

I N T E R N A T I O N A L



E N E R G Y A G E N C Y

**Geothermal Implementing Agreement (GIA)
1997 – 2002
END-OF-TERM REPORT**

Revised draft 2

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Chairman and Secretary, GIA Executive Committee

February 2002

Summary

This document follows the revised “Guidelines for End-of-Term Reports” which were approved by the CERT on 27 June 2001. After review and approval by the GIA Executive Committee (ExCo) this report is forwarded to the Renewable Energy Working Party(REWP) as an End-of-Term Report.

The Implementing Agreement for a Co-operative Programme on Geothermal Energy Research and Technology (“Geothermal Implementing Agreement”, GIA) started on 7 March 1997 and the present term will end on 6 March 2002. The first Annexes under the GIA (Annexes I, III and IV) also started in March 1997 and their first phase ended in March 2001. At the 5th ExCo meeting in October 2000 it was agreed that work under these Annexes was not complete and should continue four additional years.

Several new Tasks are being planned. Proposed Annex V, Sustainability of Geothermal Energy Utilization will focus research on the long-term stability and heat flow rates into geothermal wells. A new Annex IX, Geothermal Market Acceleration is being planned for outreach to developing countries.

At the 6th ExCo meeting in Brussels (8-9 March 2001) all GIA Participants voted, by unanimity, for an extension of the GIA with a new termination date of 31 March 2007.

A) NATURE

The GIA represents an important framework for a broad international co-operation in geothermal RD & D. It brings together significant national programmes and focuses especially on assembling specific know-how and on generating synergies by establishing direct links of co-operation between geothermal groups/specialists in the different Participating Countries.

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

The present phase of the GIA (1997 – 2002) operates under the task-sharing mode of financing.

B) OBJECTIVES

Article 1 of the GIA defines its objectives as “international collaborative efforts to compile and exchange improved information on geothermal energy research and development world-wide 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 its environmental drawbacks”. These will all contribute to the broader (but unstated) goal of encouraging the wider use of the geothermal energy option.

A first Strategic Plan for the GIA was established in 1997 and reviewed subsequently by the REWP in 1998; the Discussant confirmed that the GIA activities are well on track. At the 6th ExCo meeting (Brussels, March 2001) the ExCo addressed a new Strategic Plan which is outlined in **Attachment 1**.

The GIA encompasses practically all kinds of geothermal technology: besides “traditional” uses like power generation and direct use of heat, new technologies (hot dry rock, deep resources) are also covered.

Following a meeting with World Bank / Global Environment Fund in March 2001, the ExCo recognized the need to broaden the scope of the GIA from essentially technical issues in order to address a broader marketing strategy. A proposed Annex IX (Geothermal Energy Market Acceleration) is in preparation.

C) WORK PROGRAMME

Ongoing Annexes

☞ *Annex I: Environmental Impacts of Geothermal Energy Development (1997 - date)*

Subtask A: Impacts on natural features

Subtask B: Discharge and reinjection problems

Subtask C: Methods of impact mitigation and Environmental Manual

The work, performed on a task-sharing basis, covers:

- ? the nature, effect and cause of environmental impacts from existing geothermal developments, including the effect on natural features;
- ? analysis of the most serious impacts that might occur in the future;
- ? identification of environmentally-sound development policies.

Many of the detailed results obtained to date have already been published (see **Attachments 2 and 3**), but the intended Environmental Manual has had to be deferred for lack of funding.

Plans for the period 2001-2005 include

- ? continuation of data collection and analysis as before;
- ? establishment of a Web site and the organization of lectures and courses to widen the understanding of environmental impacts among technical non-specialists;
- ? further publications in journals and conferences, and preparation of the Environmental Manual;
- ? dissemination to the general public.

✍ Annex II: Shallow Geothermal Resources

This Annex reached a Draft stage but was closed, according to the ExCo decision at the 5th ExCo Meeting (6 October 2000). At the same time, the ExCo decided to consider inclusion of geothermal heat pumps within the IEA market Initiative.

