FOUR DECADES OF GEOTHERMAL RESEARCH AND DEVELOPMENT IN THAILAND

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ABSTRACT

There are one hundred eighteen hot spring manifestations reported in Thailand, exposed in northern extended towards western and southern Thailand. Thermal water rises up from deep reservoir along high angle dipping fractures and faults mixing with cool water then seep and shoot out to surface. Heat sources anticipate merging from varieties of tectonic phenomena e.g. high concentration of radioactive elements in granitic rocks, active tensional normal faults and relatively shallow cooling intrusive rocks.

Hot spring manifestation in northern Thailand provides higher potential than in the other part. Many expert teams point out that there are suitable for possibilities in small scale power plant i.e. 1-10 MWe. Hot springs manifest in western and southern Thailand are classified as low enthalpy and suitable for agricultural, tourist attraction sites and therapy bath. Government sector explores geothermal to utilize on power plant basis while private sector finds an opportunity to develop as tourist and public health. Direct uses are practically restricted to bathing and swimming pool.

Keywords: Thailand, geothermal, multipurpose utilization

1. INTRODUCTION

Geothermal research and development in area of non volcanic rocks like Thailand is less attractive compare to those expose in the volcanic vicinity area. Opportunity and potential to extract and generate electricity on a commercial scale is less challenged and competitive. Research and exploration activities generally carry out during energy crisis. Investors and many government sectors try to utilize for health relating purposes.

Hot spring study in Thailand began with scientists who collected thermal water and conducted chemical analysis in 1946. Systematic studies to extract geothermal energy resources in northern Thailand started in 1977 by a working group comprised the Chiang Mai University (CMU), the Electricity Generating Authority of Thailand (EGAT) and the Department of Mineral Resources (DMR). Main purpose is to utilize geothermal energy to generate electricity. Plan also set up to utilize thermal water release from power plant for agricultural-industrial processes and recreation or other word "multipurpose utilizations" (Ramingwong et al., 1979, Thienprasert, et al., 1987). Various international organizations have been cooperated on geothermal exploration and utilization in northern Thailand.

Geothermal energy potential has been classified as low, medium and high potential (Thienprasert, et al., 1987). Utilization schemes should be drafted and regulation should be endorsed as a guide lines for explorer and developer to utilize each hot spring area. Priority should be given or benefited to local people. The multipurpose utilization projects under auspices of government and foreign aid should be implemented. Government sector should encourage and provide incentive so that cut down trees as well as imported of energy can be reduced.

This paper gives updated information on past, on-going and future geothermal research and development projects.

2. FOUR DECADES OF THE GEOTHERMAL RESEARCH AND DEVELOPMENT

Hot springs collected and analyzed for its chemical as well as physical properties, had been conducted since 1946. Hot springs and geothermal studied in Thailand can be categorized based on period of time into 4 generations.

First generation or during 1977-1986 Due to energy crisis in the 1980's, many countries, included Thailand set up a working committee searching for renewable energy. Many local organizations and foreign auspicious have been collaborated in geothermal exploration and it should be called hunting period. Most of the works are searching for hot spring manifestations and performing preliminary exploration. The explorations are carried out to preliminary geothermal evaluation step. First collaboration began with a working group comprised the CMU, the EGAT and the DMR signed contract in 1977. They agreed to systematically studied hot springs in northern Thailand. Their main objective is to extract heat from geothermal to generate electricity. On the other hand, they also plan to pipe thermal water released from power plant for agricultural-industrial process as well as for recreation (Ramingwong et al., 1979).

During 1983-1986, the DMR set up geothermal project to evaluate potential of 50 geothermal areas in northern Thailand using geological and geochemical data. They also conducted geophysical surveys and shallow well drills to investigate surface hot spring extension as well as its potential (Thienprasert, et al., 1987).

The collaboration also supported by other Thai organizations e.g. National Energy Department explored geothermal on agricultural and industrial utilization. The Prince of SongKla University preliminarily explored geothermal in southern Thailand. The meteorological department and the hydrographic department, Royal Thai Navy, supported earth quake data in Thailand and neighboring countries. Office of Atoms for Peace assisted in radiometric analysis for purpose to preliminary estimate heat generation especially in area of granitic rocks. At the same time, the working group also requested many foreign organizations specialized in different fields to collaborate the work.

