Geothermal Resources Council, TRANSACTIONS Vol 5, October 1981

GEOPRESSURED-GEOTHERMAL RESOURCE POTENTIAL OF MIOCENE BAYOU HEBERT PROSPECT, VERMILION AND IBERIA PARISHES, LOUISIANA

Richard P. McCulloh and Miguel A. Pino

Louisiana Geological Survey
Box G, University Station, Baton Rouge, Louisiana 70893

ABSTRACT

The Bayou Hebert prospect is a fault-bounded block of lower Miocene shale and sandstone which covers a 75-square-mile area in southeastern Vermilion and southwestern Iberia parishes, southwestern Louisiana. The average depth to the top of the geopressured zone is 12,500 ft. Detailed correlation of shale resistivity patterns on well logs from this area has delineated faults, local unconformities, and changes in thickness and facies of lithologic units. Most faults revealed by this method are associated with the bounding fault zones, but the few delineated in the interior of the prospect could reduce the volume of potential reservoir units. Cross sections show that the Lower Miocene section thickens across growth faults by addition of new units as well as by expansion. Of the parameters of reservoir volume, salinity, temperature and permeability, reservoir volume shows the most significant variation and indicates that the eastern fourth of the prospect has the most geopressured-geothermal potential.

GEOLOGIC SETTING

The fault block evaluated here for geopressured-geothermal potential lies immediately northwest of Vermilion Bay in southwestern Louisiana. Three main bounding fault zones trend east, northeast, and north, and give the block a triangular shape. Electric log cross sections constructed for this study show substantial thickening of the Lower Miocene section across the growth faults which form the southern boundary of the prospect. The abundance of persistent marker beds recognizable by consistent and characteristic resistivity traces makes it possible to distinguish two mechanisms of thickening: (1) expansion on the downthrown sides of faults by the same units which lie on the upthrown sides, and (2) addition of new units on the downthrown sides of faults. The second of these processes is the most signigicant, as a single one of the intervals added may be up to 2,100 ft thick.

Two dip sections indicate differential subsidence along the southern boundary fault zone; a 720 ft interval of section is added between two marker beds on the western section with no equivalent on the east, while the eastern section shows 2,100 ft of new section not represented on the west, between a different pair of markers. Therefore the eastern section shows about 1,400 ft of net subsidence downdip of the fault zone. A corresponding deepening of the top of geopressure shows around the eastern section downdip of the fault zone. Both sections show addition of 500 to 700 ft of new section between a third set of markers.

Faults show discernible growth only below and slightly above the top of geopressure, a situation which Dickey and others (1968) attributed to mutual stimulation between growth faulting and abnormal pressure genesis. Maps of net sand thickness within intervals immediately above and below the top of geopressure show that deposition in these intervals was controlled mostly by faulting. These maps also show a westward shift of the main sand depocenter on the downthrown side of the southern boundary fault zone. This depocenter migration reflects differential subsidence along the east-trending fault zone which might ultimately have been controlled by delta lobe switching.

GEOPRESSURED-GEOTHERMAL RESOURCE POTENTIAL

The top of geopressure corresponds to the base of the main sand series of the Miocene, as described by Dickinson (1953), and lies at an average depth of 12,500 ft within the fault block. Steeper geothermal gradients and deeper geopressures abut the block on all sides.

Two intervals above 21,000 ft in the geopressured zone contain possibly prospective sandstone units. One has a 500 ft massive sandstone unit indicated by the gamma ray log at a depth of 20,200 ft in the Superior #1 Hulin, but this is the only well which penetrated the interval so the lateral extent of the sandstone is unknown. The other interval lies not far below the top of geopressure, where Swanson and others (1976) believed that "high pressure aquifers of large extent" would mainly occur because of fluid migration upward along faults into sealed sandstone. The interval has sandstone units thicker than 200 ft indicated by induction logs for many wells in the eastern part of the fault block. The area underlain by the shallow geopressured sandstone units is estimated at about 58 mi^2, so that the total volume is about 2.2 mi^3 if the units are in hydrologic communication and average 200 ft thick.

Selected core analyses indicate that the average permeability of sandstone in the top of the geopressured zone in Bayou Hebert exceeds the 20 md minimum prescribed by Bebout and others (1976). But the 300°F isotherm lies well below these sandstones at depths of 17,000 - 19,000 ft. The 212°F isotherm lies near the top of geopressure and more nearly approximates the temperature within shallow geopressured reservoirs.

Salinity values calculated from well logs in the Bayou Hebert prospect range from about 50,000 to 250,000 mg/l TDS within individual sandstone units as well as for the prospect as a whole. The values show erratic vertical and lateral distribution in both hydropressured and geopressured horizons, and lack any consistent relationship to faults.

Gentle temperature gradients within the fault block and the lack of a regular pattern of salinity values make reservoir volume the main criterion for evaluating geothermal potential. Based on this criterion, the eastern fourth of the Bayou Hebert prospect has the most potential for development of the geopressured-geothermal resource, but reservoir volume will be affected by local differential permeability, the extent of hydrologic communication between individual sandstone units, and faults. The faults delineated in the interior of the fault block may represent but a fraction of the total, yet alone could substantially fragment the total volume of shallow contiguous geopressured reservoirs.

REFERENCES CITED

Bebout, D. G., R. G. Loucks, S. C. Bosch, and M. H. Dorfman, 1976, Geothermal resources Frio Formation, Upper Texas Gulf Coast: Univ. Texas Austin, Bur. Econ. Geol., Geol. Circular 76-3, 47 p.

Dickey, P. A., C. R. Shriram, and W. R. Paine, 1968, Abnormal pressures in deep wells of southwestern Louisiana: Science, v. 160, p. 609-615.

Dickinson, G., 1953, Geological aspects of abnormal reservoir pressures in Gulf Coast Louisiana: Bull. Am. Assoc. Petr. Geol., v. 37, no. 2, p. 410-432.

Swanson, R. K., P. Oetking, J. S. Osoba, and R. C. Hagens, 1976, Development of an assessment methodology for geopressured zones of the Upper Gulf Coast based on a study of abnormally pressured gas fields in South Texas: U. S. E. R. D. A. Contract No. E(11-1)-2687, Southwest Research Institute, San Antonio, 75 p.