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"Asia Geothermal Database" as a DCGM-4 Project of CCOP

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ABSTRACT

The Coordinating Committee for Coastal and Offshore Geoscience Programmes in East and Southeast Asia (CCOP) devotes to coordination and cooperation in scientific activity related to coastal and offshore geological and geophysical surveys, regional map compilation, database construction, human resources development and technology transfer. Activity of CCOP covers four sectors: energy, mineral resources, coastal zone management and geohazards.

In East-Southeast Asia, demands of energy are increasing, and establishment of clean energy infrastructure in the region is needed for preservation of global environments. Fortunately, East-Southeast Asia is in the Circum-Pacific and Himalayan continental collision volcanic zones, and has potential of geothermal energy, which is one of clean energies, available to local electrical power supply and direct use.

Maturity of geothermal development is various among CCOP countries. One country is already well matured and other country is just starting to develop, and geothermal setting is also different from immature island arcs to continental collision zones. Therefore, as a first step to understand and develop geothermal resources in each member country, a geothermal database under common criteria should be built. Under these circumstances, the three-year (2001-2003) multi-lateral international project "Asia Geothermal Database" was proposed in the 36th CCOP Steering Committee Meeting at Bangkok, October 2000, and has met with the approval of the meeting.

The geothermal database was made through compilation of various data sets of each countries with a GIS software, and includes data of geothermal power plants, drillholes, hot springs, Quaternary volcanoes, thermal gradient and disastrous earthquakes with magnetic and Bouguer anomaly maps are shown on base geological maps in the East-Southeast Asia area.

1. INTRODUCTION

The Coordinating Committee for Coastal and Offshore Geoscience Programmes in East and Southeast Asia (CCOP) devotes to coordination and cooperation in scientific activity related to coastal and offshore geological and geophysical surveys, regional map compilation, database construction, human resources development and technology transfer. Activity of CCOP covers four sectors: energy, mineral resources, coastal zone management and geohazards. Development of geothermal resources has come to be a key issue in an energy sector of CCOP countries although it had not yet been treated as CCOP cooperation projects so far.

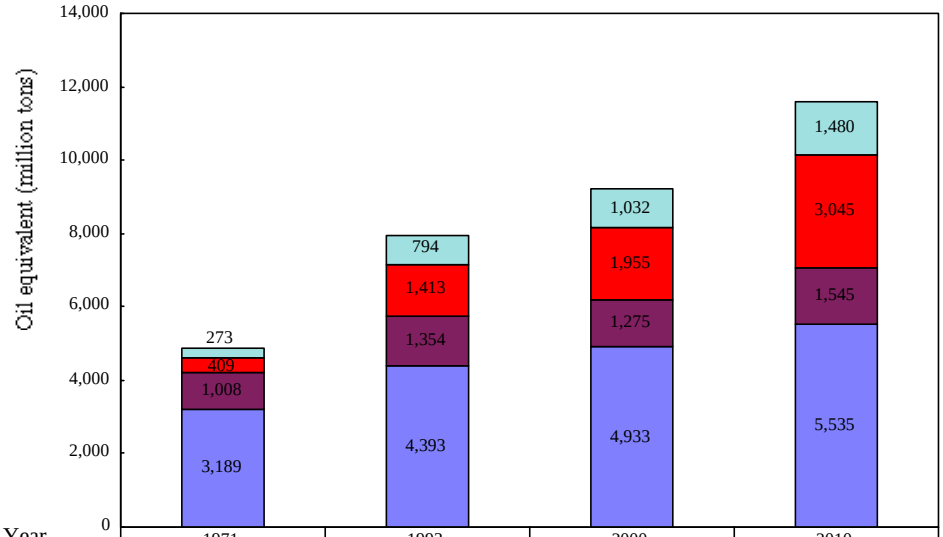
In East-Southeast Asia, demands of energy are increasing, and establishment of clean energy infrastructure in the region is needed for preservation of global environments. Fortunately, East-Southeast Asia is in the Circum-Pacific and Himalayan continental collision volcanic zones, and has potential of geothermal energy, which is one of clean energies, available to local electrical power supply and direct use. In order to develop geothermal energy effectively in the CCOP countries, correct understanding of geothermal resources in each country is necessary, and a geothermal database under common criteria should be helpful for the purpose. Under these circumstances, the three-year multi-lateral international project of "Asia Geothermal Database" was proposed coupled with "Groundwater Database" in the 36th CCOP Steering Committee Meeting at Bangkok, October 2000, and has met with the approval of the meeting.

