Cretaceous Transgression of Coahuila Peninsula, Potrero de la Mula and Sierra del Fuste, Coahuila, Mexico

Exposures of the Late Jurassic to Early Cretaceous Coahuila peninsula have been reported at three localities northwest of Torreon and at Potrero de la Mula in central Coahuila. Exposures also occur at Sierra del Fuste, about 25 km northwest of the La Mula outcrops. At Potrero de la Mula, granites to granodiorites containing xenoliths are cut by dikes of six ages. Deep pre-Cretaceous weathering, thin transgressive arkose, and overlap by the Padilla Formation confirm these as basement rocks.

In early Neocomian time the basement was a source of detritus for the basinward San Marcos Formation. Subsequently, seas partly covered the La Mula area, depositing the lagoonal facies (Oballos Member) of the Padilla Formation, which thins to a featheredge against the higher parts of the basement. A 1 to 2-m arkose, which seems restricted to paleotopographic lows, is present at the base of the Padilla. Overlying the Padilla, marine shales and a progradational sequence of fluvial and marginal-marine sandstones compose the La Mula Formation. Upper La Mula shales grade upward into sabkha deposits of the lower La Virgen Formation. Normal-marine shelf conditions existed at Potrero at several different times, causing carbonate tongues to be deposited in the La Virgen Formation and ultimately forming the Cupido Formation. Possible subaerial exposure of the Cupido preceded deposition of the La Peña shales and calcareous mudstones, which grade upward into calcareous mudstones of the Aurora Formation.

MCKENZIE, JUDITH ANN, KENNETH J. HSU, and JEAN SCHNEIDER, Swiss Federal Inst. Technology, Zurich, Switzerland

Movement of Subsurface Waters Under Sabkha, Abu Dhabi, United Arab Emirates, and Its Relation to Dolomite Genesis

Field work was carried out during the years 1971-73 to investigate the hydrology of the Abu Dhabi sabkhas with the purpose of determining (1) the source of subsurface water inducing the diagenesis of Holocene sediments and (2) the directions and rates of hydrologic movements. The ionic ratios of Cl/Br and K/Br and the stable isotope contents of the subsurface brines of the sabkha separated them into three distinct categories according to their origin: (1) coastal sabkha zone, of evaporated marine waters from supratidal flooding (a) daily near the coast from the lagoon and (b) occasionally farther inland from the open sea; (2) intermediate sabkha zone, a mixture of marine waters with meteoric groundwaters which are isotopically altered by capillary evaporation and/or diagenesis, that is, the oxygen-18 content increases while the deuterium content remains relatively constant; and (3) continental sabkha zone, of meteoric groundwater with variable isotopic composition as a result of evaporation and sporadic addition of rainwater.

The intermediate sabkha zone is the site of extensive diagenesis, precipitation of gypsum and anhydrite, and formation of dolomite. Unusual winter storms in conjunction with spring tides produce high supratidal flooding in the intermediate zone by open seawater. The groundwater table rises nearly to the surface. Floodwaters dissolve and transport away interstitial salts, which are carried seaward surficially or downward through the aquifer at an average rate of 11 cm/year. Subsequent secular evaporation tends to lower the groundwater table and induce Darcy flow under a vertical hydraulic gradient of evaporative pumping, that is, upward movement of water through the saturated zone to replace water lost by capillary evaporation. An appreciable vertical groundwater gradient is induced by the presence of a cemented crust which serves as an aquiclude about 1 to 2 m below the surface.

MEBBERSON, ANDREW J., and DENNIS J. MORTON, Esso Australia Ltd., Sydney, Australia

Massive Marine-Sandstone Facies, Mackerel Field, Gippsland Basin, Australia

The Esso-Hematite Mackerel oil field in the Gippsland basin, Australia, is in a high-quality Paleocene sandstone section and has been delineated by four exploratory wells.

A predevelopment stratigraphic model of the field was constructed from detailed analysis of high-quality seismic data. Although the sandstone section initially appeared to be massive and homogeneous, seismic data quality was sufficient to separate 11 discrete depositional units, each with an apparent marine progradational character. The boundaries of these seismic units were then tied back to minor variations in log and core lithologic characteristics, providing facies and depth control for the model.

It was possible, therefore, to construct a detailed geologic picture—with emphasis on the vertical and lateral extent of facies distribution. petrographic character, and reservoir properties—in a section which initially appeared to be generally ambiguous in its stratigraphic and paleoenvironmental position in the depositional framework of the surrounding area.

MEISSNER, FRED F., and W. JERRY KOCH, Filon Exploration Corp., Denver, Colo.

