same conclusions as for coals. (9) Surface and subsurface continuity of stratigraphic units and paleontologic zones from the central India shield to central Afghanistan and Iran proves that India has been a part of Asia since the latter part of Proterozoic time.

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GEOLOGIC FACTORS WHICH MAY AFFECT GAS OCCURRENCE IN ANADARKO BASIN, OKLAHOMA

The Anadarko basin in Oklahoma, the Texas Panhandle, and in southwestern Kansas contains many reservoirs which produce commercial quantities of gas with subordinate quantities of oil. The producing formations are Permian; Upper, Middle, and Lower Pennsylvanian; Upper and middle Mississippian; Hunton; and Ordovician. Each of these groupings can be considered a genetic stratigraphic unit in which the depositional and structural history is closely related.

Gas analysis is a powerful tool in the exploitation of a given reservoir. Some reservoirs in the Anadarko basin are blanket-type sandstones in which the analyses will be uniform over a broad area. Gas analyses showing abnormally high BTU values, subnormal formation pressures, or exceptionally high nitrogen content can be producing from a sandstone lens (either channel or offshore bars) or a limited carbonate porosity zone in which there has been no communication of fluids.

Hunton gas analyses show a higher percentage of CO_2 at depth, whereas the BTU values decrease because of the decreasing percentage of gas liquids below 14,000 ft. Pressures in the Hunton, although a little below the so-called normal bottomhole pressures, increase in a fairly uniform manner. The Morrow sandstones are productive over most of the Anadarko basin. Variations in the analyses from these sandstones appear to depend on the depth of production and on the chemical content of the gases. It is evident that many of the anomalous values of the analyses depend on the extent of the local reservoir and its geometry.

Gas analyses are a major factor in the economics of gas production. The Hunton gases along the northern shelf of the Anadarko basin yield high percentages of valuable gas liquids. Other zones yield variable amounts of gas liquids. Nitrogen values are small in all reservoirs except in the Permian where several "noninflammable" gases are reported. In contrast with the Oklahoma and Texas panhandle gas production, helium does not appear to be a factor—only traces to less than 1.0% helium are reported.

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PRELIMINARY DIAGENETIC MODEL OF CARBONATE BEACH SEQUENCES

Detailed studies of Cretaceous Edwards carbonate beaches revealed striking vertical sequences of first generation, early diagenetic fabrics which are thought to represent the diagenetic imprint of the original hydrologic regimen on the sediments during and soon after their deposition.

The classic environmental zones of the beach can be recognized in the Cretaceous prograding beach sequences and contain, from top to bottom, the following diagenetic features.

The *backshore zone* contains penecontemporaneous dolomite, dedolomite, montmorillonite-caliche paleosoil zones; all evidence points to a meteoric-vadose diagenetic environment.

The *foreshore zone* contains much moldic porosity, micrite rims on grains, beach rock cemented during deposition by metastable carbonates; all intragranular cements have a low iron content indicating an oxidizing vadose cementation environment. These features indicate the influence of both meteoric and marine hydrologic conditions.

The *lower foreshore zone* is characterized by dominant inversion textures preserving shell structure of original aragonite grains, the notably poor development of micrite rims, the presence of early metastable carbonate cementation (beach rock) and relatively high iron content of intragranular cements. These features indicate reducing phreatic, dominantly marine hydrologic conditions during diagenesis.

The *offshore zone* contains high iron intragranular cements, multiple bored, and inverted bored surfaces. The diagenetic environment was no doubt marine phreatic.

Companion studies of Holocene carbonate beach sediments, rocks, and interstitial water confirm to a remarkable degree, the diagenetic patterns found in the foreshore and upper offshore zones of the Edwards carbonate beaches, which lends strong support to the use of these patterns as a preliminary model of carbonate diagenesis in the beach environment.

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POROSITY-CEMENT-DEPTH RELATION FOR MINNELUSA SANDSTONES, POWDER RIVER BASIN, WYOMING

Upper Minnelusa reservoir sandstones of Wolfcampian (Permian) age show a linear reduction of porosity with depth. However, porosity is not a simple function of compaction, but is related also to composition and maximum depth of burial.

Wolfcampian sandstones are fine-grained orthoquartzites that have calcite (and dolomite), anhydrite, and silica cements. From grain-packing studies in thin section, 3 stages of compaction are evident. The first stage is characterized by a linear decrease of effective porosity to 26% at 6,000 ft of maximum depth of burial, during which quartz grains and calcite clasts were compacted. The second stage is characterized by decrease in effective porosity to 10% or less by change of calcite clasts to calcite cement. The third stage of compaction is characterized by a linear decrease of intergranular porosity to 26% at 16,000 ft maximum burial during which quartz grains were compacted and calcite and anhydrite cements were dissolved and replaced by secondary silica. Intergranular porosity includes both voids and cement, as distinct from total and effective porosity.

It appears that permeability is greatly reduced at less than 10% effective porosity at a maximum burial of 12,000 ft and present drilling depths of 10,000 ft. Therefore, this depth may represent economic limits for Minnelusa exploration.

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ISLAND CHAINS, ASEISMIC RIDGES, AND PLATE MOTIONS

Transform fault and spreading-rate data have been reexamined and a worldwide synthesis of relative plate