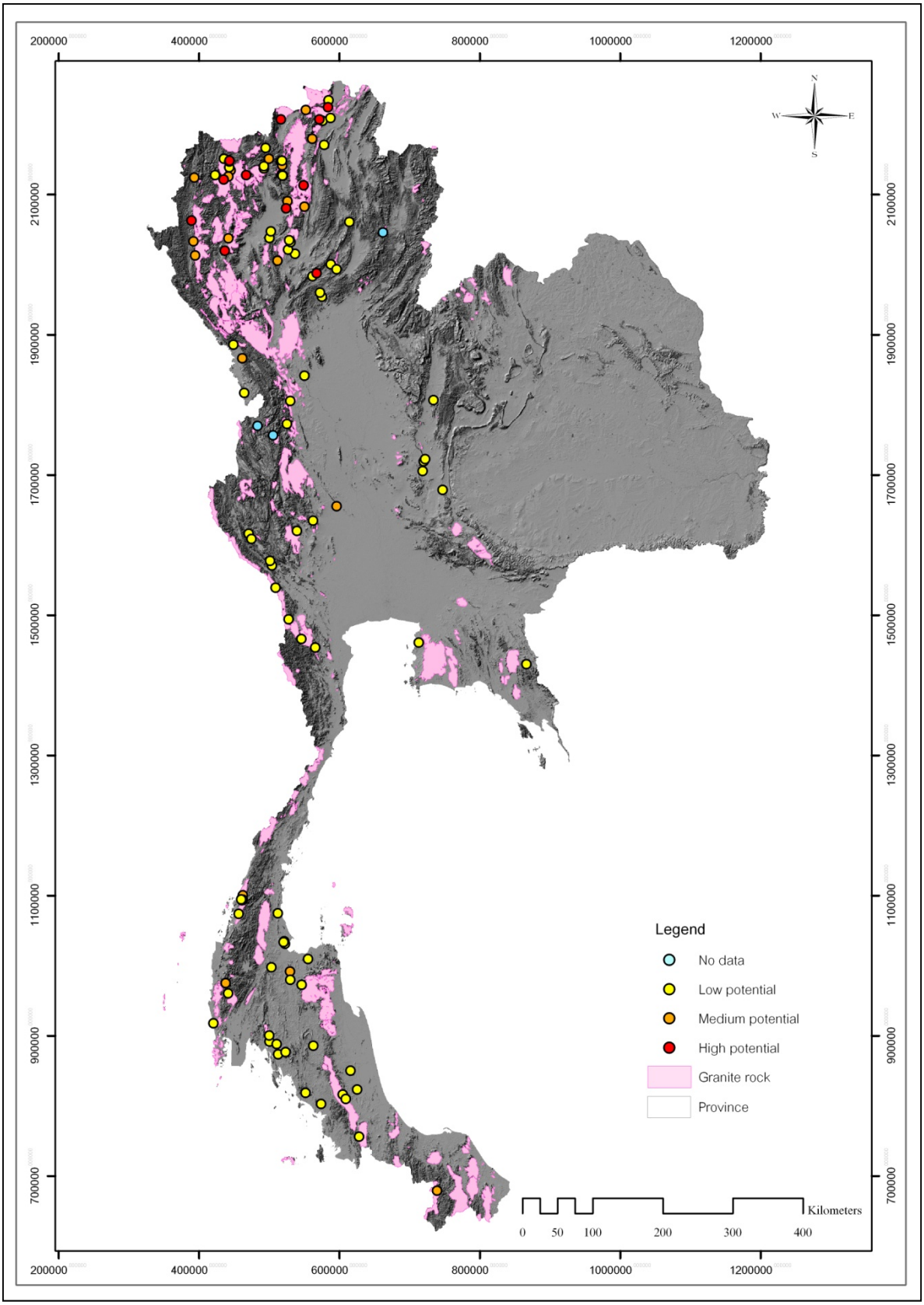

Figure 2. The location of 112 hot springs in Thailand, which associated with granite rock.

