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Faunal Similarities Across Pacific Among Mesozoic and Cenozoic Invertebrates Correlated with Plate Tectonic Movement

The degree of invertebrate faunal similarity across the Pacific Ocean basin generally increased during the Jurassic, Cretaceous, and Cenozoic as the Atlantic widened and the Pacific narrowed. The paleontologic data source is the *Treatise on Invertebrate Paleontology,* which includes mostly marine genera. The faunal similarities are expressed by the Simpson coefficient, C/N_1, C being the number of taxa occurring in both the American area and the Indopacific-Asian area, and N_1 being the total number of taxa occurring in the area having the smaller number. Genera which occur in Europe and Africa in addition to the two trans-Pacific areas were eliminated to reduce the effect of trans-Altantic migration, the easier route.

Simpson coefficient values for post-Triassic time intervals when correlated with ocean basin widths estimated from paleogeographic maps, yield a correlation coefficient of 0.956 for the Atlantic and −0.942 for the Pacific. Atlantic widths were used in addition to Pacific widths because paleogeographic control is better in the Atlantic.

The data indicate that the closing Pacific basin had a strong effect on trans-oceanic dispersal. Anomalously high similarity values in the Cretaceous may have been caused by accretionary tectonics around the Pacific margin. The results support the orthodox plate tectonic model rather than expanding earth hypotheses.

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Formation of Diagenetic Alteration Zones by Leaking Reservoir Hydrocarbons over Three Oil Fields in Oklahoma

Examination of rotary-drill well cuttings from 105 wells within and adjacent to the Eola, Velma, and Chickasha oil fields in southern Oklahoma has revealed diagenetic mineral zonations within Permian sandstones overlying the fields. Permian sandstones which are usually red on outcrop are altered to white over the fields, owing to a change in cementing materials from limonite, hematite, and carbonates to ferroan calcite, ferroan dolomite, and, in some places, pyrite. Bleaching and mineralization were restricted to sandstones and were brought about by the reduction of iron oxides by hydrogen sulfide associated with petroleum and/or generated by a reaction between hydrocarbons and sulfate ions. Hydrogen sulfide reacted with iron oxide to form pyrite, and with oxygen in ground water to form sulfur.

Pyrite cement occurs in zones that overlie pre-Permian faults, oil productive areas, and zones that are elongated along structural trends. Zone boundaries are nearly vertical and extend to the surface. Average pyrite content of mineralized sandstone is 3%. Pyrite occurrences show that petroleum-bearing fluids were introduced into Permian rocks by vertical movement along high-angle normal and reverse faults that cut reservoirs at depth and that intersect unconformities at the base of the Permian section.

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Deposition on Pacific Shelf Edge: Zone of Contrasts

Pacific-style continental margins, such as in western North America, are marked by large contrasts in shelf-edge sedimentary deposits and processes. The United States Pacific shelves are generally much narrower than Atlantic-style shelves, and the source areas exhibit more relief. The result is a generally high rate of sedimentation in humid areas, and fluctuating (areal and seasonal) patterns and rates in semiarid areas.

Sediment shed from the adjacent landmass is discharged onto the U.S. Pacific continental shelf at point sources; intervening zones of the shelf edge between point sources are commonly sediment starved. Where submarine canyons intercept the shelf, sediment bypasses the shelf and slope to fan and basin environments. Spillover from channelized transport in canyons results in local sedimentary accumulations at the shelf break.

Major sediment sources of the northwestern United States and the Gulf of Alaska feed directly onto swell- and storm-dominated shelves. On narrow unprotected shelves, the sediment has a short residence time in submarine deltaic deposits before remobilization and dispersion to outermost-shelf and upper-slope environments. In these environments, prograding sequences of shelf-edge sedimentary deposits form, commonly with a high potential for preservation in the geologic record. On broad or protected shelves, however, prodelta deposits have a longer life expectancy, and only a small amount of sediment escapes to the shelf edge.

The high seismicity and active tectonism that characterize the strike-slip and underthrusting regimes of western North America are important in forming sedimentary sequences on the outer shelf–upper slope. Failure of rapidly accumulating mud, rich in organic material on the outer shelf of the Gulf of Alaska and northern California, is triggered by large-magnitude earthquakes and local uplift. Repeated failures over long periods result in unique sedimentary packages that have potential for becoming both source beds and stratigraphic traps for hydrocarbons.

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Large Submarine Slump Off Eureka, California

Repeated seismic-reflection surveys of the northern California continental margin off Eureka delineate a large slump zone measuring 10 × 15 km in area. The zone lies on a structural plateau of low slope (1 to 2°) in water depths of 450 to 650 m. The area is immediately west of the Eel River, which has an annual suspended-sediment load of nearly 24 million T/year.

High-resolution (3.5-hKz, 1-kJ, uniboom) acoustic-reflection records show a rhythmic, hummocky surface topography and back-rotated broken beds within the upper 80 m of the sediment mass. Numerous west-dipping failure planes with a spacing of approximately 400 m occur within the slump mass. A history of repeated failure within the region is indicated on deep-penetration (160 kJ sparker) seismic-reflection records that show additional failures bounded by flat-lying, undisturbed acoustic reflectors to depths of 500 m below the sea floor.

Analyses of 3-m-long gravity cores in the slump zone show that the sediment is overconsolidated, composed dominantly of silt, is gassy, and enriched in plant and wood debris. Radiographs of split cores show contorted bedding in some areas of the slump zone that suggests a degree of plastic deformation.