2. BACKGROUND OF THE PROJECT

The International Energy Agency (IEA) estimated that Asia is the most increasing sector for energy demands among four sectors in the world, that is, OECD countries, the former USSR plus East Europe, Asia and other developing countries, from 1971 to 2010 (Figure 1).

There are various kinds of energy sources that we should use. If we choose hydrocarbon energy sources, this must exhaust much carbon dioxide. Carbon dioxide emission is now seriously increasing, and may cause global warming by an excessive green house effect. As well known, sea level will rise, and islets and many cities at low heights may disappear by the global warming. When we consider that Asia is the most increasing sector for energy demands, establishment of clean energy infrastructure in the area is critically important for preservation of the global environment.

Uchiyama (1993) estimated carbon dioxide emission of various energy sources including emission during production processes of facility: for example, coal-fired, oil-fired, solar-cell, solar-thermal, nuclear, geothermal, and so on (Figure 2). Base on the estimation, even solar energy is not necessarily clean because it spends much energy during production of semiconductors that are used for solar power generation. Nuclear energy is clean as for carbon dioxide emission, but has unsolved problems on waste disposal to environment. Therefore, actually clean energy is small-scale hydro- and geothermal powers. Their carbon dioxide emissions are less than 1% respective to conventional fire-power generation, and development of geothermal energy resources effectively relieves the serious global warming.



Year	1971	1993	2000	2010
Other developing countries	273	794	1,032	1,480
Asia excepting Japan	409	1,413	1,955	3,045
USSR and East Europe	1,008	1,354	1,275	1,545
OECD countries	3,189	4,393	4,933	5,535

Figure 1: World energy consumption and outlook from 1971 to 2010 (IEA,1996)

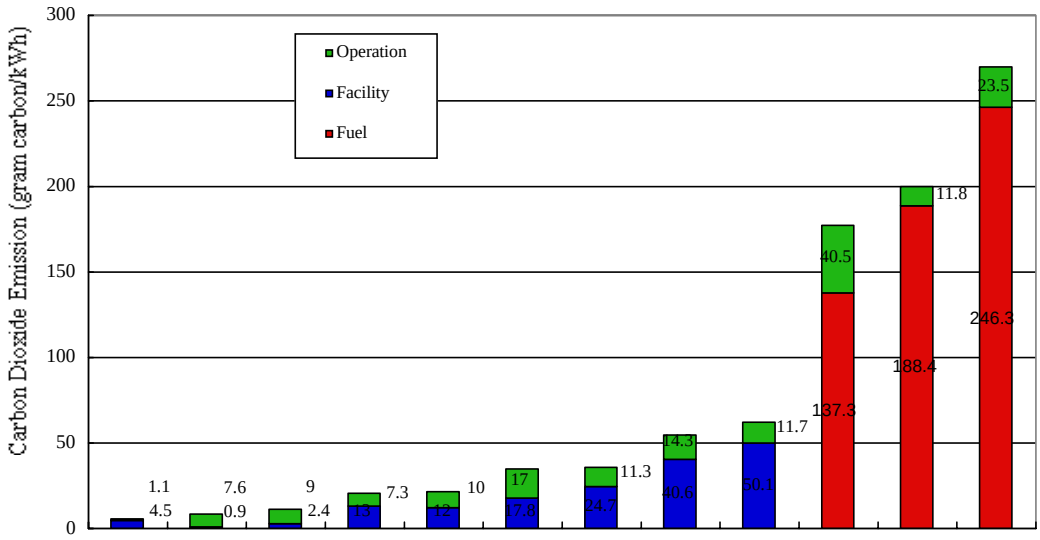


Figure 2: Cleanness of various energy sources in terms of carbon dioxide emissions (Uchiyama, 1993)

