Paired basement ridges: Spreading axis migration across mantle heterogeneities?

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ABSTRACT

The origin of off–Mid-Oceanic-Ridge (MOR)-axis paired (conjugate) basement ridges and other conjugate structures is examined, with a focus on the North Atlantic. Paired-ridge morphologies are found at volcanic edifice scales (influencing ~25- to 75-km spreading boundary) and at 200- to 1000-km scales (where structures may be V-shaped, suggesting propagation along the axis at rates from a few to 200 mm/yr). Both scales modulate the longest-scale along-axis MOR topographic anomalies (~3100 km for the Azores and ~3800 km for Iceland). At the short scale, MOR axial magma centers with off-axis "split-volcano" pairs suggest magmatic episodicity at 0.1- to 1-m.y. intervals, erratic along-strike displacements (1–10 km) between episodes, and no fixity in a hotspot frame. However, along-strike axis motion (calculated from the Gripp and Gordon, 2002, model) seems to inhibit formation of organized, long-lived axial volcanoes. Intermediate-scale ridge pairs have been attributed to "blobs" and temporal variability of mantle plumes, but some may have formed by passive tapping of anomalous mantle patches as the MOR migrates across them. A great variety of such passive "conjugate ridges" is geometrically possible as a function of MOR velocity over the mantle, the spreading rate and its asymmetry, the plan-view shape of the MOR axis (with transforms, normal, and oblique spreading), and the mantle source, whose shape (outline) could be constrained if the model is shown correct. Among observed ridge pairs (e.g., Morris Jesup Rise/Yermak Plateau; Reykjanes Ridge V-shaped ridges; East and West Thulean Rise; Flores and Faial Ridges; J-Anomaly and Madeira ridges; Ceara and Sierra Leone ridges), some have sharp older and/or younger edges, implying that the anomalous mantle sources, whether fixed or not, also have sharp boundaries, some of which are diachronous, implying along-strike propagation. The short and long scales appear nearly symmetrical along-strike, but the intermediate scales, including geochemical and isotope anomalies in axial basalts, suggest preferential southward propagation, perhaps reflecting the southward asthenosphere motion predicted by counterflow models. Discrimination between the "passive heterogeneity" and "active plume" concepts is discussed.