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INSTITUTIONAL STANDARDIZATION OF GEOTHERMAL FLUID CHARACTERIZATION TECHNIQUES

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ABSTRACT

The characterization of geothermal fluid has been performed over the years using a wide variety of techniques. Some of these have led to very inaccurate results with subsequent uncertainty as to the true nature of the resource. In the last years several organizations have worked to correct the situation and arrive at standard methods.

The program at Battelle to achieve these ends is described. The formation of the ASTM Geothermal Resources Committee and Environmental Protection Agency efforts are related to the program. The participation of industry is described, and additional participation is solicited for this current and final phase.

The complimenting parts of the Battelle Geothermal Program are described: the development of high-pressure, temperature instruments and the monitoring of the performance of operating plants (Magma's binary cycle facility).

HISTORY

Geothermal energy use in the United States has grown since the 1800's when it was primarily known for its use in health spas. Later uses included utilization of the energy for space heat and process applications. More recently there has been increasing interest and successful experience in the production of electric power from geothermal fluids.

Throughout this history chemists and engineers have characterized the fluids in order to predict their behavior and the result of using them. These predictions addressed in part concerns about the effect of geothermal utilization on the nearby communities. There are concerns from the users' standpoint as to how the fluid will behave in the power utilization system, i.e., will it cause corrosion or deposit scale. To meet these two ends, environmental protection and utilization technology, scientists have sampled and characterized the fluids using their own individual and often untested techniques.

THE PROBLEM

Frequently these characterization techniques were adopted because of the ease of operation or past application to surface water sampling. There was little appreciation for biases introduced in geothermal applications. In some cases the technique for sampling has been as rudimentary as dipping a sample with a bottle and sending it to the lab. In other cases the technique involved an approach using a special evacuated metal flask for connection to a pressurized geothermal flow. Some actual worst case errors resulting from this latter technique are illustrated in Figure 1.

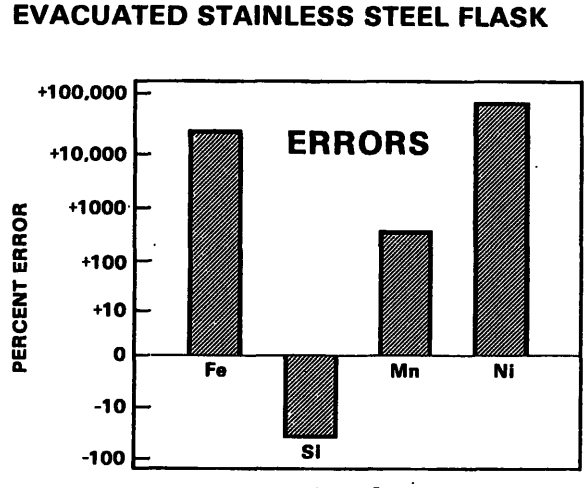

FIGURE 1

Other investigators have run into trouble when trying to reproducibly characterize two-phase geothermal flows. Figure 2 shows the widely varying CO_2 concentration in a stratified two-phase flow - depending on where the scientist sampled any value could have resulted.

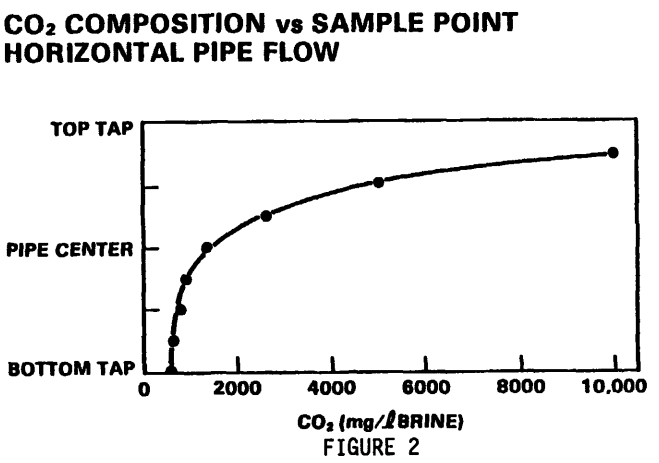

FIGURE 2

STANDARDIZATION

These types of concerns about the accuracy and reproducibility of geothermal fluid characterization prompted Battelle, with cooperation and funding from the Department of Energy, to undertake a project to improve the reliability of the fluid data. The project direction was established to divide the effort into four general activities permitting maximum industry input and participation in each phase. These four activities are shown in Figure 3.

