ADVISORY GROUP MEETING, PISA, 8–12 SEPTEMBER 1975
An expert group of 31 scientists from 8 countries discussed the "Applications of Nuclear Techniques in Geothermal Studies."

Geothermal Energy

Geothermal steam, often reaching temperatures of 250° to 300°C, always was and is especially now one of the most economical sources of energy. The steam, extracted from wells reaching a depth of 500 m to 1500 m in most cases, is directly conveyed to turbines to produce electricity. However, for a number of reasons, the present development and exploitation of geothermal energy are limited to a few areas in the world, where the existence of high temperature fluids at relatively shallow depths has long been known because of the presence of thermal phenomena at the surface.

At present, the major producers of electrical energy from geothermal sources are Italy, New Zealand and USA. Power plants of a smaller size are in operation in El Salvador, Iceland, Japan, Mexico and USSR. In Iceland and in Hungary the major use of geothermal energy is for heating buildings and greenhouses.

Intensive research is going on in order to discover new geothermal fields. Promising results have been obtained in many countries, among them Chile, France (Guadelupe), Indonesia, Kenya, Philippines, Turkey, etc. In many cases the research was carried out with UNDP financial support.

In the United States, studies and experiments are under way to create artificial geothermal fields by extracting heat from artificially fractured dry hot rocks by means of injected water.

In the field of geothermal studies, geochemical methods including the use of environmental isotope methods are among the most important. For this reason the IAEA called an Advisory Group Meeting on the Application of Nuclear Techniques to Geothermal Studies, in co-operation with the Instituto Internazionale per le Ricerche Geotermiche of the Italian Consiglio Nazionale delle Ricerche, which was held in Pisa from 8 to 12 September. The scope of the meeting was to review the existing data critically, to present new methods and ideas, and to indicate future research trends.

Scientists from France, Federal Republic of Germany, Iceland, Israel, Italy, Japan, New Zealand and USA attended; Dr. A.J. Ellis (New Zealand) was elected Chairman. One day was devoted to an excursion to Larderello, about 100 km south-east of Pisa, to visit the most important Italian geothermal field, one of the largest in the world, and the first to be exploited for the production of electrical power (1904).

Conference papers dealt with rare gases in geothermal fluids, evaluation of temperature at depth by means of geochemical and isotopic methods, and field studies with isotope techniques of geothermal systems in France, French Territory of Afars and Issas, Greece, Iceland, Italy, Japan, New Zealand and USA.

RARE GASES

It was shown how the content of rare gases and isotopic composition depend upon the geological and geochemical features of geothermal systems. Radon can be used to investigate the reservoir time characteristic of already exploited geothermal fields, as well as those of artificially stimulated geothermal systems.

Helium isotopic composition is a relatively new tool in isotopic geochemistry of geothermal systems. The first results indicate an ^3He enrichment in geothermal fluids, and in volcanic gases of about one order of magnitude with respect to helium isotopic ratio in the atmosphere, indicating an inflow of primordial helium.

Radon and helium in groundwater are also new tools for earthquake prediction; this was accidentally discovered in the 1966 earthquake in Tashkent, USSR. Now a programme has been set up in USA to monitor radon and helium in groundwater along a stretch of the San Andreas fault in California, an area of high seismic and geothermal activity.

GEOCHEMISTRY

Chemical and isotopic analyses of geothermal fluid components may lead to an evaluation of the temperature at depth. The basic assumptions are: 1) that chemical and isotopic equilibrium existed among the reactants of a given temperature-dependent reaction at the conditions of the geothermal reservoir at depth, and 2) that re-equilibration does not occur after the reactants have left the reservoir till the moment of sampling. Mixing fluids with different characteristics and mixing them with shallow groundwater may complicate the temperature evaluation. However, using more than one geothermometer, one might be able to evaluate the mixing and therefore to construct correct models of the geothermal systems.

The main chemical geothermometers currently used are those based on quartz solubility and on NA–K–Ca ratios. The main isotopic geothermometers are those based on the isotopic equilibrium in the systems CH_4-H_2, H_2O-H_2, CO_2-CH_4, $SO_4^{=}-H_2O$, $SO_4^{=}-H_2S$.

FIELD STUDIES

Isotope techniques have been used in detailed studies carried out in the major geothermal fields in the world and for reconnaissance studies in potential geothermal areas.

Isotope techniques are often a unique means of obtaining certain types of information on geothermal fields, such as the origin of geothermal fluid components (for instance, twenty years ago it was believed that magnetic water was the major component of the geothermal fluid, until isotopes demonstrated the meteoric origin of geothermal water), flow pattern from the recharge area, mixing and interaction with other fluids, temperature at depth, etc. If the isotopic measurements are repeated at different times, they give information on the changes that occurred in the geothermal field as a consequence of exploitation, which might have an important bearing on the management of the field.

It was agreed at the meeting that improvement was needed in the exchange of information and in the co-ordination and co-operation among the various institutes and laboratories working in this field.

Future research should be carried out more systematically, delegates concluded. Three main patterns should be followed:

(1) Exploration —systematic reconnaissance studies using all possible isotope and geochemical methods in areas where potential geothermal fields have been located;

(2) Monitoring — isotope and geochemical measurements at regular time intervals in the already known geothermal fields;

(3) Laboratory investigation — experimental determination and collection of basic data, such as the determination of isotopic fractionation factors and of exchange kinetics in compounds, under conditions generally encountered in geothermal fields.

ADVISORY GROUP MEETING, VIENNA 8–12 SEPTEMBER 1975
"The Monitoring of Radioactive Gaseous and Liquid Effluents at Nuclear Facilities" was discussed by 20 participants from 12 countries and 2 international organizations.

Airborne and Liquid Radioactive Contaminants

The International Atomic Energy Agency, along with other national and international bodies, has been devoting much attention in recent years to achieving agreement on procedures for establishing limits on the amounts of radioactive material that can be released to the environment during the operation of nuclear facilities.

When setting the actual release limits, usually referred to as the authorized discharge limits, for a particular facility, it must be ensured that the dose limits for the critical groups of the population are complied with, that the doses received are as low as is reasonably achievable taking into account social and economic conditions, and that due consideration is given to other present facilities and to facilities that may be constructed in the future. The procedures for setting such limits are discussed in a document[1] prepared by a group of experts convened by the Agency in June 1974.

It is the responsibility of the person in charge of each facility, usually referred to as the operator, to provide assurance that the actual releases to the environment during normal operation of the facility do not exceed these authorized limits and to notify the appropriate authorities and to take the necessary actions in the event of any accidental releases. To provide such assurance the operator must monitor the airborne and liquid releases from his facility to show that the amounts released are within the authorized limits and, in the case of accidental releases, to give early warning of the nature and extent of the release.

The design of effective effluent monitoring systems, that is systems for monitoring the airborne and liquid releases dose to the points of discharge, is thus a matter of great importance for the operators.

In order to help define the objectives of effluent monitoring programmes for planned and unplanned releases and to provide guidance on the design and operation of adequate

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1 Procedures for establishing limits for the release of radioactive material into the environment, — Report of a panel of experts which met from 17 to 21 June 1974 (in preparation).