# Systematic Differences in Ge/Si Between Enriched and Depleted MORB

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Germanium behaves like Si, so that the Ge/Si ratio is usually considered to be invariant. To better understand the behaviours of invariant element ratios, we performed precise LA-ICP-MS analysis of MORB glasses from the Mid-Atlantic Ridge (MAR). Repeated measurements of the VG 2 glass yielded a precision of ± 3% on the Ge/Si. The Ge/Si in MAR glasses does not vary as Mg# changes from 65-50, indicating that fractional crystallization has a negligible effect on the Ge/Si. All MAR basalts define a Ge/Si range of $6\text{-}7\times10^{-6}$. Modelled partial melting of a spinel peridotite yields melts that have essentially the same Ge/Si independent of the degree of partial melting and the model melt compositions overlap the field defined by MORBs from MAR. When the samples are grouped into D-, N- and E-MORB [1], E-MORBs have a lower Ge/Si ratio than D- or N-MORBs. There are two possible ways of getting a lower Ge/Si. (1) Subaerial lavas tend to have lower Ge/Si than submarine lavas from the same volcano due to the degassing of volatiles. This effect is small and is not expected to affect MORBs that erupted under several kilometres of seawater. (2) During partial melting, Ge is compatible in garnet, incompatible in olivine, and has D~1 in pyroxenes. Therefore, low degree partial melting of a garnet pyroxenite produces Si-rich melts (dacite) that were modelled to have low Ge/Si. Mixing of a small amount of this dacite melt into a melt derived from depleted spinel peridotite (e. g. D-MORB) will yield a melt with lower Ge/Si ratio like observed for E-MORB. Several models have been proposed for the generation of E-MORBs, including (i) entrainment of plume mantle into adjacent ridges, (ii) re-fertilization of depleted mantle by partial melts of subducted slabs, or (iii) the presence of recycled pyroxenite in MORB sources. The first two scenarios are unlikely to impact the Ge/Si ratios of MORBs significantly. The presence of a higher proportion of recycled pyroxenite in MORB sources could explain the lower Ge/Si ratio and the more enriched chemistry of E-MORBs. This enriched component will also effect melt production rates and crustal thickness. Our new results show the importance of Ge/Si for constraining the lithologic heterogeneity beneath ridges.

[1] Gale et al. (2013) $G^3$ 14 (3): 489-518