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Water Conflicts from the Viewpoint of a Regulator

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A recurring problem with respect to the development of most energy resources in the Western United States is the availability of water. From the perspective of one who is charged with the administration of water resources, Mr. Hansen examines the development of geothermal resources in the light of this problem.

WATER CONFLICTS FROM THE VIEWPOINT OF A REGULATOR†

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INTRODUCTION

Within the past several years, the potential and feasibility of developing geothermal resources for power generation and other uses has become more and more apparent. Most of the interest in developing geothermal resources is in the thirteen Western States and two Gulf Coast States. Nearly all of the Western States have adopted legislation to control geothermal development[1] and have vested the authority to administer it with either their oil and gas or mineral resources agency, or their water rights agency, depending on whether the resource was defined within the state as a mineral or water resource. However, regardless of how the geothermal resource is defined or regulated within a state, the fact remains that water is the medium by which the heat energy is conveyed in a geothermal system. Thus, the interrelationship between the geothermal system and other hydrologic systems needs to be examined.

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1. SACARTO, STATE POLICIES FOR GEOTHERMAL DEVELOPMENT: UNCOVERING A MAJOR RESOURCE 61 (1975).

During the early period of geothermal development it was believed that all thermal waters were of magmatic origin, but in recent years this concept has been discarded. Now it is generally believed that most thermal waters are of meteoric origin[2] (being recharged from the surface precipitation). If thermal waters are indeed meteoric in origin, then the problem of perhaps increasing the natural recharge to the geothermal reservoir as large quantities of geothermal fluids are withdrawn is a concern to other water users in the area. Also, in several locations in the West, thermal waters have occurred on the surface as seeps and springs and are presently being used for recreation and therapeutic purposes, space heating and agricultural uses, such as greenhouses, fish farming, irrigation, and stockwatering. Many of these uses of thermal waters have been established under state water laws and, therefore, it is the state's responsibility to protect them.

POTENTIAL OF GEOTHERMAL IN THE WEST

The Western United States appears to have the greatest potential for geothermal development in the United States.[3] The Geysers in California is currently the only place in the United States where electricity is produced commercially from geothermal sources. The present generating capacity at the Geysers is 500 mw.[4] There are also numerous places in the West where thermal waters are used for nonelectric purposes such as irrigation, industrial, space heating, and recreational uses.

Geothermal reservoirs can be divided into three basic types: (1) hydrothermal systems, (2) geopressured systems, and (3) hot dry rock systems. The hydrothermal systems can be divided into three subgroups: (1) dry steam systems in which only steam is produced, (2) wet steam systems in which both steam and hot water are produced, and (3) the hot water systems in which water is produced having a temperature below the boiling point. The dry steam systems are quite uncommon and only three have been developed in the

2. Muffler & White, *Geothermal Energy*, 39 THE SCIENCE TEACHER 40 (1972).
3. GODWIN, HAIGLER, RIOUX, WHITE, MUFFLER & WAYLAND, CLASSIFICATION OF THE PUBLIC LANDS VALUABLE FOR GEOTHERMAL STEAM AND ASSOCIATED GEOTHERMAL RESOURCES 6 (1971) (U.S.G.S. Circular 647).
4. SACARTO, *supra* note 1, at 7.

world of which the Geysers in California is one. The wet steam systems are characterized by hot springs and fumaroles. This type of system possibly will be the main type developed in the Western United States.[5] The hot water systems do not have the potential for power generation, but it does appear that this type of system may be used for various agricultural, industrial, commercial and domestic heat uses.

The geopressured systems, which occur in sediments that have been deeply and rapidly buried, can produce bodies of high-pressure hot water. This type of system has been found along the coast of the Gulf of Mexico in Texas and Louisiana.[6] Because recharge of this type of system is very limited, each system would have a finite life and would not interfere with other hydrologic sources.