Asia is situated in the Circum-Pacific and Himalayan volcanic zones, and abundant geothermal resources are estimated in the area. According Japan Geothermal Energy Association (2000), the Philippines is the second largest geothermal electricity production country in the world, and Indonesia is the fifth at the end of 1999. Geothermal energy supplies about 22 % and 4 % of total electricity consumption in the Philippines and Indonesia, respectively.

Asia has many inaccessible villages such as remote islands and high-mountain areas where major electric grids are hard to be constructed. Accordingly, there are many unelectrified rural areas in Asia. One of merits of geothermal resources is potentiality of local and off-grid power generation systems that provide electricity even in remote areas as archipelagoes and mountainous areas. Another merit is direct use for industry and house heating without transportation of fuel.

3. GENERAL PLAN OF THE PROJECT

As mentioned before, first of all, we must consider that maturity of geothermal development is various among the CCOP countries: some countries are already well matured and others are just staring. Geothermal setting is also different from immature island arcs to continental collision zones. Therefore, general inventory surveys are acceptable as a first step of construction of a database and map for geothermal resources.

The general inventory surveys for geothermal resources include collection of primary data, for example, hot springs (temperature, pH and chemistry), alteration haloes (mineral assemblage and zonation), fumaroles (temperature, pH and chemistry), volcanoes (type, rock series, age and volume), existing wells (temperature log data and lithology), existing geothermal plants (installed capacity) and existing direct use facilities (utility type and thermal output). The collected data must be what can be opened and has been

already published to the public, not classified. These date sets are formulated as a spread sheet type database and are drawn on the available geotectonic maps using GIS technique. These products are finally published as a CD-ROM. CCOP and Geological Survey of Japan (GSJ) have published some digital geological maps in CD-ROMs: for example, CCOP and GSJ (1997, 2000, 2002). The maps contain various kinds of geological information, and can be available to a base map of geothermal resources database. Final output image of the geothermal resources map in East and Southeast Asia should be similar to geothermal resources maps in Japan by GSJ (2002). The compiled database will be published by AIST as a "CCOP Technical Bulletin" with CD-ROM, and the final goal of this project aims to perform an assessment of geothermal resources in each participating country.

4. ACTIVITIES IN THE PROJECT

4.1 First working group meeting

The first working group meeting of national compilers was held at Bangkok in April 2001, coupled with the "Groundwater Database" working group. The implementation plan of the geothermal database compilation and map of the CCOP region was presented by the Chief Compiler, Okubo. The plan is expected to be completed in March 2004 with the generation of digital maps, which would be decided at a later stage of the project, and will be published either in CD-ROM and be distributed to the member countries. After the meeting each participant from the member countries is required to search and fill out the "Availability Data Sheet" provided by Okubo to determine the data availability for the generation of geothermal database. The in-house training and meetings of the national compilers are also scheduled between 2001 and 2003 to meet the objective of the geothermal database generation. As to the ownership of the generated data-output of the project, it was reiterated that CCOP will have the copyright ownership and the data can be accessed through CD-ROM or WWW, however member countries will retain ownership of their own data.

4.2 Second working group meeting

The second working group meeting was held at Manila in February 2002. During the workshop, it was agreed that the final product of the project includes basemaps and geothermal database to be published as the CCOP Technical Bulletin with CD-ROM (cf. http://www.ccop.or.th/aboutpublic.asp). This project is foreseen as the starting point of the development of geoscientific databases of CCOP region, thus the need of database design and management training is considered. The collection of all data will be on March 2004 while the publication of the final product will be on March 2006 or earlier as recommended by the Project Coordinator, Dr. Yamada.

