THEME 5: THE DEEPER EARTH

Session 5.6: Dynamics of slow and ultra-slow spreading ridges

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A ridge system involves physical and chemical processes that are inextricably linked. The slow end of the spreading rate spectrum (<4 cm per year full rate) provides unique constraints on mantle heterogeneity, melt production and transport, crustal accretion, and solid state deformation. This session invites both geochemical and geophysical approaches to these topics, with an emphasis on how each specialty casts light on the larger system. For example, we invite geochemists to frame their observations in terms of constraints on physical processes and geophysicists to consider how their studies might shed light on or predict chemical observations, rather than specialized reports on particular measurements or field areas. Major new investigations of slower spreading ridges (e.g. SWIR, Gakkel, ODP leg 209) will provide a springboard for discovery and discussion of larger scale questions.

5.6.11

Petrogenesis, alteration, and deformation in mantle peridotite from 14° to 16°N on the Mid-Atlantic Ridge: ODP Leg 209

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Ocean Drilling Program (ODP) Leg 209 was conceived to test the hypothesis that at slow spreading ridges mantle flow, or melt extraction, or both are focused in three dimensions near the centers of magmatic ridge segments. An operational plan designed around a strike line of drill holes extending across magmatic segments was envisioned to provide a scope unaccommodated by dredging or submersible studies. Several outstanding observations have led us to develop new hypotheses for igneous petrogenesis and mantle deformation at slow spreading ridges. From six sites between 14° and 16°N we recovered residual mantle peridotite (75%) and evolved gabbroic rocks (25%). These proportions are consistent with dredging and submersible collections from this region but significantly more gabbro rich than similar collections from ultra-slow spreading ridges. The gabbros recovered from most sites have an intrusive relationship to the host residual mantle peridotite and there are abundant gabbroic intrusions present all along the strike line of drill sites. We see no evidence of focused accumulation toward the center of ridge segments. Hydrothermal alteration is variable in products and intensities. At one site, pervasive serpentinization of peridotite has been overprinted by talc mineralization. At another site, talc alteration is more subdued. The presence of brucite at two sites likely reflects abundant dunite in the protolith. Penetrative deformation in residual mantle peridotite is minimal, rather at all sites where peridotite was recovered deformation appears localized along high temperature shear zones, contacts between gabbro and peridotite, and later brittle faults. These observations lead us to interpret that mantle peridotites in this region are incorporated into the lithosphere, are intruded by gabbroic magmas, and the lithosphere cools with little deformation. Ridge extension is accommodated by local shear zones that evolve into brittle faults as the peridotite is exhumed. The high proportion of gabbroic intrusions do not represent cumulates that yielded basalts, but rather accumulated in the lithosphere rather than erupting leaving more primitive gabbroic cumulates distributed at depth in the crust.