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Remote-predictive geologic mapping of the Reykjanes Ridge: Implications for the volcanic and structural evolution of a slow-spreading Mid-Ocean Ridge

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The Reykjanes Ridge is a spreading center that presents an opportunity to track the dynamic formation of structural and volcanic features at an asymmetric slow-spreading plate boundary. The ridge spans the northern ~1000 km of the Mid Atlantic Ridge and has been spreading at a full spreading rate of ~20 mm/year [1]. The characteristic along-ridge basement depth, crustal thickness, and chemical gradient have been variably attributed to an active mantle plume beneath Iceland, or a passive mantle anomaly pre-dating the rifting [1]. A unique feature of the ridge is that it spreads obliquely to the spreading axis: a consequence of the change in spreading direction from ~125° to ~100° due to the failure of the triple junction between the Greenland, Eurasian, and North American plates 37 Mya [2]. Along with the sudden change in orientation, disjunct ridge segments were formed and separated by transform faults which have been continuously eliminating from north to south, thereby re-establishing the original linear geometry of the ridge [1]. The Bight Transform Zone is the final remaining transform fault and constitutes the boundary between the southern Reykjanes Ridge and the northern Mid-Atlantic Ridge. Despite the termination of strike-slip transform fault motion, the ridge remains in a state of active tectonic deformation as demonstrated by the time-dependant orientations of linear structures, lengths of spreading segments, and deviation from the previously asserted linear continuity of the ridge. Investigating the relationship between structures, volcanism, and regional geodynamics is possible with the application of a novel remote-predictive geological mapping method based on interpretations from newly acquired bathymetric and acoustic backscatter data. Notably, the bathymetric data provides significant high-resolution coverage of both on-axis and off-axis regions, allowing us to track the evolution of the ridge for up to 13 Mya. The acoustic backscatter data aids in the interpretation of geologic features and terrains whose distribution and morphology reflect both present-day and historic ridge dynamics. This analysis will produce new insight into the on-going first and second-order deformation of the Reykjanes Ridge, its controls, and its effects on diffuse low-temperature vs. focused high-temperature hydrothermal venting.

[1] Martinez et al., 2020. Reykjanes Ridge evolution: Effects of plate kinematics, small-scale upper

mantle convection, and a regional mantle gradient. Earth-Science Reviews.

[2] Jones, Stephen M., 2003. Test of a ridge–plume interaction model using oceanic crustal structure around Iceland. Earth and Planetary Science Letters.