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PENNSYLVANIAN AND LOWER PERMIAN SHELF-MARGIN MOUNDS AND REEFS IN THE PERMIAN BASIN REGION (WEST TEXAS-NEW MEXICO): COMPOSITION, EVOLUTION, DISTRIBUTION, AND RESERVOIR CHARACTERISTICS

The composition, distribution, and reservoir facies characteristics of tropical mounds and reefs in the Permian Basin (west Texas and southeastern New Mexico) evolved through the Pennsylvanian and Early Permian in response to a combination of biological, ecological, and geological factors. Lower-Middle Pennsylvanian (Morrowan-Atokan) carbonate buildups were mostly broad low-relief mudmounds and banks constructed on ramps by baffling thicket communities of calcareous algae (e.g., phylloid algae, *Donezella/Dvinella*, *Cuneiphycus*, *Komia*). Following the widespread mid-Pennsylvanian (Strawn, Desmoinesian) sealevel rise, phylloid algae dominated Upper Pennsylvanian (Strawn-Bursum, Desmoinesian-Virgilian) shelf and shelf-margin buildups throughout the region, and continued to be common through the earliest Permian (Hueco, Wolfcampian). Large well-bedded phylloid algal banks covered broad paleotopographic highs on shelves, and more localized and massive phylloid algal mounds grew along shelf and shelf-margin topographic breaks. The high reproductive and growth rates, and the gregarious habit, of the opportunistic phylloid algae allowed them to rapidly re-colonize and dominate shallow-water environments during the Late Pennsylvanian period of high-frequency glacioeustatic sealevel fluctuations. During that same period, in somewhat deeper-water peripheral interbank/mound areas, and in upper slope settings, relatively small boundstone reefs were constructed by a thicket community composed of erect calcareous sponges, phylloid algae, fenestrate and ramose bryozoans, and crinoids, which was encrusted by a laminar encrusting algae, fistuliporid bryozoans and *Tubiphytes*.

Latest Pennsylvanian-earliest Permian tectonism, high-amplitude glacioeustatic sealevel fluctuations, and erosion accentuated shelf-to-basin topography and created an ideal geological and environmental setting for the development of shelf-margin organic carbonate buildups. In the earliest Permian (Wolfcampian), elements of the Pennsylvanian phylloid algal mound and peripheral boundstone communities underwent radiations and, together with some newly evolved elements, organized into a new Permian shelf-margin reef community. The Wolfcampian reef community consisted of a framework composed primarliy of phylloid algae (green and red algae), calcareous sponges, fenestrate and ramose bryozoans, and commonly specialized brachiopods, which were encrusted and bound together by *Tubiphytes*, laminar encrusting algae, fistuliporid bryozoans, microbialites, and often abundant marine radial fibrous cements. The Early Permian waning of continental glaciation, and the resultant decrease in the frequency and/or amplitude of glacioeustatic sealevel fluctuations, created a more stable environment and gave the more complex reef community time to establish itself. That reef community persisted and radiated, and played a major role in the growth, geometry and facies relationships of shelf-margin systems, throughout the remainder of Permian time, reaching an acme of development in the Permian Basin with the development of the Middle Permian (Guadalupian) Capitan Reef.

Marine radial fibrous botryoidal cements generally increased in abundance and importance in organic carbonate buildups during the latest Pennsylvanian and Early Permian, which reflects a change in seawater chemistry that was probably related to the warming paleoclimate. It should be noted that phylloid green algae, calcareous sponges, and the radial fibrous cements were all originally aragonitic in composition, and red algae, microbialites, and *Tubiphytes* are thought to have been originally high-Mg calcite in composition. Warm seawater temperatures facilitate the precipitation of aragonite and high-Mg clacite. Significant to subsequent reservoir development, aragonite tends to dissolve relatively easily producing skelmoldic porosity, and high-Mg calcite components are prone to recrystallization and the development of microporosity.

Phylloid algal buildups were most commonly developed during the upper (highstand) parts of Upper Pennsylvanian cyclic depositional sequences, and therefore were often subsequently exposed subaerially. The resultant meteoric diagenesis caused dissolution and collapse of the framework of originally-aragonitic phylloid algal plates, creating a porosity system of skelmolds, vugs, and fractures. Conversely, Lower Permian algal-calcisponge-cementstone reefs were developed largely during the transgressive-early highstand phases of depositional cycles, and grew mainly below normal wavebase, and topographically below and seaward of crestal shelf-margin shoals. Those reefs have well-developed bioclastic packstone-grainstone flank beds, and they shallow-upward into thick, capping, bioclastic (fusulinids, phylloid and dasycladacean algae, *Tubiphytes*) grainstone shelf-margin shoal facies that usually contain scattered *Tubiphytes* patch reefs. With the correct post-depositional and diagnetic history, Lower Permian shelf-margin reefs could develop a phylloid algal mound type of porosity system, but the flanking and capping bioclastic packstone-grainstone facies often have a well-developed intergranular-intragranular-skelmoldic porosity system and can be a volumetrically more significant reservoir facies. Lower Permian (Hueco, Wolfcampian) shelf-margin carbonate buildup reservoirs are particularly well-known along the eastern margin of the Central Basin Platform in the subsurface of west Texas. Excellent outcrop analogs for those shelf-margin buildup reservoirs are exposed in the Hueco Mountains of far west Texas, which were paleogeographically situated along the western margin of the Diablo Platform.