4.3 Third working group meeting and in-house training

The third working group meeting with in-house training was held at Bangkok in March 2003. In the meeting, it was agreed that prioritization of data to compile should be done, since there are already data compiled by Japan which could be of use for the Project. Training on database management shall also be considered in the course of the project implementation. The Chief Compiler (Okubo) stressed that the project plans to produce digital maps with browser on the CD-ROM as one of its final products. Some existing databases in and around Japanese islands were introduced and database management systems were demonstrated. Dr. Jan Safanda invited form Czech Republic lectured a paper on "Inverse method for reconstruction of ground surface temperature history from borehole temperatures" as an example of analysis for borehole temperature profiles.

4.4 Final working group meeting

The final working group meeting was held at National Institute of Advanced Industrial Science and Technology (AIST), Tsukuba, Japan, February 2004. In the meeting, the prototype of the database was demonstrated and the future plan on geothermal resources was confirmed and discussed. It has been agreed that the project will produce a CCOP Technical Bulletin that will include technical papers and country reports from the Member Countries. Papers and reports will be submitted to the Chief Compiler (changed from Okubo to Sawaki) by the end of September 2004. The publication of the database provided by the Member Countries and it was agreed that the Chief Compiler would make some consultations and communicate with National Coordinator from the Member Countries on which data can be published through the various products of the project.

Table 1: Numbers of data used for the database

Country	Item	Total number of data
Cambodia	Hot Spring	3
China	Hot Spring	2038
	Drillhole Temperature	143
	Volcanology	12
	Earthquake	129
Indonesia	Hot Spring	251
	Drillhole Temperature	334
	Geothermal Power Plant	5
	Volcanology	186
	Earthquake	104
Japan	Hot Spring	3918
	Drillhole Temperature	554
	Thermal Garadient	1882
	Geothermal Power Plant	20
	Volcanology	323
	Earthquake	357
Korea	Hot Spring	287
	Drillhole Temperature	435
	Thermal Garadient	788
	Volcanology	3
	Earthquake	163
Malaysia	Hot Spring	93
	Volcanology	1
	Earthquake	42
Papua New Guinea	Hot Spring	122
	Drillhole Temperature	17
	Thermal Garadient	84
	Volcanology	63
Philippines	Hot Spring	338
	Drillhole Temperature	245
	Geothermal Power Plant	13
	Direct Use	2
	Volcanology	52
	Earthquake	197
Thailand	Hot Spring	111
	Thermal Garadient	109
	Geothermal Power Plant	1
	Direct Use	59
	Earthquake	15
Vietnam	Hot Spring	171
	Drillhole Temperature	113
	Geothermal Power Plant	6
	Volcanology	6
	Earthquake	46

5. PROTOTYPE OF THE GEOTHERMAL DATABASE

A prototype of the geothermal database was made through compilation of data sets mainly provided by the National Compilers with a GIS software on MS-Windows, ArcView. In the prototype, data of geothermal power plants, drillholes, hot springs, thermal gradients, Quaternary volcanoes, direct use and disastrous earthquakes with magnetic and Bouguer anomaly maps are shown on base geological maps of CCOP and GSJ (1997, 2000, 2002). Individual data can be seen by clicking the dots on the database. Numbers of the used data are listed in Table 1. As examples of outputs of the database, plots on hot springs with temperature ranges are shown in Figures 3 and 4, and classification on the hot spring data of China is different from the other countries.

6. SUMMARY

When we complete this project, we may proceed into more borehole data-oriented or resource estimation-oriented project as a second step. We also hope many lines of Asian geothermal cooperation projects will be performed in near future. These efforts should, more or less, accelerate the Asian geothermal resource development markets.

