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Structural inheritance versus magmatic weakening: What controls the style of deformation at rift segment boundaries in the Gulf of California, Mexico?

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Rifts are commonly segmented into several hundred kilometre long zones of opposing upper-plate transport direction with boundaries defined by accommodation and transfer zones. A number of such rift segments have been recognized in the Gulf of California, a youthful oceanic basin that is currently undergoing the rift-drift transition. However, detailed field studies have so far failed to identify suitable structures that could accommodate the obvious deformation gradients between different rift segments, and the nature of strain transfer at segment boundaries remains enigmatic. The Bocana transfer zone (BTZ) in central Baja California is a linear, WNW striking structural discontinuity separating two rift segments with different magnitudes and styles of extensional deformation. North of the BTZ, the Libertad fault is part of the Main Gulf Escarpment, which represents the breakaway fault that separates the Gulf of California rift to the east from the relatively stable western portion of the Baja peninsula. The N-striking Libertad escarpment developed during the Late Miocene ($\sim$10-8Ma) and exhibits a topographic relief of ca. 1,000m along a strike-length of ca. 50km. Finite displacement decreases from $\sim$1000m in the central fault segment to $\sim$500m further south, where the fault bends SE and merges with the BTZ. In the hanging wall of the Libertad fault, a series of W-tilted horsts are bound along their eastern margins by two moderate-displacement E-dipping normal faults. South of the BTZ, extension was much less than further north, which explains the comparatively subdued relief and generally shallower tilt of pre-rift strata in this area. The BTZ itself is characterized by two en echelon WNW-ESE striking dextral-oblique transfer faults with a significant down-to-the-NNE extensional component. Strain is transferred from the Libertad breakaway fault onto the transfer faults over a distance of >20km through a network of interacting normal, oblique and strike-slip faults. The shape, location and orientation of the main faults were strongly influenced by pre-existing rheological heterogeneities. Major normal faults are parallel to either the Mesozoic metamorphic foliation or Cretaceous intrusive contacts, and developed where the foliation was at a high angle to the extension direction. In contrast, the oblique-slip faults of the BTZ formed parallel to the metamorphic foliation where formlines are at a small angle to the regional extension direction. Compared to the BTZ, deformation in other known accommodation zones of the Gulf of California rift occurred distributed across a much wider zone, and appropriate transfer faults are either lacking or minor. In these cases, however, the accommodation zones coincide with the locations of significant pre- and synrift volcanism, suggesting that thermal weakening associated with magmatic activity may have promoted the distribution of strain across a wider region instead of localising it into discrete transfer faults.