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Thermal Structure of Lucky Strike Segment, Mid-Atlantic Ridge: indications from microearthquakes and thermal modeling

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Modeling the thermal state of the oceanic crust is important to understand the construction of the oceanic crust that covers two thirds of the surface of the planet. The thermal structure primarily controls the rheology of the oceanic lithosphere, and the presence/absence of a magma chamber, and therefore the accretion at the axis. Published thermal models do not predict steady state crustal magma chambers (CMCs) along mid-ocean ridges at spreading rates less than 30 mm/year. The discovery of a CMC at the slow-spreading Lucky Strike segment of the Mid-Atlantic Ridge gives a motivation to further investigate the parameters that control the presence of a CMC, and its long term stability or temporal variability. To constrain the thermal state of the lithosphere in the Lucky Strike segment, we used microearthquakes as their distribution is a good indicator for brittle to plastic transition. The thermal state of ridge segments is predominantly influenced by the rate of the magma supply and by the efficiency of hydrothermal circulation. By varying the rate and the geometry of melt supply, and the efficiency of hydrothermal cooling, we constrain thermal conditions which allow for the presence of CMCs at Lucky Strike. Our models indicate that long-lived CMCs can be present at slow-spreading ridges only if large volumes of melt are focused to the segment center. We find that such strong melt focusing cannot be sustained in a steady-state fashion, so that CMCs are indeed likely to be transient features of at slow ridges. Interplay between the CMC and the hydrothermal system results in a

three-dimensional thermal structure with steep thermal gradients, which is consistent with the observed distribution of earthquake hypocenters near the Lucky Strike CMC.