Various international organizations signed agreement to assist Thai's scientist to explore and utilize geothermal. The United State Geological Survey under an auspicious from USAID sent an expert to assist geothermal evaluation in 1980. Experts from Los Alamos Scientific Laboratory under financial supported from the Coordinating Committee for Geoscience Programmes in East and Southeast Asia (CCOP) gave guidance on preliminary evaluation of geothermal potential as well as evaluation steps in 1980. A team from Geological Survey of Japan (GSJ) leaded by Dr. Kawada, an expert to the CCOP at that period, assisted DMR for preliminary geological and geochemical studied of geothermal in northern Thailand for a period of 4 years during 1980-1983. This study conveyed to technical collaboration between the EGAT and the Japan International Cooperation Agency (JICA) on purpose to define geothermal potential at the San Kamphaeng geothermal field, Chiang Mai province during late 1981-1989. Many explorations had been carried out. Geological, geochemical and geophysical studies had been conducted to select for drilling locations during 1982-1984. Ten exploration wells were drilled during 1984-1989 (Table 1, Fig. 1). Two deep exploration wells, GTE-7 and GTE-8 at 1,227 and 1,300 meter depths were completed in 1989. These wells failed to provide enough data to evaluate reservoir potential for power plant. Well GTE-8 encountered fracture zones at various depths from 330-920 m., but only the last fracture at depth 920 m. discharged 40 ton/hour of thermal water at temperature 125°C. The project was postponed due to exploration deep wells did not strike expected high enthalpy reservoirs (Thienprasert, et al., 1987).

Table 1 Wells drilled for geothermal exploration and utilization in Thailand.

Organizations	Field name	Province	Depth (meters)	Number of wells	years	remarks
EGAT	- San Khampaeng	Chiang Mai	< 100	40	1981-1987	-Electricity,
			< 500	6		multipurpose
			1200-1300	2		
	- Fang	Chiang Mai	< 100	27	1981-1985	-Electricity,
			< 150	10		multipurpose
			< 200	7		
			< 500	3	1992-1994	
	- Muang Rae	Mae Hong Son	50	10	1994	-Agricultural
			200	3	1995	
	- Muang Paeng	Mae Hong Son	250	4	1996	-Agricultural
DMR	- Pong Kum	Chiang Mai	20-30	30	1984-1986	-Direct uses
	- Ban Pong	Chiang Mai	150	1		
	- Nong Krok	Chiang Mai	120	1		
	- Sob Pong	Chiang Rai	20-30	16		
	- Mae Choke	Phrae	100	1		
	- Pan Jane	Phrae	100	1		
DEDP	- Tepanom	Chiang Mai	100	3	1994	-Direct uses
	- Pong Pu Fueng	Chiang Rai	100	2		
	- Pong Nam Ron	Lam Pang	100	1		
	- Mae Kasa	Tak	84	1	1995	
	- Nong Haeng	Mae Hong Son	100	2		
	- Mae Chan	Chiang Rai	100	2	1996	
	- Phasert	Chiang Rai	100	2		
	- Muang Ngam	Chiang Mai	100	2	1997	
	- Pha Bong	Mae Hong Son	79	1		
DASTA	- Ban Thung Yo	Ranong	140	2	2006	-Direct uses
	- Ban Porn Rang	Ranong	200	2		
	- Ban Had Yai	Ranong	140	2		

EGAT = Electric Generating Authority of Thailand DMR = Department of Mineral Resources
DEDP = Department Of Energy Development and Promotion DASTA = Designated Areas for Sustainable Tourism Administration

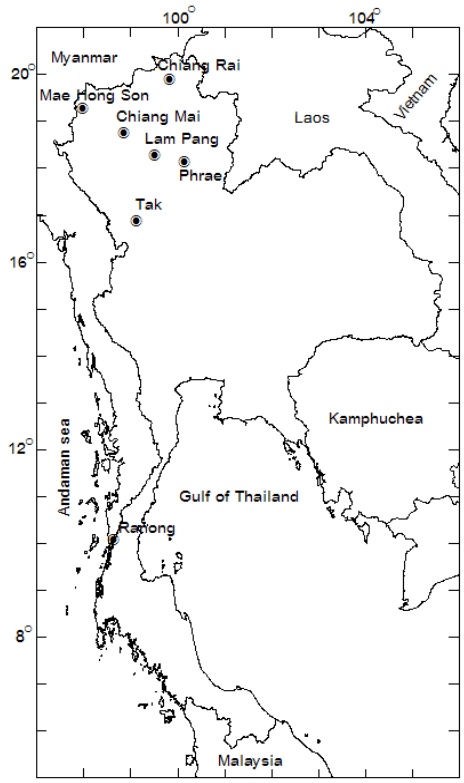

Fig. 1 Thailand map indicates location of provinces drilled for geothermal investigation.