✍ Annex III: Hot Dry Rock (1997 - date)

Subtask A: Hot Dry Rock Economic Model

Subtask B: Application of Conventional Geothermal Technology to Hot Dry Rock (HDR)

Subtask C: Data Acquisition and Processing

Subtask D: Reservoir Evaluation

The work of this Annex draws on the shared experience gained from field projects operated by the participants and, again on a task-sharing basis, has addressed the following topics:

- ? development of an economic model, to predict production costs and to identify the most cost-sensitive parameters on which to focus the research;
- ? the opportunities for technology transfer between conventional geothermal developments and HDR / EGS (Enhanced Geothermal Systems);
- ? collection and archiving in consistent formats of data from the field projects;
- ? evaluation of various techniques for evaluation of reservoirs, based on shared experience from the field projects.

The Annex has also been used as an umbrella to facilitate the exchange of personnel and equipment between the US, European and Japanese groups.

Plans for 2002-2005 include:

- ? completion and final publication on a web site of the economic model;
- ? extension of collaboration to new Australian and German partners;
- ? continued exchange of personnel, information and experience between the projects.

✍ Annex IV: Deep Geothermal Resources (1997 - 2001)

Subtask A: Exploration Technology and Reservoir Engineering

Subtask B: Drilling and Logging Technologies

Subtask C: Material Evaluation Programme

The work addresses, on a task-sharing basis:

- ? Sub-task A - collaborative research on exploration technologies and reservoir engineering for deep, hot reservoirs;
- ? Sub-task B - collaborative research on drilling and logging technologies, with review and collation of experience from within participating countries;
- ? Sub-task C - exchange of information and establishment of a database on fluid chemistries, materials properties and corrosion issues, together with field testing.

All these Sub-tasks terminated at the end of 2001, and NEDO stood down as Operating Agent. The results from all the Sub-tasks will be published in the form of a CD-ROM. The future plan for Annex IV, including the choice of a new Operating Agent, is being discussed among the participating countries.

☞ Annex VII: Advanced Geothermal Drilling Techniques (2001 -)

Subtask A: Documentation of Drilling Costs

Subtask B: Geothermal Drilling Best Practices

Subtask C: Advanced Drilling Collaboration

Work plans include documenting costs and best practices for drilling geothermal wells both for electricity and for direct use; and organizing international collaboration for field tests of new drilling technologies. Plans for 2002-2005 include

- ? Developing a draft of Best Practices Handbook
- ? Employment of economic modelling to predict cost savings by advanced drilling techniques
- ? Compilation of cost data to a database.

For participation in these Annexes, see Table 1 on p.7. The Operating Agents and Task leaders are:

Annex	Operating Agent	Task Leader
I "Environment"	Institute of Geological and Nuclear Sciences/ New Zealand	Dr. T. Hunt (IGNS Wairakei, N.Z.)
III "Hot Dry Rock"	NEDO/Japan	Dr.I. Matsunaga (AIST Tsukuba, Japan)
IV "Deep resources"	NEDO/Japan (<i>to end-2001</i>)	Dr. M. Sasada (GSJ, Tsukuba, Japan)
VII "Advanced Drilling"	Sandia National Laboratories/USA	Dr. J.T. Finger (Sandia Laboratories, Albuquerque, USA)

Annexes in preparation

Annex V: Sustainability of Geothermal Energy Utilization

Annex VI: Geothermal Power Generation Cycles

Annex VIII: Direct use of Geothermal Energy

Annex IX: Geothermal Market Acceleration

D) TECHNOLOGY / MARKET STATUS AND BARRIERS

Electricity generation for geothermal resources

Worldwide annual production still outweighs solar and wind energy. However, the pace of development slowed down from > 16 % annual increase in installed capacity before 1985 to < 4 % afterwards. The reason is insufficient legal and institutional framework as well as the lack of sufficient financing schemes.

Direct use

Whereas the traditional areas of direct utilization of geothermal heat (e.g. district heating) are still evolving to some extent, some new lines like geothermal heat pumps have shown remarkable market penetration. This breakthrough is, however, not universal: spectacular in some countries like USA and Switzerland, but practically non-existent in others. The main obstacle is simply the lack of knowledge/information.

The new Annex IX “Geothermal Market Acceleration” will be established, following an IEA/REWP initiative, specifically to address these difficulties.

