PLAGIOCLASE ACCUMULATION AND PHENOCRYST REACTION IN OCEANIC THOLEIITE: AN INDICATION OF SPREADING RATE

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ABSTRACT

A comparison of basalt lithology and chemistry for different mid-ocean ridge spreading axes indicates: (1) basalt generated at slow spreading axes (< 5 cm/yr, e.g. Mid-Atlantic Ridge) reflects widespread flotation of calcic plagioclase and phenocryst-liquid reaction; (2) basalt generated at fast-spreading axes (> 5 cm/yr, e.g., Juan de Fuca Ridge, Galapagos spreading Center, East Pacific Rise) is invariably aphyric or sparsely phyric, phenocrysts if present representing low pressure liquidus crystallization products. Interestingly, basalt generated at intermediate spreading rates (e.g., Costa Rica Rift, Gorda Rise, Gulf of California shows incipient development of the «slow-spreading» petrographic tendencies. Recent experiments demonstrate a tendency for calcic plagioclase to float in basaltic melt at pressures greater than 6-7 Kbars, while

phenocryst-liquid reaction (often attributed to magma mixing) may be explained as due to re-equilibration of high pressure liquidus assemblages during low pressure storage of cogenetic magma. These effects can be plausibly ascribed to polybaric fractionation processes, with significant cooling and crystallization near the zone of initial melt segregation. Ridge-axis geotherm configurations, modelled as a function of spreading rate, and constrained by experimentally determined PT conditions for mantle-melt equilibration, imply transient polybaric fractionation systems at slow-spreading axes, but exclusively low pressure fractionation for fast-spreading axes. These qualitative predictions are confirmed by seismic evidence for near-surface magma reservoirs at the East Pacific Rise and their apparent absence from the Atlantic spreading axis. Petrographic and whole-rock chemical distinctions between fast and slow spreading axes thus appear to be sensitive to thermal and kinematic conditions at ocean ridges. Such discriminants may be applicable to obducted ocean crust of unknown provenance.

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