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CURRENT ISSUES OF THE HOT SPRING DISTRIBUTION MAP IN THAILAND

Manop Raksaskulwong
Economic Geology Division, Department of Mineral Resources, Bangkok10400, Thailand

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ABSTRACT

Hot spring distribution map is part of an accelerated data base system developed in the Department of Mineral Resources. Preliminary exploration and chemical analysis have been conducted in the previously known hot spring manifestation areas. Geothermometer, geologic description, chemical analysis and heat flow data will be published in the map.

Geothermal resources in Thailand are classified into low-medium enthalpy. The water contains low concentration of dissolved chemical species and is characterized by high alkali-sodium and bicarbonate. Heat sources anticipate to merge from varieties of tectonic phenomena e.g. granitic rocks comprise high concentration of radioactive elements, active tensional normal faults and relatively shallow cooling intrusive rocks. The first 300 kW binary cycle power plant was established in 1989 at the Fang geothermal field. Thermal water released from the power plant is exploited through drying house and cool storage.

Most possibilities for future geothermal utilization in collaborating between private sector and government sector should be cool storage, barn dryer and therapeutically recreation bathing.

1. INTRODUCTION

Hot springs, natural phenomena indicating that the earth's interior is hotter than its surface, have been studied since 1946. More than one hundred hot springs with surface temperatures ranging from 40 to 100°C, scattered from north to south, occur in Thailand (Fig. 1). They appear not only within volcanic outcrops, but also within granitic and sedimentary rocks of various ages. Surprisingly, there are no hot spring manifestations occurred in northeastern Thailand. Generally, local community uses hot spring water to boil their agricultural product e.g. bamboo shoot and egg, or for recreational bathing.

Systematic studies to extract the geothermal energy have been conducted in northern Thailand by a working group comprised the Chiang Mai University (CMU), the Electricity Generating Authority of Thailand (EGAT) and the Department of Mineral Resources (DMR) since 1977. The main purpose is to utilize geothermal energy to generate electricity. Thermal water released from power plant will be piped to agricultural-industrial processes and recreation (Ramingwong et al, 1979).

Various international organizations have been cooperated on geothermal exploration. During 1982-1989, the EGAT and the Japan International Cooperation Agency (JICA) established technical collaboration to define geothermal potential at the San Kamphaeng geothermal field. The reconnaissance survey of geothermal resources in northern Thailand, under the United Nations Development Programme (UNDP) on behalf of the working group, was established during 1983-1984. A pilot plan for utilization of geothermal energy to generate 300 kW electricity at the Fang geothermal field, under the cooperative between EGAT and the Bureau de Recherches Geologigues et Mineres (BRGM) of France, began in 1987.

The 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.

The EGAT investigated geothermal potential at the Muang Rae and Muang Paeng geothermal area in the Pai district during 1994-1996 and concluded that the areas are suitable to utilize geothermal energy for agricultural purposes. The Mae Chan geothermal area exhibits high potential and has been recommended by many workers to extract thermal energy for direct uses (Ramingwong et al, 1980, 1985; Chuaviroj, et al, 1984; Geotermica, 1984; Manoonvoravong and Virapun, 1996). An on going work at the DMR is to collect hot spring waters in Thailand for chemical analysis. Thailand hot spring distribution map will be produced in near future.

Tectonic influences in hot spring occurrences may be derived from granites (including granodiorite and diorite) and tensional faults. The granites can be divided into three belts lying N-S direction (Nakapadungrat and Putthapiban, 1992). *The Eastern Belt Granites* occur as small batholiths of Triassic age and show I-type affinity. *The Central Belt Granites* occur as major batholiths and large complex plutons of mainly Triassic age and disclose S-type affinity. *The Western Belt Granites* comprise a mixed population of S-type and I-type, indicate Cretaceous. The Indian-Eurasia collision during the Cenozoic caused tensional faulting which indicated by widespread fields of late Tertiary and early Quaternary alkaline basalts in Thailand and Indochina (Bunopas, 1981; Mitchell, 1981; Bunopas and Vella, 1983, 1992; Gatinsky, 1986; Peltzer and Tapponnier, 1988).

2. GEOTHERMAL RESOURCES

Geothermal energy, a naturally occurring heat of the earth's crust, has been used since earliest time for a variety of purposes. Hot spring and geyser manifestations have long been known to associate with areas of high geothermal gradient and heat flow, suggesting possibilities of geothermal energy resources underneath.

2.1 Hot Springs

Hot springs have been investigated intensively in northern Thailand since 1977 whereas preliminary hot spring investigation has been conducted sometimes in other part of Thailand. Hot springs expose near community, have been used to boil agricultural products e.g. bamboo shoot and egg,

or for recreational bathing. Natural hot water, discharged from the hot spring, is rather clear. Hot springs with surface temperature around 100°C, express as geyser, fumarole, bubbling and boiling springs whereas hot springs with surface temperature less than 80°C, display as hot and seep pool.

