INTERNATIONAL ENERGY AGENCY

Geothermal Implementing Agreement (GIA) - Annual Report 1997

L. Rybach (ETH Zurich/Switzerland; GIA Executive Committee Chairman)

BACKGROUND

The IEA Energy Technology Collaboration Program (ETCP) has already included Implementing Agreements with geothermal objectives in the past, like the MAGES Project ("Man-Made Geothermal Energy Systems"), 1978 - 1980 and "Geothermal Equipment Testing", 1979 - 1981 but there were no such activities in the following years.

In 1995 the IEA Secretariat (Paris) made an effort to revive geothermal activities within the ETCP. At an ad-hoc meeting in May 1995, convened in conjunction with the World Geothermal Congress'95 in Florence, representatives of 14 countries expressed general interest in international collaboration under the IEA ETCP umbrella. An IEA Geothermal Expert Panel was formed, especially to formulate the IA Annexes. In two subsequent meetings in Paris (November 1995, April 1996) the legal text and the technical Annexes of the IEA IMPLEMENTING AGREEMENT FOR A CO-OPERATIVE PROGRAMME ON GEOTHERMAL RESEARCH AND TECHNOLOGY (GIA) were formulated. The IEA Secretariat provided great help in all these activities.

The GIA officially went into effect in early March 1997 and is designed to operate for four years.

NATURE AND OBJECTIVES

The GIA represents and important framework for a broad international cooperation in geothermal R & D. It brings together significant national programs and is especially focusing on assembling specific knowhow and on generating synergies by establishing direct links of cooperation between geothermal groups/specialists in the different Participating Countries.

Task/Annexes

Currently there are three active Annexes:

- *Annex I: Environmental Impacts of Geothermal Energy Development* (2 Subtasks)
  The Work Plan of Annex I is designed for 4 years. Operating Agent is the Institute of Geological and Nuclear Sciences, Ltd. (New Zealand); Task Leader is T. Hunt (Wairakei).

- *Annex III: Hot Dry Rocks* (4 Subtasks)
  The Work Plan of Annex III is designed for 4 years. Operating Agent is the New Energy & Industrial Technology Development Organization (NEDO, Japan). Task Leader is M. Kuriyagawa (Tsukuba).

- *Annex IV: Deep Geothermal Resources* (3 Subtasks)
  The Work Plan of Annex IV is designed for 4 years. Operating Agent is NEDO (Japan). Task Leader is K. Kimbara (Tsukuba).

Detailed Annual Reports of these Annexes (including activities in 1997, results, future plans, and references), prepared be the Task Leaders, are given in the **ENCLOSURE.** The 1997 Annex Reports are organized in the following format:

- Introduction
- Work performed in 1997
- Work plan for 1998
- References.

The following Annexes are still in preparation:

- Annex II: Shallow Geothermal Resources
- Annex V: Sustainability of Geothermal Energy Utilization
- Annex VI: Geothermal Power Generation Cycles.

The status of the preparations is different. Whereas Annex V is relatively well developed, Annex VI awaits the participation of Italy which proposed this Annex. Annex II is waiting for the engagement of countries active in the utilization of shallow resources like the USA (e.g. Geothermal Heat Pump Consortium).

Nature of work

The GIA activities aim primarily at the co-ordination of the ongoing national activities of the Participating Countries. In addition, new activities –as defined in the GIA- are initiated and implemented.

The GIA operates under the task-sharing mode of funding.

Objectives

The GIA defines, under its Article 1 the objectives as ”international collaborative efforts to compile and exchange improved information on geothermal energy research and development worldwide concerning existing and potential technologies and practices, to develop improved technologies for geothermal energy utilization, and to improve the understanding of geothermal energy’s benefits and ways to avoid or ameliorate ist environmental drawbacks”.

PARTICIPATION

From the outset of the GIA (March 1997), 5 countries (Japan, New Zealand, Switzerland, United Kingdom, USA) and 1 organization (Commission of the European Communities, CEC) have signed the Agreement; upon unanimous agreement of the ExCo, Greece and Mexico joined in June, Australia in August.