The hot dry rock system constitutes yet another potential geothermal resource. This system consists of rock at a high temperature with low porosity and permeability and thus no water is present. The Energy Research and Development Administration is currently financing an experiment in New Mexico to determine the feasibility of such a system.[7] If the feasibility of this system can be proven, then water from surface supplies or shallow underground sources would be needed to convey the heat energy to the surface and it could have a significant effect upon the water resources of an area.

In the past, several individuals and organizations have made estimates of the electricity that could be generated from geothermal resources in the Western United States. These estimates have ranged from about 30,000 mw to 400,000 mw[8] depending upon the data used and the various assumptions made.

In 1975 the United States Geological Survey (U.S.G.S.) published a report entitled *Assessment of Geothermal Resources of the United States — 1975*. In this report it is stated that, based upon presently identified hydrothermal convec-

5. *See* Muffler & White, *supra* note 2.
6. U.S. FISH & WILDLIFE SERVICE, GEOTHERMAL HANDBOOK 6 (1976).
7. *Id.*
8. Pearl, *Hydrological Problems Associated with Developing Energy Systems*, May-June 1976 GROUNDWATER 129.

tion systems with temperatures greater than 150°C. in the Western United States, there is a potential for generating 8,000 mw for one hundred years or 26,000 mw for thirty years. Of this 8,000 mw, about 3,500 mw are recoverable with present technology and at a cost that is now competitive with other energy resources. Also, it is estimated that there is another 38,000 mw for one hundred years that will come from as yet undiscovered geothermal resources. Therefore, the U.S.G.S.'s estimate of potential electric generation from hydrothermal systems with temperatures greater than 150°C. total 46,000 mw for one hundred years or 153,400 mw for thirty years.

If those hydrothermal systems with temperatures between 90°C. and 150°C. presently identified could be used for space heating in homes and industrial plants the U.S.G.S. estimates that they have the potential of replacing 27,500 mw for one hundred years. It estimates that the undiscovered hydrothermal systems with temperatures between 90°C. and 150°C. have the potential of replacing 82,600 mw for one hundred years. This type of low temperature geothermal resource has a significant potential if agricultural, industrial, commercial and domestic uses can be located so as to take advantage of this resource.

Regardless of the estimates used concerning the geothermal resources of the Western United States, it appears to be very large.

WATER REQUIREMENTS

The amount of water that will ultimately be used by geothermal development will depend largely on whether it is used for the generation of electricity or for non-electric purposes such as irrigation, and space heating.

If the geothermal waters are used for non-electric purposes, the amount of water consumptively used is relatively small. Irrigation is perhaps the largest potential consumptive use of the non-electric uses but the extent of irrigation by thermal waters does not appear to be of great magnitude. This is largely because most of the geothermal reservoirs contain fairly significant amounts of total dissolved solids (TDS).

In Utah all of the geothermal fields are expected to be hot water fields, and it is also anticipated that they will contain a fairly high TDS concentration. For this reason it is not anticipated that irrigation uses will be able to economically utilize the geothermal waters. With present uses of thermal waters for space heating the consumptive use is small, if any. If the geothermal fluids are used solely for heat extraction and reinjected back to the underground, the potential consumptive use would not be significant.

The use of the geothermal resources for the generation of electricity has the potential for being the largest consumptive use of geothermal waters in the Western United States. In the Geysers area of California it is currently estimated that about eighty percent of the total water diverted for the generation of electricity is consumptively used by evaporating it into the atmosphere.[9] To express this as a function of the generation capacity, it would be about 48,000 acre-feet/year/1000 mw.[10] In areas where geothermal wet steam reservoirs will be developed it is anticipated that about twenty percent of the fluid taken from the well will be evaporated through the process with the remaining eighty percent of the fluid being reinjected back into the geothermal reservoir.[11] The amount of water consumptively used per unit of energy is perhaps the largest and most important problem facing the development of geothermal resources in the Western United States. If we use the United States Geological Survey's estimate that 46,000 mw for one hundred years can be produced from hydrothermal systems in the Western United States, then the water consumptively used each year would be about 2.2 million acre-feet.

