Geothermal Patterns and Petroleum Traps, Louisiana

Published literature documents varying degrees of correlation between geologic structures and geothermal highs (halos) of several petroleum fields. In conjunction with these fields, additional structures and associated productive trends have been evaluated in order to develop certain predictive criteria. The studies attempted in this regard include structural and stratigraphic traps, rollover anticlines, and salt domes with productive horizons of various ages in Louisiana.

As part of the characterization of the subsurface temperature regime of the regions studied, the following broad generalizations seem to be in order. (1) Geothermal halos observed near faults appear astride the fault, or clearly confined to one fault block or the other. (2) A single geothermal halo in a deep section may be overlain by multiple halos, generally of lower relief, in shallow sections. (3) Geothermal halos associated with deep-seated salt domes are located in the sedimentary section on or near the top of the dome, near the perimeter or on the flanks. Such halos are not discernible on shallow domes. (4) In the interior basin, a salt dome with productive horizons appears to have a geothermal halo of higher relief than those in the vicinity with no petroleum accumulations. (5) Even some petroleum traps, created by sedimentary facies changes with no distinct structural closures, are marked with geothermal halos.

The observed characteristics of the subsurface thermal regimes are generally explicable in terms of thermal properties of rocks and pore fluids and by hydrodynamics.

KUMAR, NARESH, ARCO Exploration Co., Denver, CO, and ROGER M. SLATT, ARCO Oil and Gas Co., Dallas, TX (present address: Cities Service Research, Tulsa, OK)

Deep-Water Stratigraphic Traps in Interior Basins: Examples from Anadarko Basin, Oklahoma

As in modern oceans, there is ample evidence that sands bypassed shelf-edges of ancient interior basins and accumulated in deeper parts of the basins. Although water depths in these basins were never in the abyssal zone, these deposits are today recognizable as "deep-water" sands.

Based on a seismic, subsurface, and sedimentologic study of the Tonkawa Sandstone (Missourian), we have developed a seismic-stratigraphic model for Pennsylvanian sands in the Anadarko basin. Typically, the Tonkawa and other sands are regressive and cyclic and are bounded at the base and top by transgressive limestones. The sands consist of three facies: (1) an upper shallow-water shelf facies, (2) a middle submarine slope-channel facies, and (3) a lower submarine fan-lobe facies. Each sandstone unit exhibits characteristic electric log and seismic signatures and distinctive sedimentary structures and textures. For each depositional cycle, the shelf edge may be formed by a contemporaneous reef, and the break in bathymetric gradient at the base-of-slope may be marked by an older reef. Besides the Tonkawa Sandstone, this model is applicable to the following formations: (1) Springer/Morrow (Springeran/Morrowan); (2) Red Fork (Desmoinesian); and (3) Cleveland and Cottage Grove (both Missourian).

The model predicts that both individual slope sands and submarine fan lobes are potential stratigraphic traps. Associated carbonate banks may also form traps. We suggest that many deep-water traps remain to be found in the Anadarko basin.

KUMATI, SUGAIER M., Mobil Oil Libya Ltd., Tripoli, Libya (S.P.L.A.J.), and JOSEPH M. ANKETELL, Univ. Manchester, Manchester, England

Structural Analysis of Western Sirte Basin, Libya (S.P.L.A.J.)

Examination of surface sediments and tectonic features in the oil-rich Hofra area, western Sirte basin, Libya (S.P.L.A.J.), demonstrates that this area was subject to periodic movement of blocks due to faulting and probably also eperiogenic uplift.

It is here proposed that the faults are the major structures in that it is possible to interpret some, if not all, of the folds as having formed in relation to reactivation of the fault systems. The fault systems may be interpreted in terms of a major "bull-nose" Riedel P Shear structure related to a deep-seated fault along which there was left-handed movement. The faults making up the major bull-nose structure and in particular the Abu Shush fault system display Riedel Shears in patterns indicative of left-handed movement. Abu Shush fault system appears to display a northerly change from styles ranging from those typical of a pre-residual to a peak structural situation. In addition, the post-peak to pre-residual styles typical of the southern part of the Abu Shush fault zone are associated with reversal of stress patterns along a major P zone in the southern part of the Gedari fault zone.

The complexities in stratigraphic relationships resulting from such events may often not be easily recognized in boreholes without exhaustive paleontologic studies, particularly when one considers that most of the unconformities display little variation in dip across the unconformable surface.

KURESHY, A. A., Staten Island, NY

Large Tertiary Foraminiferal Biostratigraphy, Kirthar Province, Sind, Pakistan

Large foraminifera of Pakistan are chronostratigraphically diagnostic and are the basis for stratigraphic correlation of marine Tertiary carbonate deposits. The sedimentary deposits of Pakistan are divided into three basins, among which the carbonate deposits of the lower Indus basin are very rich in large foraminifera. The lower Indus basin is divided into Sulaiman and Kirthar provinces. The Tertiary deposits of Kirthar province are mainly carbonate with intercalation of argillaceous sediments, designated to Lakhra, Laki, Kirthar, Nari, and Gaj formations, and range in age from Paleocene to early Miocene. The large foraminifera of these deposits are divided into ten distinct foraminiferal zones. These are: (1) Lakra Formation, characterized by *Nummulites muttalii* zone of late Paleocene age; (2) Laki Formation, characterized by *Assilina granulosa* zone of early Eocene age; (3) Kirthar Formation (4) zone, characterized by *Nummulites beaumonti* zone (middle Eocene), *N. pengaroensis* zone (late Eocene), *N. fichteli* zone (early Oligocene), and *N. fichteli/Lepidocyclina* (E) *dilatata* zone (middle Oligocene); (4) Nari Formation (3 zones), *N. fichteli, N. fichteli/Lepidocyclina* (E) *dilatata* zone, and *L.* (E) *dilatata* zone (of early, middle, late Oligocene respectively); and (5) Gaj Formation, characterized by *Miogypsina gunteri* and *M. thecideaeformis* zones (Aquitanian and Burdigalian, early Miocene). The foraminifera are mostly restricted to their respective zones. Post-early Miocene rocks of Kirthar province, Sind, Pakistan, are nonmarine and devoid of foraminifera.

LAMBERT, MICHAEL W., Chevron U.S.A., Inc., New Orleans, LA

Vitrinite Reflectance of Woodford Shale in Anadarko Basin, Oklahoma

The Woodford Shale (Upper Devonian-Lower Mississippian) is a black shale thought to be an important oil-source bed in the Anadarko basin of western Oklahoma. The reflectance in immersion oil (R_o) of first-generation vitrinite particles found in this stratigraphic unit is related to temperature history and thus