E) PARTICIPATION

At present, 11 countries (Australia, Germany, Greece, Iceland, Italy, Japan, Mexico, New Zealand, Switzerland, United Kingdom, USA) and 1 international organization (European Commission) have signed the Agreement. Three of these joined the GIA during 2000: Italy in May, Germany in July, and Iceland in December. There is substantial and increasing industrial involvement in the work under the Annexes. In some cases this is through government sponsored collaboration and in other cases private resources and funding are used by participants. The involvement of the Participants in the different Annexes is shown in Table 1 (overleaf).

Member Countries

In order to extend the GIA further the ExCo is investigating a possible participation of France and Sweden.

Non-Member Countries

Contacts to China, Turkey and the Philippines to join the GIA are sustained. In fact, Philippine scientists already participate actively in the work of Annex I and IV; their involvement has significantly broadened the range of data and experience available to the formal participants. Input from Turkey would have a similar effect in Annex I.

Table 1. Task participants as of February 2002

Participating country / organization	Annex I (Environment)	Annex III (Hot Dry Rock)	Annex IV (Deep resources)	Annex VII (Advanced drilling)
Australia		P	P	
CEC		P		P
Germany		P	P	
Greece	P			
Iceland	P, I			P
Italy	I	I	I	
Japan	P	P	P	P
Mexico	P		P	P
New Zealand	P, I		P, I	I
Switzerland		P		
United Kingdom		I		
USA	P	P	P	P

Key: P = publicly-funded research institute or university I = industry

F) COORDINATION WITH OTHER BODIES

IEA CERT

In November 1998 the GIA ExCo prepared and submitted an input document for the CERT Ministerial paper, as requested by the IEA Secretariat.

IEA REWP

- ✍ On 11 October 2000 the REWP organized a Workshop in Paris on “Developing a New Generation of Sustainable Energy Technologies – Long Term R&D Needs”. This Workshop aimed to summarize and to evaluate appropriate long-term R&D topics, their benefits and possible market pathways. The GIA contribution is included in the Workshop Report “*Developing a New Generation of Sustainable Technologies – Long-term R&D Needs*”.
- ✍ On January 23-24, 2001 in Paris the GIA contributed to the REWP Cabinet meeting with Renewable Energy Implementing Agreement Chairmen on Renewable Energy Market Acceleration. The contribution was strongly assisted by the IEA Secretariat (Rick Seller, Laurent Ditrack, Johan Wide).
- ✍ A further GIA contribution was presented at the REWP meeting in Paris on 4 April 2001.

International Geothermal Association (IGA)

Every five years the IGA organizes an International Geothermal Congress. The last one, the WORLD GEOTHERMAL CONGRESS 2000 (WGC2000) took place in Japan, 30 May - 10 June 2000. WGC2000 was the main international geothermal event of the past five years (1 500 participants). During Plenary Session IV “International Co-operation in Geothermal R&D” (Morioka, 5 June), Dr. H.-J. Neef, Head of Energy Technology Collaboration Division of IEA, reported on IEA activities in renewable energy technology in general, and about the GIA activities in particular. The platform of WGC2000 was used for an extensive presentation of GIA activities and results: 7 Special GIA Sessions were held with 34 oral communications, accompanied by 13 poster presentations; for details see **Attachment 2**. These contributions have been published in the Conference Proceedings (printed and CD-ROM versions).

World Bank & UNEP-Global Environment Facility (GEF)

On May 7, 2001 a well-attended co-ordination meeting was hosted by the European Commission in Brussels, jointly organized by GEF and GIA. It was decided that GIA and GEF will join forces in global geothermal market development and form a strategic partnership collaboration. In particular, the objectives and the follow-up agenda/schedule for the GIA-GEF Alliance were agreed. Details are recorded in the Minutes of the 6th ExCo meeting.

The conditions of collaboration with GEF will be discussed case by case. Generally, for agreed actions GEF will provide 50 % of the project sum.

G) DISSEMINATION OF RESULTS

The GIA follows the normal method of disseminating research results: publications in scientific/technical journals. Special emphasis is given to Conference Proceedings.

