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GEOTHERMAL PROGRAM REVIEW X

PROCEEDINGS

"Geothermal Energy and the Utility Market - The Opportunities and Challenges for Expanding Geothermal Energy in a Competitive Supply Market"

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DISCLAIMER

Survey of California Geopressured-Geothermal Potential

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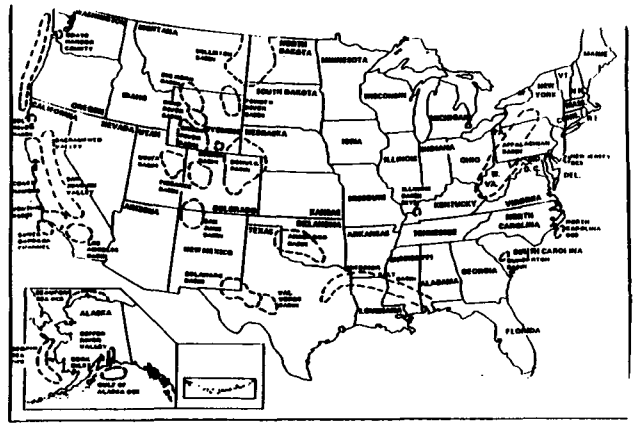
Geopressured reservoirs contain three types of energy: thermal, hydraulic, and methane gas. The thermal energy generally is a function of depth of burial. It can be converted to electricity using the binary or flash power plant cycle, the flash technology being commercial only if the fluid temperature exceeds about 340°F. The hydraulic energy can be converted to electrical power using a hydraulic turbine. The dissolved gas can be separated and either used to produce electricity using a gas turbine or sold commercially.

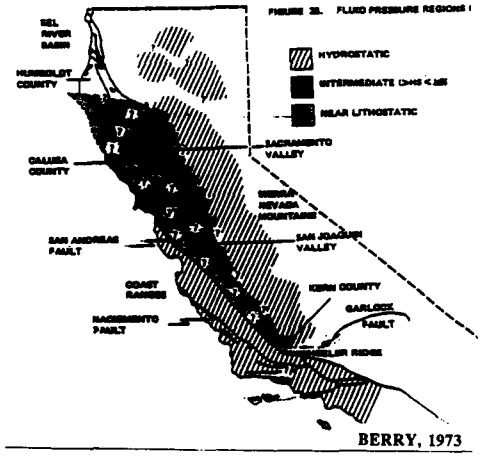
These reservoirs occur in many states in the USA, including California. (Fig.1,2) An overburden pressure is caused by the combined weight of the formation rock and the fluids (water/gas/oil) present in the pore spaces overlying the formation of interest. The overburden pressure, in general, increases relatively uniformly with depth, whereas the hydrostatic gradient is mainly a function of two variables: the dissolved solids concentration and the temperature gradient. The hydrostatic pressure gradient for fresh water is 0.433 psi/ft. Geopressured reservoirs are overpressured; that is, the fluid pressure in the reservoir exceeds the pressure corresponding to the local hydrostatic pressure gradient. (Fig. 3) Confining bed or cap rock is necessary in order for a formation to be geopressured. Otherwise, the pressure would equalize to hydrostatic through upward flow. The pressures in a geopressured reservoir may approach the overburden pressure of about 1 psi/ft.

Gulf Coast geopressured reservoirs typically exist between 12,000 to 20,000 feet below the surface. Flow rates of between 10,000 to 40,000 barrels per day, temperatures from 270° to 500°F, bottom hole pressures from 12,000 to 18,500 pounds psi, salinities of 20,000 to 200,000 milligrams per liter, and gas contents of 23 to 100 standard cubic feet per barrel, have been reported from geopressured wells.



GEOPRESSURED LOCATIONS IN US OUTSIDE OF THE GULF COAST
STRONGIN, USDOE FINAL REPORT, PHASE I, 1980

FIG. 1
STRONGIN, O., USDOE/NV/10133-1, 1980



GENERALIZED MAP OF GEOPRESSURED POTENTIAL IN CALIFORNIA
- WEST SIDE OF CENTRAL VALLEY
- NORTHERN COAST RANGE
- LOS ANGELES BASIN
- VENTURA BASIN

FIG. 2
BERRY, F.A.F., 1973, BULL. AAPG, V.57, NO. 7

There are several suspected geopressured basins in California. Some of these are prospects for commercial development of the geopressured-geothermal resource, for example parts of the Sacramento Valley, San Joaquin Valley, Los Angeles Basin, and the Ventura Basin. (It is in the interest of the people of California to assess the geothermal potential of these geopressured basins.)

The Commission proposes that GeothermEx, Inc., identify the basins in California that are geopressured. GeothermEx will:

1. Gather all publicly available information on the suspected geopressured basins of California.

2. Develop a map of California showing the sedimentary basins with prospects for the occurrence of geopressured reservoirs overlain on a temperature gradient map of the state. From this map and the supporting database, identify the most favorable geopressured geothermal prospect areas in California.

