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Near-axis melt anomalies and segmentation of axial melt: a common framework for the EPR and Endeavour ISS?

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The EPR 9°50'N and Endeavour ridge segments were originally selected for focused investigation under the Ridge2000 program as contrasting fast spreading magmatic (EPR) and intermediate spreading tectonic (Endeavour) ridge systems. Recent studies reveal structural similarities on both a regional and local scale that indicate a common framework for the magmatic and hydrothermal regime at these sites.

On the regional scale, both the EPR and Endeavour sites are adjacent to off-axis seamount chains and ridge-melt anomaly interaction may contribute to localization of magmatism at both sites. The Lamont seamounts are located immediately west of the EPR "bulls eye" (9°49-9°51'N). Here, the ridge axis and the underlying mid-crust magma lens are locally shallow indicating an elevated axial thermal regime, hydrothermal venting is clustered, and the lavas with highest Mg# have erupted. The two documented volcanic eruptions of 1991/92 and 2005/06 both occurred within this region sourced from the same site, with the location of hydrothermal venting persisting through the volcanic eruptions and only minor changes in lava chemistry.

Similar relationships are observed at Endeavour segment where the hydrothermally and magmatically active portion of this segment coincides with the on-axis projection of the Heckle seamount chain. An axial magma lens is present for only ~20% of the segment beneath the central shallow portion where active venting is also focused. Seismic data indicate thicker crust has been accreted within this central portion of the segment for the past 0.7 Ma coincident with timing of ridge intersection with the Heckle chain. An important prediction of the ridge-melt anomaly interaction apparent at these sites is that regions of locally enhanced axial magmatism are likely to persist for long time periods (10's– 100's of ka) and longevity in the axial hydrothermal system is also expected.

On a local scale, fourth-order segmentation of the mid-crustal magma lens may play a key role in the variability in seafloor volcanism and hydrothermal activity at both sites. At the EPR, segmentation of the axial magma lens into discrete overlapping lenses with along-strike dimensions of 5-10 km is evident in a new 3D multichannel seismic reflection data set. The main clusters of hydrothermal venting at the EPR site (at 9°49'-50' and ~9°46-47') are underlain by separate lenses indicating distinct heat sources. Fine-scale geochemical sampling within the region reveals variations in major element geochemistry, also linked to the underlying magma lens segmentation. Although the detailed geometry of the magma lens at Endeavour segment can not be confidently established without a 3D seismic survey, the existing 2D seismic reflection data indicate magma lens segmentation on a similar scale may be present, with a discrete lens beneath the Mothra vent, offset from a shallower lens beneath the vents to the north and possibly a deeper lens to the south. Along-strike differences in Mg# are similar to the

EPR, and there also are differences in trace element and isotope ratios that require different melting events and melt lenses. How these relate to the imaged segmentation awaits future work.