Hot spring systems in Thailand can be classified, on surface temperature basis, into three systems as: (1) hot spring system indicates surface temperature between 80-100°C, exposes in northern Thailand; (2) warm spring system indicates surface temperature between 40-80°C due to mixing of geothermal water with ground water during circulation and upflow to the surface. These hot springs represent most of all the hot springs in Thailand; (3) geyser system yields surface temperature between 90-100°C, finds only at the San Kamphaeng, the Fang, the Pa Pae and the Mae Chaem geothermal fields, in Chiang Mai province (Geotermica, 1984).

2.2 Geochemical Characteristics

Thermal water discharges from hot springs in Thailand is rather clear, colorless and pH ranges between 6.4 - 9.5. The thermal water is very young, probably has been derived from meteoric water and rain, infiltrated through the ground. The water receives heat transfer from hot rock then heated up and exposed to surface.

Generally, the water contains low concentration of dissolved chemical species and is characterized by high alkali-sodium and bicarbonate (Takashima and Jarach, 1987, Thienprasert et al, 1987). There are no strong sulphide smells derived from the hot spring. In northern Thailand, fluoride concentration is rather high especially where hot springs manifest near granitic rocks and sulphide smell is rather strong whereas in southern Thailand, the fluoride concentration is rather low and sulphide smell is rather mild. In southern Thailand, chemical compositions of some hot springs disclose high chloride content affected by mixing between thermal water and sea water e.g. at the Krabi, Trang and Surat Thani provinces. The chemical composition indicates that hot spring can be used for agricultural and domestic. Most of Geothermal resources in northern Thailand are classified into medium enthalpy (Geotermica, 1984; JICA, 1988).

There are neither active volcanoes nor recent volcanic rocks associated directly with hot spring manifestations. However, about two-thirds of the hot springs are found to be related to some active geologic fractures, lineations and granitic plutons of various ages (Curray et al, 1978; Bunopas, 1981; Bunopas and Vella, 1983; Vella, 1983).

2.3 Laws and Regulation

Geothermal exploration and utilization have not been governed by any laws or regulation. There are some concerns and laws that prospecting organizations should take into considerations. In the case that hot spring location situated in forest reserve area or public community, the exploration and utilization licenses should be requested from that organizations. DMR regulates and governs the ground water act, which stated that any ground water well of a depth more than 30 meters should get drilling license and utilization license. Fee for each licenses cost 500 bahts (approximately 13 US$). Commercial bottled drinking water and bottled mineral water is governed and licensed by the Ministry of Public Health. Considerations of the above scenarios, geothermal exploration and utilization is widely open for competitive organizations to invest in Thailand.

2.4 Data Gathering

Various data sources are gathered and qualified for data base system and hot spring distribution map. Two types of the data can be classified.

Old data include hot spring distribution map, geologic description, chemical analysis will be taken from Ramingwong et al, 1979, 1980; Thienprasert et al, 1987. The heat flow, heat generation are from Raksaskulwong and Thienprasert, 1995; Takashima et al, 1989; Thienprasert et al, 1982; Thienprasert and Raksaskulwong, 1984.

New data DMR has collected thermal water samples and analysed them recently. Simple geological description and physical property have be discussed.

3. UTILIZATIONS

A preliminary geothermal study revealed that there were many high-potential hot spring areas in northern Thailand with main reservoir temperatures reaching 200°C. Two geothermal areas of the first priority group, viz., San Kamphaeng and Fang, were selected for detailed studies in 1980. These studies carried out in collaboration with foreign geothermal expert groups, indicated a moderate geothermal potential. The exploration and utilization of the San Kamphaeng and the Fang geothermal fields have been studied since 1980. The Fang geothermal field provides good schemes for multipurpose utilizations in the area of medium enthalpy resources.

3.1 Power Plant

A joint technical cooperation project between the BRGM, Geowatt of France and the EGAT was formulated during 1981-1984. Purposes are to model geothermal reservoir and to appraise geothermal enthalpy targeting for electrical generation. The first geothermal power plant in Thailand using binary cycle was installed and completed on December 1989. The inlet vaporizer temperature, after past through the air released tank, varies between 115°C to 120°C and temperature of hot water released from vaporizer outlet is approximately 80°C (Korjedee and Prasatkhetwittaya, 1997). The thermal waters released from the power plant, since these are very clean, are planned to be exploited downstream for non-electrical utilizations and will be discussed later. Output from the 300 kW generator is connected to the local distribution grid system of the Provincial Electricity Authority (PEA) and will provide 1.2 million kWhr annually to the grid.