A Special Issue (Vol. 29, 4/5, 175 pages) of the journal *Geothermics*, entitled “Environmental aspects of geothermal development”, was published in 2000. This journal is one of the leading international scientific journals focused on geothermal science and technology. The Special Issue was edited by Dr T. Hunt, and contains a Foreword by Prof. L. Rybach. It contains a total of 10 papers, drawn from: Japan (1), Iceland (1), Mexico (1), New Zealand (5), Turkey (1), and The Philippines (1). Subjects covered include:

- ? Exploitation-induced ground subsidence
- ? Effects of development on natural thermal features and methods for their preservation
- ? Use of economic instruments to minimize environmental effects
- ? Rainwater acidity
- ? Sulphur gas emissions

The individual papers are listed in **Attachment 3**.

A total of 47 GIA-derived papers were published in the WGC2000 Conference Proceedings, as already mentioned above. These papers (see **Attachment 2**) were presented in the following Special Sessions:

- ☞ Session F2: IEA Hot Dry Rock (Hijiori/Japan)
- ☞ Session F3: IEA Hot Dry Rock (Ogachi/Japan)
- ☞ Session G3: IEA Environment I

- ✍ Session G4: IEA Environment II
- ✍ Session F4: IEA Hot Dry Rock (Soulz/France)
- ✍ Session F6: IEA Deep Geothermal Resources I
- ✍ Session F7: IEA Deep Geothermal Resources II.

Several further publications deal with GIA work and activities related to it (see **Attachment 4**).

The dissemination of GIA results by a brochure and by a GIA website is still in preparation.

H) SCALE OF ACTIVITIES

Executive Committee

In the report period (1997 – 2001) the ExCo held 6 meetings: Sendai/Japan, 10 March 1997; Wairakei/New Zealand, 10 November 1997; Washington D.C./USA, 18 September 1998; Paris/France, 8 November 1999; Soultz-sous-Forêts/France, 6 October 2000; Brussels, 8-9 March 2001. A further meeting in 2001 is scheduled for 12-13 November in Cuernavaca/Mexico. Prof. L. Rybach/Switzerland has served as ExCo Chairman since 1997, having been re-elected annually. ExCo Vice Chairmen were T. Imanaga/Japan (1997-1999) and Dr. A. Jelacic/USA (2000-).

There was no formal ExCo Secretary in the first two years of the GIA's existence and the administrative work was done by temporary volunteers in the ExCo and/or by the ExCo Chairman. Dr. J. Garnish (EC) has been the ExCo Secretary since 1999.

The ExCo prepared and submitted to IEA the Annual Reports 1997, 1998, 1999, and 2000 (see **References**). Detailed Minutes of all ExCo meetings are available.

To date, the Annex activities in general and the ExCo work in particular have been implemented under the task-sharing mode. This includes also the work of the Operating Agents. A special Planning Committee of the ExCo was established at the 2000 ExCo meeting especially to work out the requirements for increased GIA activities (e.g. Market Acceleration Annex, GIA-GEF Alliance), the Secretariat (GIA brochure and website), and the related financial implications (establishing a Common GIA Fund, see **Outlook**).

Annexes

The ongoing Tasks organize their own meetings, workshops, field trips etc. The following events should be mentioned:

- ✍ Start-up meetings for Annexes I, III and IV at the NEDO International Geothermal Symposium (Sendai/Japan; 12 March 1997)
- ✍ Annex IV meeting in conjunction with the GRC 1997 Annual Meeting (San Francisco/USA; 14 October 1997), Annex IV field trip (Mexico, USA; 17-20 October 1997)
- ✍ Annex I and IV meetings/technical sessions at the 29th New Zealand Geothermal Workshop (Auckland/N.Z.; 12 November 1998), Annex IV field trip (New Zealand; 14-16 November 1998)
- ✍ Annex III meeting in conjunction with the 4th International HDR Forum (Strasbourg/France; 27 September 1998)
- ✍ Annex III/Subtask C&D meeting (Sendai/Japan; 19 March 1999)

- ✍ Annex IV workshop (Pisa/Italy; 10 November 1999), Annex IV field trip (Italy, 11-12 November 1999)
- ✍ Start-up meeting for Annex VII at WGC2000 (Morioka/Japan, 7 June 2000)

D) ACHIEVEMENTS AND BENEFITS

The GIA has contributed to world-wide geothermal technology development through information sharing and task-shared co-operative research. In particular, the GIA has been instrumental in uniting national forces and programmes in geothermal R&D, and in facilitating the exchange of personnel and equipment. The increasing number of Participating Countries demonstrates clearly the great interest of key geothermal countries in the GIA work. The regular contacts between ExCo members and their feedback to national authorities enable better co-ordination of ongoing and new geothermal projects, especially in the various fields of geothermal technology.

