tion (Lower Pennsylvanian) of north-central Tennessee were deposited in a complex of deltaic and nearshore environments. A geographically restricted unit near the top of the Fentress consists of laminated, fine-grained sandstones with thin interbedded mudstones. It grades laterally into cleaner sandstones lacking mudstone interbeds. Exceptionally well-preserved trace fossils occur on large exposed, bedding-plane surfaces. Commonly, individual traces can be followed for considerable distances allowing direct comparison of behavioral patterns between the fossil organisms and modern counterparts.

Polinices duplicatus produces traces of different morphology in intertidal environments at Barnstable Harbor as a response to both depth of movement beneath the substrate-water interface and sediment grain size. In tidal channels, V-shaped trails result from snails moving several centimeters below the sediment surface. On high tidal flats, the trail is wider and shallower as the snail moves nearer the surface. On compacted sands, the trace has transverse markings resulting from surface probing by the snail's foot. Experimental results indicate that *P. duplicatus* produces more V-shaped and deeper traces in coarse sands than in muddy sands.

Traces in the Fentress Formation also exhibit differing morphology attributable to depth of movement and sediment grain size. Single traces from clay-rich parts of the Fentress sandstones change from V-shaped to bilobed and finally to longitudinal rows of tiny knobs produced, apparently, by movement at decreasing depth below the sediment surface. Traces produced in coarser sands are flat-bottomed and lack transverse markings.

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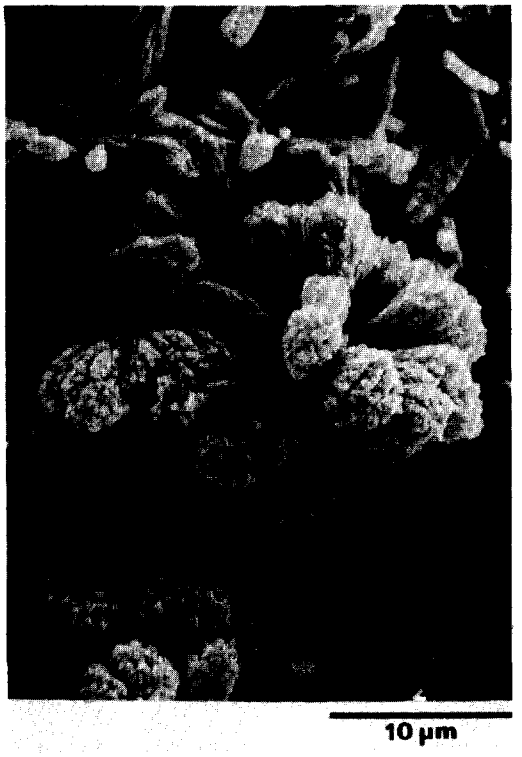
Early Cementation by High-Magnesium Calcite from Gulf Coast of Louisiana

Sandstone pebbles can be found on many of the Gulf Coast beaches of southern Louisiana. Preliminary analyses indicate cement composition to be high-magnesium calcite with 10 to 15 mole % magnesium carbonate. Petrographically, the cement appears in the form of blades and fibers. SEM observations, however, indicate a complex arrangement of stacked euhedral to subhedral crystals.

Field observations have led to the discovery of the lithified sandstone in situ. Cementation occurs along a narrow band between beach dunes and a salt-water marsh on the leeward side of the dunes. Apparently lithification occurs at or near the surface where high temperatures and salinities exist in a supratidal environment. X-ray analyses indicate a cement composition of high-magnesium calcite. The mole percent of magnesium carbonate ranges from 20 to 50%. Although mole percentages are high, X-ray analyses do not indicate the presence of well ordered dolomite. Petrographically, the calcite appears both as a "microspar texture" and fiber-radiate rim cement. As with the reworked sandstone pebbles, SEM observations indicate the presence of stacked euhedral to subhedral crystals that average 0.25 μm in diameter. These aligned or stacked crystals form pseudofiber bundles and blades. Preliminary studies indicate that the in-situ high-magnesium calcite is unstable and probably undergoes molecular leaching when exposed to normal sea water. This is exemplified by the composition of the reworked sandstone pebbles.



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Lithology and Structures of Quaternary Sediments of Indus Fan

The surface sediments of the Indus fan are primarily chalks, marls, and brown clays. Massive terrigenous sediment dilutions occur only in the areas within 100 km from the Indus River confluence. Throughout most of the fan, underlying the sediments, are gray-green muds and turbidites of Pleistocene age. However, the details of lithology and structures of Pleistocene sediments vary from region to region in the fan. The sediments of the upper fan region are primarily fine-grained muds (with several, small silt beds, T_{d-e}), except on the valley floors where coarse-grained turbidites (T_{a-e}), are commonly present. Two main valley systems, one eastern and the other western, exist on the upper fan. Bioclastic turbidites are common in the eastern valley system, and are derived from the sediment slumps of the Indian margin. Most of the terrigenous, coarse-grained sediments have bypassed the upper fan and reached the

distal areas extending to the Carlsberg Ridge. The percent sand is higher and the number of thick sand beds is more common in the distal areas of the fan; Bouma turbidite sequences, T_{a-e}, are common. Two main sand lobes are distinguished in the distal fan—an extensive western lobe, derived through channels resulting from the branching of the western valley system, and a restricted, eastern lobe, derived from the eastern valley system. The distributions of these lobes coincide with areas of thick sediments as seen on seismic profile records, implying that sediment dispersal similar to that in the Pleistocene occurred in earlier times.

