Hierarchical Arranging of Geologic Processes as Related to Passive Continental Margin Evolution

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The evolution of a passive continental margin (PCM) is the result of a combination of high- and low-frequency interrelating geologic processes. The term "geologic process" is used here to mean those phenomena and forces that are recognizable in the present and past as unique and distinct and appear to act alone within the natural world. Different processes have differing intensities (amplitudes) and periodicities (wavelengths). Geologic processes are arranged here in an exponential hierarchy ranging from 10^0 to 10^8 yr to aid visualization. Processes are assigned to the hierarchical level in which that process is most obvious, e.g., seasonal changes are obvious on the annual (10^0-yr) level and PCM evolution on the hundred-million-year (10^8) level. These assignments are general and crude in that geologic process subtleties may well be obscured.

Low-frequency processes generally have periodicities from 10^6 to 10^9 yr. Tectonic and structural processes of such periodicities often give the appearance of greater geologic import than do similarly aged sedimentation, oceanography, and climatic processes. Separating and reuniting of continental plates in a Gondwanaland-type exercise may take 10^9 yr. Initial rifting as in East Africa lasts 10^8 years. Similarly, the evolution of an intraplate basin may take 10^8 yr or multiples thereof. A single subsidence or uplift event may last 10^6 to 10^7 yr. High-frequency processes appear to be prominent at periodicities ranging from 10^0 to 10^7 yr. As here defined, high-frequency processes are those that are recorded but no longer active in the sediment accumulations and tectonic evolution within a PCM. Sediment formations are the result of wind, weather, and waves, and the forces that create them.

Paleoenvironments of Deposition and Salt Location from Paleotectonic Restorations, Seismic Reflection Data, and Simulations across Mississippi Embayment—Gulf of Mexico

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Inferences of paleoenvironment of sediment deposition and salt location in various interrelated types across the dynamic Mississippi Embayment–Gulf of Mexico basin are of paramount importance to petroleum exploration. Paleotectonic restorations have been published for north Louisiana, the south Arkansas basin, and offshore western Louisiana. A published schematic dip depth section from the Ouachita orogen to Yucatan has been restored, aiding regional visualization and quantification of Louann Salt migration and delineation of paleoenvironments.

Along the Louisiana slope, closely spaced dip bathymetric profiles at 5-mi spacing reveal a series of east–west-oriented seafloor highs. These highs are known to be underlain by salt at some depth. The highs are continuous across the data set, some 100+ mi. An interpretation is that the Louisiana slope, from shelf break to Sigsbee Escarpment, is subdivided into generally continuous lenticular strike-oriented intraslope basins. The uniformity of salt-ridge distribution requires an orderly evolutionary mechanism. Whatever detailed salt migration models are applied, salt migration along paleoslope may have been orderly. Although there is general bathymetric conformity across the Louisiana slope and an implied single originating mechanism, there is heterogeneity of seismic stratigraphy and paleophysiography of the outer shelf/upper slope of the east and west Louisiana offshore (Mississippi Canyon contrasted with the Garden Banks/Green Canyon). In the Mississippi Canyon area, the shelf break retreated 6 mi from 10.0 to 8.2 Ma, then advanced 55 mi from 8.2 to 2.8 Ma, followed by a retreat of 30 mi from 2.8 to 0.7 Ma. Since then, the shelf break has advanced 20 mi. The west Louisiana shelf break prograded 100 mi during the last 6.7 Ma. These oscillations are dated from paleontological determinations. Representative seismic sections have been simulated to verify calculated geologic inputs.