The publication of GIA/Task results in journals and Conference Proceedings, as well as the intensive discussions with scientists and engineers not directly involved in GIA-related activities, help the advancement of geothermal energy utilization all over the world. The extension of GIA activities to developing countries and their involvement has not yet been tackled but remains an interesting prospect.

J) OUTLOOK, PLANS BEYOND 2002

Ongoing and new annexes

The continuation of Annexes I, III and IV has been decided by the ExCo; the work plans beyond 2002 (cf. WORK PROGRAMME) are currently under review and revision. Annex VII has just started, its work plan for 2002 is in preparation by the Operating Agent. Annexes V, VIII and IX are at various stages of preparation.

Special emphasis will be given to launching Annex IX (Geothermal Energy Market Acceleration), especially in view of the well-initiated GIA/UNEP/GEF alliance. The alliance will undertake focused efforts in regions with high geothermal potential like Africa, Central & Latin America and Central and Eastern Europe, followed by selected developing countries.

Change in funding arrangements

It has become clear that the increasing scope of activities under the GIA, and particularly the implementation of Annex IX, will require greater resources than can be supplied by the present ExCo Secretary. To carry out the proposed new tasks (e.g. GIA brochure, website, administration of Annex IX) will need a dedicated Secretariat and a Common GIA Fund. The ExCo has agreed to the principle of this enhanced activity and changed method of working, but details (e.g. level of funding) have yet to be agreed formally between the Participants. In any case, the expanded GIA programme will lead to an increased work load for the ExCo and Secretariat.

There are increasing uncertainties facing this new phase of the programme. The reporting period (1997-2001) has shown – and there are some signs for the immediate future too – that governmental funding of geothermal R&D at the national level can be unstable and unpredictable. Besides the year-to-year changes there are contrasting tendencies and trends: whereas in some countries the funding has decreased successively some other countries are speeding up their geothermal efforts. These somewhat unclear perspectives call for a strong dedication and efforts in the next phase of GIA activities. It will be necessary to adapt the GIA Strategic Plan to the changing budgetary environment.

Acknowledgements

It is the pleasure of the ExCo to acknowledge gratefully the constant and efficient support of IEA: Dr. H.-J. Neef, Dr. R. Sellers, Dr. L. Dittrick, and, especially, Dr. J Wide in various stages of the ExCo work. Lynette Rogers-Goderum was often helpful in administrative matters.

K) REFERENCES

Annual GIA ExCo Reports 1997 (15 pages), 1998 (24 p.), 1999 (18 p.), 2000 (30 p.).

The Annual Reports follow the same format: Background, Nature and Objectives, Participation, ExCo Activities in the Reporting Year, Plans for the Next Year; Annex Reports.

The Annex Reports include

- ? Introduction
- ? Work performed in the reporting year (by Subtasks)
- ? Work plan for the following year (by Subtasks)
- ? Output (publications).

GIA related publications

Publications other than in the WGC2000 Proceedings (see **Attachment 2**) are listed in **Attachment 4**.

ATTACHMENT 1: GIA Strategic Plan (outline)

ATTACHMENT 2: Presentation of GIA results at WGC2000

ATTACHMENT 3: Content of IEA Special Issue of *Geothermics*

ATTACHMENT 4: Further GIA related publications

ATTACHMENT 1

International Energy Agency Geothermal Implementing Agreement Strategic Plan

Draft outline prepared by A Jelacic, USDOE (8 February 2001)

Contents

- 1.0 Background and review
 - 1.1 Introduction
 - 1.2 Technical, Economical, Institutional and Market Status
 - 1.3 Geothermal Implementing Agreement Role
 - 1.4 Objectives of the Implementing Agreement
 - 1.5 Means and Results
 - 1.6 Specific Structure

- 2.0 Review of the Objectives of the Implementing Agreement
 - 2.1 Overall Priorities
 - 2.2 Programme of Work for 2001-2005
 - 2.3 Potential Users and Outreach to Them