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USCHEM, Geochemical Data File of National Coal Resources Data System (NCRDS), Applied to Study of Appalachian Coal Bed

USCHEM, a geochemical data file, is a part of the U.S. Geological Survey's computerized National Coal Resources Data System, NCRDS. The purpose of this data file is to store and retrieve geographic, geologic, and chemical-analytical information for each coal and coal-related rock sample submitted for analysis to the USGS. Each sample is analyzed by the USGS for major-, minor-, and trace-element, and oxide concentrations; splits of coal samples are also analyzed by the U.S. Department of Energy for proximate and ultimate data, forms of sulfur, free-swelling index, ash-fusion temperatures, and Btu information.

Data for samples of the Waynesburg coal bed in the Appalachian region are useful to demonstrate the capabilities of USCHEM as an aid to geologic, geochemical, environmental, and technological studies. Available techniques for presenting and manipulating the data are: sorting, listing, mathematical redefinition, tabulation, statistical analysis, and graphic displays. Graphic displays include: plots of point locations, trend surfaces of single and multiple variables, isoline maps, histograms, and two- and three-dimensional graphs. Data in USCHEM can be used to delineate geographical areas that meet (1) specific individual criteria, for example, areas where arsenic is <10 ppm, or (2) multiple criteria, for example, areas where sulfur is $<3\%$, ash is $<10\%$, and Btu is $>10{,}000$. Trace-element data can be presented on an ash or whole-coal basis, and proximate and ultimate data on an "as-received" or " dry" basis.

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Diagenetic Features of Grand Rapids Formation, North-Central Alberta, Canada

The Lower Cretaceous Grand Rapids Formation of north-central Alberta consists of three massive sandstone units separated by shales and siltstones. Average thickness of the formation is approximately 90 m. In the subsurface these sandstones are impregnated with bitumen and form the Wabasca oil sands deposit, with resources estimated at 10.5×10^9 cu m (66×10^9 bbl).

The Grand Rapids sandstones are arkosic to lithic sandstones with a fairly heterogeneous mineralogy in which the predominant constituents are quartz, feldspar, chert, rock fragments, mica, glauconite, and locally siderite. They are poorly consolidated, the main cementing agents being authigenic clays. Kaolinite tends to be the dominant clay mineral in the oil-saturated sandstones while montmorillonite and Fe-rich chlorite predominate in the underlying water-bearing sandstones. Scanning electron microscope studies show that kaolinite occurs as booklets, irregularly scattered throughout the sandstone in a pore-filling habit. Montmorillonite and chlorite have both pore-lining and pore-bridging habits, while illite is mostly a pore-bridging clay. Montmorillonite-chlorite mixed layer clays are found in some samples. The clays in the sandstones all appear to be authigenic in origin.

Calcite is the only other common cementing agent. The calcareous cement formed early, apparently replacing most of the original matrix material and locally forming large concretions up to 5 m in diameter in the lower sandstone unit. Other authigenic minerals which may be local cementing agents include siderite, K-feldspar, pyrite, and zeolites(?).

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Investigation of Measurements of Heat Flow Regime in Oceans as Related to Hydrocarbon Generation

Geothermal gradients and conductivity measurements taken by shallow penetration gravity cores and used in calculating heat flow values are not necessarily indicative of the temperature regime and heat flow below. Any attempt to associate generation and maturation of hydrocarbons to heat flow values is erroneous. Geothermal gradients measured in wells cannot be compared with or against proximal shallow penetration heat flow values. Because of many near-surface effects, heat flow values are superfluous calculations unless deep penetration data are used and compared.

Attempts at relating heat flow values to hydrocarbon generation fail because values within and without sandstone bodies are of low magnitude, and the differences that are calculated are within the error of temperature and conductivity measurements; therefore, any differences will not be detectable near the surface.

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Early Porosity and Permeability Reduction in Deep-Sea Fan Sandstone and Shale By Authigenic Smectite and Carbonate Cement

A preliminary study of DSDP cores from deep-sea fan deposits off southern California and Baja California indicates that sandstone turbidites and interbedded shales can be rapidly and extensively altered at shallow burial depths. Their porosity and permeability are reduced or totally occluded by the early (commonly precompaction) formation of authigenic smectite and carbonate cements. As a result, many turbidite sands become tightly cemented at burial depths shallower than 400 m and thus lose their potential as petroleum reservoirs.