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Organic Matter Types and Depositional Environments in Thrace Basin, Turkey

The distribution of organic matter in the Eocene-Oligocene sequence of the Thrace basin, Turkey, may be used to help identify depositional cycles and environments. Four types of organic matter (amorphous, herbaceous, woody, coaly) were microscopically recognized and organic matter profiles were prepared for the Ceylan-1, Osmancik-1, and Abalar-1 wells.

Deposition of Tertiary sediments in the Thrace basin commenced with a middle Eocene transgression, resulting in the Sogucak and Ceylan formations. This transgression was followed by a regression and the Mezardere Formation (lower middle Oligocene) lagoonal sediments were deposited. A subsequent minor transgression is represented by the lower Osmancik Formation. The Oligocene ended with deposition of Danismen lagoonal-deltaic sediments. The organic matter profiles from the above mentioned wells correspond to the depositional cycles.

Amorphous organic matter is common in the Eocene sediments in the examined wells. The lower Oligocene regression was indicated by an increase in herbaceous and woody organic types. The Mezardere Formation shows differences in organic types in the examined wells. Abundance of amorphous organic matter in the Abalar-1 well instead of abundant terrestrial organic matter in the others indicates that marine influences were far greater at Abalar-1. The regressive and the transgression phases correspond to increases in the relative abundances of terrestrial and amorphous organic matter respectively. The increase in the abundance of amorphous type indicates a marine transgression at the base of Osmancik Formation. This was followed by a regressive period, which is indicated by abundant terrestrial matter with little or no amorphous organic matter.

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Variations in Structure and Salt Tectonics, Gulf of Mexico Continental Slope Basins

Detailed geophysical surveys were conducted over five intraslope basins on the northern Gulf of Mexico slope off Texas and Louisiana. Analysis of the seismic reflection data shows that these depressions are the result of coalescence of diapiric salt structures. They are filled with numerous thick sedimentary sequences with variable drape and onlapping relations. The difference in bedding attitudes which distinguish the sequences are believed to be a result of episodic salt movement. The five intraslope basins show great individual variability in the details of their physiography and structure. However, they may be classified into two main structural types: (1) eastern basins that are generally deep depressions with steepened slopes which display evidence of recent vertical motion and mass sediment movement and are underlain by salt at relatively shallow depths; and (2) western basins which are broad and shallow, formed between elongate ridge systems and which have undergone less deformation. The marked structural difference east to west is believed to be the result of differences in the thickness of the underlying salt. A thicker accumulation of salt to the east allowed for greater relative vertical motion in response to differential loading, and consequently more localized subsequent deposition. Differential loading on a thinner layer of salt may be expected to produce less vertical motion and broader basins, such as in the west. The composition and structure of the sedimentary sequences reflect complex interactions of sea-level fluctuations, thick sediment deposition, relative vertical motion of salt structures, related faulting, and mass sediment movement. Once formation of intraslope basins is initiated, they become the main loci of deposition for sediments reaching the continental slope.

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Clay Mineral Evidence for Movement of High Temperature Subsurface Fluids

The study of geopressured formations has provided considerable information on the probable pathways for subsurface fluid movement. The fluids have been traced and associated with structure, pressure distribution, salinity of formation waters, a variety of organic and inorganic diagenetic effects, and local changes in the geothermal gradient and the formation temperatures. The temperature changes may be measured directly or inferred from the presence of temperature-controlled reaction products such as the modification of illite/smectite.

Clay mineral changes are detected initially at temperatures as low as 50°C (122°F) and may extend to temperatures in excess of 300°C (572°F). The smectite-illite conversion is most pronounced in the range from 50°C to about 160°C. Significant changes in kaolinite and chlorite occur between 75°C and 250°C.

In shales from the Gulf Coast, the smectite-illite conversion is readily recognized, while kaolinite-chlorite reactions are most apparent in associated sands. In several examples, the development of kaolinite in sandstones is directly linked to the movement of high temperature fluids and the subsequent blocking of secondary porosity. Kaolinite is most abundant in those zones which experienced maximum flushing.

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Relevance of Cratonic Erosional Unconformities and Sedimentary Veneers to Mineral Exploration in Weathered Terranes

On stable platforms, erosional intervals may persist for great lengths of time either as continuously exposed planation surfaces or, when buried by sedimentary covers, as unconformities. On the West Australian craton, for example, erosional unconformities and thin sedimentary veneers are closely comparable in attitude and altitude. Repeated cycles of weathering, stripping or exhumation, and burial of shields constitute a morphogeodynamic pattern, a cratonic regime, which accounts for the slow but progressive lowering of cratonic erosion surfaces. Because phases of intense chemical weathering initiated in the later Mesozoic and continuing in Tertiary times tend to mask the presence of buried paleogeomorphic surfaces, specialized techniques are required for detection of degraded (weathered) unconformities. Application of stratigraphic principles to weathered zones and micromorphological analysis of paleosolic and weathered rock fabrics, as well as interpretation of geochemical and sedimentological data, facilitate reconstruction of paleoenvironments. Stone lines, saprolitic fabrics, gravel-clay interfaces, reverse weathering differentials, and etched or embayed skeleton grains showing the effects of epidiagenetic alteration are key to the detection of unconformities in strongly weathered cratons. Differentiation of soil-stratigraphic layers from sedimentary deposits requires proof of pedogenic existence and is in large part based on interpretation of boundaries between them, i.e., pedologic, lithologic, and geomorphic discontinuities. Paleogeomorphic reconstructions incorporating unconformities have practical application in mineral exploration because they provide a rational basis for pedogeochemical sampling techniques applicable to the search for base metals, the detection of deep leads (buried stream channels containing placer deposits), and telethermal uraniferous deposits associated with calcreted valley fills.

