EVALUATION OF THE GEOTHERMAL RESOURCE IN THE GEOPRESSURED ZONE ALONG THE TEXAS GULF COAST

D.G. Bebout
Bureau of Economic Geology
The University of Texas at Austin
Austin, Texas

ABSTRACT

During the last several years, estimates of the energy resource available from the geopressured zone along the Gulf Coast have ranged widely from 100,000 quads to 150 quads (for comparison, the U.S. now consumes 20 quads of natural gas per year); the energy occurs in the form of hot water (geothermal) and methane dissolved in the water. These widely ranging reserve estimates emphasize the lack of knowledge which now exists in the public domain concerning the geologic and engineering aspects of the geopressured zone and resulted in the initiation of an extensive study of the resource in Texas by the Bureau of Economic Geology funded by the U.S. Energy Research and Development Administration (ERDA). The geopressured geothermal project is divided into two main parts: the first part to study the regional distribution of reservoir sandstones in geopressured Frio, Vicksburg, and Wilcox Formations and to identify potentially prospective areas (fairways) and the second part to study in detail these fairways in order to locate favorable areas in which to drill a test well. Both parts have been completed for the Frio Formation and will be the subject of this presentation.

The Tertiary of the Texas Gulf Coast comprises a number of terrigenous depositional wedges, some of which thicken abruptly at their downdip ends as a result of contemporaneous movement of growth faults and underlying salt. The Frio Formation, one of these wedges, has been studied regionally by means of a grid of correlation cross sections aided by micropaleontological control. With these sections, the Frio was subdivided into six mapping units; maps of sandstone distribution within these units delineate elongate main sandstone trends parallel to the Gulf Coast composed of deltaic, barrier bar, and strandplain sandstones.

These broad regional studies, followed by detailed local investigations, were pursued in order to delineate areas prospective for production of geopressured geothermal energy. A prospective area must meet the following minimum requirements: reservoir volume of 3 cubic miles, minimum permeability of 20 millidarcys, and fluid temperatures of 300 degrees F. Several geothermal fairways were identified as a result of this Frio study.

The Hildalgo Fairway is located in Hidalgo, Cameron, and Willacy Counties and contains many thick, laterally extensive deltaic sandstone bodies with fluid temperatures greater than 300 degrees F but extremely low permeabilities. The Armstrong Fairway, located in Kenedy County, contains a number of thick sandstones which extend over an area of 50 square miles and have probable core permeabilities of 20 millidarcys but fluid temperatures of less than 300 degrees F. The Corpus Christi Fairway, located primarily in Nueces County, contains sandstones with temperatures greater than 300 degrees F but the sandstones are thin, are of limited lateral extent, and have low permeability. The Matagorda Fairways contain sandstones with high fluid temperatures but the sandstone beds are thin and extremely limited in areal extent. In the Brazoria Fairway the section deeper than 13,500 feet contains several hundred feet of sandstone with fluid temperatures greater than 300 degrees F and permeabilities between 40 to 60 millidarcys. The major limiting factor in all of the above fairways is finding adequate permeability in reservoirs with fluid temperatures of 300 degrees F. Only the Brazoria Fairway meets all of the specifications for a geothermal prospect.

In the Brazoria Fairway, located in Brazoria and Galveston Counties, contemporaneous deltaic sedimentation, movement along growth

ENERGY QUEST OF THE SOUTHWEST, SWS AAPG Annual Meeting 1978

faults, and withdrawal of deep salt into domes resulted in the accumulation of several hundred feet of sandstone with fluid temperatures greater than 300 degrees F. Permeabilities within these reservoirs are greater than 20 millidarcys; this high permeability is related to secondary leached porosity which developed in the moderate to deep subsurface.

A prospective geothermal well site has been located within the Austin Bayou Prospect, Brazoria Fairway, which will have 250 to 350 feet of reservoir sandstone with core permeabilities between 40 to 60 millidarcys and fluid temperatures from 300 to 350 degrees F. The sandstone-shale section within the Austin Bayou area is composed of seven progradational depositional events, several of which are characterized by low-porosity prodelta and distal delta-front shale and sandstone at the base and porous distributary-mouth bar and delta-plain sandstone and shale at the top. The lower depositional events represent the distal half of a lobate delta and the upper events, the entire deltaic complex.

The effective gas permeabilities determined from production flow tests are estimated to range from 1 to 6 millidarcys and absolute permeabilities lie between 2 and 10 millidarcys for selected wells in the Chocolate Bayou Field, Brazoria County, Texas. In a reservoir with a permeability of 10 millidarcys, a sandstone thickness of 380 feet and a drawdown pressure of 5,000 psia, flow rates of 40,000 barrels of water per day can be achieved. Salinity of this water will range from 40,000 to 80,000 ppm and methane content may range from 25 to 45 cubic feet per barrel. The average geo-thermal gradient is 1.8 degrees F per hundred feet and reservoir fluid pressures lie between 0.465 and 0.98 psia per feet for depths below 10,000 feet in the nearby Chocolate Bayou Field.

In summary, detailed geological, geophysical, and engineering studies conducted on the Frio Formation have delineated a geothermal test-well site in the Austin Bayou Prospect which extends over an area of 60 square miles. The test well is scheduled to be drilled by the end of 1977 with General Crude Oil Company as operator and with funds from ERDA. The well will encounter 800 to 900 feet of sandstone between the depths of 13,500, the depth below which fluid temperatures exceed 300 degrees F, and 16,500 feet. At least 250 feet of the sandstone will have core permeabilities of 20 to 60 millidarcys. Assuming a drainage area of 4 square miles then the reservoirs penetrated by this test well should contain at least 10 billion barrels of water; if the water is saturated with 40 cubic feet of methane per barrel, then the total gas resource should be 426 billion cubic feet in place. Water produced at a rate of 20,000 to 40,000 barrels per day will be disposed of by injection into shallower sandstone reservoirs.