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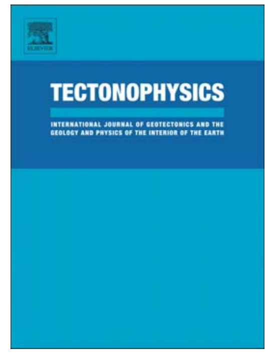

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A bottom-driven mechanism for distributed faulting in the Gulf of California Rift

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Abstract

Observations of active faulting in the continent-ocean transition of the Northern Gulf of California show multiple oblique-slip faults distributed in a 200 x 70 km^2 area developed some time after a westward relocation of the plate boundary at ~2 Ma. In contrast, north and south of this broad pull-apart structure, major transform faults accommodate Pacific-North America plate motion. Here we propose that the mechanism for distributed brittle deformation results from the boundary conditions present in the Northern Gulf, where basal shear is distributed between the Cerro Prieto strike-slip fault (southernmost fault of the San Andreas fault system) and the Ballenas Transform fault. We hypothesize that in oblique-extensional settings whether deformation is partitioned in a few dip-slip and strike-slip faults, or in numerous oblique-slip faults may depend on (1) bottom-driven, distributed extension and shear deformation of the lower crust or upper mantle, and (2) the rift obliquity. To test this idea, we explore the effects of bottom-driven shear on the deformation of a brittle elastic-plastic layer with the help of pseudo-three dimensional numerical models that include side forces. Strain localization results when the basal shear abruptly increases in a step-function manner while oblique-slip on numerous faults dominates when basal shear is distributed. We further explore how the style of faulting varies with obliquity and demonstrate that the style of delocalized faulting observed in the Northern Gulf of California is reproduced in models with an obliquity of 0.7 and distributed basal shear boundary conditions, consistent with the interpreted obliquity and boundary conditions of the study area.

Key words: Oblique rifting, basal shear, strain partitioning, lower crustal flow, continent-ocean transition, delocalized deformation.