Fang is one of the predominantly agricultural producing in the Chiang Mai province. After harvesting, many crops can be stored at room temperature for a short time and many percentages of crops have to throw away due to sprouting and spoliation. Major cultivation is garlic, onion, rice, lichee, chili, tobacco potato, soybean, maize, cotton, etc. The geothermal energy released from the binary cycle power plant can be exploited at downstream for agricultural-industrial and so on. Concepts to extract the released thermal water for

agricultural-industrial utilization are considered into two categories.

3.2 Drying Process

Faculty of Engineer at the Chiang Mai University, incorporated with the Mae Cho Agricultural Technology Institute and the EGAT, had collaborated in extraction of the geothermal energy for tobacco curing and drying agricultural products in 1986. The first pilot drying house had been constructed at the GTE-6 well in the San Kamphaeng geothermal field. Experiment for curing and drying tobacco, banana, chili, garlic, maize, peanut etc. shows satisfactory results compared to an old drying style using firewood and lignite. At present, government enterprise encourages local community to renovate his old drying house and switch to geothermal energy.

At the Fang geothermal field, the drying house is also built and experiment has been performed on chili and tea. Thermal water, released from the binary cycle power plant temperature 77°C, is fed to the process.

3.3 Cooling Storage Process

Hypothesis of this research, technically and economically consideration, is to extract energy of the released thermal water to develop a cool storage. The project, using the absorption refrigeration system, commenced in 1988. The pilot cool storage, dimension 3x4x2.2 meters and could store 5 tons of agricultural products, was insulated by polystyrene. The cooling capacity was 24,000 btu/hr and provided cool temperature at 4°C. Agricultural products used in the experiment were lemon, onion and lichee. The periodical evaluation of the system performance indicated that spoliation of the products has been decreased to only 8.2% loss of lemon and 10% loss of lichee within one month. The large cooling storage approximately 2,000,000 btu/hr is designed and planned to construct at the Fang geothermal field in near future.

3.4 Public Water and Recreational Ground

Down stream utilization of thermal water released from the drying and the cooling storage room is piping to recreational bathing and medical therapy. The released thermal water contains an average temperature higher than 40°C, which is suitable for therapeutic bathing. Many private sectors as well as local communities express their interests in promoting hot spring water for the touring visiting places. Hot spring bathing in a prestigious spa, offered at hotel, is one of the best alluring commercials in Thailand.

In many places, local community plays an important role to monitor use and preserve hot springs in the area. It is fashionable to decorate the area as a tourist visiting place as well as to provide hot spring utilization to private sector. Hot spring manifestation at the Ranong province, exposed in the Cretaceous granitic rocks and discharged thermal water temperature 65°C at approximate rate of 6.94 liter/second, is promoted in such plan. Developing purposes are to promote hot spring area for tourist visit and to pipe thermal water to local community for an alternative domestic uses instead of public water provided by the Provincial Water Authority. The hot water was collected and piped to hot water storage tank nearby. These thermal waters have been piped through Ranong community and private sector e.g. hotel. Thermal water cost will be charged base on water use read in the meter. Finally, parts of the lukewarm water will be sent through natural stream to provide extra recharge of surface water for crop cultivation.

CONCLUSIONS

Thailand neither situates in recent volcanic area nor in seismicity zone. There are more than one hundred hot springs with surface temperatures ranging between 40°C to 100°C, scattered from the north through the south, occur in Thailand. The regional N-S trending tensional and extensional normal faults, widespread in the Southeast Asia during Tertiary, play a key 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 the surface. Generally, local community uses hot spring water to boil the agricultural products e.g. bamboo shoot and egg, or for therapeutic bathing.

Systematic studies to extract the geothermal energy have been conducted in northern Thailand, where there are about 50 hot-spring manifestations. The multipurpose projects, under auspices of foreign experts, are to utilize geothermal energy to generate electricity. Thermal water released from power plant will be piped to agricultural and industrial processes.

A good example of multipurpose utilization of thermal water is at the Fang geothermal field. The installation of the geothermal power plant of 300 kW electricity applying binary cycle technique is completed on December 1989. The inlet vaporizer temperature varies between 115°C to 120°C and temperature of hot water released from vaporizer outlet is approximately 80°C. Output from the 300 kW generator is connected to the local distribution grid system of the Provincial Electricity Authority and provides additional 1.2 million kWhr annually to the grid.

The thermal waters released from the power plant, since these are very clean, are exploited downstream for non-electrical purposes. The drying house has been performed on chili and tea. Thermal water, released from the binary cycle power plant temperature 77°C, is fed to the drying process. Geothermal energy should be an alternative selection for local industrial to switch fuel from firewood and/or lignite to geothermal energy. Government enterprises should encourage and subsidize money for the renovation.

