where the number of intervals is less than 20% of the total number of identified units. Best results are obtained if coincident layers of identical lithology are treated as a unit facies rather than as multistory facies. The effect of varied identification of lithologies is critical. For example, grouping clay and shale gives markedly different results from cases in which they are distinguished. It can be concluded that (1) Markov tests support current beliefs in that they indicate relative lack of memory in shelf sediments indicating many breaks in sedimentation, and (2) consistent evaluation of facies is critical, as different labels for the same lithology cause large-scale variation in numerical results.

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DIAGENESIS OF SHALY ROCKS

Argillaceous rocks show major chemical and mineralogic trends as a function of geologic age. If the trends are compared by eras, they are of global significance. The ratios of the various metal oxides to Al_2O_3 plotted against geologic age form 3 distinct behavioral groups and oxide–Al_2O_3 ratios, except those of K_2O and FeO, diminish with increasing rock age.

The first group, water ($-H_2O$), CaO, and CO_2, decreases with rock age from high to very low values. The covariance of H_2O with CaO and CO_2 is consistent with a gentle water leach of shale and loss of original calcium carbonate through time. MgO, Na_2O, and SiO_2 form a second group, but change with geologic age much less than the first group. The chemical trends of these second group oxides, along with K_2O, reflect the differences in shale mineralogy as a function of age. The increase in illite percentage in older rocks results in a slight "relative" enrichment in K_2O whereas the abundance of expanded clays in younger shales gives rise to Mesozoic-Cenozoic shales of higher Na_2O, MgO, and SiO_2 content. This interpretation requires that reactions of the following type obtain within shales in the first few hundred million years after burial: (low silica) kaolinite + (high silica) expanded clay + potassium = (intermediate silica) illite + MgO, Na_2O, and SiO_2 (lost from shale).

The third group includes FeO and Fe_2O_3. There is a reciprocal relation between these oxides; young rocks are high in oxidized iron, old rocks low, but the total iron oxide concentration in shale is almost constant with geologic age. This trend partly reflects the postdepositional oxidation of organic matter and attendant reduction of iron in shales as they progressively age.

These time-dependent chemical and mineralogic trends are in harmony with the general concepts of differential sedimentary cycling and chemical uniformitarianism; concepts that predict approximately the kinds of long-term, postdepositional, selective changes expected in argillaceous rocks as a function of geologic age, and that help to discriminate between primary and secondary chemical and mineralogic features.

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SABLE ISLAND DEEP TEST OF SCOTIAN SHELF

Mobil Oil No. 1 Sable Island was drilled to a total depth of 15,106 ft on the Scotian shelf of the Canadian Atlantic offshore. It was the first deep test in the region. The well, on the outer shelf, 190 mi east of Halifax, Nova Scotia, used historic Sable Island as a drilling platform.

The exploratory test was drilled into the Lower Cretaceous; thus, it not only documented the extension of the submerged Atlantic coastal plain south of Nova Scotia, but also indicated the presence of a thick Cretaceous sedimentary succession in the region.

The well section is predominantly marine clastic rock composed of 4,050 ft of Tertiary and Quaternary, and 11,056 ft of Cretaceous strata. These sequences can be subdivided into 11 units on the basis of sandstone percentage, paleontologic data, and other lithologic criteria. These units indicate the occurrence on this part of the Scotian shelf of fluctuating, mainly marine Cretaceous and Tertiary deposition in littoral to bathyal water depths.

Encouraging but noncommercial gas shows were tested in several zones, particularly in the Lower Cretaceous. A trace of oil was recovered on a test at total depth. Porous sandstone is abundant through most of the section.

The discovery by the Sable Island well of a thick, marine, Cretaceous-Tertiary section with indications of hydrocarbon generation and potential reservoir beds greatly enhances oil and gas prospects in the Canadian Atlantic offshore and the Scotian shelf in particular.

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CRITIQUE OF MEMBRANE-FILTRATION CONCEPTS AS APPLIED TO ORIGIN OF SUBSURFACE BRINES

Membrane-filtration processes capable of filtering dissolved inorganic salts from water have been well documented in the laboratory and in industrial applications (desalination). Application of such processes to earth (sedimentary-basin) models, however, is inadequately documented and subject to several difficulties. These difficulties include the facts that (1) natural pressure gradients adequate to overcome the osmotic pressures required to separate salt from water do not appear to be available or reported in sediment-sedimentary rock environments, and (2) salt exclusion properties of membranes correlate inversely with permeability. To achieve geologically significant enrichment of salts in subsurface fluids requires that large volumes of fluids pass across what would normally be regarded as aquicludes and nonreservoir rocks under relatively leak-free conditions. No proof of such massive movements has been offered. In fact, the consequences of such movements, consistently applied to sedimentary basins, would negate much of the existing principles and practice of petroleum geology and petroleum engineering.

Recent pore-fluid studies from ocean drilling operations show no evidence of membrane filtration in deep-ocean sediments or in geosynclinal sediments from the Gulf of Mexico. These factors contribute to the conclusion that membrane filtration concepts as presently formulated have little importance in enriching subsurface waters in salt, and probably have only minor influence on the ionic composition of subsurface fluids.

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