Detachment of Baja California from Mainland Mexico, and the Ongoing Creation of Rifted and Sheared Continental Margins Within the Gulf of California

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The 1300km-long Gulf rift began opening along a young volcanic arc near the end of the Middle Miocene, as northwest motion of an underlying slab of Pacific lithosphere dragged the Cretaceous batholiths of Baja California away from the rest of North America. Several distinctive features of this initially intra-continental rift are inherited from this history: (i) it has opened very obliquely, with right lateral shearing dominating extension, because the overall trench-parallel strike of the arc is very oblique to Pacific-North America motion; (ii) it has an asymmetric structure, with high rift-shoulder uplifts on its southwest margin, and the high rapidly eroding volcanic plateau of the pre-existing Sierra Madre Occidental along its northeast side; and (iii) there was a rapid magmatic evolution from silicic arc volcanism to Late Miocene bimodal basaltic/rhyolitic rift volcanism and Plio-Pleistocene tholeiitic volcanism, as the plate boundary zone developed rapidly but spasmodically into a staircase of long en echelon transform faults linked by short spreading centers accreting oceanic crust. The staircase has not been stable; during the Plio-Pleistocene some transforms and spreading axes have been gradually or episodically replaced by others, so the time of initial crustal accretion varies in an unsystematic manner within the Gulf, beginning as early as 6Ma some basins but less than 1 Myr ago in others. Mature, actively growing oceanic basins in the Gulf have short rifted margins, long shearing margins, and (on the other side of ridge-transform intersections) lengthening sheared margins. Our geophysical studies and ROV sampling of these young continental margins show that the boundary between oceanic and continental crust is sharp and well defined along some examples of both sheared and rifted margins, with tholeiitic flows and sills lapping up to the feet of granitic escarpments. Though we see no true “transitional zone” between oceanic and continental crust, except for narrow zones of rhyolitic volcanism that immediately preceded tholeiitic sea-floor spreading, the crustal boundaries are commonly obscured (especially on seismic profiles) by shallow basaltic sills within the sediment cover. Tholeiitic magmatism has not been highly focused at the spreading axes; there has been much recent and continuing eruptive and intrusive off-axes volcanism in the oceanic basins, and in the continental crust of the adjacent margins.