The involvement of the Participants in the different Annexes is shown in Table 1. In this context it must be mentioned that not all Participants are active in all Subtasks of the Annexes in which they participate. The ExCo makes efforts to harmonize this situation.

Table 1. Task participants as by August 1997

	Participating country/organization								
	Australia	CEC	Switzerland	Greece	Japan	Mexico	New Zealand	UK	USA
I: Environmental Impacts				**x**	**x**	**x**	**x**		**(x)**
III: Hot Dry Rock	**x**	**x**	**x**		**x**			**x**	**x**
IV: Deep Resources	**x**				**x**	**x**	**x**	**x**	**x**

Member Countries

Negotiations are underway to secure the participation of the Member Countries Italy and Iceland which are prominent in geothermal R & D. The IEA Secretariat is instrumental in these efforts. It is highly probable that these two countries will join the GIA in 1998.

Non-Member Countries

So far, Turkey and the Philippines have shown interest to join the GIA. A further candidate could be Indonesia, which certainly would add to the GIA, by its very substantial geothermal energy development program. The assistance of the IEA Secretariat is highly needed here also.

ACTIVITIES

Meetings

The ExCo had two Meetings in 1998: The first one in Sendai/Japan (on 10 March) and the second one in Wairakei/New Zealand (on 10 November). The list of current ExCo members is attached.

At its 1st Meeting the ExCo elected Prof. L. Rybach (Switzerland) as Chairman, Dr. T. Imanaga as Vice Chairman for 1997. Both were re-elected for 1998 at the 2nd ExCo Meeting. Unfortunately, it has not been possible so far to find a Secretary for the ExCo.

Several Workshops have been organized for the individual Annexes. Details about these can be found in the **ENCLOSURE**.

Two international conferences (NEDO International Geothermal Symposium, Sendai/Japan, 10-14 March 1997; Geothermal Resources Council 1997 Annual Meeting, 12-15 October, San Francisco/USA) had Special Sessions entirely devoted to GIA Annexes (see the individual Task reports in the **ENCLOSURE**). First publications can be found in the Proceedings of these conferences (for references see the **ENCLOSURE**). A special presentation of the GIA was given at the 19th New Zealand Geothermal Workshop in Auckland on 13 November (see Reference below).

Costs of Agreement

The GIA operates, as mentioned above, in the task sharing mode. The actual amount of work carried out for the GIA cannot be quantified at this moment. As a general rule it can be assumed that the involvement of the individual countries is somewhere on the order of one to several man-year(s).

Dissemination of Results

It is envisaged that the GIA follows the normal way of results dissemination: Publications in scientific/technical journals. Special emphasis is given to Conference Proceedings (see above). It is anticipated that substantial results will be presented at the WORLD GEOTHERMAL CONGRESS 2000 (Japan, 30 May – 10 June 2000).

Co-ordination with Other Implementing Agreements

Shall Annex II (Shallow Geothermal Resources) be implemented, co-ordination with IA ”Energy Conservation through Energy Storage.” will be essential. First coordinative steps have already been undertaken (presentation of the GIA at an ExCo Meeting of this IA/Annex 13).

ACHIEVEMENTS AND BENEFITS OF CO-OPERATION

Since the GIA started only in March 1997 there are no directly visible achievements, except for the above-mentioned Conference Proceedings. It can be expected that this situation will gradually improve.

REFERENCE

Rybach, L. (1997): The IEA Geothermal Implementing Agreement. In: S.F. Simmons, O.E. Morgan & M.G. Dunstall (eds.): Proc. 19th New Zealand Geothermal Workshop, Auckland, p. 187-193

ENCLOSURE: Task Reports

IEA GIA Annex I : ENVIRONMENTAL IMPACTS OF GEOTHERMAL ENERGY DEVELOPMENT – 1997 Annual Report

Prepared by Task Leader Dr. T. Hunt (IGNS Wairakei, New Zealand)

1. INTRODUCTION

In the last decade, concern has mounted about the environmental impacts of developing energy resources. Geothermal is generally regarded as a benign energy source, particularly when compared to nuclear, coal and oil; however, experience shows that there are some environmental problems associated with its exploitation. History shows that hiding or ignoring such problems is, in the long-term, counterproductive to development of an industry because it leads to a loss of confidence in that industry by the public, regulatory, and financial sectors. If our aim is to further the use of geothermal energy, then possible environmental effects should be clearly identified, and countermeasures devised and adopted to avoid or minimise their impact. To assist in this, a new international scientific research program entitled "Environmental Impacts of Geothermal Energy Development" has been set up to form Task I of the GIA.