Test-Tube Pyrolysis—Simple Technique for Identifying Yield and Maturity of Source Rocks

When small samples (i.e., well cuttings) of kerogen-rich rock are pyrolyzed in a test tube placed over a propane torch, oil-like material may be generated and condense as a brown residue around the walls of the tube. This simple technique may be used to identify source rocks capable of generating liquid oil. The artificial test-tube-generating process is believed to be similar to that associated with natural time- and temperature-dependent processes accompanying rock burial in depositional basins. The relative amount of oily residue pyrolytically generated in a test tube is therefore a semiquantitative measure of the natural oil-generating capacity of the rock. Source rocks which have been subjected to advanced stages of thermal maturation are not capable of generating liquid hydrocarbons and there-

fore do not yield oily pyrolysis residues. The disappearance of pyrolysis residues from rock samples representing deep-burial and high-temperature histories relative to those which yield good residues at shallower depths and lower temperatures may be utilized to determine the depth of the oil-generating to gas-condensate-generating maturity threshold.

The technique has been utilized to map source-rock distributions and maturity thresholds in the Pennsylvanian of the western Anadarko basin.

MILLER, BETTY M., U.S. Geol. Survey, Denver, Colo.

Development of Petroleum Resource Appraisal Methods in U.S. Geological Survey and Role of Appraisal Group in Resource Assessment Studies

In 1973 the Oil and Gas Resource Appraisal Group was originated within the U.S. Geological Survey (USGS) to develop resource appraisal methodology and apply these methods in assessing the nation's petroleum resources on a regional basis. The resource appraisals were published in USGS Circular 725 on the undiscovered oil and gas resources of the United States for 102 geologic provinces. Since this first assessment, the evolution in the development of petroleum resource appraisal procedures within the Resource Appraisal Group has been significant.

The appraisal methods are designed to evaluate all the known geologic and geophysical data available for a prospective petroleum basin or province. Resource appraisals can be made with any amount of data. However, the amount and kinds of data available will determine the method or methods to be used in the appraisal for any basin or stratigraphic unit. Methods will also change with time, as the amount and nature of the information in a specific area will vary with exploration activity and availability of data.

In frontier areas of exploration (where only gross interpretation of the basin geology is available) by applying the principles from worldwide experience for the occurrence of oil and gas it is feasible to use subjective judgment with minimum data to provide an estimate of the potential petroleum resources. More advanced methods employing objective data and statistical analysis are being employed when increased exploration provides an expanded data base. The methods used in making resource assessments are evolving in complexity to the point that we can deal with exploration plays by stratigraphic units within each prospective province. In areas where data are extremely abundant, the choice of methods used may become more a function of the objectives of the resource assessment and the availability of staff for the study. If data and time permit, the ultimate approach for a complete resource assessment is to use as many methods as possible as a means of cross-checking results.

MOMPER, JAMES A., and JACK A. WILLIAMS, Amoco Production Co. Research Center, Tulsa, Okla.

Geochemical Exploration in Powder River Basin, Northeastern Wyoming and Southeastern Montana

Combined geochemical and geologic information from this structural basin accurately delimited areas and stratigraphic sequences prospective for crude oil and thermal hydrocarbon gases. Using volumetric and performance data for each effective source sequence, quantities of expelled oil and gas were calculated which readily account for in-place oil reserves of more than 6 billion bbl and minor amounts of associated gas.

Oils expelled from Lower and Upper Cretaceous source beds are similar. The Mowry siliceous shale and Niobrara calcareous shale and marl expelled most of the oil indigenous to the basin. A second major oil type is correlated to the remote Permian Phosphoria source area centered in southeastern Idaho. Oil migration paths have been mapped, gathering areas identified, and time of migration determined. Three of five giant oil fields—Salt Creek, Lance Creek, and Bell Creek—are located on separate gathering areas around the basin periphery. Hilight and Hartzog Draw fields are stratigraphic traps paralleling structural strike on the basin's eastern flank, oriented to receive maximum flow of migrating oil.

An Early Jurassic regional migration emplaced Phosphoria oil in upper Paleozoic reservoirs before the basin formed. Expulsion from deepest Cretaceous source rocks began in Eocene time and probably continued into Pliocene time as the expulsion front moved upsection and updip. Laramide structure controlled migration of Cretaceous oil.

Recharge water affected oil preservation. Consequently, temperature and salinity anomalies are commonly associated with accumulations in recharge areas, where two types of bacterial alteration are recognized.

More than 20 mutually supporting chemical and physical parameters from rocks and fluids proved useful in defining prospective areas.

MOMPER, JAMES A., Amoco Production Co., Tulsa, Okla.

Domestic Oil Reserves Forecasting Method and Assessment of Regional Potentials

The forecasts of undiscovered giant oil fields in the United States, beginning with the initial study in 1960, seemingly have predicted subsequent exploration results with considerable accuracy. The probable number of undiscovered giant fields was predicted from the trend in discovery rates during previous decades.

The forecast number of undiscovered giants, multiplied by the average recoverable oil content in discovered giants, approximates the amount of recoverable oil in undiscovered giants. This value is then enlarged by the proportion of recoverable oil discovered in nongiant fields relative to giant fields. The resultant is the total undiscovered resource of new oil, using existing recovery capabilities. The quotient was adjusted upward for anticipated improvements in enhanced recovery technology to obtain the amount of ultimately recoverable oil in all undiscovered domestic fields.

Remaining reserves of discovered oil also were adjusted upward using a similar enhancement value. Based on established trends, future additions to existing reserves resulting from extensions, deeper pool, and