Integration of Subsidence Analysis and Gravity Modeling in the Permian Basin, West Texas

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ABSTRACT

The Permian Basin of West Texas and southeast New Mexico is considered to be one of the most prolific oil-producing basins in the United States. This region experienced complex faulting and fracturing followed by two areas of extreme (30–42 m/myr) subsidence underlie the Permian and Delaware basins that resulted from latest Paleozoic collisional reactivation of a preexisting, east-west-trending zone of weakness in the underlying continental crust. Regional gravity shows that both of these basins overlie a 650 km long gravity low that has been previously inferred to represent a batholith of Early Mesoproterozoic age. Subsidence history based on eight representative well logs throughout the Permian Basin define five tectonic phases that controlled the patterns of basin sedimentation: (1) Pre-collisional, passive margin phase from the Late Precambrian to Late Mississippian (850–320 Ma) with deposition of shallow-marine facies at an average subsidence rate of 8 m/myr; (2) Collisional phase from the Late Mississippian to Mid Permian (320–265 Ma) with deposition of mixed, siliciclastic-carbonate deep-marine facies at an average subsidence rate of 42 m/myr; (3) Post-collisional, Permian Basin phase from Middle Permian to Late Triassic (265–230 Ma) with deposition of shallow-marine, carbonate facies at an average sedimentation rate of 30 m/myr; (4) Stable platform phase from Late Triassic to Late Cretaceous (230–80 Ma) with deposition of shallow-marine, carbonate facies at an average sedimentation rate of 4 m/myr; and (5) Laramide and Neogene tectonic modification phase from Late Cretaceous to Early Eocene (80–2.58 Ma). Compilation of published seismic lines shows reactivation of north-south-striking basement faults as thrust and reverse faults. Their possible relationship to deeper crustal structuring is tested in a regional 2D gravity model. The model incorporates density and lithological controls from well logs that reached the Ellenburger formation, and published refraction data and sediment thickness maps.

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