Another utilization of the released thermal water from the power plant is to develop a cool storage room. The pilot cool storage stored 5 ton of agricultural products, was commenced in 1988. The cooling capacity is 24,000 btu/hr can reduced sprouting of agricultural product when keeping at 4°C.

In many places, local community plays an important role to monitor hot water uses at the area. The Ranong governor team collected naturally flow of hot spring in storage tank and delivered hot water for domestic and hotel uses. It is fashionable to decorate the hot spring area as a tourist-visiting place as well as to provide hot spring utilization concession to private sector. Under sponsorship of the government organization as well as auspicious of the foreign aid, the

multipurpose project will reduce amount of cut down of trees as well as import of energy in the future.

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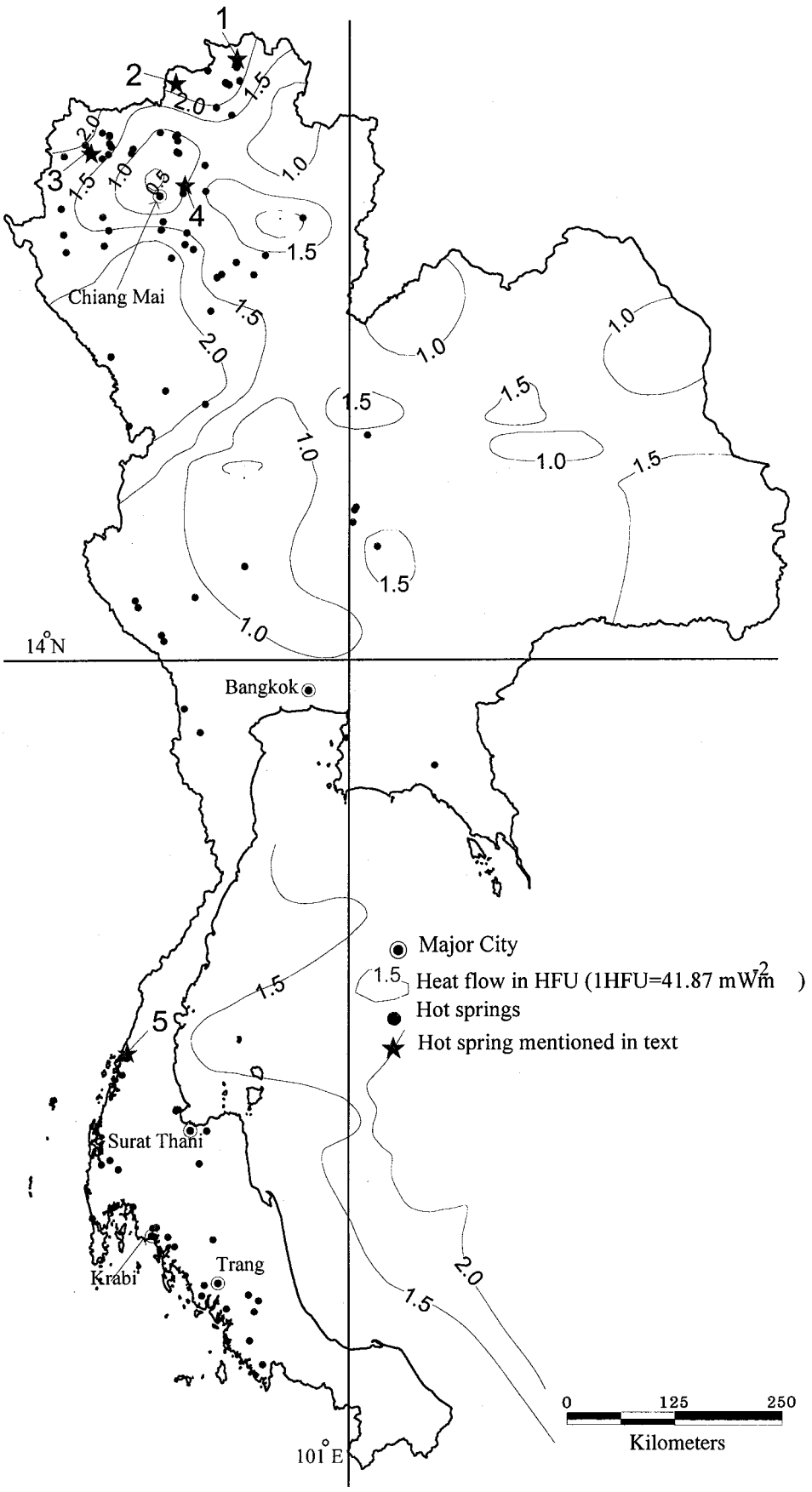

Figure 1. Map shows hot spring distribution in Thailand. Numbers indicate hot springs mentioned in text; 1. Mae Chan, 2. Fang, 3. Pai, 4. San Kamphaeng, 5. Ranong.