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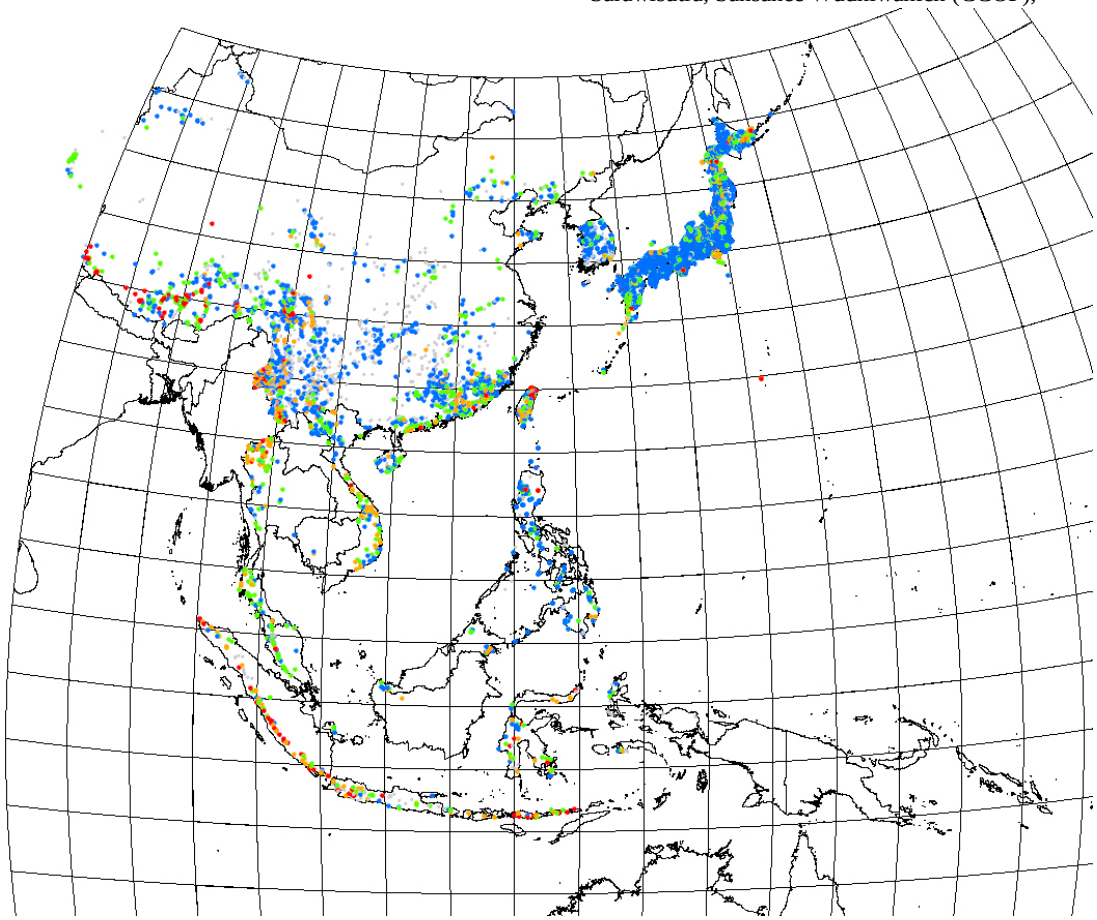

