

Concomitant with this regional subsidence were localized uplift and extensional block faulting in the vicinity of the incipient Red Sea rift (the Safaga-Quseir coastal plain). Here, lower Eocene carbonate facies are indicative of shallow water platforms developed on horst blocks, and deeper water, turbidite-fed basins in intervening grabens.

GARVEY, TIMOTHY P., Cabeen Exploration Corp., North Hollywood, CA

Hydrocarbon Accumulations in Turbidite and Contourite Sands of Upper Cretaceous Forbes Formation, Bounde Creek Gas Field, California

Upper Cretaceous marine strata of the Forbes Formation in the northern Sacramento Valley are composed of terrigenous clastic detritus deposited in westward-prograding shelf to basinal sedimentary environments that existed in a south-trending fore-arc basin. Subsurface stratigraphic investigations in the Bounde Creek gas field indicate that upper, middle, and lower informal divisions of the Forbes Formation are composed of submarine fan and slope sediments deposited in the northern extension of the fore-arc basin.

The upper Forbes contains deposits of inner slope sub-association. Predominantly very fine to fine-grained contourite and feeder channel sands are present within this upper section. These inner slope deposits are underlain by, and are interpreted to pass westwardly into, outer slope and inner fan deposits that comprise the middle part of the Forbes. Sands within this middle part are generally coarser (very fine to coarse-grained), thicker bedded, and have greater stratigraphic irregularity than vertically adjacent deposits within the formation. The lower Forbes consists of middle and outer submarine fan deposits. Sand bodies in this interval were deposited in channels and as suprafan lobes. Ongoing analysis indicates that channel configurations were, in some places, influenced by syndepositional faulting that created steep channel margins and abrupt route alterations and/or abandonments. Sand lobe deposits exhibit areal continuity and lateral lithologic gradations.

In the Bounde Creek gas field, distinct hydrocarbon accumulations occur in sand packages that are interpreted to represent: (1) feeder channels and contourites of slope associations; (2) channel lag or mouth bars of middle to inner fan sub-associations; and (3) suprafan lobes of middle to outer submarine fan sub-associations. Paleogeographic reconstructions of depositional horizons within the Forbes reveal a scenario of development and progradation of these inner slope to outer fan associations, and allow geometric projections of hydrocarbon-bearing sand bodies within the system.

GAUTIER, DONALD L., and DUDLEY D. RICE, U.S. Geol. Survey, Denver, CO

Significance of Gamma-Ray Spectroscopy for Evaluating Shallow Gas Reservoirs from Bowdoin Dome, Montana

Natural gas is currently being produced from shallow gas reservoirs of Late Cretaceous age in the Bowdoin dome area, north-central Montana. Clay-rich rocks of the Mosby Sandstone Member of the Belle Fourche Shale, the Greenhorn Formation, and the Carlile Shale are the principal reservoirs. Laterally equivalent rocks are major producers of gas in southeastern Alberta. The Mosby consists of composite bedsets of lenticular to wavy-bedded sandstone and dark-gray shale. The Greenhorn, which unconformably overlies the Mosby, is as much as 40 ft (12 m)

thick and consists of black, organic carbon-rich (as much as 9% organic carbon) shales, bentonites, and calcarenites consisting mainly of inoceramid prisms. Lateral equivalents of the Greenhorn are probably the principal source beds for oil occurrences farther west in the Montana disturbed belt. The Carlile Shale overlies the Greenhorn with apparent conformity and is lithologically similar to the Mosby. However, the Carlile mudstones contain more smectitic mixed-layer clays than those of the Mosby.

Exploration and production of hydrocarbons from these clay-rich rocks present significant problems in log interpretation and in well completion and treatment procedures. In an effort to address these problems, a detailed geochemical, petrologic, mineralogical, and stratigraphic study was undertaken to characterize the gas-productive formations at Bowdoin dome and to evaluate the usefulness of natural gamma-ray spectroscopy for interpreting geology and reservoir quality. The gamma-ray spectral log resolves the total gamma-ray spectrum into the three most common components of radiation—gamma rays from ^{40}K , U-series decay, and Th-series decay. In principle, the log can be used to determine clay content, clay composition, source-bed richness, and lithology. Results of this investigation suggest that the log successfully estimated organic-carbon content, identified bentonites, and located the unconformity at the base of the Greenhorn. In addition, subtle differences in clay composition between the Belle Fourche and Carlile Shales were apparent. These differences in clay mineralogy have important implications for interpreting the irreducible water saturation and water sensitivity of the formations and thus for the choice of drilling and completion techniques.

Detailed analyses of individual core samples provide much more accurate information about single point samples than did interpretations of single points from the spectral log. However, analyses of individual core samples only distinguish mineralogical or geochemical deviations with frequencies greater than two times the sampling interval. In contrast, the log provided a running average capable of resolving relatively small-scale fluctuations and displayed considerable precision and accuracy when calibrated to laboratory analyses. In conclusion, gamma-ray spectroscopy provides a potentially important tool for the investigation of unconventional gas reservoirs and source beds in clay-rich and organic carbon-rich rocks.

GAWARECKI, S. L., and S. K. PERRY, Univ. South Carolina, Columbia, SC

Exploration Implications of Neotectonic Fault Pattern, Gulf of Suez

Detailed topographic mapping of the Ras Issaran area along the west bank of the Gulf of Suez reveals Quaternary faulting along preexisting trends, cross-fault reversals, and tectonically controlled sedimentation. The neotectonic fault systems of the region were identified and mapped by altimetry of selected bed-rock units and Quaternary gravel surfaces. The relict gravel surfaces are tilted gulfward, bowed near faults, displaced across faults, and show fault-induced drainage changes, evidenced by truncation and rerouting of wadis. Although the current major fault scarps on the high Quaternary surface have migrated back from the original bed-rock faults, the configuration and magnitude of the Quaternary faults are clearly visible. This has important implications for the interpretation of subsurface data. In particular, ability to detect subsurface structures, reversed faults, and significant fault trends is enhanced by knowledge of the modern fault patterns.

Tectonic activity in the Ras Issaran area is dominated by movement occurring on two major sets of normal faults. The primary