1.1 Goals

- To encourage the sustainable development of geothermal energy resources in an economic and environmentally responsible manner.
- To quantify any adverse or beneficial impacts that geothermal energy development may have on the environment.
- To identify the means of avoiding, remedying or mitigating the adverse effects that geothermal energy developments may have on the environment.

1.2 Objectives

- Study the effects that existing geothermal developments have had on the environment and determine their cause.
- Identify the most likely and serious adverse effects that geothermal developments can have on the environment.
- Identify the development technologies that have proven to be environmentally sound.
- Publish the results of the studies in international journals and present the results at international forums.
- Improve communications between individuals and organizations in different countries, and between different professional groups involved in geothermal development by involvement in collective presentation of the results in international forums.

1.3 Scope of work

The work may include scientific, social (cultural), and economic studies of the environmental impacts of both existing geothermal developments and future possible developments. The terms environment and impact are interpreted in their broadest sense, and the latter can be taken to include the absence of any detectable change. Studies of natural changes in geothermal areas are also included because these are important for the identification of exploitation-induced changes. The term geothermal may include all natural thermal systems in the earth.

1.4 Output

It is important that the results of the studies are presented collectively, and their impact is not diminished by individual publication in separate issues of a wide variety of journals. To avoid this happening, the results will be presented at a Special Session of the World Geothermal Congress 2000 (Japan) and in Special Issues of international journals.

1.5 Responsibilities

The Task is managed by New Zealand, with the Institute of Geological and Nuclear Sciences as Operating Agent. Each participant (country, organization, individual) will be responsible for funding the work they undertake in this program. The IEA and New Zealand will organize and arrange the presentation (but not the cost) of the work in a manner acceptable to the participants.

1.6 Potential study topics

The following topics were identified as potential areas for research and development:

Effects of Drilling operations
Impacts of access and field development, effects of drilling operations on the environment (noise etc), and methods to minimize pollution of groundwater by waste drilling fluid.

Monitoring Techniques
Requirements for establishing baseline data sets, development of cost-effective environmental monitoring techniques, and development of standard sampling and analytical procedures.

Effects of Mass Withdrawal
Degradation of natural thermal features with cultural significance, depletion of groundwater resources, changes in surface ground temperature, ground subsidence, and hydrothermal eruptions and other hazards.

Effects of Waste Liquid Disposal
Effects on fauna and flora (surface disposal), effects on natural waterways (surface disposal), effects on groundwater systems (shallow disposal), and induced seismicity (deep disposal).

Effects of Waste Gas Disposal
Effects on fauna and flora, microclimatic effects, and development of system designs to minimize gas discharges.

Management
Development of environmental monitoring programs, field management strategies to control and minimize environmental effects, the concept of "sustainable" exploitation and the environment, strategies for public awareness and involvement, guidelines for regulatory authorities, assessment of hazards, compilation of literature databases, documentation and reviews of existing operations (lessons learned), cultural and social values of geothermal features, and cultural and socio-economic effects of exploitation.

1.7 Work plan

In the process of setting up, and initial operation of the Task, the following were agreed upon:

1.7.1 Subtasks

Sub-Task A: Impacts on natural features (Leader: Dr M Sorey, USA)
Sub-Task B: Discharge and reinjection problems (Leader: Dr T Hunt, New zealand)
Sub-Task C: Methods of impact mitigation and Environmental Manual (Leader: Dr S Goff, USA)

1.7.2 Activities

Review paper to be prepared, examining the nature and effectiveness of countermeasures presently available to mitigate environmental impacts.

Preliminary results of studies to be presented at a Workshop in Japan, hosted by NEDO (March 1997). Compilation begun of results to date for publication in a Special Issue of an international scientific journal (see 2.2). Report to Executive Committee.

