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WESTERN STATES COOPERATIVE DIRECT HEAT GEOTHERMAL PROGRAM OF DOE

Phillip M. Wright and Duncan Foley
Earth Science Laboratory, University of Utah Research Institute, Salt Lake City, Utah

Clayton R. Nichols
U.S. Department of Energy, Division of Geothermal Energy, Washington, D.C.

Paul J. Grim
National Geophysical and Solar-Terrestrial Data Center, NOAA, Boulder, Colorado

Objectives and Scope of Program

The objectives of the Western States Cooperative Direct Heat Geothermal Program are 1) to assist the U.S. Geological Survey in extending the inventory of geothermal resources to include the low temperature ($\pm 20^{\circ} < T < 90^{\circ}$) resources most suitable for direct heat application[1], and, 2) to stimulate reservoir confirmation studies at sites with an apparent but unquantified potential for direct heat application development. It is the belief of the participants that development of direct-heat geothermal resources will have a significant near-term impact by helping to fulfill U.S. energy requirements.

The Program will be conducted separately but concurrently in each of about 15 western states by interdisciplinary groups of people from state agencies, the Division of Geothermal Energy, the U.S. Geological Survey, the University of Utah Research Institute, the National Oceanic and Atmospheric Administration, and Los Alamos Scientific Laboratory. Each state project will be carried out in two phases, which may or may not operate concurrently.

Phase I:
1. Compilation of available data and possibly collection of new data on temperature, temperature gradient, water quality, aquifer productivity, and related peripheral geoscience items as specified further below;
2. Submission of the basic data from (1) above for inclusion in the U.S. Geological Survey computer file GEOTHERM;
3. Publication of maps and reports based on detailed interpretation of the above data compilation.

Phase II:
1. Selection of specific sites for detailed testing by use of the Phase I data base;
2. Geoscience investigations of the above specific sites to select drill test locations;
3. Drill testing for reservoir confirmation and assessment;
4. Publication of site-specific results, including distribution of maps and reports to potential developers of direct-heat geothermal resources.

A summary of the responsibilities of the participating organizations is as follows:

State Agency: Project management within the state, data compilation and interpretation, site-specific geoscience studies and drill-testing, publication of reports and maps, and preparation of resource maps for NOAA publication.

Division of Geothermal Energy: Technical and administrative management of contracts, liaison with U.S. Geological Survey and with other Federal and State organizations.

U.S. Geological Survey: Technical assistance to the state agencies as requested, liaison with other USGS geothermal programs, updating of file GEOTHERM and delivery to NOAA of geothermal data in digital form, and delivery to NOAA of digitized base data for state maps.

University of Utah Research Institute: Management assistance to DGE, technical advice on all phases of the project to the state agency as requested, and project coordination.

National Oceanic and Atmospheric Administration: Publication of state maps showing low temperature geothermal resources.

Los Alamos Scientific Laboratory: For the states of Arizona and New Mexico, management assistance to DGE and technical advice on all phases of the project to the state agencies as requested.

Present Knowledge of Low Temperature Geothermal Resources

Low-and moderate-temperature geothermal resources are relatively plentiful in the western United States. The recently published (1977) map "Geothermal Energy Resources of the Western United States" (produced by Paul J. Grim, NOAA) shows approximately 950 geothermal sites, about

[1]The presently existing geothermal resource inventory published in the U.S. Geological Survey Circular 726 tabulates resources where $T \geq 90^{\circ}C$.

700 of which have measured or geochemically indicated reservoir temperatures less than 100°C. Typically plots of frequency of occurrence vs temperature for these geothermal resources show increasing frequency as temperature decreases, as illustrated in Fig. 1 (data from White, D.E., and Williams, D.L., 1975, Assessment of Geothermal Resources of the United States-1975: U.S. Geol. Surv. Circ. 726, Tables 3, 4, 5) and Fig. 2 (data from Mundorff, J.C., 1970, Major Thermal Springs of Utah: Utah Geol. and Mineral Surv. Water Resources Bull. 13, Table I). The relatively small number of occurrences in the range 90°C -120°C in Fig. 1 is likely due to present lack of an adequate data base.