The Eureka area is a seismically active region lying immediately north of the Mendocino Ridge and has an expected earthquake frequency of one event greater than magnitude 6 per decade. In addition, some areas of the sea floor are undergoing local uplift; there is evidence that this activity, which may not be accompanied by measurable earthquakes, also causes some failures. These tectonic factors appear to be important in triggering repeated failures in the thick sedimentary unit that is forming offshore of the Eel River.

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Mineralogic Analysis and Uranium Distribution of Sedimentary-Type Uranium Ores

Nine cores from a sedimentary-type uranium orebody of the upper Jackson Formation, Karnes County, Texas, were studied to determine the stratigraphy and the mineralogy in relation to the uranium distribution, and to provide guidelines for further exploration and/or exploitation. The uranium concentration ranges from 1.4 to 6,000 ppm in approximately 200 samples, as determined by delay neutron counting.

The orebody is generally a fine-grained, gray, well-sorted, arkosic sandstone that is enclosed in finer grained, poorly sorted lagoonal or paludal mudstone or lignite. The depositional environment of the orebody is presumably a beach-barrier-bar sequence with its northeastern end delineated by a downward-cutting fluvial system.

The bulk mineralogy of the ores consists primarily of quartz and feldspar with minor amounts of biotite, muscovite, augite, clinoptilolite, and very minor amounts of hematite, pyrite, and coffinite. The clay analysis of the less than 2 μm fractions reveals a preponderance of smectite with very minor amounts of kaolinite and illite.

The high concentration of uranium in the cores is generally associated with a high concentration of clays, zeolites, and/or carbonaceous material. Additionally, uranium concentration usually increases with a decrease in size fraction. Since smectite dominates the clay mineral assemblage in the ore, the expandable and absorptive smectite could be a significant factor in uranium mineralization.

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Athabasca Oil Sands—Facies Characteristics and Distribution

The Athabasca oil sands represent one of the world's great untapped energy resources, with in-place bitumen reserves estimated at 146 × 10^9 m^3 (922 × 10^9 bbl). About 10% of the reserves lie close enough to the surface to be mined in open-pit operations, but the vast majority (~90%) must be developed by as yet unproved in-situ means. A geologic understanding of the facies is crucial in applying in-situ techniques.

Most of the rich oil sand bodies are channel deposits in the Middle Member of the Lower Cretaceous McMurray Formation. This member, averaging 35 m in thickness, is dominated by upward-fining sequences interpreted as meandering river deposits. Earlier detailed work on epsilon cross-strata in outcrop confirms the interpretation of single channels 20 to 30 m deep. The channel sequence is dominated by trough cross-bedded sands at the base, grading upward into thinner bedded rippled sand units with increasingly abundant clay drapes toward the top. Burrowing is common in the upper parts but palynology indicates a basically freshwater setting. The channels are part of a complex fluvial-deltaic system associated with standing bodies of fresh to brackish water.

The fluvial Lower Member fills lows in the underlying Devonian limestone. The sands are commonly very argillaceous or water-bearing, but in places, form good reservoirs.

The Upper Member is a 20-m-thick sequence of shoreline deposits. This member is generally very argillaceous, but extensive upward-coarsening marine sands near the top commonly make good reservoirs.

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Induced Spectroscopy: A Mineralogy-Lithology Well Log

Nuclear spectroscopy logging, specifically with the induced gamma-ray tool (GST), measures the relative yields of gamma rays resulting from interactions of neutrons with different elements (isotopes) present in downhole formations.

The data are interpreted by associating the spectra of certain elements with sedimentary rocks which are typically dominated by the element (e.g., silicon = sandstone). The measured elemental yields are proportional to the volume fractions present in the rock formations. The yields are also proportional to some unknown values: effective neutron flux, concentration of selected elements in other sedimentary rocks, microscopic thermal neutron capture cross sections, and gamma-ray production and detection efficiencies. The effects of these unknowns can be minimized by laboratory calibration of yields in known formations or by comparison with whole or sidewall core data.

With the above and some additional information (SARABAND, NGT), the well-site analysis or a more sophisticated computerized presentation yield volume fractions of effective porosity, sandstone, limestone, feldspar, and the total clay ("shale") volume which may be further divided into volumes of clay porosity, illite, and chlorite. The resulting visual representation of these data becomes an invaluable aid to stratigraphic analysis.

In a field study of tight gas shaly sandstones in the Cotton Valley Group (Upper Jurassic) in east Texas, the analysis not only described the clay mineralogy and lithology but also highlighted several important geologic features which are important in designing an efficient hydraulic fracturing program: genetic units of sedimentation, laminated and thick-bedded shales, hydrated shale beds, and zones of well-developed intergranular pore-filling (quartz or calcite) cements—all of which may be fracture-containment boundaries.

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Surface Wall Texture and Evolutionary Classification of Cenozoic Planktonic Foraminifera

The classification most widely applied to Cenozoic planktonic Foraminifera employs relatively simple morphologic criteria, such as chamber shape and apertural position, to sort test forms into genera. Because the criteria are few and distinct, this traditional approach is easy to apply and has been generally accepted by stratigraphic paleontologists. Most morphologic features, however, evolved several times during the Cenozoic. Peripheral keels appeared independently at least eleven times. Form-genera based solely on such features are unavoidably polyphyletic.

Surface wall texture, in contrast, has been evolutionarily conservative during the Tertiary. Once developed, the few basic wall-textural types persisted within lineages. A classification based primarily on surface wall textures and secondarily on gross morphology most accurately reflects patterns of descent recognized from species-by-species evaluation of