1998: Publication of Special Issue. Presentation of further results at an international geothermal conference. Report to Executive Committee.

1999: Form Committee to organise Special Session for presentation of results at World Geothermal Congress 2000 (Japan). Report to Executive Committee.

2000: Presentation of results at Special Session of World Geothermal Congress 2000. Final report to Executive Committee.

1.8 Participation

Currently, 10 countries are actively contributing

New Zealand	- 7 projects
Canada	- 1 project
Greece	- 1 project
Iceland	- 6 projects
Italy	- 1 project
Japan	- 5 projects
Mexico	- 1 project
Philippines	- 4 projects
Turkey	- 2 projects
United States	- 2 projects

Further participation is likely from Japan.

1.9 Publications about Task I

To advertise the setting up of the Implementing Agreement and solicit participation, the following articles have been published:

Hunt, T.M. 1996. New international geothermal research programmes, IGA News, 23: 8-9.

Hunt, T.M. 1996. IEA Task I: Environmental impacts of geothermal energy development. Geothermal Resources Council Transactions,20: 263-264.

Rowley, J., Hunt, T.M. 1996. International geothermal energy collaboration opportunities. Geothermal Resources Council Bulletin 25: 261-263.

Rybach, L. 1997. The IEA Geothermal Implementing Agreement (GIA) 1977. Proceedings 19th NZ Geothermal Workshop: 187-191.

2. WORK PERFORMED IN 1997

2.1 Technical Session

A Technical Session was organised for the NEDO International Geothermal Symposium held in Sendai (Japan) on 12 March 1997. Financial support to enable some members to attend the conference was kindly supplied by NEDO. Ten papers were presented from: Iceland (1), Indonesia (1), Italy (1), Japan (2), New Zealand (3), and United States of America (2). These were published in the conference Proceedings.

Ehara, S., Fujimitsu, Y., Nishijima, J., and Ono, A.: Effects of development on geothermal systems deduced from gravity and thermal measurements: Japanese case studies.

Goff, S. and Goff, F.: Environmental impacts during geothermal development: some examples from Central America.

Hunt, T.M. and Glover, R.B.: Precursory changes to natural thermal features during testing of the Wairakei and Broadlands-Ohaaki fields.

Kristmannsdottir, H., Sigurgeirsson, M., Armannsson, H. and Hjartarson, H.: Emission, dispersion and reaction of H_2S in steam from geothermal fields in Iceland.

Scott, B.J. and Cody, A.D.: Effect of bore closure at Rotorua, New Zealand.

Tosha, T. and Sugihara, M.: Geophysical monitoring in the Sengan (Hachimantai) thermal area, Northeast Japan.

Yusa, Y., Ohsawa, S. and Kitaoka, K.: Changes in the Beppu hydrothermal system (Japan) due to exploitation.

Sorey, M.L.: Hydrologic changes associated with geothermal development in Long Valley Caldera, California.

Sulaiman, S. and Pudyastuti, K.: Reinjection lesson from Sibayak geothermal field, North Sumatera-Indonesia.

Rossi, A. and Squarci, P.: Geothermal space-heating of the CNR research campus in Pisa: problems in environmental monitoring.

2.2. Special Issue of GEOTHERMICS

Organisation of a Special Issue of Geothermics journal, on "Environmental Aspects of Geothermal Development", was started and at present 12 contributions have been promised:

Allis (NZ)	Ground subsidence at Wairakei, Ohaaki and Kawerau
Bromley (NZ)	Natural variations to thermal features
Ehara (Japan)	Repeat gravity monitoring in Japan
Glover & Hunt (NZ)	Reversible and irreversible changes to natural features
Goff (USA	Environmental impacts of developments in Central America
Hunt & Glover (NZ)	Mitigating the impact of development - a NZ example
Kristmannsdottir (Iceland)	Emission and dispersion of H2S in steam
O'Shaunassey et al (NZ)	Geothermal environmental legislation
Simsek et al (Turkey)	Environmental protection at Pamukkale
Scott (NZ)	Recovery of features at Rotorua
Verma (Mexico)	Groundwater quality at Los Azufres and Los Humeros
Yusa (Japan)	Long-term changes to Beppu system

Dr E Barbier (Editor in Chief) and Dr S Engebritsen (American Editor) have been informed and are enthusiastic, but advise there is no urgency on production of issue as they have numerous manuscripts already being processed.

