are neither professional sinners nor philosophical saints, but if we allow the development of professional unionism within our Association, our value as scientific, economic, and political decision makers in the search for, discovery, and production of our natural resources will be greatly impaired. Personal pride in profession is the outstanding characteristic of excellence among scientists. Are geologists scientists? I say emphatically, Yes!

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FORMATION OF AUTHIGENIC CLAY IN DETRITAL SAND

Coarse Columbia River sand, with neither silt- nor clay-size grains present, altered to sediment composed of 82 wt. % sand, 5% silt, and 13% montmorillonitic clay in a 5-month hydrothermal experiment. Run conditions were 200°C and 200 psi in a brine solution as the fluid phase. The original sand was composed largely of volcanic detritus from andesitic sources. Hypersthene grains were severely etched during the runs, and other mineral grains and lithic fragments probably also participated in the reaction to form clay. The clay, which coated various parts of the hydrothermal apparatus, appeared to form at least partly as a precipitate. The fluid phase showed a slight increase in Na and K, a slight decrease in Ca and Mg, and saturation with Si. The pH remained constant at 3.5. Oxidizing conditions probably prevailed throughout the experiment.

A similar experiment was run with Columbia River silt as starting material. Montmorillonitic clay was also produced, and the fluid phase showed the same changes.

Similar reactions undoubtedly take place in natural systems. Clay matrix in sandstones must, at least in part, be formed by chemical alteration of thermodynamically unstable clasts.

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CUMBERLAND BASIN, NOVA SCOTIA—POSSIBLE RIFT

The Cumberland basin of Nova Scotia has long been considered a structural basin by virtue of the elliptical outcrop and inward dip pattern of the Pennsylvanian outcrops. Recent data indicate that subsidence began in the Late Devonian perhaps resulting from a graben or rift. The Mississippian sediments which filled the growing depression were continental, lacustrine, and marine with evaporites. The cessation of the rift-forming processes are recorded by the alluvial swamp-type sediments of the Pennsylvanian which filled the depression. More than 25,000 ft of Carboniferous rocks are believed to be present in the deepest part of the basin. Starting with the rift hypothesis some speculations about the kinds of sediments and their locations, and about the structural features present beneath the Pennsylvanian surface may be ventured. From surface exposures and a limited amount of subsurface data, it is theorized that the Mississippian evaporites acted as glide zones which effectively divided the basin into 2 horizontal structural layers. The rocks above the evaporites, responding to Appalachian stresses, formed the long diapiric folds with cores of over-thickened evaporites. Below the evaporites the structures are related to movements of the rift floor, compaction closures, and structures formed by differential horizontal movements of the rift walls. In its deeper parts the rift probably contains more and a greater variety of marine rocks than the outcrops indicate. Should the rift hypothesis be correct, the possibility of finding hydrocarbons is enhanced.

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GEOGRAPHY AND FAUNAL PROVINCES IN TREMADOC EPOCH

A major change took place in trilobite faunas during Late Cambrian and Early Ordovician time, that is, during the Tremadoc Epoch. The majority of preexisting families died out shortly before or during this epoch. They were replaced by several short-lived, new groups and the earliest members of other families which dominated succeeding Ordovician trilobite faunas. The dissimilarities between samples of Tremadoc trilobite faunas from 18 areas in the world were analyzed by a nonmetric multidimensional scaling technique. Groupings obtained by such analyses reveal faunal provinces of the Ordovician, and for the early part of the period 4 provinces were recognized. The analyses of Tremadoc faunas should reveal whether or not changes in provinces occurred during this epoch. The assumption that a faunal province originally extended over the shallow seas surrounding a single continental mass is used, with palaeomagnetic data, to propose a model for Tremadoc paleogeography.

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CHARACTERIZATION OF OIL TYPES IN THE WILLISTON BASIN

The characterization of genetic crude oil types within a given petroleum province can be accomplished readily by 4 commonly used techniques—carbon isotope ratio measurement, gas chromatography, optical rotation measurement, and infrared spectrophotometry. Obtaining carbon isotope ratios on both the whole oil and its aliphatic fraction is desirable. Gas chromatography is carried out on the C_4-C_7 fraction and the $C_{15}+$ fraction of each oil. A semilog plot of carbon isotope ratio versus optical rotation is helpful in characterizing oil types.

Application of these techniques to approximately 200 oils from the Williston basin has revealed the presence of 3 major oil types within the basin. One type occurs primarily in Ordovician reservoirs, but is found in some Silurian, Devonian, and Mississippian reservoirs as well; a second type is found almost entirely in Mississippian Madison reservoirs, and the third type is restricted to Pennsylvanian Tyler reservoirs. A few oils either were derived from minor sources or were modified by contributions from minor sources. Other oils appeared to be mixtures of 2 major types. A classic example of commingled Ordovician and Madison types was found in Weldon field. The effects of thermal maturation are evident on the carbon isotope optical rotation plot.

The source of the Madison-type oils appears from geochemical data to be the Upper Devonian–Lower Mississippian Bakken Shale. The Tyler-type oil seems to have originated in the Tyler shales. Geochemical data have not established clearly the source for the Ordovician-type oil, but its prevalence in Ordovician reservoirs suggests the Ordovician Winnipeg Shale as the probable source.