NUCLEAR WELL-LOGGING IN PERMAFROST

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ABSTRACT

A Mount Sopris portable well logger was calibrated for gamma-gamma density and neutron porosity in dry geophysical-type borehoes in unfrozen materials. Since the hydrogen index of ice is less than that for water, the responses of the neutron porosity for 100 percent ice reads as approximately 72 percent porosity. Thus, by cross plotting gamma-gamma density vs. neutron porosity it is possible to determine if soils are frozen and also to estimate the unfrozen water content.

Using the cross plotting technique outlined above, it is believed that the hydrogen indices of natural gas hydrates, detected in oil wells on the North Slope of Alaska, provide a sufficient contrast with those of water and /or ice to provide a method of quantitative evaluation of hydrates in situ.

Logs of a hole drilled through a buried artificial ground-ice mass showed that the natural gamma-gamma log count decreased significantly in the vicinity of the ice, indicating that the natural gamma log could prove very useful for the detection and delineation of massive ice.

Calibrated logs were also used to estimate potential thaw conditions, and to follow seasonal variations in moisture content and bulk density.

EFFECT OF GEOTHERMAL, PORE-PRESSURE CONDITIONS, AND NATURAL GAS COMPOSITION ON THE IN-SITU NATURAL-GAS HYDRATE OCCURRENCES, NORTH SLOPE, ALASKA

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ABSTRACT

The factors which control the distribution of natural gas hydrates (solid compounds composed of natural gas and water) in the Earth include mean annual ground temperatures, geothermal gradients, subsurface pressure conditions, gas composition, and pore-fluid salinity. A thorough analysis of the effect of these parameters on thickness and depth of hydrate stability zones has been conducted. A thermodynamic model has been used to compute depth and thickness of zones of stability of gas hydrates in 34 representative wells on the North Slope, Alaska. Several well logs in these depth ranges have been analyzed to determine hydrate zone thickness, porosity and hydrate saturation. In well log analysis, the hydrate presence has been indicated by the following evidence: increase in acoustic velocity, strong resistivity deflection, small spontaneous potential deflection, gas shown on mud log, oversized caliper, increase in the neutron porosity, separation of long normal from short normal, decrease in drilling rate. In several of these wells, multiple zones of hydrates have been detected.

In the Prudhoe Bay and Kuparuk oil fields, hydrates are expected to occur in primarily six stratigraphic horizons, mostly in a series of unconsolidated units, characterized by a poorly sorted sandstone and conglomeratic lithology. Detailed examination of the neutron porosity and sonic velocity responses within one hydrate horizon in six wells in Kuparuk field indicates an average porosity of 44 percent and hydrate saturation of 93 percent. Such information is extremely relevant to quantification of gas hydrate deposits.

TRACKING UP PUTNAM RIVER.

(Stoney, G. M., 1900, Naval explorations in Alaska: U.S. Naval Institute, Annapolis, facing p. 8)

Alaskan North Slope Geology, Volumes I and II, 1987