Electrical imaging of the Mohns Ridge in the Greenland Sea

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A detailed 120 km deep electromagnetic joint inversion model for the ultra-slow Mohns Ridge was constructed combining controlled source- and magnetotelluric data. About one third of mid-ocean ridges have a spreading rate less than 20 mm/yr, but due to lack of deep imaging, factors controlling melting and mantle upwelling, depth to the lithosphere – asthenosphere boundary (LAB), crustal thickness and hydrothermal venting are not well understood for this class of ridges. Modern electromagnetic data have significantly improved understanding of fast-spreading ridges, but have not been available for the ultra-slow ridges. The new inversion images show mantle upwelling focused along a narrow, oblique and strongly asymmetric zone coinciding with asymmetric surface uplift. Though the upwelling pattern shows several of the characteristics of a dynamic system, instead it likely reflects passive upwelling controlled by slow and asymmetric plate movements.

Upwelling asthenosphere and melt are enveloped by the 100 Ωm contour denoted the electrical LAB (eLAB). This transition may represent a rheological boundary defined by a minimum melt content. We also find that a model where crustal thickness is directly controlled by the melt-producing rock volumes created by the separating plates can explain the thin crust below the ridge. Fluid convection extends for long lateral distances exploiting high porosity at mid crustal levels. The magnitude and long-lived nature of such plumbing systems could promote venting at ultra-slow ridges. Further, active melt emplacement into ca 3 km thick oceanic crust culminates in an inferred crustal magma chamber draped by fluid convection cells emanating at Loki’s Castle hydrothermal field.