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Neogene Evolution of Rifting in the Northern Gulf of California: Tectonostratigraphic analysis of seismic reflection and borehole data

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The northern Gulf of California contains >5,000 of sedimentary fill, which constitutes a detailed record of Neogene rifting and tectonic subsidence. The interpretation of several exploration wells, and ∼4000 km of seismic reflection data from PEMEX (Mexican national oil company) indicate that the northern Gulf contains two basin systems (1) the Tiburon-Tepoca-Adair-Altar along the eastern margin offshore Sonora, and (2) the Delfín-Wagner-Consag and Cerro Prieto basins along the western margin adjacent to Baja California. A north-south trending basement high divides these two basin systems from the northern tip of Isla Angel de la Guarda to the northern Sonora coast. We identify three main sedimentary sequences in boreholes and seismic sections. The lower sequence (A) directly overlies the acoustic basement and has parallel reflectors and a largely uniform thickness that reaches up to 1.5 km in the Tiburon basin and gradually pinches out toward the lateral margins of the gulf. Importantly, sequence A is found in both basin systems and does not show obvious changes in thickness near the basin bounding faults, which suggests that the unit was deposited prior to the segmentation of the basin systems. However, based on borehole samples, sequence A in the Tiburon-Wagner-Consag basins is marine and yields late Miocene microfossils (<12 Ma), whereas, in the Altar-Cerro Prieto basins to the northwest sequence A is much younger (latest Miocene to Pliocene), which likely reflects time-transgressive marine incursion. Sequence B conformably overlies sequence A, and is characterized by up to 2 km growth strata with a fanning geometry that show a clear genetic relationship to the major transtensional faults that control the segmentation of

the two basin systems. In the Altar and eastern Cerro Prieto basins to the north, sequence B is composed of Pliocene sandtone-siltstone-mudstone deltaic deposits from the Colorado River that locally reach 3 km in thickness. Sequence C in the Tiburon and Tepoca basins is comparatively thin (<800 m) and includes several unconformities, but is much less affected by faulting. In contrast, sequence C in the active Wagner, Consag and Upper Delfin basin is a much thicker (up to 2 km) growth sequence. Marked variations in sequence C in the different basin systems clearly demonstrate a major westward shift of deformation and subsidence at this time. In summary, sequence A was deposited across most of the northern gulf in the late Miocene, sequence B marks the onset of two discrete transtensional basin systems controlled by both low and high-angle faults in late Miocene-Pliocene, and sequence C marks the regional migration of plate-margin shearing to its present location in the western gulf. Thermal affects associated with abundant volcanism along the western margin of the gulf likely controlled the asymmetric partitioning plate margin shearing during the most recent phase of oblique rifting.