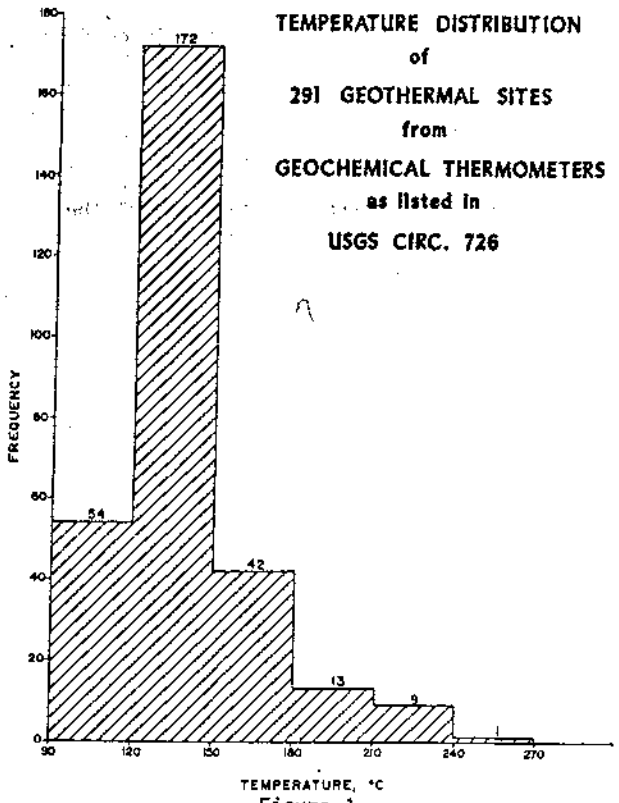

Figure 1

Known occurrences of low-and moderate-temperature geothermal resources in the West seem to be predominantly of two kinds: 1) resources associated with heating of water by recent igneous activity, illustrated by the Geysers, Roosevelt Hot Springs and others, and 2) resources associated with deep circulation of meteoric water, illustrated by the many fault-controlled springs in the Basin and Range. There is good reason to believe that the known resources are only a small portion of the total resource population, and that many discoveries remain.

There are no presently existing, up-to-date maps or reports which give the location and pertinent facts for all known direct-heat geothermal resources for the Western states. Only pieces of the total picture exist. The authors believe that it is very important to compile and interpret existing geothermal resource data, and to present these data in map and report form. It is anticipated that this will be one of the principal methods for promoting the use of this neglected alternate form of energy.

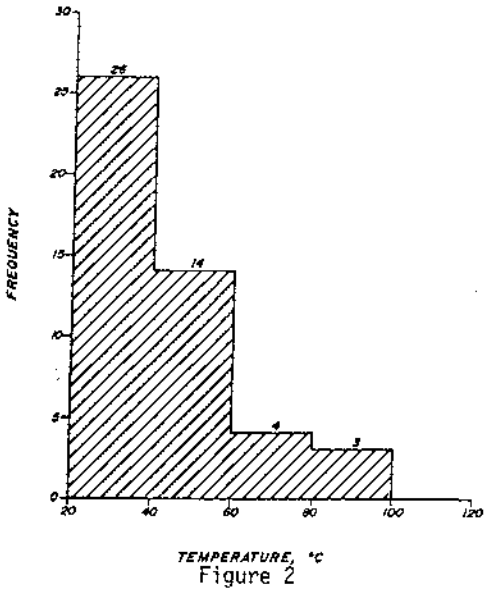

Figure 2

It is also important that collection of new data, especially temperature data in drill holes, be encouraged, both on a regional and on a local scale. A better understanding of crustal temperature distribution will be very important to discovery of new geothermal resources.

Maps and Reports Resulting from Phase I of this Program

One purpose of Phase I of this Program is to produce maps and reports illustrating on a state-by-state basis the location and characteristics of anomalously warm groundwater. The lower cutoff temperature for data compilation is stated as ±20°C only for purposes of discussion. It is apparent that the practical cutoff varies with shallow groundwater temperature, which usually approximates mean annual air temperature. Because focus will be on shallow or otherwise easily available resources, depth information will be important and will be integrated with temperature information. Present plans therefore call for outlining on maps interpreted areas of anomalously warm groundwater, where specifications of what is anomalously warm are determined after considering mean shallow groundwater temperatures, depth of temperature measurement, geothermal gradient, and perhaps other data. Thus, the exact methods of illustration will vary from state-to-state or region-to-region.

A selection of other pertinent geoscience data will be shown on the maps along with geothermal data. The list of these peripheral items includes water quality data, geochemical thermometry data, areas of young igneous activity, faults and lineaments, spring deposits, geochemical indicators, and earthquake epicenters. The primary use of these peripheral geoscience data will be in facilitating interpretation of the geothermal data in terms of probable reservoir location and extent.

The primary results of Phase I will be maps and reports aimed at the public at large, not necessarily at the geoscience community. The many inquiries from the public sector for information on direct-heat geothermal resource location and utilization indicate that potential exists for rapid, significant development using mainly private capital. It is anticipated that by making the results easily understandable to the general public, significant new interest in development of geothermal energy will be stimulated.

Acknowledgements

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