Current Geothermal Environment of Oil and Gas in Indus River Basin of Pakistan

Subsurface temperature measurements within wells along the Indus River basin in the search for oil and gas form the data bank for this study. The objective of the work was to evaluate the geothermal environment associated with the location of oil and gas fields taking into consideration all available subsurface temperature information. The location of the study area along the thrust fault plane between continents presents an interesting opportunity to observe the current geothermal environment along such a major tectonically active feature. The paper presents the results of the survey in the form of a regional geothermal gradient map identifying areas with greater than fourfold changes in relative geothermal intensity.

VACQUIER, VICTOR, Scripps Inst. Oceanography, La Jolla, CA

Calculation of Thermal Conductivity from Lithology and Laboratory Measurements on Oil Well Cores

The harmonic mean thermal conductivity of the whole rock column traversed by a well is calculated from the thicknesses of the different kinds of rock in the section and their respective thermal conductivities. Lithologic logs provide the thicknesses; laboratory measurements on cores, the conductivities. Heat flow can be then calculated by multiplying the mean conductivity by the temperature gradient obtained from corrected bottom-hole temperatures. In the sedimentary basins of Sumatra and Brazil the conductivities range from 4.1 to 6.5 mCal/cm°C sec but the average for all the basins is close to 5. The mean conductivity of a well depends on the sand-shale ratio and can probably be calculated without loss of precision without recourse to more measurements on samples. Conductivity determinations and heat flow in three Tertiary basins in Sumatra and in two Cretaceous basins in Brazil involving over 2,000 wells are reviewed. It is suggested that calculations of mean conductivity and heat flow be added to the existing AAPG compilation of temperature gradients in North America.

VON HERZEN, R. P., Woods Hole Oceanographic Inst., Woods Hole, MA, and J. A. HELWIG, ARCO OIl and Gas Research & Development, Dallas, TX

The drilling of deep wells on the continental margins provides a means to augment the relatively sparse heat-flow data in this geologic province. For this purpose we have analyzed data from the COST B-2 well in the Baltimore Canyon basin off New Jersey. Although the temperature gradient to nearly 5 km depth is relatively well determined from successive bottom hole temperature measurements at several depths in this hole, very few cores suitable for the determination of thermal conductivity (K) were taken. We have determined K for various lithologies from transient needle-probe measurements on selected samples of drill cuttings. The appropriately average in-situ conductivity (K), over the depth intervals between temperature measurements, is estimated by using lithology and porosity determinations over the drilled section.

The correlation of K with grain size of clastic sediments is probably related to quartz content. A relatively large uncertainty in the estimated value for limestone produced only a small uncertainty in heat flow. Shale K values show a significant decrease below 3,350 m depth.

Comparison of K with laboratory results shows the large effect of in-situ porosity and temperature. The uppermost estimate of Q (1.30 HFU at 1,220 to 3,068 m) may be low owing to unrealistically low estimate of K; the reason for an even lower estimate of Q (0.78 HFU) deeper than 4 km is uncertain. The most consistent and reliable values (1.26 to 1.30 HFU) are for the depth interval between 1,220 and 4,104 m. The implications of these measurements for the maturation of hydrocarbons on passive margins will be mentioned.

ZIELINSKI, GARY W., Gulf Research & Development Co., Harmarville, PA, and PETER M. BRUCHHAUSEN, Lamont-Doherty Geol. Observatory, Palisades, NY

Thermal Anomaly Detected by Shallow Measurement Across San Sebastian Oil and Gas Field, Eastern Tierra del Fuego

Low thermal diffusivity of peat and soils overlying parts of the oil and gas province of the eastern Magellan basin has resulted in several unusually shallow (< 2 m deep) relative heat-flow determinations. The values are in agreement with the single published heat-flow value for Tierra del Fuego of 2.3 HFU and with deep bottom-hole temperature measurements located in coincidence with the shallow determinations. They are furthermore consistent with local surface air temperature measurements obtained for a period of one year prior to the field work. Compared with that for similar tectonic provinces (post-Precambrian, non-orogenic) the heat flow in eastern Tierra del Fuego appears to be about 0.5 HFU greater than might be expected. Maturation level estimates based on burial history of sediments in the area suggest considerable lateral migration (> 100 km) of hydrocarbons from deeper in the Magellan basin. A model is explored whereby the same mechanism for transport of the hydrocarbons, namely, deep ground-water movement can also explain the heat-flow results. The dramatic 10 HFU decrease in relative surface heat flow observed across the southwestern edge of the San Sebastian oil and gas field is of similar magnitude as other thermal anomalies reported to be in close association with hydrocarbon accumulations.