3. WORK PLAN FOR 1998

- Complete organisation of Geothermics Special Issue (solicitation of further papers, editing, selection of guest writer for the Preface).

- Organise and hold a Special Session at the Geothermal Resources Council Annual Meeting to be held in San Diego (USA) on 21-23 September 1998.

- Begin negotiations with WGC2000 Organising Committee for holding a Special Session at the World Geothermal Congress to be held in Japan in May 2000.

- Obtain funding to write and produce an Environmental Manual for the guidance of developers. This manual may be translated into Spanish (and possibly other languages) to assist developers in Central and South America.

4. REFERENCES

see under 1.9 and 2.1

IEA GIA Annex III : Hot Dry Rock – 1997 Annual Report

Prepared by Task lader Dr. M. Kuriyagawa (NIRE, Tsukuba, Japan)

1. INTRODUCTION

The objective of Hot Dry Rock Task may address HDR geothermal technologies as well as any other new and improved technologies which can be used to artificially simulate a geothermal resource to enable commercial heat extraction.

Annex III officially went into effect on the 10th of March, 1997 with signing of the following countries and organization:

- CEC
- Japan
- Switzerland
- UK
- USA.
- Australia (signed the GIA in Paris on the 26th of August)

The following four Subtasks are organized to carry out this Task (Task Leader: M. Kuriyagawa).

(1) Subtask A: Hot Dry Rock Economic Model (Subtask Leaders: J. Tester and H. Herzog, MIT, USA)

The Subtask will assemble input from case studies from the international participants. Finally this Subtask plans to package the updated HDR Economic model in a manner that it can be easily transferred and used by any interested party.

(2) Subtask B: Application of Technology of Conventional to Hot Dry Rock Technology (Subtask Leader: Not yet decided)

(3) Subtask C: Data Acquisition and Processing (Subtask Leader: R. Hopkirk, Polydynamics Engineering, Switzerland)

The overall aim of this Subtask is to provide a framework for the construction of a commercial HDR plant including project planning, availability of special tools and services and an overview of data, data analyses and experiences (in the way of lists of reports and publications with their abstracts) gained at the major HDR projects world wide.

(4) Subtask D: Reservoir Evaluation (Subtask Leader ; I. Matsunaga, NIRE, Japan)

The final objectives of this Subtask is to understand how much, how fast and how long geothermal energy can be extracted from a HDR reservoir system. This Subtask will make clear what kind of methods, techniques and tools are effective for reservoir evaluation, and finally will establish the evaluation method which can be applied to develop a new HDR site.

2. WORK PERFORMED IN 1997

2.1 1st Task III meeting (open to the public)

Date: March 12,1997
Place: Sendai, Japan
Attendants:

- IEA (1 person)
- Australia (3)
- CEC (2)
- Japan (11)

- Switzerland (2)
- UK (3)
- USA (4).

Major items discussed:
1) Confirmation of the Operating Agent
2) Election of Task Leader and Subtask Leaders.
3) Work plan of the Subtasks.
4) Structure of information exchange
5) Work schedule

2.2 IEA-related special sessions

NEDO organized an Technical session on Hot Dry Rock at the NEDO International Geothermal Symposium in Sendai, Japan on March 12, 1997where nine papers were presented from five countries. The title of these papers are listed in the References at the end of this report.

2.3 Establishment of HDR Task Subcommittee in Japan

NEDO, Operating Agent, has established HDR Task Subcommittee in Japan. The main role of this Subcommittee is to promote the Japanese activities of HDR tasks. It consists of nine members from NIRE, Tohoku University, GERD, CRIEPI, JAPEX and Mitsui Mining & Smelting Co., Ltd.. Two meetings were already held (July 31 and September 29, 1997), where procedures were established to support the activities of Subtasks A and C, and to promote Subtask D.