Figure 3: Hot springs in East-Southeast Asia

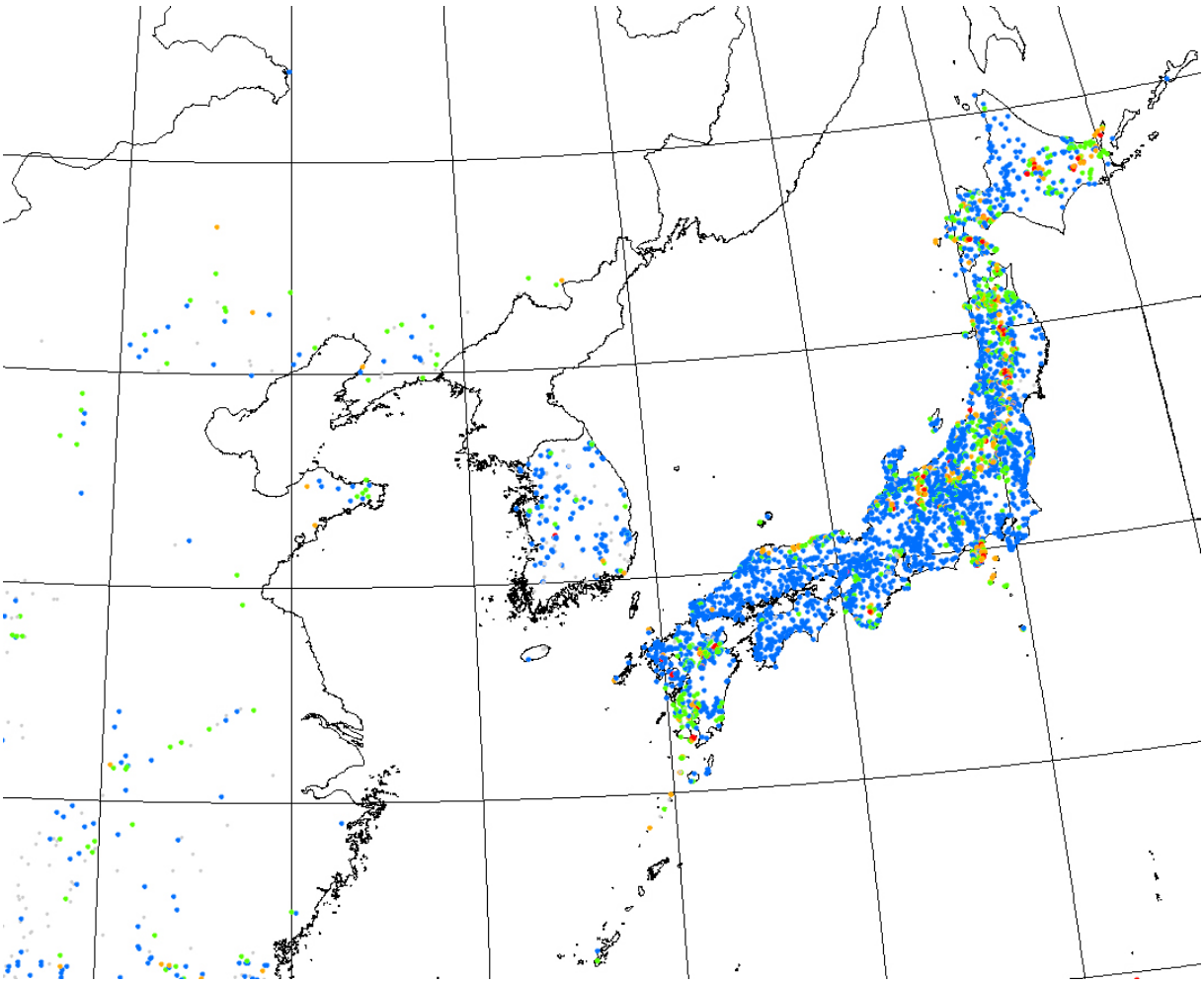

Figure 4: Hot springs around Japan in the Sheet No. 1 area of CCOP and GSJ (2002).

Legend of the dots

		(China)
	≥ 90 °C	≥ 100 °C
	90 > ≥ 60 °C	100 > ≥ 80 °C
	60 > ≥ 42 °C	80 > ≥ 60 °C
	> 42 °C	60 > ≥ 40 °C
	unknown	40 > ≥ 25 °C