- 3.0 Means, Routes and Time frame
 - 3.1 Co-operation on Research and Development
 - 3.2 Exchange of Information and State-of-the-Art Assessments
 - 3.3 Extension of the Co-operation to Non-Participating OECD and Developing Countries
 - 3.4 Encourage co-operation to encourage climate-friendly technologies
 - 3.5 Overview

- 4.0 Organizational and Financial Structure
 - 4.1 Administration
 - 4.2 Financial Structure and Costs
 - 4.3 Planning Review
 - 4.3.1 Strategic Planning
 - 4.3.2 Planning Committee
 - 4.4 Terms of the Agreement

- 5.0 Key References

ATTACHMENT 2

**PRESENTATION OF
IEA GEOTHERMAL IMPLEMENTING AGREEMENT
RESULTS
AT THE WORLD GEOTHERMAL CONGRESS 2000
(28 May – 10 June 2000, Japan)**

ORAL PRESENTATIONS AT SPECIAL IEA SESSIONS*Tuesday, June 6*

9:00 - 10:40	Session F2: IEA Hot Dry Rock (Hijiori)	Room F
Chair: Michio Kuriyagawa and Paul Kruger		

9:00	F2-1	Activities of HDR under the IEA Geothermal Implementing Agreement <i>M. Kuriyagawa, H. Herzog, L. McLarty, R. Hopkirk and T. Yamaguchi</i>
9:20	F2-2	Geochemical evaluation of the Hijiori HDR reservoir at Yamagata, Japan <i>I. Matsunaga, H. Tao and N. Tenma</i>
9:40	F2-3	Fracture network modelling of Hijiori Hot Dry Rock reservoir by deterministic and stochastic crack network simulator (D/SC) <i>K. Tezuka and K. Watanabe</i>
10:00	F2-4	The numerical modelling study of the Hijiori HDR test site <i>S. Yamaguchi, S. Akibayashi, S. Rokugawa, Y. Fujinaga, N. Tenma and Y. Sato</i>
10:20	F2-5	Analysis of heat extraction from the Hijiori and Ogachi HDR geothermal resources in Japan <i>P. Kruger, H. Karasawa, N. Tenma and K. Kitano</i>
Reserve Papers		Analysis in preparation for Hijiori long term circulation test <i>T. Okabe, K. Kiriwara, K. Hayashi, K. Karasawa, D. Swenson and R. Schroeder</i> Determination of stress state at the Hijiori HDR site from focal mechanisms <i>S. Sasaki and H. Kaieda</i>

11:00 - 11:20	Session F3: IEA Hot Dry Rock (Ogachi)	Room F
Chair: Yoshinio Hori and Howard J. Herzog		

11:00	F3-1	Outline of the Ogachi HDR project and character of the reservoirs <i>K. Kitano, Y. Hori and H. Kaieda</i>
11:20	F3-2	Fracture investigation of the granitic basement in the HDR Ogachi project, Japan <i>H. Ito and K. Kitano</i>
11:40	F3-3	A fully three-dimensional thermo-hydraulic computation of the Ogachi HDR reservoir <i>H. Suenaga, T. Yanamoto, Y. Eguchi, K. Kitano and H. Ohnishi</i>
12:00	F3-4	Ogachi HDR reservoir evaluation by AE and geophysical methods <i>H. Kaieda, R.H. Jones, H. Moriya, S. Sasaki and K. Ushijima</i>
12:20	F3-5	Re-evaluation of reservoir structure at Ogachi HDR field by precise source location of AE multiplet <i>H. Moriya, H. Niitsuma and H. Kaieda</i>
Reserve Papers		Stress state at the Ogachi site <i>K. Shin, H. Ito and Y. Oikawa</i>

11:00 - 11:20	Session G3: IEA Environment (1)	Room G
Chair: Trevor Hunt and Kan-ichi Shimada		