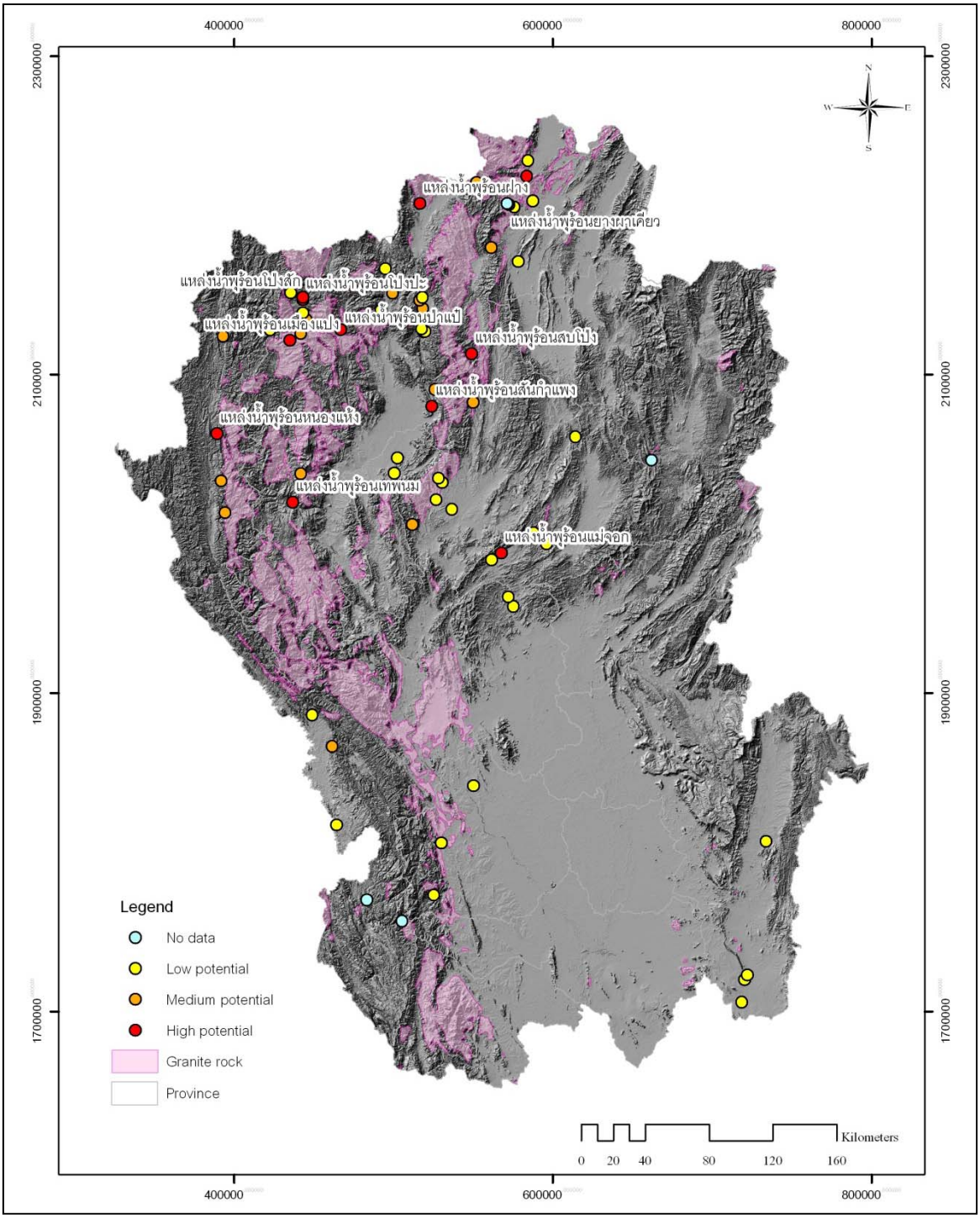

Figure 3. The location of hot springs in the northern part of Thailand, which associated with granite rock.