2.4 Progress of Each Subtask

2.4.1 Subtask A: Hot Dry Rock Economic Model

The project officially started on September 12. Work on Subtask A is underway. Also, Effort will be made to help coordinate this Subtask with other Subtask member's efforts. The original list of task plans are as follows:
a) Update model.
b) Perform case studies.
c) Document results.

2.4.2 Subtask B: Application of Technology of Conventional Geothermal Energy to Hot Dry Rock Technology (tentative)

This Subtask was proposed by USA. Subtask leader has not decided.

2.4.3 Subtask C: Data Acquisition and Processing

a) Clarify the situation with each past and present project concerning willingness and ability to contribute to the project-databases, start the cooperation and the assessment of data and literature available.
-Replies and principal agreement for Rosemanowes, Soultz, Hijiori and Ogachi.

b) Collected project-specific literature on each project.
-Received for Fjallbacka, started for Rosemanowes, Hijiori and Ogachi; agreed for Soultz; contribution expected for Higashi-Hachimantai.

c) Select suitable software for the fulfillment of the aims.
-Microsoft Access 97 selected for project data index system.

d) Formulation of databases for each project, respecting the history and organization of the project.
-Generic database designed and nearly programmed. Initial specific versions for Rosemanowes and Soultz also.
-General principle for data archiving established, using both chronological and data-type classifications.
e) Design links between bibliographic lists of reports/ publications and project activities and data.
-Integrated into index database design.
f) Include the current activities from the Swiss Deep Heat Mining project into a generic project plan for which the software is to be selected.
-Software tests and comparisons are being organized.

2.4.4 Subtask D: Reservoir Evaluation

a) Reservoir evaluation will be in four fields; geology, geochemistry, logging and modeling. To review techniques developed and/or used in each HDR project to evaluate a reservoir, this Subtask will send a questionnaires to each project.
b) To make questionnaires, techniques involved in four fields will be reviewed.
c) Reservoir evaluation techniques by Acoustic Emission will proceed in cooperation with the MTC project. Results of the Academic Review (Tohoku University, Sendai/Japan, March 1997) are incorporated in this Subtask after getting their permission.
d) The list of the questionnaires which is mailed to each project will be "what kind of techniques you applied for the reservoir evaluation in your project, and which techniques led to success or failure."
e) Third meeting of HDR Task Subcommittee in Japan is scheduled for on December 17, 1997 at NEDO. Draft questionnaire will be made at the meeting.

3. WORK PLAN FOR 1998

HDR forum will be held next September at Soultz/France. In this forum, the activities of Annex III will be discussed. The following is the work plan and final target for each Subtask.

3.1 Subtask A

a) Update model. MIT's current model breaks down HDR costs into several key components: drilling, stimulation, power plant, and operation and maintenance. All key components of this model will critically be reviewed and updated. In addition, choice of all model parameters, including resource, engineering, and economic parameters will be reviewed. Features to quantify sustainability aspects will be added. Environmental and institutional factors will be reviewed and incorporated into the model, as appropriate. The optimization and levelized-cost sub-modules of the existing program will require no updating.

b) Perform case studies. The model will be applied to both generic and specific HDR sites. In consultation with the U.S. DOE Geothermal Division, the case studies will be chosen. Generic studies will evaluate different levels of resource (high-, mid-, and, low-grade) for a variety of conditions (water availability, distance from electrical grid, cost of capital, etc.). Specific studies will look at an individual location, including the current HDR pilot sites worldwide.

c) Document results. Using the model, key research needs required for the commercialization of HDR will be identified. The sites that look best for initial development will be identified. The key barriers that must be overcome for economic development will also be identified. The findings will be documented in annual reports. Finally, the updated HDR Economic model will be packaged in a manner that it can be easily transferred and used by any interested party.

3.2 Subtask B
Has to be discussed later.

3.3 Subtask C
a) Continuation of the activities which started in 1997 and not yet finished.
b) Software selection for database on tools, equipment and services for use in the generic project development and construction plan and initialization of the design of this new database.
c) Seeking methods of linking of this database with the project planning tool.

