Rift topography linked to magmatic processes at the intermediate spreading Juan de Fuca Ridge

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Abstract

Seismic observations of crustal structure along the Juan de Fuca Ridge (JdFR) indicate that the axial rift topography reflects magma-induced deformation rather than alternating phases of magmatism and tectonic extension as previously proposed. Contrary to predictions of the episodic models, crustal magma bodies are imaged in multi-channel seismic reflection data beneath portions of all ridge segments surveyed at average depths of 2.1–2.6 km. The shallow rift valley or axial graben associated with each JdFR segment is ~50–200 m deep and 1–8 km wide and is well correlated with a magma body in the subsurface. Analysis of graben dimensions (height and width) shows that the axial graben narrows and graben height diminishes where the magma body disappears, rather than deepening and broadening as expected for rift topography due to tectonic extension. An evolutionary model of axial topography, which emphasizes the contribution of dike-intrusion to subsidence and fault slip at the seafloor, is proposed. In this model, an evolving axial topography results from feedbacks between the rheology of the crust above a magma sill and dike intrusion, rather than episodic magma delivery from the mantle.