DEVELOPMENT OF GEOTHERMAL ENERGY AT CHANDLER, ARIZONA

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Geothermal Kinetics, Inc. (GKI) was convinced that potential for geothermal did exist in Arizona. A consortium of three utilities, Arizona Public Service Company, Salt River Project, and Tucson Gas and Electric, joined to support GKI in their efforts to locate and develop potential geothermal in Arizona. The business arrangement was that GKI would determine the optimum site and drill a well. The consortium would provide some financial incentive on the first well drilled. This gave the consortium the opportunity to obtain use of any resource that was obtained.

GKI determined the most beneficial location of this activity was in an area of south central Arizona. This area is typical Arizona desert that is currently in use as farmland for the production of cotton and fruit. The location is 30 miles southeast of the city of Phoenix, and it is in the electrical service area of the Salt River Project. From a geological standpoint it is in the Basin and Range Province about 60 miles south of the Colorado plateau area. The general structure appears to be an ancient valley that was surrounded by active volcanos. Eruption had filled the valley with high-silica, acid-type volcanic ash. This was subsequently covered with various clay and sediment layers. It would appear to be typical of a batholith formation, with intruding magma providing heat to the fluid that is contained in the porous volcanic ash. This sedimentation basin has fault formations at the edge that allow percolation of runoff water from the adjacent mountain range. The exploration techniques used were primarily that of satellite photograph and deep resistivity. Some work was also done with passive seismics. In this particular area there are no obvious surface manifestations such as hot springs, geysers, or fumaroles. However, some of the ground water wells that are used for crop irrigation are abnormally warm. Wells 43° to 54°C (110° to 130°F) have been observed.

Drilling on the Power Ranch's No. 1 well was started in early 1973. The casing schedule was:

- 340 mm (13 3/8 in) down to 884 m (2900 ft)
- 217 mm (8 5/8 in) down to 1646 m (5400 ft)
- 178 mm (7 in) down to bottom depth

Down to 1829 m (6000 ft) normal drilling mud was used. Below that depth a mixture of air and water was used. Before the 178 mm (7 in) casing was set, the normal suite of logs were run. A liner was put in from the 1829 m (6000 ft) to bottom depth of 2804 m (9200 ft). This liner was perforated selectively from the 1829 m to 2438 m (6000 to 8000 ft) level.

The second well, Power Ranch's No. 2 well, was started in mid-1973 and was located 402 m (1320 ft) north of Well No. 1. Drilling mud was used all of the way to bottom depth. A core sample was taken at the 2408 m (7900 ft) level. Casing was done much in the same manner as with Well No. 1, except that slotted liner was used rather than perforations. Also, a few hundred meters at the bottom of the hole were completed without slotted liner. Total depth of the hole was 3185 m (10,450 ft). Drill cuttings did indicate correlation between wells, with No. 2 showing some upward displacement. Results from these wells did indicate the typical upper formation sands, shales, anhydrites, gypsum, silt stones and conglomerates. The lower formation is essentially volcanics with some layers of welded tuff. No granitic basement was reached in either well. Properties of the core samples indicated about 20 to 30 percent porosity with a permeability of a few millidarcy. Gas was liberated from the drilling fluid. An analysis indicated N_2 and H_2 as the major components, with a trace of hydrocarbons and ammonia. No CO_2 or H_2S was observed. Equilibrium formation fluid temperatures were indicated in the order of 160° to 171°C (320° to 340°F).

Formation pressure was sufficient to produce fluid from the perforations or slots up to a few hundred meters below the surface. At this point the cold-fluid hydraulic-head matched formation pressure. Attempts were made to remove the cold fluid leg by air blowing at various depths. An attempt was made to reduce density of the hydraulic leg by froth techniques, using detergents followed by air blowing. This also was unsuccessful. Down hole pumping was tried at the 884 m (2900 ft) level and also at the 1524 m (5000 ft) level. Pumping was able to remove fluid in the wellbore as well as that produced by the formation, but this did not result in warming of the wellbore. Thus, when pumping was stopped, the fluid would cool off as it came up in the well. During pumping operations the surface flow temperature equilibrated between 93° to 99°C (200° to 210°F). An attempt was made to warm up the wellbore by circulating the formation fluid up in the annular area rather than in drill pipe. Warm surface discharge fluid was repumped down using the mud tank as a storage. Heat added to the upper formation wellbore was not enough to lighten the hydraulic leg or get flashing.

During a period of several months while shut-in, the well temperatures were rechecked, little difference was noted. The wells were left in this shut-in condition.

Because some of the problems associated with lack of self-production may be associated with formation of stimulation and well completion techniques, a proposal was made in 1974 to National Science Foundation through TRW's research activity in this area. The present status is that the wells are still shut-in waiting disposition of further tests. If ERDA's priorities will permit these tests, it may be that natural flow can be produced. Additional exploration work done in the Chandler area field, using improved geophysical techniques, does give positive results. Although the present wells, in their current conditon, are not considered commercial, the reservoir still appears to have good potential.