In 1981, the EGAT under an auspicious from the French Agency for Energy Management studied geothermal potential at the Fang geothermal field. This research was successful lead to an installation of 300 kilowatt binary cycle power plant on December 1989 and will be briefed later.

Mean while, the DMR and the United Nations Development Programme (UNDP) signed contract number TCD CON 32/83 on behalf of the working group to collaborate on geothermal research during 1983-1984. Reconnaissance surveys of nine geothermal possibility areas in northern Thailand namely : Ban Pong, Ban Nong Krok, Pong Kum, Tepanom, Nam Mae Mon, Nam Mae Hull, Ban Sop Pong, Ban Pong Nam Ron and Ban Mae chok, had been explored. The contract hired Geothermica Italiana Srl., Italy to supervise as well as evaluate geothermal potential using available geophysical and borehole data. They concluded that geothermal resources and electricity potential capacities were at medium enthalpy fluid. The research also summarized that the Mae Chan geothermal field exhibited high potential for electricity generation.

Second generation or during 1987-1996 Results of researches during the first generation of preliminary geothermal exploration and potential classification pursuit to step of utilization in the second generation. Many organizations plan to research, develop and utilize geothermal energy and it should be called hit and run period. Various explorations at the Fang Geothermal possibility field and shallow wells drilled previously were capacity test. The EGAT and the Bureau de Recherches Geologigues et Mineres (BRGM) of France collaborated to extract thermal water for electricity generation in 1987. They gathered thermal water from three shallow wells at depth 150 meter yielded 120 degree celsius at a rate of about 60 t/hr and used to generate electricity in a 0.3 MWe ORMAT plant (85-90 % available factor). Later on, a multipurpose utilization of geothermal water was implemented. Outlet water was piped for air conditioning, cold storage and crop dryer facilities. Part of thermal water also piped for public bathing pond in recreation area.

Technical cooperation on the Fang deep geothermal development project, under the extended agreement between the EGAT and the French Environment and Energy Management Agency (ADEME), commenced in 1990. The objective is to define possibility of deep reservoir potential as well as to implement electricity generation efficiency. Geological, geochemical and electrical surveys had been carried out to define electricity generating potential of deep reservoir and geological structure control phenomena. The project is not successful and the geothermal utilization project does not receive attention anymore.

The EGAT switches to investigate geothermal at the Muang Rae and Muang Paeng geothermal fields, northwestern Thailand, in the Pai district, Mae Hong Son province in 1994-1996. Having gathering all survey data, they concluded that the areas are suitable to utilize geothermal energy for agricultural purposes.

The DMR with previous geothermal evaluation experience has explored and evaluated geothermal potential in central, western and southern Thailand during 1988-1989. One of the main purposes is to serve as tourist destination and therapy hot spring bath. This geothermal utilization has played an important role on geothermal activities to spread out to Tourist Department, Public Health Department as well as private sector. DMR work is to collect hot spring water for chemical analysis.

Third generation or during 1997-2006 The utilization at this period is for tourist destination and therapy bath. The Tourist Department spent quite a few budgets to promote hot spring and architectural design for tourist visiting area. The Public Health Department also takes care for safety and hygienic bath.

Thailand has joined an international research project, collaborated by IAEA, on Interregional Collaboration Among Circum Pacific (Asia and Latin America) Countries for Develop Geothermal Energy Resources with Environmental Protection through Geochemistry and Isotope Techniques. The Thai Geothermal Working Group requested that the National Geothermal Research Centre to be established to be responsible for geothermal energy development program.

This collaboration is not active.

The Japanese auspicious through the CCOP, under project Digital Compilation of Scientific Map phase IV, requested member' countries to participate for groundwater and geothermal data base. Activities had been carried out and were successfully geothermal and ground water digital compilation during 2001-2003.

DASTA, under the Ranong tourist destination project, selected hot spring as an outstanding attraction scene. The project combined with other tourist attraction sites is set up. Shallow exploration wells successfully drilled and got thermal artesian spring in 2006.

Fourth generation or during 2006-present At this period, direct geothermal utilization is momentum continue from the third generation. Private investment in tourist attraction area is targeting for therapy or health or wellness related development. Government tourist sector still play a key role to motivate local organizations both private and government sector to develop and share investment. Public health department also takes charge for safety as well as hygienic decoration.