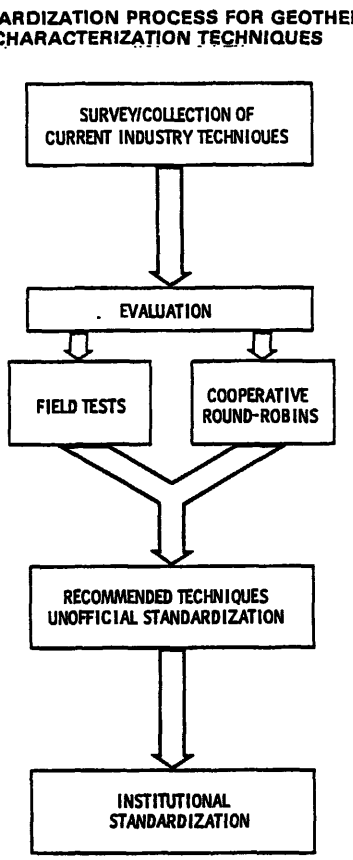

FIGURE 3

The first phase of the project - the survey and collection of current practices-culminated in the publication of both interim and final reports (J.G. Douglas, et al., 1976 and J.C. Watson, 1978). These compilations included techniques used by national laboratories, government agencies and industry, both domestic and foreign.

The evaluation stage was conducted over two years with both field tests (D. W. Shannon, et al., 1980) and industry-laboratory cooperative round robins. In addition to publicizing and stimulating interest in the characterization problem, these activities tested the suitability of some of the techniques in current use. The two earlier figures are examples of results of these tests.

Concluding these parts of the project, a technique suitable for extracting representative samples from many geothermal flows was assembled in 1979. Other organizations are now using the technique and variations of it. Battelle has encouraged this technology exchange both through individual industry contacts and active participation in workshops (C. H. Kindle and E. M. Woodruff, 1980; C. H. Kindle, 1980). This phase is also being pursued indirectly through the publication of this paper.

The final phase is formal institutional review and standardization. Because of the desireability of abroad consensus in the review it was decided that ASTM was the most suitable institution. Through a cooperative effort with the Department of Energy, ASTM held an organizational meeting in October 1979 where much of the geothermal industry was represented. The representatives present decided to form a new ASTM Committee dealing with Geothermal Resources (E45). David Anderson of the Geothermal Resource Council was elected chairman. One of the tasks of the committee will be to issue standard methods for characterizing geothermal fluids.

INDUSTRY PARTICIPATION

Under the auspices of this committee Battelle is cooperating with personnel from the Bureau of Mines, Union Oil, and Occidental Petroleum in the writing of standard techniques for sampling. Battelle, on its own, has formulated a list of techniques for the analysis part of fluid characterization. Additional industrial participation is solicited from organizations in this final stage of the effort. The standards that are written and issued will likely be the ones used by the geothermal industry and regulators in the future.

ADDITIONAL INSTITUTIONAL EFFORT

The Environmental Protection Agency (EPA) has held three workshops on characterizing geothermal effluents; the latest one in May, 1980. EPA's goal is the establishment of techniques suitable for its particular problems. Battelle and a wide range of companies have participated in these workshops.

COMPLIMENTARY PROJECTS

The standard characterization techniques that have been referred to will be widely accepted and accurate, but only a few of the desired parameters can be established on the spot. Most will require subsequent analysis in the laboratory. To address the need for immediate evaluation of fluid characteristics and its real-time performance in an operating plant, Battelle has two additional projects:

- a high-temperature, high-pressure probe development effort under M. J. Danielson,
- an operating geoplant monitoring project under D. W. Shannon.

The probe development project is aimed at providing remote probes stable enough to operate and provide real time output under the field conditions encountered downhole or in an operating plant. The parameters being addressed include: corrosion rate, conductivity, pH, sulfide level, and carbon dioxide concentration.

The geoplant monitoring project is an on-site monitoring operation of a power plant (currently Magma's binary cycle plant at East Mesa). This effort provides real-time integration of the changes of fluid chemistry and materials performance with operational changes. Monitoring and interpreting plant performance at this early stage of geo-electric plant operation will provide a technical basis for trouble shooting the design and operation of future plants. This effort draws on the output from both the probe development and standard methods projects.

The relationship of these three projects to the need for data in geothermal development is illustrated in Figure 4.

ACKNOWLEDGEMENT

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DATA FLOW FROM BATTELLE GEOTHERMAL PROJECTS

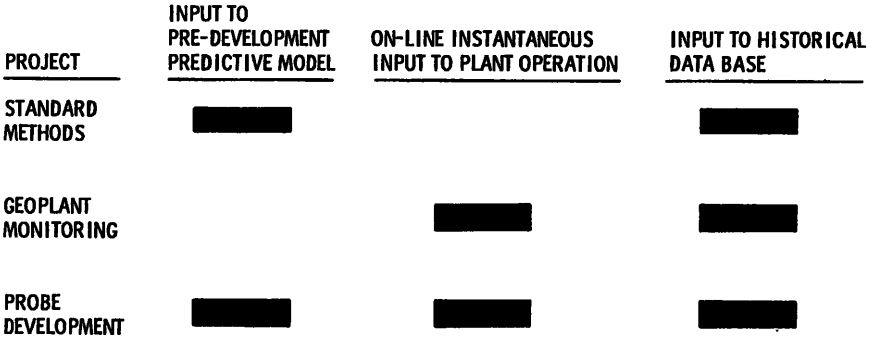

FIGURE 4