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Status of the IEA Geothermal Implementing Agreement Task III

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ABSTRACT

Status of an Enhanced Geothermal System task of the International Energy Agency's Geothermal Implementing Agreement (GIA) is described. The objective of the EGS Task is to address new and improved technologies, which can be used to artificially simulate a geothermal resource to enable commercial heat extraction.

1. INTRODUCTION

In early 70s, a group of scientists at Los Alamos Scientific Laboratory started a field experiment for extracting heat from hot dry rock at depth in the Valles caldera, New Mexico. Since then, a number of projects have been conducted throughout the world. The original concept of heat extraction from hydraulically created fractures in hot crystalline rocks has been altered by many difficulties encountered in those projects. The variations between the reservoirs are essentially a result of the different geological conditions at the sites. These variations must be taken into account during the development of HDR reservoirs. It is also believed that the experience of HDR projects around the world should be shared among scientists and engineers for developing practical HDR systems.

When an Implementing Agreement for a Cooperative Programme on Geothermal Energy Research and Technology was approved by IEA in 1997, the Hot Dry Rock Task was proposed and approved among one of four Tasks of the IEA Agreement (Rybach, 1997).

2. DESCRIPTION OF ANNEX III

The objective of the HDR Task of the GIA was to address new and improved technologies which can be used to artificially simulate a geothermal resource to enable commercial heat extraction. To accomplish this overall objective the following subtasks were proposed:

(1) Subtask A: Hot Dry Rock Economic Models

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

(3) Subtask C: Data Acquisition and Processing

(4) Subtask D: Reservoir Evaluation

The countries and organization participating in Annex □ were Australia, Germany, Japan, Switzerland, UK, USA and EC at the beginning of the Task. Kuriyagawa et al (2000) described the scope of these subtasks and activities in the early stage of the Task.

In 2001 the subtask A for performing economic analyses of Enhanced Geothermal Systems (EGS) was successfully completed. The model was completed in April 1999 and posted on the Internet (http://web.mit.edu/hjherzog/www/). The EGS model developed by MIT allows the user to define the engineering and financial characteristics of a proposed project and the available geothermal resources to determine resulting economics and to optimize the plant configuration.

Change name of the Hot Dry Rock to Enhanced Geothermal System (EGS) was approved at the 8th ExCo meeting in 2003.

3. SCOPE OF SUBTASKS AND STATUS

The following three Subtasks are now being undertaken under this Annex.

3.1 Subtask B: Application of Technology of Conventional to Hot Dry Rock Technology

Subtask B is defined as: "The Participants shall review new and future developments such as horizontal drilling, fracture mapping, and pumping in conventional geothermal energy and shall determine their applications to EGS technology." U. S. DOE has sponsored several activities using hydrothermal technology for enhanced geothermal systems. In addition, several projects initiated in response to research needs of the hydrothermal community are being implemented in geothermal fields with ongoing DOE EGS projects. Joel L. Renner of Idaho National Engineering and Environmental Laboratory is the subtask leader.

Following are subtask activities in 2003.

A new down-hole motor was tested for horizontal drilling at the Geysers geothermal field. The tool worked well in drilling a highly deviated hole using misted water as the drilling fluid.

DOE researchers and Caithness Energy continued planning for a hydraulic stimulation in the Coso geothermal field for enhancing productivity (Rose et al., 2003 and 2004).

Ormat Nevada, Inc. continued studies of the feasibility of conducting a massive hydraulic stimulation of the hot rock at East Desert Peak, Nevada (Robertson-Tait et al, 2004).

The current phase of work by Rial and co-workers on the use of shear-wave splitting as a fracture characterization tool has been completed (Elkibbi and Rial, 2003).

DOE researchers analyze the effect of injection into the Geysers reservoir (Bloomfield et al., 2003). Researchers also conducted laboratory tests of water injection into Geyser-type systems.

New methods for interpreting tracer tests are being developed to estimate fluid flow paths, sweep efficiency, and fluid and temperature velocities in fractured geothermal media (Shook, 2003 and 2004). This work extends the techniques currently available for test analysis in hydrothermal and oil and gas reservoirs.

The effect that rock-water interaction has on fracture permeability is being extended from hydrothermal systems to enhanced geothermal systems by several DOE funded research groups (Burton et al., 2004, Carlson et al., 2004, Xu and Preuss, 2004).

Heat flow studies initiated for hydrothermal exploration are also being extended to the search for areas of the United States suitable for EGS (Blackwell and Richards, 2004).

3.2 Subtask C: Data Acquisition and Processing

The overall aim of this Subtask is to assemble all available information useful for the construction of commercial EGS plants. This should include information about specific project planning processes, the availability of special tools and services and an overview of data, data analyses and experiences (reference lists of reports and publications with their abstracts) collected at the major EGS projects world wide.

During the past 30+ years EGS research projects in different countries have led to specific scientific, technical and organizational knowledge, which points the way towards the industrial construction of EGS power plants. Therefore a major task was to extract generally valid information from the site specific one. A first version of a management decisional tool, named “Project Management Decision Assistant” (PMDA), is now assembled and ready for dissemination to new EGS project teams as soon the on-going review is completed.

For the EGS-PMDA the following four characteristics have been defined:

1. It should indicate which data are needed at each stage of the planning, construction and operation and how they may be acquired.
2. It should, as much as possible, be based on all the practical and theoretical experiences gained to date throughout the World.
3. It must be easy to understand and to use by project teams new to EGS.
4. Specific parts of it should be easily adaptable to any particular project.

Therefore, it has been decided to realize the EGS-PMDA as a hardcopy classifier containing a CD-ROM with several data bases. It is now distributed for a first review.

3.3 Subtask D: Reservoir Evaluation

The overall object of Subtask D is to compile and make clear what kind of methods, techniques, and tools are effective for reservoir evaluation; and then establish the evaluation method that can be applied to develop a new HDR site, through the use of an Internet questionnaire.

The questionnaire had been finished. But the answers (especially from foreign countries) were not sufficient to complete the task. Thus, in Subtask D, we will be focusing our efforts on compiling Japanese data that includes Hijiori and Ogachi field. From December 2002, AIST began to work on a two-year contract with NEDO to compile all of the main data acquired at Hijiori test site. This contract is called as “Overall compilation and review of Hijiori HDR experiments”.

In the first Fiscal Year ending in March 2003, data consisting of drilling, acoustic emission, hydraulic fracturing, and modeling/simulation were compiled. In the second Fiscal Year, starting from April 2003, the working group chaired by Prof. Niitsuma of Tohoku University has been discussing overall design, reservoir creation, circulation-heat extraction, and monitoring methods based on Hijiori experiment. This work was completed in March 2004. Results were complied and reported (Matsunaga, et al., 2005).

3.4 A new Subtask

A new subtask for field studies of EGS reservoir performance is proposed by USA and EC.

The objective of this subtask is to conduct field studies of EGS reservoir development and performance with the intent of understanding reservoir behaviour and the sustainability of energy recovery. This topic covers a broad area and includes subjects such as hydraulic stimulation, fracture mapping, tracer analysis, geophysical methods, and geochemistry. This subtask will be conducted in cooperative work at one or more EGS site, such as Soultz, undergoing development and suitable for field studies.

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