PROCEEDINGS

TWENTIETH WORKSHOP GEOTHERMAL RESERVOIR ENGINEERING

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GEOTHERMAL PROGRAM ACTIVITIES OF THE DEPARTMENT OF CONSERVATION DIVISION OF OIL, GAS, AND GEOTHERMAL RESOURCES

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HISTORY

Thank you very much for the opportunity to address this, the 20th Annual Workshop on Geothermal Reservoir Engineering. It is a pleasure to be here. A great deal of invaluable information has been brought forward through the Annual Workshops, and I give the Stanford University Petroleum Engineering Department a tremendous amount of credit for having the foresight 20 years ago to recognize the need for such an endeavor.

While preparing for this talk, I realized it was nearly 30 years ago, this year, that the Department of Conservation's Division of Oil, Gas, and Geothermal Resources, then called the Division of Oil and Gas, began regulating geothermal development in California. Although many of you are familiar with our geothermal program, in general, you may not be familiar with the history of the program and some of the special projects with which we are involved. Therefore, I would like to take this opportunity to briefly describe our history and a few of our special projects before I discuss the theme of this conference, what we have learned in the last 20 years.

California's oil and gas industry began when the first commercial well was completed in 1876. The industry grew rapidly, and it became apparent in the early Twentieth Century that some controls were necessary to protect hydrocarbon resources, groundwater, and the environment. Recognizing the shortcomings of the local regulatory efforts that were in place, the State Legislature created what is now the Division in 1915. The Division's basic mandate was to prevent damage to oil and gas deposits from infiltrating groundwater and other causes. The charge was later expanded to encourage the wise development of oil and gas resources through good conservation and engineering practices.

Although geothermal resources were also first exploited in the Nineteenth Century, it wasn't until development began in earnest in the early 1960s that the Legislature turned to the Division to establish a geothermal program similar to the oil and gas regulatory program. The enabling legislation, which was the first geothermal law in the Nation, was passed in 1965. Afterwards, as the industry grew, the Division created a Geothermal Unit to deal with the unique characteristics of the resource.

In fact, Dave Anderson, whom you know, and who is the Executive Director of the Geothermal Resources Council, was our first Geothermal Officer. Marshall Reed, now with the U.S. Department of Energy's Geothermal Reservoir Technology Program, was one of his first assistants.

From these early beginnings, our current program has evolved.

SUBSIDENCE PROTECTION

By the 1970s, experience gained in the developed geothermal regions of the world indicated subsidence was possible in the Imperial Valley as a result of geothermal development. Subsidence was a special concern because of the irrigation systems that crisscross the Salton Sea and Heber Geothermal fields. The Division, with primary responsibility for subsidence detection and abatement in that area, began working closely with the Imperial County Surveyor to record data, maintain the integrity of the monitoring network, and review annual leveling-survey data required as a condition of injection project permits.

Currently, Division staff are working with the Lawrence Berkeley Laboratory to develop a reservoir model of the Heber Geothermal field that will include

subsidence prediction capabilities. The techniques developed with this project should be applicable in other geothermal fields.

To date, significant subsidence has been observed at only one geothermal site in the State, the Amedee Geothermal field in northeastern California, where two production wells are located near a fault that serves as a conduit for hot water. In addition to the localized subsidence that has occurred, surface fractures have also developed in the dry lake sediments along the vertically displaced fault trace.

SLOPE STABILITY MONITORING

Slope stability is monitored at The Geysers Geothermal field, which is known both for its steep, rugged, and landslide-prone terrain, and incompetent rock types. A wellsite location can present a hazard if there is a potential for a poor cement job and ground movement that can result in wellbore shear. Both conditions existed in the 1950s when well "Thermal" 4 was drilled and later blew out. Although the initial blowout was eventually controlled, total plugging has never been achieved and venting continues today.

After several more expensive blowouts occurred, the Division instituted a wellsite stability program. Now, when a new well is planned in The Geysers, the operator must submit a geological and engineering report on the proposed site. After reviewing the report, a Division engineer visits the site, conducts an onsite investigation, issues a permit (if conditions are satisfactory), and visits the site during the construction phase. The program has worked so well that no blowouts have occurred at The Geysers since the slope-stability program was initiated.

UNDERGROUND INJECTION

The Division also regulates the injection of geothermal fluids to enforce State statutes and an agreement with the U.S. Environmental Protection Agency, which administers the Safe Drinking Water Act. Project proposals are reviewed, permitted, and monitored to ensure injected fluids are confined to the intended zone(s) and the groundwater resources are protected.

WELL AND PIPELINE CORROSION MONITORING

Due to the high temperature and acidic nature of some of California's geothermal resources, steel casings, wellheads, and pipelines have a potential to fail from corrosion, which can lead to serious injury and environmental damage.

Currently, Division engineers inspect pipelines visually; however, we are beginning a program to electronically monitor the thickness of wellheads and exposed casings of idle wells to determine how much corrosion may have occurred.

INTERAGENCY CONSULTING

The Division is frequently asked to provide its expertise to other governmental agencies. For example, the California Energy Commission asks the Division to review the adequacy of geothermal resources before permitting construction of new geothermal power plants.

In addition, Division staff have participated in advisory committees that review geothermal issues, and have assisted the State of Hawaii and the Government of Peru in evaluating the adequacy of drilling regulations.

PRODUCTION/INJECTION STATISTICS AND PUBLIC RECORDS

The Division also maintains a large library of data that can be invaluable in geothermal resource evaluations. Reservoir engineers are especially interested in the computerized database of virtually all geothermal production and injection records in the State. Hardcopy well histories, well logs, and other records of all nonfederal geothermal wells in California are also available to the public.

PUBLICATIONS

The Division also publishes geothermal information in many forms, for both technical and nontechnical audiences. In addition, we provide statistical, general, and technical data and publish maps that show the State's known high-temperature geothermal

wells. We have also worked with our sister agency, the Division of Mines and Geology, to prepare a map of California's known thermal sources.

WHAT HAVE WE LEARNED?

So what have we learned in the last 20 years? For one thing, the failure of a few projects has shown that lawyers, politicians, and accountants do not make good reservoir engineers. Also, the unexpected, accelerated production decline at The Geysers Geothermal field indicates geothermal reservoirs are subject to overdevelopment and excessive production. Therefore, if we are going to exploit our resources properly, decisions regarding production rates and development should be left to the reservoir experts. Also, no two geothermal fields are alike. No drilling, workover, or plugging operations go exactly as planned. Therefore, an effective regulatory program must have the flexibility to deal with a variety of situations. As regulators, we must keep an open mind and be open to new ideas and procedures.

As in our oil and gas program, we, at the Division, have found it far more productive to work with the industry to reach desired goals, than to fall back on a rigid set of rules and regulations that prove to be self-defeating. I feel we have accomplished that goal during the past 30 years, and I hope we continue in that direction in the future. Thank you.