3. Based on the data available publicly from the files of the California Division of Oil and Gas, and other published and unpublished sources, prepare a list of the deep wells (oil, gas, geothermal, water, or waste disposal) existing within the prospect areas and the type of well pressure, temperature, and gas content information available on each well. (Other sources of such information include the Rocky Mountain Well Log Service.) From each basin choose several wells with the most complete suite of well logs and pressure, temperature, and gas content information available from public sources. Collect the database on these wells. Several dozen such wells are expected to be available for study.

4. From the well logs of the selected wells in each basin, prepare suitable profiles of such variables as measured pressure, temperature, resistivity, sonic travel time, density, neutron capture cross-section, etc., versus depth. (Fig.4,5) Use these plots to define the location of the top and bottom of the geopressured

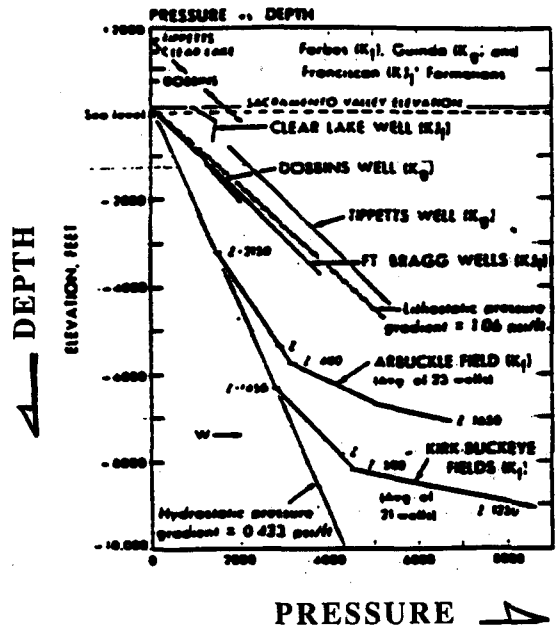
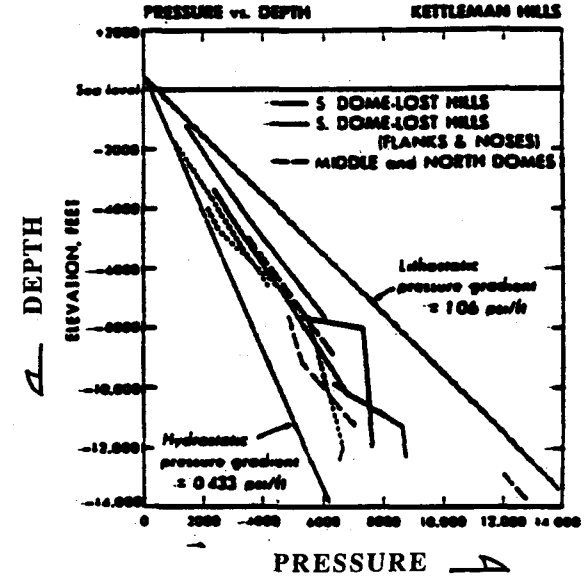


Fig. 37. Pressure gradients in selected wells and fields in Sacramento Valley (Berry, 1973)

FIG 3 (A & B)
BERRY, 1973, BULL. AAPG, V.57, NO.7



PRESSURE ABOVE NORMAL GRADIEN TEMPERATURE AT OR ABOVE NORMA GRADIENT

reservoirs, if any, encountered by these wells and estimate the amount of overpressure, temperature, and gas content, if practicable. (Fig.6,7)