Another proposed use of geothermal waters which could have a significant impact is the possibility of desalting the geothermal waters, and thus using the water for industrial or other uses. This process would take the generally saline and already hot water of the geothermal reservoir, and through a distillation process, fresh water would be produced. If this

9. *Id.* at 134.
10. WESTERN STATES WATER COUNCIL, WESTERN STATES WATER REQUIREMENTS TO 1990 25 (1974).
11. Testimony of D. W. Berthelot, Phillips Petroleum Co., at hearing before Utah State Engineer (April 29, 1976).

process was secondary to the power generation then the net loss to the system would be increased.

WATER RIGHTS AND WATER AVAILABILITY

The Western United States is an arid region with a limited water supply and, perhaps, water will be the limiting factor in future growth and development. Therefore, any new and large use of water must be examined carefully.

The method by which a water right is acquired in the Western United States is based on the doctrine of appropriation which, in essence, provides that a water right is acquired by diverting water from a natural water course (both surface and underground) and applying it to a beneficial use. The water right carries a priority date, which is the date that the first act was done to initiate the right. The importance of the priority date is that in time of short supply those water rights with the earliest priority are supplied first.

At the present time the rights to the use of water far exceed the supply in many streams and underground water basins. In many states in the West the granting of new appropriations in certain areas are no longer allowed and numerous areas have been limited to small withdrawals.

Irrigation consumes about eighty percent of the total water consumptively used each year in the West. The remaining twenty percent is used for domestic, industrial and other miscellaneous uses. Many of the geothermal areas are located in or near areas of irrigated land. Therefore, the effect on present water rights of any geothermal development is an important factor because of the large quantities of water that will be consumptively used in the generation of electricity from geothermal sources.

During the early development and investigations of geothermal waters it was believed that the thermal waters were derived from molten rock at great depths. However, modern studies now indicate that at least ninety-five percent of geothermal waters are derived from surface precipitation (mete-

roic water) and that no more than five percent is of volcanic origin (magmatic water). Thus, it appears that the source of the geothermal fluids is the same as surface and shallower groundwater supplies.

In areas in which the total supply of water is currently fully appropriated the approval of large withdrawals for geothermal purposes would result in a mining of the groundwater resources and possibly effect existing water rights either by increasing the recharge to the geothermal reservoir or by reducing the discharge from the geothermal reservoirs to the shallower groundwater aquifers. Even if the origin of the geothermal fluid is magmatic it would result in a mining of the geothermal waters because of the limited supply in the geothermal reservoir. These problems are of great concern to the regulator as well as the developer. The regulator needs to be assured that the proposed geothermal development does not impair existing water rights.

Although the proposed geothermal development could have a direct connection with other groundwater resources in the area, the extent of that interference is very difficult to evaluate. Since there are only a few places in the world where the geothermal resources have been developed to any extent, with the only place in the United States being the Geysers in California, we do not have sufficient experience or knowledge at this time to determine the possible relationship of geothermal development to other groundwater resources. The Geysers produce dry steam as opposed to the wet steam producing reservoirs in the Utah fields, thus making the interference problem completely different. It is my opinion that the states should recognize that interference very well could occur. Therefore, an extensive monitoring system should be installed to detect the extent of that interference early in the development of the geothermal resources. Thereafter decisions could be made relative to providing compensation for those injured.

SUMMARY

The potential for geothermal development in the Western United States appears very good. From the viewpoint of a

regulator, the biggest hurdle for geothermal development to overcome is the large quantities of water that will be consumptively evaporated into the atmosphere in the generation of electricity.

Many regions of the West have a limited water supply which, to a large extent, has been appropriated. Those with existing water rights expect their rights to be protected from interference. At the present there are more questions than answers as to the effects of geothermal development on existing water rights. While these existing water rights need to be protected, they should not be allowed to prevent the development of geothermal resources merely because of a presumption of interference.