3.4 Subtask D
The questionnaire for reservoir evaluation techniques will be mailed to the core member of HDR task in each country to ask comments on the questionnaire. Then, a final questionnaire which is revised will be mailed to each project at the end of March, 1998. The answers will be complied and reviewed to obtain the state of the art of the techniques.

4. REFERENCES

The followings are the papers presented at NEDO International Geothermal Symposium in Sendai, Japan on March 12, 1997:
1) P. M. Wright (USA): Sustainability of Geothermal Energy Utilization
2) D. Duchane (USA): Hot Dry Rock in the USA: Where is it going?
3) D. Brown (USA): Review of Fenton Hill Project HDR Test Results
4) D. Wyborn and P. Chopra (Australia): Australian's Favorable Geological Environment for Economic Extraction of HDR Energy: and Current Proposal
5) A. Gerard, J. Baumgartner and R. Baria (France) R. Jung (Germany): An Attempt towards a Conceptual Model Derived from 1993-1996 Hydraulic Operations at Soultz
6) L. Rybach (Switzerland): Geothermal R&D in Switzerland: Achievements and Prospects
7) M. Nagai and N. Tenma (Japan): Development of Hot Dry Rock Technology at Hijiori Test Site -Program for a Long-term Circulation Test-
8) I. Matsunaga (Japan): Reservoir Evaluation of the Hijiori Hot Dry Rock Geothermal System
9) K. Kitano (Japan): Present Status and Tasks of the Ogachi HDR Project

IEA GIA Annex IV : Deep Geothermal Resources – 1997 Annual Report

Prepared by Task lader Dr. K. Kimbara (GSJ, Tsukuba, Japan)

1. INTRODUCTION

The objective of this task is to address the issues necessary for the commercial development of Deep Geothermal Resources which prevail at depths of approximately 3000 meters and deeper. The task consists of three Subtasks:

"Subtask A: Exploration Technology and Reservoir Engineering"
"Subtask B: Drilling and Logging Technologies"
"Subtask C: Material Evaluation Programme".

The Task officially went into effect on March 10, 1997, when New Zealand and Japan signed the Agreement at the 1st Executive Committee (ExCo) Meeting. As of December 1997, five countries participate in the Task: Australia, Japan, Mexico, New Zealand, and USA.

The participating organizations of Australia, Japan, Mexico and New Zealand are as follows:

- The Australian National University (ANU), Australia,
- The New Energy and Industrial Technology Development Organization (NEDO), Japan,
- The Geological Survey of Japan (GSJ), Japan,
- The National Institute for Resources and Environment (NIRE), Japan,
- The Tohoku National Industrial Research Institute (TNIRI), Japan,
- The Instituto de Investigaciones Electricas (IIE), Mexico,
- The Institute of Geological and Nuclear Sciences Ltd. (IGNS), New Zealand,
- The Industrial Research Limited (IRL), New Zealand.

The USA has not yet decided its participatinge organization yet. Italy has expressed its intention to join the Task with the governmental approval for signing.

Japan is responsible for leading the task and NEDO acts as the Operating Agent (OA). OA nominated Dr. Keiji Kimbara (GSJ) as the Task Leader and Dr. Hirofumi Muraoka (GSJ), Mr. Hideo Kobayashi (NIRE) and Mr. Norio Sanada (TNIRI) as the Subtask Leaders of Subtasks A, B and C respectively. They were approved at the 1st ExCo Meeting.

2. WORK PERFORMED IN 1997

2.1 Task Meetings

The OA organized two Task Meetings as follows:

a) 1st meeting on March 12, 1997 in Sendai, Japan
The number of attendees was twenty-eight from seven countries: Italy, Japan, Mexico, New Zealand, the Philippines, Switzerland and USA. The meeting was held as a side-meeting of the NEDO International Geothermal Symposium and was opened to the public in order to bring further participants. The major topics were the four-year work plan as well as the detailed work programme for 1997.

b) *2nd meeting on October 14, 1997 in San Francisco, USA*
The number of attendees was twenty-one from five countries (Italy, Japan, Mexico, New Zealand and USA). The meeting was held as a side-meeting of the GRC 1997 Annual Meeting. The main topics were a report on the task progress in 1997, status reports from participants and work programme for 1998.

