TALBOT, J. S., Dow Chemical Co., Houston, Tex.

Requirements for Monitoring of Industrial Deep-Well Waste-Disposal Systems

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THOMAS, G. E., Geophoto Services, Denver, Colo.

Continental Plate Tectonics: North America

A series of basement weakness zones trending northeast and northwest define a plate framework in the basement rocks of North America. The weakness zones began during the primordial solidification of the crust as a result of differential rotation between the equator and the poles, which created a left-lateral couple in the northern hemisphere.

The northeasterly weakness zones were formed by this hemispheric coupling as major tensional zones which define a series of northeast-trending horsts (Slave and Superior plates) and grabens (Arctic, Churchill, and Appalachian-Grenville plates). The northwest-trending weakness zones developed as faults flanking a major dragfold (Canadian shield) produced by the hemispheric coupling.

As horsts and grabens, the northeast-trending plates became the sites of Precambrian erosion and deposition. They later were deformed during Precambrian orogenies by severe coupling produced by right-lateral simple shear acting upon the northeast-trending weakness zones. The orogenic forces producing the simple shear were provided by periodic opening of the Pacific Ocean, which compressed North America during Precambrian and Paleozoic times.

The opening of the Atlantic Ocean, which began in the Triassic, forced North America west-southwestward over the eastern Pacific and eventually on to the mid-Pacific ridge. This caused the Laramide orogeny, which activated the northwest-trending weakness zones, producing coupling of the northwest-trending plates. The oblique encounter of North America and the East Pacific Rise also produced right-lateral, simple shear phenomena along the continent's western margin.

THOMPSON, A. M., and P. A. OFFUTT, Dept. Geol., Univ. Delaware, Newark, Del.

Sedimentologic Data on Ordovician-Silurian Boundary in Central Appalachians

The Ordovician-Silurian boundary in the western Valley and Ridge province is in an unfossiliferous, continental sequence, and has been traditionally placed to separate red Juniata Formation from the overlying white Tuscarora Formation. The systemic boundary, thus based on color differences, has been assumed to represent a time-parallel surface of considerable paleogeographic significance. Detailed field and mineralogic data now indicate that this assumption leads to ambiguities in correlations, and that a new means of defining the boundary is necessary.

Sedimentologic aspects of rocks adjoining the color boundary provide primary control on diachroneity. Westward-prograding and eastward-transgressing fluvial regimes generated a sequence of distinct conglomerate, sandstone, and shale lithofacies recognizable over wide areas and occupying the 3,500-ft interval between datable Upper Ordovician and Middle Silurian fossiliferous marine units. Boundaries based on lithofacies approach more closely than other kinds of boundaries to time-parallel surfaces. The color boundary, for example, fluctuates as much as 400 ft vertically, both parallel with and across depositional strike, irregularly and unpredictably crossing lithofacies boundaries. Zones of constant clay, heavy, and opaque mineralogy within lithofacies are likewise randomly truncated by the color boundary.

These data strongly suggest that redefinition of the Ordovician-Silurian systemic boundary in terms of the newly recognized lithofacies sequence is in order. Such revision depends fundamentally on precise time correlations of specific lithofacies with age-established marine units outside the Valley and Ridge area. In the absence of such rock units and of meaningful ichnofossil data, exact location of the boundary may not be possible.

TOHILL, B. O., Amoco Production Co., Denver, Colo.

Depositional Environments and Hydrocarbon Traps in "J" Sandstone (Lower Cretaceous), Denver Basin, Colorado

"J" sandstones in northeastern Colorado were deposited primarily in 2 delta systems. The large eastern delta prograded toward the northwest from northwestern Kansas. A smaller western delta prograded eastward between Denver and Colorado Springs.

The eastern deltaic sequence is more than 200 ft thick in places and consists of 3 distinct genetic units, in ascending order, (1) marine delta front of low-energy marine clayey sandstones and clayey siltstones; (2) nonmarine delta plain of alternating sandstone, siltstone, and shale deposited in distributary channels, interdistributary bays, marshes, swamps, natural levees, and crevasse splays; and, (3) transgressive marine of low- to high-energy sandstones and shales.

The western deltaic sequence is up to 190 ft thick and consists predominantly of 1 genetic unit, a nonmarine delta plain, similar to that in the eastern delta. Core and log controls indicate that well-developed lower delta-front sandstones are absent in most areas. Upper marine shoreline sandstones are well developed on the north flank of the western delta.

Eastern and western delta sandstones apparently interfinger in some areas. Sediments of the 2 deltas can be distinguished by mineralogy, because western delta sediments are more mature than eastern delta sediments.

Oil reserves in the southwestern part of the eastern delta total about 250 million bbl. The major part of these reserves is trapped in transgressive marine zones at fields such as Adena, Plum Bush Creek, Little Beaver, and Badger Creek. Some additional reserves are trapped in delta-plain channels. Very little oil has been discovered in delta-front sandstones under the eastern delta plain.

Oil accumulations in the western delta have been found in delta-plain channel sandstones at Peoria, North Peoria, Jamboree, Dull Knife, Hombre, Latigo, Byers, and Bennett fields. Gas has been discovered in the thick upper marine shoreline sandstones at Totem field and south of Totem field.

Further exploration should result in the discovery of additional oil and gas accumulations in delta-plain channel sandstones near the updip edge of the western delta plain. Also, more oil and gas accumulations