During 2010's period, It is similar to the first generation due to an abrupt increase in petroleum prize. People are more aware of security in energy with an affordable price. They explored for alternative energy and geothermal is one of the targets. Conservation and Alternative Energy Department requests collaboration research for utilize geothermal in electricity generating. They invite Ground Water Department, EGAT and Petroleum Authority of Thailand (PTT) to sign contract for research in geothermal development. They also set up criteria, goal and budget for this research. Then it should be called "Renaissance period".

I anticipate that the collaboration among them will be successfully utilized geothermal for electricity generation, at scale 1-10 MWe. I also anticipate that more government incentives for foreign investment are drafted and announced.

3. GEOTHERMAL POWER GENERATION OPPORTUNITIES

Research for geothermal utilization has been carried out in hot spring manifestation areas for 40 years. Most of hot springs in Thailand occur and/or associate with granitic rock aged Triassic and Cretaceous and nearby major faults. It is tectonic influence or the other word hot springs manifestations derive from deep reservoir rise along highly dipping faults or fault sets. Most of them expose as hot pool and seepage in granitic out crop, sedimentary rocks of various ages and unconsolidated sediments. Heat sources do not derive directly from volcano but tectonic (Takashima et al., 1989, Raksaskulwong and Thienprasert, 1995).

It may be summarized that opportunities are only for construction of small and medium sized (1-10 MWe) geothermal power generations applying binary cycle system. Multipurpose utilization should be planned using thermal water released from power generation for direct uses i.e. agricultural and recreation area. Many hot springs expose in remote area where transmission and distribution grid are limit are targeted. The low-medium geothermal potential generating electricity can benefit instead of expensive transmission investment.

Combine sources between hydro and geothermal power plant can alleviate need for electricity in remote area. An example is at the Fang geothermal field where 300 kWe power plant has been developed. The plant pipes water from stream to circulate cooling tower. Later all, a small check dam are constructed and a 3 MWe using hydropower plant piped water from this dam.

Careful, realistic calculations of planned geothermal project economics and of current true power costs must be made. Assuming that they confirm the economic viability of a planned project, they will be critically important in convincing governments and utility officials that geothermal power will be less expensive and more reliable than their traditional generating systems. Developer should analyze types of incentives that government should provide.

4. GEOTHERMAL PROFESSIONAL MANPOWER ALLOCATION

Thai Universities do not provide degree directly towards geothermal studies. Geothermal research and development personnel come from their organizations interested to extract energy at each period. It can be said that people conducted geothermal studies strictly worked at the organizations mentioned in the First generation or during 1977-1986. The other word, one can point out that people in the government, university, foreign aid programs, health and tourist sectors make an effort to utilize geothermal energy for their interest scenes.

5. ON-GOING AND FUTURE RESEARCH AND DEVELOPMENT

At present, tourist and health related sectors have played a key role in extract geothermal energy for direct uses. Natural hot spring and drilled thermal water are piped to local and luxurious resorts.

Strengthen basic research and technology relevant to geothermal should be established during the latest working group. Geothermal industrialization promotion on basis of market oriented development has to inform to public. Development of low-medium enthalpy geothermal resources locate in non volcanic area and sedimentary basins should be sophisticated planned. Combine geothermal with hydropower generation like in the Fang geothermal field is sustainable and ecology-environmental friendly. Optimum exploitation pattern and research for drilling, reservoir engineering and environmental protection should be drafted. Heat pump technology should be implemented and informed widely to public.

6. CONCLUSIONS

Thailand neither situates in recent volcanic area nor in seismicity zone. There are one hundred eighteen hot spring manifestations with surface temperatures ranging between 40° C and 100° C exposed in Thailand. The regional N-S trending tensional and extensional normal faults, widespread in the Southeast Asia during Tertiary, play an important role in providing channels to heat sources at depth. The high geothermal gradients near the hot spring areas may be affected by uprising of deep circulating waters to surface.

Hot springs manifest in granitic, and sedimentary rocks and provide low-medium enthalpy. Careful and detail investigation can locate areas yielded capacity of 1-10 MWe applying binary cycle. Multipurpose utilization and combine with hydropower generation should be planned. Tourist and health related sectors have played a key role to develop for tourist destination. Generally, local community uses hot spring to boil agricultural product e.g. bamboo shoot and egg or for therapeutic bathing.

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