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ABSTRACTS

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Two-Stage Laramide Orogeny in Southwestern United States: Tectonics and Sedimentation

The Laramide orogeny (80-40 Ma) in the southwestern United States is usually thought of as a single tectonic event with attention concentrated on its early stage because of its dramatic expression in the sedimentary record. The sharpest pulse of deformation, however, occurred in the latest Paleocene-early Eocene and was separated from the early stage by a tectonic lull and development of widespread lateritic weathering profiles, remnants of which are preserved in some early Tertiary basins. The first stage correlates plate tectonically with opening of the North Atlantic and Labrador Sea, the second stage with opening of the Norwegian Sea and Eurasian basin in the eastern Arctic. Rapid convergence between the North American and Farallon plates decreased the dip of the subducting Farallon plate, until by early Eocene (55 Ma), strong viscous coupling was occurring between the Farallon plate and the overlying lithosphere. Change in direction of convergence from west-southwest–east-northeast during the early stage to southwest-northeast during the late stage brought the first-order shear direction into near parallelism with the north-northeast–trending southern Rocky Mountain deformed belt in New Mexico. This parallelism allowed the Colorado Plateau to decouple from the craton along right-lateral wrench faults. The Colorado Plateau was translated 100-130 km north-northeast with a comparable shortening across the Wyoming province.

Both sedimentation rates and coarseness of synorogenic sediments increased dramatically from Wyoming to the Gulf Coast of Texas beginning in the early Eocene. Simultaneously, an en echelon series of strike-slip basins formed along the zone of decoupling from southern New Mexico to southern Wyoming. Deformation in the Wyoming province also increased sharply, resulting in as much as 21 km of overhang on range-front thrusts and up to 15 km of structural relief between adjacent uplifts and basins. As much as 2,500 m of Eocene orogenic sediments were deposited in rapidly subsiding basins. Deformation was so rapid that surface drainage was disrupted and runoff was impounded in huge lakes in which as much as 1,000 m of lacustrine sediments accumulated to form the oil shale province.

Wrench faulting along the eastern margin of the Colorado Plateau was distributed across a 100-km wide belt that followed zones of weakness inherited from Precambrian and late Paleozoic deformation. Wrenching changed from nearly parallel in New Mexico to strongly convergent in Colorado and southern Wyoming because of a change in structural grain from north-northeast in New Mexico to north-northwest in Colorado. At least 25 km of shortening across the zone of decoupling during convergent wrenching caused conspicuous low-angle thrusting, which has tended to mask the lateral component of movement. Major north-northeast shortening across the Wyoming province and a lack of such shortening on the High Plains demand right-lateral wrench faulting. Offset of transverse aeromagnetic anomalies across the zone of decoupling in Colorado and New Mexico, offset of Precambrian metavolcanic belts and age province boundaries, and offset of northeast-trending lineaments and distinctive rock types provide independent measures of the magnitude of right slip. Northward translation of the Colorado Plateau was a relatively minor part of regional right-lateral shear that extended through much of the North American cordillera in the early Tertiary.

Recognition of the wrench-faulted nature of the eastern margin of the Colorado Plateau and Wyoming province creates new opportunities for petroleum exploration. These can be divided into: (1) subthrust plays beneath low-angle faults caused by convergent wrenching; (2) structural, stratigraphic, and fracture-controlled traps along wrench faults; and (3) fracture reservoirs along northeast-trending lineaments dilated during wrenching. Recognition of wrench faults paralleling the structural grain of the southern Rocky Mountains also means that isopach and facies maps drawn smoothly across the zone of decoupling should be reevaluated with careful attention to control points.

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Depositional and Structural Architecture of the Northwest Gulf Coast Tertiary Continental Platform

The northwestern margin of the Gulf of Mexico is a broad depositional platform constructed in the Cenozoic by terrigenous clastic sediment derived from the continental interior of North America. This platform was built onto transitional crust fringing a deep oceanic basin. Cooling and loading of stretched transitional crust by sediment infill induced flexural subsidence, producing a total Tertiary sequence exceeding 6.5 km in thickness.

The large-scale depositional architecture of the platform is characterized by offlap. Successive continental margins cumulatively prograded basinward approximately 350 km from the Mesozoic margin. The combination of offlap depositional geometry and flexural subsidence produced a primary depositional unit resembling a highly flattened sigmoid, which is thickest at the position of its contemporary paleomargin. Depositional geometry and consolidation history of the continental margin and slope lead to a predictable distribution of tensional and compressional stress regimes. Mobilization of thick Jurassic salt complicates this relatively simple structural pattern along the Quaternary margin.

Source terranes for this tremendous sediment influx included the southern and central cordillera and adjacent high plains, as well as the continental interior and adjacent volcanic and epeirogenic uplands. Depocenters shifted from the Houston to the Rio Grande and finally to the Mississippi embayments, reflecting contemporary tectonic events of the western North American craton. Large-scale offlap pulses recorded Laramide (late Paleocene-early Eocene) deformation of the southern cordillera, late Paleogene uplift and volcanism, and Neogene extension and epeirogenic uplift of the Rockies and adjacent high plains.

Offlap of the continental platform was episodic, and most of the depositional episodes encompassed two or more depocenters. Each major offlap unit consists of several principal depositional elements, including one or more fluvial/deltaic systems and wave-dominated shore-zone systems, along with a shelf system, offlap slope sequence, and localized onlap submarine canyon and fan complexes. The correspondence of episodes with the proposed worldwide eustatic curve is relatively good in the late Neogene, when glacial eustasy became increasingly likely. However, relationships of Oligocene episodes to eustatic events are confused at best. Eustatic correlation in the older Paleogene section appears poor.

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Depositional and Structural Architecture of Prograding Clastic Continental Margins

Progradation of a clastic continental-margin sediment wedge onto attenuated continental or oceanic crust is characterized by load-induced crustal subsidence and a predictable internal structural and depositional architecture. The prograding wedge has one free surface, characterized by a very low but nonetheless unstable slope. Here, sandy, normally consolidated sediment is deposited on top of an underconsolidated mud-rich