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| 11:00 | G3-1 | An enforcement project on environmental impact of geothermal exploitation in Iceland
<i>H. Kristmannsdóttir, H. Armannsson and K. Arnason</i> |
| 11:20 | G3-2 | The influence of effluent water discharged from the Námafjall geothermal field on local groundwater
<i>S. Hauksdóttir, H. Kristmannsdóttir, G. Axelsson, H. Armannsson, H. Bjarnason and M. Olafsson</i> |
| 11:40 | G3-3 | Monitoring of geyser activity in Whakarewarewa, New Zealand
<i>Y. Nishi, T. Ishido, M. Sugihara, T. Tosha, N. Matsushima and B.J. Scott</i> |
| 12:00 | G3-4 | Development and verification of a method to forecast hot springs interference due to geothermal power exploitation
<i>H. Tokita, H. Takagi, Y. Kiyota, K. Matsuda, H. Hatanaka, K. Shimada, H. Inuyama, R. Young,</i> |

13:40 - 15:20	Session G4: IEA Environment (2)	Room G
Chair: Michael Sorey and Mahendra Verma		

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| 13:40 | G4-1 | Geothermal development and changes in surficial features: examples from the Western United States
<i>M.L. Sorey</i> |
| 14:00 | G4-2 | Some environmental changes resulting from development of Ohaaki geothermal field, New Zealand
<i>T.M. Hunt and C.J. Bromley</i> |
| 14:20 | G4-3 | Hot spring interference study for predicting hot spring change in geothermal field
<i>K. Shimada, F. Inuyama and H. Tokita</i> |
| 14:40 | G4-4 | Elevation and gravity changes at geothermal fields on the Reykjanes peninsula, SW Iceland
<i>H. Eysteinnsson</i> |
| 15:00 | G4-5 | An investigation of boiling processes in hydrothermal eruptions
<i>T.A. Smith and R. McKibbin</i> |

13:40 - 15:20	Session F4: IEA Hot Dry Rock (Soulztz)	Room F
Chair: Hiroaki Niitsuma and Hisatoshi Ito		

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| 13:40 | F4-1 | Over 10 years of geological investigations within the HDR Soulztz project, France
<i>A.Y. Genter, H. Traineau, B. Ledesert, B. Bourguine and S. Gentier</i> |
| 14:00 | F4-2 | Heat and fluid flow at the Soulztz hot dry rock system in the Rhine Graben
<i>D. Pribnow and C. Clauser</i> |
| 14:20 | F4-3 | Reflection imaging of HDR reservoir at Soulztz by means of the AE reflection method
<i>N. Soma, H. Niitsuma and R. Baria</i> |
| 14:40 | F4-4 | The effect of the 1993 stimulations of well GPK1 at Soulztz on the surrounding rock mass: evidence for the existence of a connected network of permeable fractures
<i>K.F. Evans</i> |
| 15:00 | F4-5 | Soulztz-sous-Forêts: main technical aspects of deepening the well GPK2 .
<i>J. Baumgärtner, A. Gerard and R. Baria</i> |
| Reserve Papers | | Steps towards a comprehensive thermo-hydraulic analysis of the HDR test site Soulztz-sous-Forêts
<i>T. Kohl, D. Bächler and L. Rybach</i> |

Wednesday, June 7

9:00 - 10:40	Session F6: IEA Deep Geothermal Resources (1)	Room F
Chair: Masakatsu Sasada and Graham J. Weir		

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| 9:00 | F6-1 | Current state of development of deep geothermal resources in the world and implications to the future
<i>H. Muraoka, K. Yasukawa and K. Kimbara</i> |
| 9:20 | F6-2 | Ohaaki reservoir chemistry: insights into the nature and location of the heat source(s)
<i>B.W. Christenson, E.K. Mroczek, M.K. Stewart, G. Lyon and B.M. Kennedy</i> |
| 9:40 | F6-3 | Contact metamorphism in the Larderello geothermal system
<i>G. Gianelli and G. Ruggieri</i> |
| 10:00 | FG-4 | The deeper parts of the Geysers thermal system - implications for heat recovery
<i>D. Nielson and J. Moore</i> |
| 10:20 | FG-5 | A mathematical model coupling heat and mass flow and extension rate in the Taupo volcanic zone, New Zealand
<i>G.J. Weir</i> |

11:00 - 12:40	Session F7: IEA Deep Geothermal Resources (2)	Room F
Chair: Hideo Kobayashi and H. Muraoka		