Table1. List of previous activities in geothermal exploration and development of Thailand

Time periods	Activities	Organizations	Remarks
1973	Reconnaissance survey in possibility for geothermal utilizations	NEA and KAZ	NEA: National Energy Administration of Thailand
1979-1981	Geothermal working group formed and geothermal potential studied in 30 well-known hot springs	EGAT, DMR and CMU	KAZ: Kingston Reynoldsthom & Allardice Ltd. Of New Zealand EGAT: Electricity Generating Authority of Thailand
1982	Additional areas for geothermal potential studied	CMU and DEDP	DMR: Department of Mineral Resources
1982-1988	Pre-feasibility study on geothermal development in San Kamphaeng	EGAT and JICA	CMU: Chiang Mai University
1982-1992	Geothermal energy for electricity generation in Fang	EGAT and ADEME	DEDP: Department of Energy Development and Promotion
1983-1986	Geological and geochemical prospecting in 50 geothermal areas in northern part including geophysical and drilled well data evaluated	DMR, UNDP and GIS	JICA: Japan International Cooperation Agency FAEM: French Agency for Energy Management
1989	Two deep exploration wells at 1,227 and 1,300 m. completed in San Kamphaeng	EGAT and JICA	IAEA: International Atomic Energy Agency
1989	Geothermal electricity power plant was established with a capacity of 0.3 MW in Fang	EGAT and FAEM	CCOP: Coordinating Committee for Coastal and Offshore Geoscience Programmes in East and Southeast Asia
1992-1996	Geothermal exploration for exploiting hot water in small scale direct uses including more 9 geothermal areas investigated	DEDP	UNDP: United Nation Development Program
1994-1998	Geothermal investigation and drilling exploration in Mae Hong Son province	EGAT and CMU	DEDE: Department of Alternative Energy Development and Efficiency
1997-1999	Investigation of hydrology of Fang geothermal system by isotope and chemical tools	CMU, DMR and IAEA	ADEME: French Environment and Energy Management Agency PTT: Petroleum Authority of Thailand
2001-2003	Digital compilation of groundwater and geothermal database in Thailand	CCOP and DMR	DGR: Department of Groundwater Resources
2005	Potential of geothermal resources in Thailand project by means of geochemistry	DEDE and CMU	GIS: Geothermica Italiana Srl.
2011-present	New phases of geothermal exploration for electricity power plant comprise of geophysical investigation as MT, gravity, seismic reflection and drilling	PTT, DEDE, DMR and DGR	

It is obvious that the previous works seem to explore in terms of general views and shallow subsurface of hot spring resources, particularly in northern part of Thailand by having 21 areas and 220 boreholes (Korjedee, 2002). There are only 2 deep boreholes depth to 1,227 and 1,300 m., respectively, and the rest is mostly less than 200 m. However, only one in Fang area that can be established a geothermal electricity plant by binary cycle system in 1989 with shallow productive boreholes - less than 150 m. and its capacity of 0.3 MW by discharged hot water of 125^{o}C and a total of flow rate of 22 l/s. Recently, most of hot springs areas have been developed to be healthy spa or resort by local administration or national park organization. The latest study occurred in 2006 by DEDE and CMU, in order to review and evaluate potential geothermal resources throughout Thailand in terms of geochemical analysis and their utilization, indicated that Fang, Sankamphaeng, Mae Chan and Pai hot spring areas are highly potential to develop shallow geothermal energy for electricity. However, in fact, Hot Dry Rock (HDR) and Hot Sedimentary Basin (HSB) are new challenge concept that should be promoted as an appropriated concept for geothermal exploration in Thailand but the cost of deep borehole drilling is still very expensive nowadays and will be affected the whole project again.

3. METHODOLOGY

The propose methodology of new recurrent geothermal exploration in Thailand under MOU between PTT, DEDE, and DGR, is divided into four steps: desk study; phase I; phase II; and phase III, respectively (fig. 4). The first step is desk study, which including data gathering, initial analysis for geothermal potential, geology and structural geology, geochemistry, geophysical model, aerial and satellite images. In this phase, the 112 areas of hot springs will be screening by multi criteria method using GIS and only 16 suitable sites will be selected. The second step is ground follow check and combining with other field works. Field geology and structural