1.2 Technical Workshops

The OA organized two technical workshops as follows:

a) 1st workshop on March 12, 1997 in Sendai, Japan
The workshop was held as a technical session at the NEDO International Geothermal Symposium. Sixteen papers were presented from seven countries (Italy, Japan, Mexico, New Zealand, the Philippines, UK and USA).

b) *2nd workshop on October 14, 1997 in San Francisco, USA*
The workshop was held as a technical session at the GRC 1997 Annual Meeting. Nine papers were given from five countries (Italy, Japan, Mexico, New Zealand and Switzerland).

1.3 Field trip to Cerro Prieto, Mexico and Salton Sea, USA

The OA organized a field trip to the Cerro Prieto and Salton Sea geothermal fields to learn and discuss the present status of deep geothermal development in the two areas. The field trip was carried out from October 17 to 20 right after the GRC 1997 Annual Meeting. Ten experts from the three countries, Italy, Japan and New Zealand, participated in the trip. The trip was very successful in getting a lot of information and deepen our understanding of deep geothermal resources.

1.4 Distribution of questionnaire on the Work Plan

The OA made and distributed a questionnaire to fourteen representatives of six countries in order to ask for their opinions concerning the activity in the task and the "Deep Geothermal Well Database". Five replies were received. Based on the replies, OA understood that it is premature to develop a full-scale database which was proposed by OA at the 1st Task Meeting, because of the difficulty in collection of data. Instead, OA will collect the deep well data from published papers worldwide and put summarized information on an Internet home page.

1.5 Home page

The OA is preparing home page consisting of hardware (data storage and Web server machines) and software (Fire Wall System) which will consist of two parts: open pages and confidential pages. Only Participants will be able to make access to the latter system after he/she has a password given by the OA. The task home page is scheduled to be opened in April 1998.

1.6 Progress report to ExCo Meeting

The OA reported the 1997 progress and work plan at the 1st ExCo Meeting. OA reported the task progress in 1997 and work programme for 1998 at the 2nd ExCo Meeting.

3. WORK PLAN FOR 1998

The activities for 1998 will be as follows:

3.1 General

- Make continuous efforts to invite more participants.
- Continues to collect and store the data related to the deep geothermal resources in close cooperation with the participants.
- Open a task home page in April 1998, which will provide a useful tool for information exchange among the participants.
- Plan to hold a Task Meeting and/or a special technical session during the 20th New Zealand Geothermal Workshop.
- Organize a field trip in New Zealand before or after the 20th New Zealand Geothermal Workshop if possible. The trip may include a visit to the Philippines (Tongonan).
- Report task progress to ExCo Meeting.
- Make and publish an annual report of the task.

3.2 Subtask A

a) Make a conceptual model for model fields.
b) Construct a database related to information on deep geothermal fields, deep geothermal explorations and deep geothermal drill holes which will be collected as a by-product through major research products and field trips.
c) Collaboration through Internet communications, task meetings and field trips.

3.3 Subtask B

a) Continue to collect and store data on geothermal drilling and well logging.
b) Exchange progress reports on proposed R&D programs.
c) Progress will be presented at the New Zealand Geothermal Workshop.

3.4 Subtask C

a) Continue to collect the data on chemistry of fluids, materials and their failures.
b) Continue to develop the database related to the subtask.
c) Continue to make a corrosion model for high-temperature and two-phase flow.

4. REFERENCES

(1) Proceedings of NEDO International Geothermal Symposium, pp.98-233. March 11-12,1997, Sendai, Japan
(2) GRC Transactions Vol. 21, pp.271-324. October 12 -15, 1997, San Francisco, USA

ATTACHMENT

ExCo members as by 31 December 1997

Australia	D. Wyborn
CEC	J. Garnish
Greece	K. Karytsas
Japan	T. Imanaga (Vice Chairman)
Mexico	D. Nieva
New Zealand	T. Hunt
Switzerland	L. Rybach (Chairman)
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Zurich, 21 January 1998

L. Rybach
ExCo Chairman