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Geology of Norton Basin, Northern Bering Sea

The rocks that floor the Norton basin are most likely of Precambrian and Paleozoic age, like those that crop out around the basin. A maximum of 6.5 km of mainly Cenozoic rocks lies over basement in the basin. I believe that alluvial fans are present deep in the basin and border major basement fault blocks. These fans are the lowest units of the basin fill in many areas and probably consist of uppermost Cretaceous and Paleogene, coal- and volcanic-rich rocks. Mainly clastic nonmarine sedimentary rocks overlie the fan deposits. The Neogene and Quaternary basin rocks apparently were deposited in a marine environment.

The Norton basin comprises two structural areas that are separated by a major northwest-striking horst. The first structural area lies west of this horst, where major normal faults strike northwest to form local areas where the basin is as deep as 5.0 km. The second area, east of the horst, includes major normal faults that strike east and northeast; the deepest part of the Norton basin (6.5 km) lies there.

During the Late Jurassic and Early Cretaceous, basement rocks now beneath the Norton basin were affected by the orogeny that formed the Brooks Range. These basement rocks were metamorphosed and thrust, and then eroded deeply nearly 50 m.y. before the basin began to form. In the middle Late Cretaceous, the area of the eastern Seward Peninsula and eastern Norton Sound was subjected to east-west compression and consequent eastward thrusting. During the latest Cretaceous and early Paleogene, the compression gave way to regional extension that formed northeast-trending grabens onshore, east of Norton basin. I believe that the Norton basin most likely formed in response to this regional extension. Initial deepening of the basin was controlled by major normal faults and occurred rapidly, whereas later subsidence was slower and more regional in scale.

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Petrologic and Stratigraphic Controls of Secondary Porosity, "Second" Frontier Sandstone (Late Cretaceous), Moxa Arch, Wyoming

The "Second" Frontier sandstone along the Moxa arch, southwestern Wyoming, forms a progradational sequence of marginal-marine and paralic to fluvial deposits that host important gas reservoirs. Thickness trends indicate that the paralic or fluvial sands had different immediate sediment sources than underlying marginal-marine sands did. Environmental interpretations imply that both deltaic and interdeltaic sedimentation controlled the distribution of sand deposits. Storage capacity mainly is in secondary "intergranular" pores, many of which formed by dissolution of calcite replacements of interstitial clay.

The development and preservation of secondary porosity entailed a complex diagenetic paragenesis that was controlled by deep burial and compaction, by compositional and textural variations imparted by depositional environments, and by position on structure. Best effective porosity is in thick deposits of medium to coarse-grained paralic or fluvial sandstone that contained, prior to dissolution, less than 60% chert and from 10 to 30% interstitial clay, calcite, and other unstable components. Other effective porosity is in fine to medium-grained marginal-marine sandstone that likewise contained appreciable unstable constituents. The smectite content and ordering of mixed-layer illite-smectite are related to permeability (IM ordering and more smectitic clay in more permeable sandstone; IMII ordering and less smectitic clay in less permeable sandstone). Many of the diagenetic reactions, as growth of authigenic albite and recrystallization and authigenesis of clay, entailed components that already were available in the sandstone. Some diagenetic products suggest local kinetic controls that operated in realms nearly as small as single pore volumes.

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Sandstone Stratigraphy Using Core Description, Dipmeter Curves, and Other Available Logs

Smaller reservoir targets and enhanced recovery projects demand exacting stratigraphic interpretation to evaluate economic feasibility of a field. The stratigraphic interpretation of a formation requires an accurate geologic model and detailed rock information. Although detailed information may be obtained from cores, cores are not available in large portions of the reservoir rock being studied. Electric logs are available in most wells, but few logs provide the detailed information required for stratigraphic study. The dipmeter, electromagnetic propagation tools, and microresistivity devices can provide detailed data. Only the dipmeter makes high resolution measurements on different sides of the borehole and provides the orientation of the information in space. Using the dipmeter, the interpretations obtained can be projected into the region away from the borehole. The dipmeter has been capable of providing high resolution data from the resistivity curves for the last decade, but until recently only a few have used the curves.

The synergism of geologic models, dipmeter resistivity curves, core data, and other logs is an invaluable aid to the accurate interpretation of the stratigraphy of sand and shale units. Examples discussed include: a fluvial point bar of the Fort Union Formation in the Wind River basin, Wyoming; a Shannon Sand marine bar facies; and an analysis of the internal characteristics of a Tensleep Formation reservoir in an eolian system. These examples show that once the model is established and the dipmeter resistivity curve response is understood, the stratigraphy and some of the heterogeneous characteristics of these reservoirs can be more easily described.

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Secondary Porosity in Laumontite-Bearing Sandstones

Some sedimentary rocks, particularly those containing volcanogenic material, develop laumontite cements during burial with increasing temperature. The development of laumontite cements in sandstones is highly destructive to reservoir potential. As a result, in the search for hydrocarbons, laumontite-bearing sedimentary rocks commonly are considered economic basement. However, it is possible to develop secondary porosity after the formation of laumontite.

Theoretical considerations show that the stability of laumontite (Lm) is limited by the following equilibria: (1) Lm + CO_2 = Calcite (Cc) + Kaolinite (Kao) + 2 Quartz (Q) + 2 H_2O,