geology will be launched in detailed at 16 selected sites and will be narrow to only 5 appropriated sites. After that, geochemistry works will be followed by collecting water and gas samples and sends those samples to the lab to analyze the cation, anion, and gas content. The best three sites will be selected and follow up the field geophysical survey will be employed. The Magnetotellurric (MT) survey will be the main part, others are gravity, Resistivity, Magnetic, and seismic reflection surveys. The phase II comprises of test hole drilling, 300 meter depth in each area, in order to obtain temperature gradient of each site. Then, the data will be processing and the best one will be selected. Hence, the 2,000 meter depth exploration drilling will be launched in order to proof the models. Due to the cost of 2,000 m. borehole drilling is very expensive, therefore, this step is a crucial step and will terminate the next phase if the result does not match the conceptual models. However, the last phase is production and injection well drilling. The detailed design of well size and casing programme is upon the results from the previous phase.

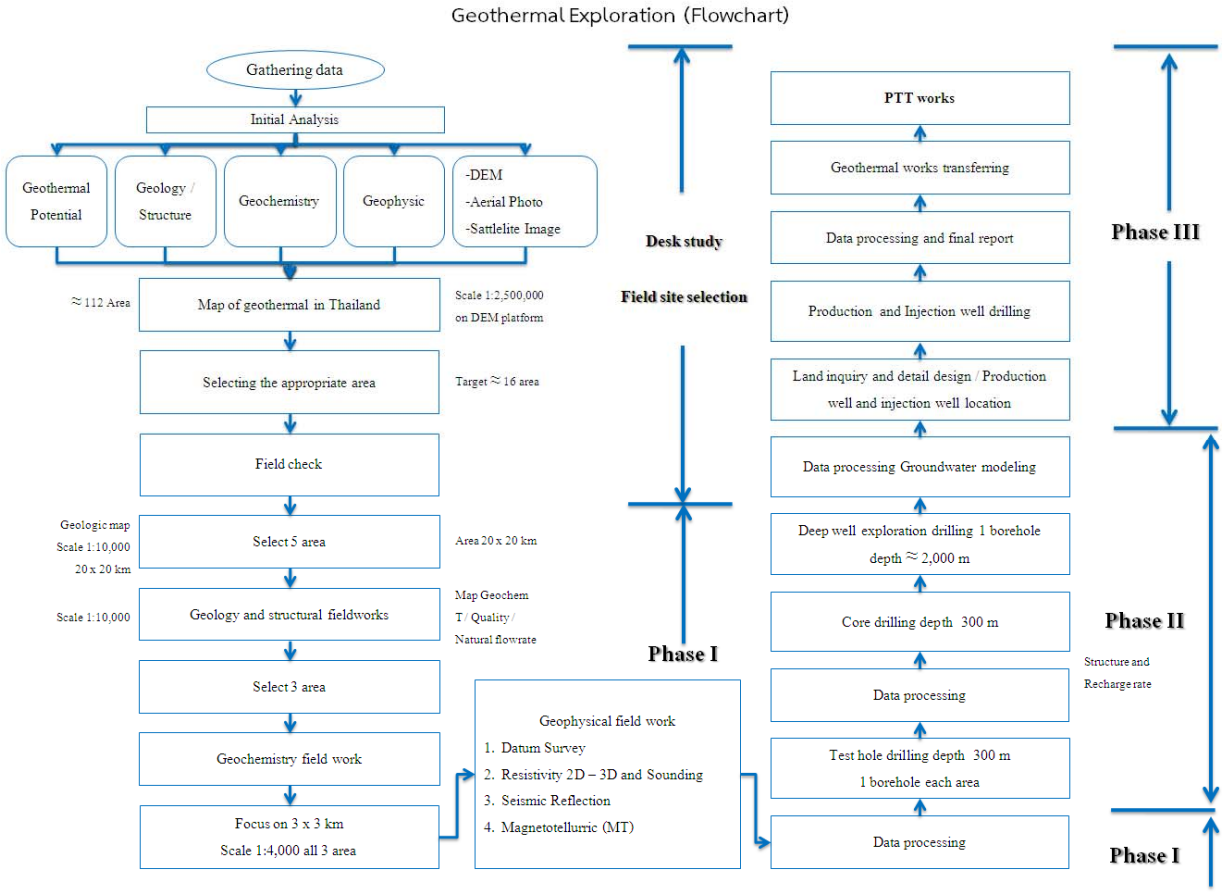

Figure 4. The flow chart of the new phases of recurrent geothermal exploration in Thailand under the MOU between PTT, DEDE, and DGR, which is divided into four steps: desk study; phase I; phase II; and phase III, respectively.