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| 11:00 | F7-1 | Activity report on drilling and logging technology of IEA deep geothermal resources task
<i>H. Kobayashi</i> |
| 11:20 | F7-2 | Advanced drilling system for drilling geothermal wells - an estimate of cost savings
<i>J. Rowley, S. Saito and R. Long</i> |
| 11:40 | F7-3 | IEA deep geothermal resources subtask C: materials, progress with a database for materials performance in deep and acidic geothermal wells
<i>N. Sanada, Y. Kurata, H. Nanjo, H. Kim, J. Ikeuchi and K.A. Lichti</i> |
| 12:00 | F7-4 | The fluid geochemistry and reservoir model for the Kakkonda geothermal system, obtained by NEDO's deep-seated geothermal reservoir survey, Japan
<i>K.Kasai, Y. Hishi, D. Fukuda, O. Kato, N. Doi, V. Akaku, T. Ominato and T. Tosha</i> |
| 12:20 | F7-5 | Deep geothermal drilling, on the Reykjanes ridge - opportunity for international collaboration
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PRESENTATIONS IN POSTER SESSIONS

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- PM-086 Steps towards a comprehensive thermo-hydraulic analysis of the HDR test site Soultz-sous-Forêts
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- PM-089 Soultz-sous-Forêts: main technical aspects of deepening the well GPK2
J. Baumgärtner, A. Gerard and R. Baria
- PM-090 Geological structure around the Ogachi hot dry rock test site using seismic reflection and Csamt surveys
K. Suzulki and H. Kaieda
- PM-091 A study of the pressure-flow response of the Hijiori reservoir at the Hijiori HDR test site
N. Tenma, T. Yamaguchi, K. Tezuka and H. Karasawa
- PM-092 Study on surface area estimation of the Ogachi HDR reservoir by geochemical method
K. Kiho
- PM-093 Stress state at the Ogachi site
K. Shin, H. Ilo and Y. Oikawa
- PM-094 Determination of stress state at the Hijiori HDR site from focal mechanisms
S. Sasaki and H. Kaieda
- PM-095 Plugging method for HDR reservoir using hydrothermal processing of smectite clays to improve recovery efficiency
N. Hirano, S. Higashi and N. Yamasaki
- PM-096 Analysis in preparation for Hijiori long term circulation test
T. Okabe, K. Kiriwara, K. Hayashi, K. Karasawa, D. Swenson and R. Schroeder

IEA Deep Geothermal Resources

- PM-104* A summary of results of the IEA task activities of deep geothermal resources
K. Kimbara, H. Muraoka, H. Kobayashi, N. Sanada, K. Fujimoto and K. Ohsato
- PM-105* Recent results of "deep-seated geothermal resources survey" project in the Kakkonda geothermal field, Japan
T. Tosha, K. Koide, T. Ohminato, K. Akaku and N. Doi

ATTACHMENT 3**Content of *Geothermics* Special Issue „Environmental Aspects of Geothermal Development“, Vol. 29, Nos. 4/5, p. 449-625 (2000), T. M. Hunt, editor**

T.M. Hunt: Preface (p. 449-451).

L. Rybach: Foreword (p. 453-454).

Allis, R.G.: Review of subsidence at Wairakei Field, New Zealand (p. 455-478)

Allis, R.G. and X. Zhan: Predicting subsidence at Wairakei and Ohaaki geothermal fields, New Zealand (p. 479-497).

Bolanos, G.T., Egmedio, V. and Parilla, Jr: Response of Bao-Banati thermal area to development of the Tongonan geothermal field, Philippines (p. 499-508)

Glover, R.B., Hunt, T.M. and C.M. Severne: Impacts of development on a natural thermal feature and their mitigation - Ohaaki Pool, New Zealand (p. 509-523).

Kristmannsdóttir, H., Sigurgeirsson, M., Ármannsson, H., Hjartarson, H., and M. Ólafsson: Sulphur gas emissions from geothermal power plants in Iceland (p. 525-538).

O'Shaughnessy, B.W.: Use of economic instruments in management of Rotorua Geothermal Field, New Zealand. (p. 539-555).

Simsek, S., Günay, G., Elhatip, H. and M. Ekmekçi: Environmental protection of geothermal waters and travertines at Pamukkale, Turkey (p. 557-572).

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ATTACHMENT 4

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