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Lateral variability of crust and mantle at ultraslow spreading ridges

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Several recent studies at ultraslow spreading ridges in the Arctic and along the SW Indian Ridge have shown that ultraslow spreading ridges represent a new class of ocean ridge distinct in their tectonic features from slow-spreading ridges. Locally, tectonics and crustal accretion can closely resemble that at slow spreading ridges, but elsewhere, long sections of ultraslow ridges exhibit features that are rare at best at the latter – if the exist at all. In particular, as spreading slows to below 12 mm/yr, transform faults and magmatic ridge segments are replaced by amagmatic segments that can take any angle to the plate spreading direction. These sections often expose abundant mantle peridotites and both geophysical and dredge data suggest that the crust may be anomalously thin or even absent for many kilometers. Magmatic centers are often widely spaced between amagmatic segments, but where they occur they may be as large or larger than magmatic segments at slow spreading ridges. Tectonically, magmatic segments at ultraslow spreading ridges appear nearly identical to those at slow spreading ridges.

Gabbroic rocks at ultraslow spreading ridges may be highly localized, occurring in abundance in association only with major modern magmatic centers, or at the location of an extinct magmatic center. Unlike suites from transform walls, mantle peridotites from the amagmatic segments rarely include gabbroic rocks, and then only as vein assemblages.

Mantle peridotites, despite the very low degrees of melting inferred from the sparsity of basalts and gabbros along the amagmatic zones, are very close in composition to those from slow spreading ridges and transform faults globally. This presents major problems for modeling mantle melting of the abyssal mantle, in that it suggests a much

lower primary clinopyroxene content than is normally assumed in the source. Dunite is common in the mantle dredge suites, but nearly clinopyroxene-free intergranular harzburgites produced by reactive porous flow in the mantle constitute close to 30% of the peridotites from the amagmatic zones. This suggests that away from transforms at slow spreading ridges where the crust is thicker, such rocks will entirely dominate the mantle-melting-column. The major lithology in the zone of melt transport, then, is likely harzburgite at depth, while dunites dominate at shallow depths beneath the base of the crust.

Taken together, these results suggest highly focused melt flow beneath ultraslow spreading ridges, with only minor volcanism over long stretches between major magmatic centers.