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COOPERATIVE RESEARCH AND DEVELOPMENT IN GEOTHERMAL ENERGY

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1. FOREWORD

During the last few days we have heard that the DOE/ENEL Agreement on Cooperative Research and Development in Geothermal Energy, signed in June 1975, encouraged the implementation of joint activity in five projects. One of these projects deals with the various aspects of 'RESOURCE ASSESSMENT AND RESERVOIR PHYSICS AND ENGINEERING' and is referred to as Project DOE/3.

2. OBJECTIVES

The general objective of Project 3, as defined in the DOE-ENEL Agreement, is to "seek procedures for optimizing the techniques required in the resources assessment and reservoir engineering of geothermal systems." However, when drawing up the Program Outline for Project 3 it was decided that, in view of the multiplicity and variety of problems that might arise, and to simplify the operative side, the activity of the Project should be divided into three separate areas of research. These are:

- (1) resource assessment
- (2) reservoir physics and engineering
- (3) reservoir modelling

2.1

The first of these areas of research includes the specific tasks relative to exploration methodology problems, (geological geophysical

and geochemical), as well as the problems involved in evaluating the regional and local geothermal potential.

With regard to the latter, in particular, the objective was to develop the methodological approach of an "a priori" estimation of geothermal energy, at the same time attempting a general classification of geothermal potential in terms of "resources" and "reserves."

2.2

The second area consists of the study of the problems connected with defining the physical properties of the geothermal reservoirs. The main objective in this case was to develop appropriate processing techniques for the physical and thermodynamic data from the wells. Starting with the methods tried and tested in the oil industry, the aim was to extend these to geothermal research in general and to the long-term forecasting of the behaviour of productive wells in particular.

2.3

The third area of research consisted of the investigation of geothermal systems by means of physical and mathematical models, directed at developing a reference base for a better understanding of the nature and behaviour of these same systems. The model approach, besides representing a generalized means of studying exploited geothermal systems, was also regarded as a useful tool for defining the natural physical parameters of these systems in their pre-drilling undisturbed conditions. In other words, one of the objectives of this area of research of Project 3 was to model natural geothermal systems with a view to understanding how they can form and persist within the earth's crust.

3. TASK OF PROJECT 3

With these objectives in mind, the following 12 specific technical tasks (shown in Table 1) were devised for the three areas of research. Most of them have, by the way, already been completed.

Table 1. TASKS COMPLETED OR IN PROGRESS UNDER PROJECT 3

A) "RESOURCE ASSESSMENT AND EXPLORATION METHODOLOGY"

- * /DEA-3/1 Methods for regional assessment of geothermal resources.
 - * /DEA-3/2 Assessment of geothermal potential of Central and Southern Tuscany
 - + /DEA-3/11 Helium prospecting in geothermal areas.
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B) "RESERVOIR PHYSICS AND ENGINEERING"

- * /DEA-3/3 Analysis of reservoir pressure and decline curves in Serrazzano zone.
 - * /DEA-3/4 Well-testing in Travale-Radicondoli geothermal field.
 - * /DEA-3/5 Thermodynamic study of Bagnore field.
 - + /DEA-3/9 A depletion model of the Gabbro zone - North Larderello.
 - + /DEA-3/10 Reservoir engineering studies of the Travale-Radicondoli Reservoir.
 - § /DEA-3/15 Study of water influx and variation of fluid composition in the Bagnore field.
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C) "RESERVOIR MODELLING"

- + /DEA-3/5 Study of effects of re-injection with a mathematical model.
 - + /DEA-3/7 Modelling vapor-dominated geothermal reservoirs.
 - § /DEA-3/12 Numerical investigation of geothermal production and injection of fluids.
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OTHERS

- * /DEA-3/8 Workshop on Geothermal Resource Assessment and Reservoir Engineering.
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* Presented at the 1st DOE-ENEL Workshop (Larderello, September 1977).

+ Presented at the 2nd DOE-ENEL Workshop (Berkeley, October 1980).

§ Preliminary results.

The first DOE-ENEL Workshop represented another non-technical task. The final results of the tasks indicated by an asterisk in Table 1 were presented and discussed during the first Workshop, held in Larderello in September 1977 and are now published in a special issue of the journal Geothermics.

The results of the other tasks (indicated by a dagger in the Table) are detailed in the following pages (Project 3).

4. MAN-POWER REQUIREMENTS

All the tasks of Project 3 were devised and implemented in close collaboration between Italian and US researchers. This collaboration necessitated frequent working visits of American scientists to the ENEL offices in Pisa and Larderello and of Italian researchers to the USGS (in Menlo Park and Denver), to Stanford University and to Lawrence Berkeley Laboratory.

Without speaking of the engagements of personnel that were necessary to implement these joint tasks, to give some idea of the close techno-scientific 'rapport' created by Project 3, we need only say that there were approximately 20 visits of US scientists to Italy and about 15 of ENEL personnel to the USA, totaling about 550 and 400 man/day spent abroad for strictly scientific reasons.

5. CONCLUSIONS

The Project Leaders, that is the writers of this Introduction, will not presume to draw conclusions on the validity of the scientific results obtained until now by Project 3.

My colleagues along with the international geothermal community, having read the 20 odd papers already in print on the Proceedings of the first and second DOE-ENEL Workshops, will be able to draw their own conclusions.

What we would like to say is that the type of collaboration adopted for Project 3, with its joint implementation of the defined tasks, has resulted in an extremely prolific exchange and comparison of know-how and experience. We wish also to add that the joint

undertaking of these tasks has generated a strong spirit of emulation and close ties of friendship between all those contributing to Project 3. To these contributors, the Project Leaders want to address their thanks and deep appreciation for the work carried out.