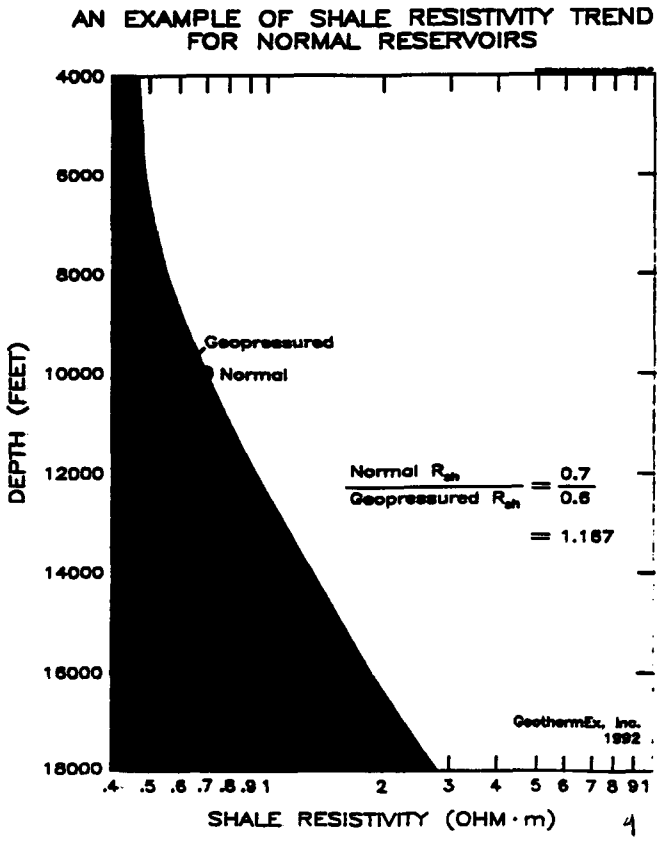
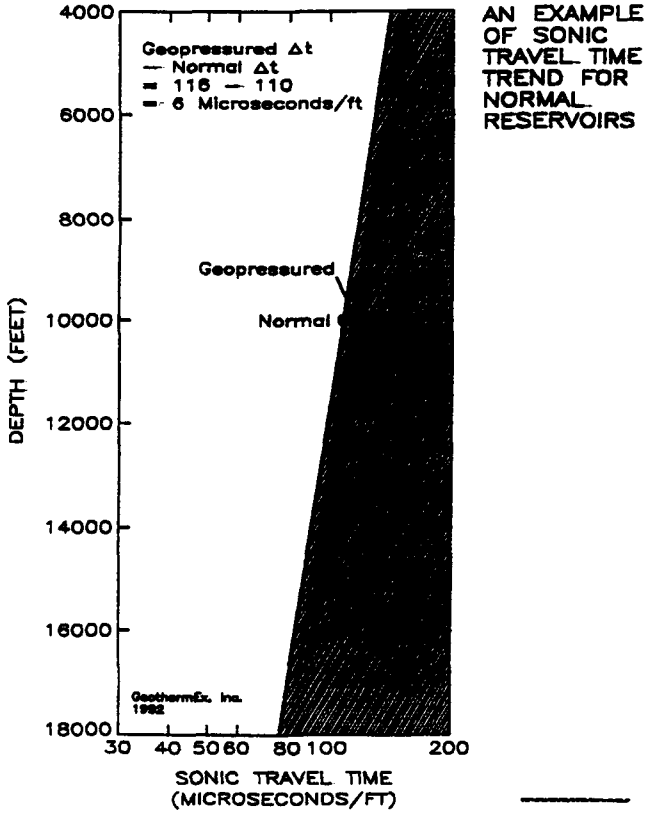


FIG. 4 (ABOVE), 5 (BELOW) DR. S. SANYAL, GEOTHERMEX, RICHMOND, CA.



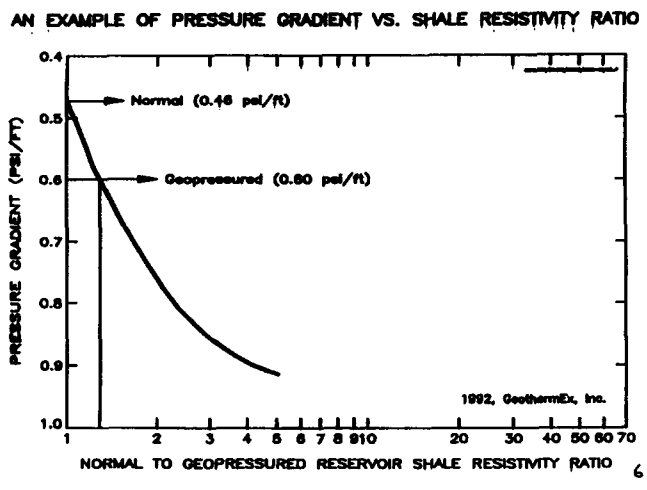
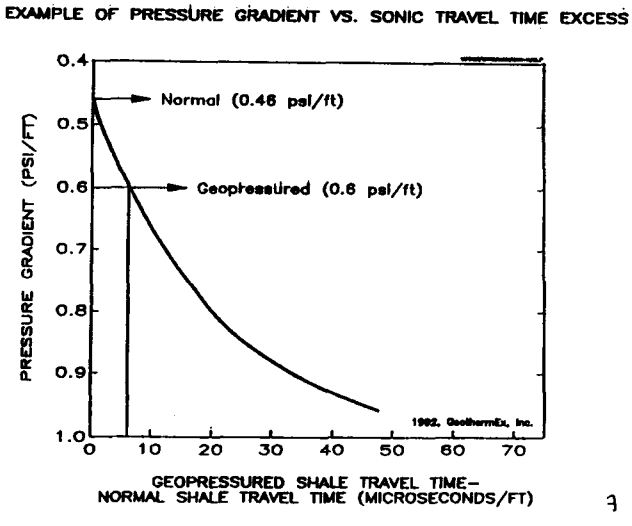


FIG. 6 (ABOVE), 7 (BELOW) DR. S. SANYAL, GEOTHERMEX, RICHMOND, CA.



5. Based on the results of Task 4, identify the geopressured geothermal basins in California and estimate the depth of occurrence of geopressure in each.

The staff at the California Energy Commission will, while GeothermEx is investigating, make inquiries to the operators of various large gas and oil fields in the state for voluntary information on the occurrence of geopressured resources in those fields. The responses will be concatenated with the results from GeothermEx for ultimate release as a publication from the CEC for public use. Follow up by the CEC may include, as warranted, close commercial cooperation with field operators in the development of pilot programs.