Permian Marine Sand Wave Complex in Central Arizona

The Lower Permian Rancho Rojo Member of the Schnebly Hill Formation exhibits unusual large-scale compound or intraset cross-stratification near Sedona, Arizona. The very fine-grained, moderately sorted subfeldspathic to quartzarenite, is divided into four facies. The lowermost tabular-planar foreset facies comprises giant foresets that dip westward at 13-19°, with foreset bundles of planar, wavy, and minor intraset cross-strata separated by surfaces of erosion.

The intraset cross-stratified facies consists of giant foresets arranged in bundles that contain compound cross-stratification including tabular-planar herringbone pattern and complex trough sets separated by planar and trough erosion surfaces. The westerly dipping master sets have superimposed intrasets that display widely varying current vectors.

Both facies were deposited in a marine sand wave complex following rapid transgression across underlying fluvial-estuary deposits. The erosion surfaces that bound the master sets were likely formed during storms. The intraset planar and trough sets were formed by migrating tidally driven megaripples on the westerly dipping surfaces of the sand wave. Documentation is provided by close similarities with other reported ancient sand waves and the newly proposed Allen sand wave model.

These two facies are overlain by the ripple-laminated and homogeneous sand facies that developed during the waning stages of sand wave deposition. The former was probably produced by shoaling waves and the latter by bioturbation. The well-exposed Rancho Rojo will help advance the study of these controversial sand bodies and aid in the paleogeographical interpretation of the Permian in central Arizona.

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Geochemistry of Mississippian and Devonian Oil Shales of Northeastern Kentucky

Detailed chemical analyses were conducted on 10 cores drilled in Lewis and Fleming Counties of Kentucky in an oil-shale resource assessment funded by the U.S. Department of Energy. The stratigraphic units studied include the Sunbury Shale and the Ohio Shale, which is divided (from top to bottom) into the Cleveland Member, the Three Lick Bed, and the Huron Member. The chemical analyses include C, H, N, S, major element oxide, and trace-element determinations from 760 samples.

Carbon concentration was found to increase from top to bottom in the Sunbury Shale and Huron Member, and decrease in the Cleveland Member of the Ohio Shale. Average carbon concentrations were 11%, 6%, and 9% by weight in these intervals, respectively. Oil yield was determined by Fischer-assay and a good correlation with carbon was found. The Cleveland produced approximately 10% more oil per unit of carbon than the Sunbury. Although C, H, N, and S showed significant stratigraphic variability, the distribution patterns for these elements were found to be highly correlatable. The only systematic geographic variation of note was a 15% increase in hydrogen concentration in the Sunbury and Huron from north to south in the study area.

The Sunbury Shale was the least siliceous of the stratigraphic intervals and had the highest concentration of trace elements. Trace elements could be placed into four groups based on major element affinities: (1) those elements that showed strong association with carbon (Cu, Cr); (2) those with a weaker association with carbon (Ni, V, U); (3) those with an affinity for sulfur (Co, Mo, Pb, Zn); and (4) those with an inorganic affinity (Ba, Rb, Sr, Zn).

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Freshwater Diagenesis of Holocene Carbonate Sediments

Holocene carbonate sediments that compose small buildups in the Joulters Cays area of the Bahamas have been extensively altered by freshwater. Sediments, which include skeletal packtones and grainstones, and oolitic grainstones, were deposited in open shelf and ooid shoal environments. Evidence of the subsequent freshwater diagenesis includes mineralogic, petrographic, isotopic, and geochemical data. Mineralogically, the sediments are calcite with no high magnesium-calcite and only minor amounts of aragonite. Aragonitic grains such as mollusks and ooids have been dissolved resulting in skelmoldic and oomoldic textures. Such dissolution results in relatively high porosity despite extensive pore-filling cement. Values of δC^{13} are negative indicating exchange with isotopically light meteoric water. Analyses by atomic absorption spectroscopy and electron microprobe reveal low Mg^{++} and Sr^{++} values which reflect the flushing of freshwater through the system.

There are two possible sources for the freshwater: (1) the Pleistocene high just seaward of South Joulters Cay which could serve as a barrier to open-water exchange with the ocean. Ponding and freshening (by rainfall) of seawater would result in freshwater phreatic alteration of underlying sediments; and (2) the freshwater lens associated with a previous, older Joulters Cays. A modern analog is the Florida coastal acquifer which extends seaward several tens of km and phreatically alters carbonate rocks which remain well below sea level. It is likely that an earlier Joulters Cays existed and that the sediments were altered by the freshwater lens associated with those islands.

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Uraniferous Pyrobitumens from Southwestern Oklahoma

Pyrobitumen nodules from the northern flank of the Wichita Mountains, Kiowa County, Oklahoma, contain unusually high concentrations of uranium (2,235 to 10,112 ppm), while the thorium content is low (0.1 to 2.0 ppm). The nodules are surrounded by a halo of gray dolomitic siltstone in a Permian (Hennessey Group) red dolomitic siltstone matrix. Microscopic examination indicates that the nodules consist of at least two phases of distinctly different reflectivity. Surprisingly, the uranium is associated with the low reflectance phase, in which it ranges up to 10% by weight.

Stable carbon isotope ratios of the uraniferous nodules show a consistent decrease from −31.2 ppt in the center of the nodule to −31.6 ppt at the outer edge (all values relative to PDB). This isotopic lightening at the edge of the nodule is also reflected in the surrounding siltstones. The carbon of the carbonate within the gray siltstone immediately surrounding the nodule is always lighter than that in the adjacent red siltstone by 0.3 to 0.8 ppt. Atomic H/C ratios of whole nodules average 0.83, while atomic O/C ratios of the nodules average 0.15, indicating that the nodules are extremely oxidized.

