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Reykjanes Ridge evolution and the elimination of transform faults in the North Atlantic

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The ridge-transform stair step geometry of the Mid-Atlantic Ridge is it's most prominent structural expression. An exception is along the Reykjanes Ridge where a single oblique-spreading and un-segmented plate boundary has replaced a set of earlier ridge-transform structures. This large-scale tectonic reconfiguration extends southward for nearly 1000 km from Iceland to the Bight transform fault that marks the resumption of orthogonal ridge-transform spreading farther to the south. The elimination of transform faults flanking the Reykjanes Ridge has been interpreted in geodynamic models as a southward migrating thermal effect of the Iceland hotspot but direct geophysical observations of the tectonic mechanisms involved have not been previously made. In August-September 2013 R/V Marcus G Langseth conducted a geophysical survey of the southern Reykjanes Ridge and flanks to the Bight transform fault including the first orthogonally spreading segment to the south. The objectives were to better understand how the Reykjanes Ridge replaced the earlier transform fault-dominated structure. The survey acquired full-coverage multibeam bathymetry and acoustic backscatter imagery and coincident gravity and magnetic profiles. Preliminary analyses of the Bight transform fault and surrounding segments indicate a geologic mechanism for the elimination of transform faults. The Bight transform fault is a narrow and well-defined tectonic boundary. The ridge segment to the south is undergoing small but clearly discernible relocations of the neovolcanic zone such as to decrease the offset with the ridge segment to the north. The short segment to the north of the Bight transform fault appears to have recently eliminated its northern bounding transform fault by propagating across it and replacing it with a highly oblique neovolcanic zone linking it to the next northward segment. The preliminary analysis suggests that small-scale ridge propagation events occur within transform-bounded ridge segments such as to decrease the offset distance between neighboring ridge segments. When the ridge offset distance shortens to about the width of the plate-boundary zone (on the order of 10 km) a volcanic axis can propagate across the transform fault, eliminating it and forming a non-transform offset. The non-transform offsets can then further migrate to align with the linear trend of the oblique axis to the north to form a continuous, non-transform, wide, plate boundary zone comprised of en-echelon axial volcanic ridges, as characterizes the present-day Reykjanes Ridge.