4. SUMMARY

In 2011, a new partnership or new Working Group has been formed comprising of Petroleum Authority of Thailand (PTT), Department of Alternative Energy Development and Efficiency (DEDE) and Department of Groundwater Resources (DGR) under Memorandum of Understanding (MOU) in order to cooperate in exploration and development of geothermal resources for electricity generation by setting a target plant with a capacity of 5 -10 MW and an initial budget for this preliminary exploration is more than US$ 10 million. The propose methodology of new recurrent geothermal exploration is divided into four steps: desk study; phase I; phase II; and phase III, respectively. The desk study will cut down the 112 to 16 geothermal sites. The second step is ground follow check and other field works and only 5 appropriated sites will be selected. After that, geochemistry works will be followed, and only the best three sites will be selected. The Magnetotellurric (MT) survey will be the main part of geophysical survey, the rest are gravity, Resistivity, Magnetic, and seismic reflection surveys. The phase II is test hole drilling, 300 meter depth, in each area, following by 2,000 meter exploration drilling. Due to the cost of 2,000 m. borehole drilling is very expensive, therefore, this step is a crucial step and will terminate the next phase if the result from this step does not match the conceptual models. Then, the wrap up step is production and injection wells drilling, which the well size and casing programme is

upon the results from the previous phase. It is therefore important to note that recent technological advances would be an extremely important role to be fruitful in exploration and development, particularly in Hot Dry Rock (HDR) that should be appropriated for Thailand geological conditions or non-volcanic zone.

5. REFEERENCES

Barr, S.M., Ratanasathien, B., Breen, D., Ramingwong, T., and Sertsrivanit, S., 1979. Hot springs systems and geothermal gradients in northern Thailand. Geothermics, v. 8. p.85-95.

DEDE (Thailand Department of Alternative Energy Development and Efficiency), 2005. Hot spring development project at Mae Chan – ChiengRai [online]. available: http://www3.dede.go.th/dede/fileadmin/upload/pictures_eng/Webpage_MaeChan_HotSpring.pdf [accessed April 18, 2013].

DEDE 2012., The Renewable and Alternative Energy Development Plan for 25 Percent in 10 Years (AEDP 2012-2021) [online]. available: http://www.dede.go.th/dede/images/stories/dede_aedp_2012_2021.pdf [accessed July 8, 2013].

Geotermica Italiana SRI, 1984. Geothermal reconnaissance survey of northern ThailandFinal Report, Geology. unpublished report, Pisa, Italy, 86 p.

JICA (Japan International Cooperation Agency), 1984. The pre-feasibility study - The San Kamphaeng Geothermal Development Project for the Kingdom of Thailand. Technical Report (1st and 2nd phase study), unpublished report.

Korjedee, T., 2002. Geothermal exploration and development in Thailand. Proceedings World Geothermal Congress 2000. Kyushu-Tohoku, Japan, May 28-June 10, 2000, p. 56-66. [online]. Available: http://kgvrs.mine.kyushuu.ac.jp/GVR%20report/No11/thailand.pdf [accessed April 18, 2013]

Ramingwong, T.; Praserdvigai, S., 1984. Development of San Kampaeng geothermal energy project in Thailand. Geothermal Resources Council Bulletin 13 (6), 19-26.

Ramingwong, T., and Lertsrimongkol, S., (1995). Update on geothermal development in Thailand. Paper presented at World Geothermal Congress, Florence, Italy.

Ramingwong, T.; Lertsrimonkol, S., Asnachinda, P., Praserdvigai, S., 2000. Update on Thailand geothermal research and development. Proceedings World Geothermal Congress 2000. Kyushu-Tohoku, Japan, May 28-June 10, 2000, p. 377-386.