The presence of petroliferous rocks in the subsurface of the study area and zones of reduction along cracks and faults in the red siltstone suggest that the pyrobitumens are secondary,

that is, alteration products of crude oil. This interpretation is further supported by microscopic examination revealing fracture-infilling by bituminous material. Finally, uranium was provided by ground waters rather than by concentration due to the oil-pyrobitumen transition.

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Clastic Lacustrine Sedimentation in Triassic of Southwestern Colorado

Very fine sandstone and mudstone facies of the Upper Triassic Dolores Formation of southwestern Colorado provide evidence for shallow lacustrine deposition coeval with clastic lacustrine systems of the Dockum Group in Texas. Dolores and Dockum lakes had frequent water-level fluctuations; however, Dolores lakes were filled primarily by shoreline sequences, in contrast to the delta-filled Dockum lakes.

Typical Dolores shoreline sequences fine upward, are laterally continuous over 3 km, are 5 to 15 m thick, have sharp nonerosional planar bases, and grade upward from very fine sandstones into mudstones. The very fine sandstones contain wavy, 1-cm thick bedding; low-angle trough and planar tabular cross-bedding; and isolated symmetrical channels. The overlying silty mudstones are commonly intensely bioturbated. These fine-grained shoreline deposits suggest that weak longshore currents distributed sand away from distributary mouths, and/or that sediment was transported by flow across the low-gradient, lake-margin plain.

Frequent subaerial exposure of these shoreline sequences is documented by abundant desiccation-cracked and rain-textured mudstone drapes, and by well-developed caliche profiles. During low stages of Dolores lakes, distributary channels locally prograded across and sometimes incised into the shoreline sequences. These symmetrical channels, 8 to over 50 m wide, commonly contain basal mudstone-clast/caliche-pebble conglomerates and were abandoned episodically as indicated by alternating beds of very fine sandstone and mudstone. Lake-edge distributary channels contain fillings of wave-reworked, wavy-bedded to rippled very fine sandstone.

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Cenozoic Radiolarian Paleogeography of Eastern Pacific

Along the east Pacific margin two dominant factors influence the distribution of planktonic radiolarians: east boundary ocean currents and the physiography of the southern California borderland. The east boundary current system is mainly wind driven on the surface and geostrophically controlled at depth. It is stratified into distinct water masses owing to differences in salinity, temperature, and current direction. The California borderland is a unique geomorphic province of successive basins and ridges with local circulation patterns. These factors influence present-day radiolarian assemblages but have also influenced such assemblages during the Cenozoic.

Nassellarian and spumellarian radiolarians reflect the temperature and depth of the water masses at the time of deposition. The California borderland serves as an environment similar to, yet distinct from, the boundary currents. Thus, this area seemingly has isolated species and increased their chance for allopatric speciation. These borderland species would eventually have been dispersed into the equatorial region.

Samples studies are from the DSDP Sites 33, 77, 173, 289, 468, and 469, where deposition was influenced by east boundary currents, and from the U.S. Geological Survey dart-core samples from the southern California borderland, to trace the development of the water masses through time. Once the dynamics of the water masses is determined, speciation and extinction events may be more easily postulated. Whereas previous investigations have dealt with present-day circulation, this study is the first attempt to map the influence of the dynamic current systems through time.

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Shelf Break on Modern Passive Margins: Structure, Sedimentation, and Progradation

The time-integrated structural-stratigraphic configuration of the shelf-to-slope break of many modern margins records the interplay of tectonics, submarine erosion and/or depositional processes. A simple process-response model may be used to help interpret the variations of shelf-break configuration and progradational patterns of passive continental shelves. The key factors are (a) the amount and nature of the sedimentary flux (F) provided to and across the shelf, and (b) the depth at which particles come to rest (H), which is largely a function of the local hydrodynamic and boundary layer conditions and of the grain size and density of the particles being transported. By maintaining factors F and H as constants, we can evaluate the role of structural displacement and importance of the relative position of the shelf surface to sea level in the development of the shelf-to-slope configuration.

In places where a shelf subsides, or when there is a demonstrable eustatic rise while an ample sediment supply is provided, a sediment layer may accumulate over much of the shelf; excess seaward-transported sediment will accumulate at and beyond the shelf break. If a shelf remains relatively stable or if there is an appreciable eustatic drop in sea level, much of the sediment can bypass the shelf and will accumulate beyond the shelf break, on the slope, rise, and abyssal plain. As equilibrium is attained, we can expect that D (shelf depth) $\leq$ H on a continental shelf, and D $>$ H on a continental slope. Thus, in this example, H becomes coincident with the depth at the shelf break.

The model is tested at shelf-slope interfaces on the Tuscany and Ligurian margins in the western Mediterranean, and on the Iberian margin in the eastern Atlantic. Seismic profiles indicate that the structural-stratigraphic configuration and progradational patterns at shelf breaks observed on subbottom profiles are variable. We correlate this variability with age and tectonic development of a margin, and thus with the successive structural stages through which a passive margin evolves.

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Past and Potential Mass Movement on Continental Slope Off Northeastern United States

Although evidence of mass movement is common on continental slopes, the importance of mass movement as a geologic process in most slope areas remains unknown, and questions concerning the likelihood of future events are still largely unanswered. Accordingly, the U.S. Geological Survey