PUGMIRE, RALPH U., Consulting Petroleum Geologist, Farmington, NM

Types of Tight Gas Reservoirs, San Juan Basin, New Mexico and Colorado

The San Juan basin of New Mexico and Colorado is an asymmetrical basin formed during the Late Cretaceous and early Tertiary. The structurally deepest part of the basin is near the Colorado-New Mexico border. Presently, the only applications for the incentive price for gas produced from tight sandstones involve reservoirs of Cretaceous age. These reservoir rocks were deposited in open shelf to lower delta-plain environments associated with the Western Interior Cretaceous sea which transgressed and regressed the area in a general southwest-northeast direction. Coastal-barrier sandstones are significant gas producers and typically exhibit a strong marine influence. These sandstones are represented by long, linear northwest-southeast reservoir trends.

The tight gas applications for the San Juan basin, to date, concern reservoirs which can be placed into a spectrum with two end-member types. One type is characterized by continuation of mappable sand trends which extend from economic producing areas. Even though reservoirs of this type generally look similar to those in economic wells, they require production testing to determine their economic potential. This unpredictability is caused by the presence or absence of natural fractures. The other type of tight gas reservoir is related to the thinning of the good reservoir section or the increase in content of silt and clay-size material within the productive interval. This type of reservoir looks poor on well logs because of interbedding of siltstones and shales with thin, good reservoir sandstones and/or the presence of considerable silt and clay in the sandstones themselves.

QI, FEI, WANG XIE-PEI, and ZHANG JIA-HUA, Wuhan College of Geology, Beijing Graduate School, Beijing, People's Republic of China

Cenozoic Diapiric Traps in Eastern China

Genetically, there are 2 types of Cenozoic diapiric traps in the oil fields in eastern China. One type is produced by "cold diapirism" owing to the rise of evaporites and soft mudstone. This type can be divided into 3 patterns. The first pattern is the faulted ridge with 1,000 m (3,300 ft) closure and flanks dipping up to 30°. A complex graben system is developed on the top. The amplitude of the core of the anticline is about 3,000 m (9,800 ft). The Xiangzheng structure in the Shengli oil field and the Wang-cung structure in the Qian-jiang depression are examples. The second pattern is the gentle anticline or dome with 50-300 m (160-985 ft) closure and 3°-10° dip on the flanks. The incompetent strata beneath it are about 1,000 m (3,300 ft) thick. The Tuocung-Shengli structure in the Shengli oil field is an example. The third pattern is a nose-like structure with less than 50 m (160 ft) closure. This pattern is usually located near the zero edge of incompetent strata. The Serniusi structure in the Dagang oil field is an example.

Another type of Cenozoic diapiric trap results from "hot diapirism" associated with the intrusion of gabbro or diabase. Such traps are typically small, round domes. The dip of the flanking strata generally increases with depth as the diapir is approached. A graben system is developed on top of the diapir. The distribution of these traps is related usually to regional fault zones and coincides with the distribution of the magmatism. The Matouzung structure in the Jinhu depression is one of the examples.

RAPOPORT, L. A., and G. C. GRENDER, Virginia Polytechnic Inst. and State Univ., Blacksburg, VA

Probability Distribution of United States Oil and Gas Discoveries for Various Levels of Exploratory Drilling Density

Comprehensive computer-supported analyses of the exploration histories of the main sedimentary provinces of the conterminous United States have led to the development of a large number of discovery functions by basins and depth zones. This paper extends the previously reported results by presenting frequency distributions of the amounts of hydrocarbon discoveries for successive increments of exploratory drilling density (ft/mi^3). The manner in which these distributions vary with depth is illustrated by considering successive depth zones across all the United States sedimentary provinces. The analysis further distinguishes between frequency distributions of the discovery of oil and of nonassociated gas. These frequency distributions can be interpreted as representing the probabilities of discovering different amounts of oil and/or gas at different future stages of exploration, i.e., at different exploratory drilling densities.

REDIN, TOM, Union Oil Co. of California, Ventura, CA

Oil and Gas Production from Submarine Fans of Los Angeles Basin

The Los Angeles basin is a small but relatively deep Neogene basin located in the most northeast portion of the southern California continental borderland. It was formed along a transform margin during the early to middle Miocene, as were numerous basins within the continental borderland south of the Transverse Ranges.

A series of prograding submarine fans filled most of the basin during the middle to upper Miocene, Pliocene, and Pleistocene. The morphology of these fans appears to fit most basin-floor fan models but these models were greatly modified by paleobathymetry. The sediment transport mechanism was primarily turbidity flows from submarine canyons but other mass sediment transport such as debris flows, fluidized sediment flow, grain flow, etc was also significant.

Three primary, often coalescing, submarine fans have been recognized: the Tarzana fan in the northwestern Los Angeles basin, the San Gabriel fan in the central and southern parts, and the Santa Ana fan in the eastern part of the basin. Most of the oil produced in the Los Angeles basin comes from submarine fan sandstones. Much of the future oil to be found will be from the same fans or heretofore unrecognized submarine fans. Structural geologic concepts will be of equal importance when exploring for these subtle traps.

Total cumulative production to 1982 has been 7.3 billion bbl of oil and 5.8 tcf of gas. Per unit volume of sediment, the Los Angeles basin is one of the richest in the world. It was a silled basin within the oxygen-minimum oceanographic zone during the upper Miocene and Pliocene. A combination of rich biogenic sedimentation along with rapid burial by coarse to fine clastics and relatively high paleoheat flow provided almost perfect conditions for the generation and migration of oil and gas. Structural deformation was intermittent throughout the Neogene but was most intense and culminated in the late Pleistocene to Recent. The multistoried oil sands with different crude oil types suggest most of the oil is indigenous to the formation in which it is found.

RICE, DUDLEY D., U.S. Geol. Survey, Denver, CO

Controls of Shallow Gas Accumulations in Low-Permeability Reservoirs of Northern Great Plains

Significant resources (about 100 tcf in place) of natural gas are entrapped in low-permeability, low-pressure reservoirs at depths less than 3,000 ft (900 m) in Montana and the Dakotas. The gas occurs in fine-grained sequences of Late Cretaceous age deposited on a shallow, open-marine shelf. The low-permeability reservoirs were deposited during progradations and consist of discontinuous lenses and laminae of siltstone and sandstone enclosed by silty clay shale. The siltstone and sandstone layers are porous and permeable, whereas the enclosing shale is impermeable. The large proportion of allogenic clay, including highly expansive mixed-layer illite-smectite, causes extreme water sensitivity as well as high measured and calculated water saturation values in the reservoir sequence.

Gas production has been established in "sweet spots" on structural highs where the reservoirs are best developed. Recurrent tectonic movement resulted in winnowing of coarser grain sizes on the highs by southward-flowing, geostrophic currents. In the future, exploration will occur off structure for lower quality reservoirs.

The gas was generated in the marine environment by decomposition of organic matter by anaerobic microorganisms and is referred to as biogenic gas. The most important mechanism of methane generation in marine sediments is reduction of CO_2. Organic carbon values, rates of sedimentation, and products of early diagenesis indicate that biogenic gas production was widespread during deposition. Most of the gas was initially retained in solution in the pore waters because of higher methane