AAPG Annual Meeting
March 10-13, 2002
Houston, Texas

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3-D Stochastic Modeling of Norwegian Sea FIS Data Depicts Regional Petroleum System

Geostatistical modeling of Fluid Inclusion Stratigraphy (FIS) data effectively depicts regional petroleum system features in the Norwegian Sea. Anomalous concentrations of light hydrocarbons and sulfur compounds in the shallow subsurface probably reflect anaerobic alteration of vertically seeping gas-range compounds from depth by sulfate-reducing bacteria. This effect is recorded at maximum depths predominantly in the range 1100-1500 m, corresponding to maximum present-day burial temperatures of 64-80^{o}C. Statistically, FIS microseeps tend to be most prominent over deep, hydrocarbon charged reservoirs, particularly those containing liquid petroleum (oil or gas-condensate). A regional seal zone occurs between 1500-2500 m, and is generally comprised of fine-grained Tertiary to Cretaceous lithologies of the Hordaland, Rogaland, and Shetland Groups. Underlying Jurassic reservoir units show regional increases in petroleum responses with maximum concentrations observed where hydrocarbons have migrated or accumulated. Water-soluble anomalies (chiefly benzene and acetic acid) occur in several areas within these reservoirs and suggest potential for undiscovered liquid petroleum. The distribution of mature source rocks (particularly gas-prone coals in the Triassic, but also liquid-prone source rocks in the Jurassic) are defined by regionally anomalous concentrations of gas and liquid-range petroleum species, as well as aromatic compounds and some sulfur-bearing volatiles. Anomalies generally occur below 3500-4000 m and are consistent with petroleum-window maturities inferred from basin modeling results. Post processing geostatistical simulations of key FIS data (e.g. methane, benzene, acetic acid and several ratios) results in 3-D Risk cubes. These cubes indicate the probability of exceeding concentration or ratio thresholds.