Chalcophile elements contents in Mariana trough basalts

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To investigate the evolution of chalcophile elements in convergent margin magmatic systems with less influence of subduction components and lower degree of mantle depletion relative to arc front, and their comparative potential of economically important metals such as Cu, Ag and Au, we report the chalcophile element contents in basalts from the northern Mariana trough. Previous works show that oxygen fugacity of Mariana trough basalts (MTBs) are similar to MORBs[1] and MTBs are slightly enriched in large-ion lithophile elements(LILEs) and fluid-mobile elements[2], indicating that limited subduction-derived components are involved into their mantle source.

Sulfides globules in MTBs are present in olivine crystals and in the groundmass. Unlike incompatible behavior of chalcophile elements during the differentiation process of typical hydrous and oxidized melts[3], Cu, Ag, Pd and Pt contents and Pd/Cu ratio in MTBs show a decrease with decreasing MgO. These results indicate that MTBs are sulfide saturated during the overall magma evolution. However, at given MgO contents, Cu, Ag, Pt and Pd contents in MTBs are systemtatially lower (about a factor of two) than those of global MORBs[4], suggesting that the mantle source beneath the northern Mariana trough is depleted in chalcophile elements. This feature may result from prior mantle depletion events, which is consistent with low Yb-TiO2 contents in basalts with MgO > 8 wt.%. The depletion of chalcophile elements in MTBs and their early stage of sulfide saturation cannot be suitable for significant enrichment of metals for ore deposits at Mariana trough relative to arc fronts. This may explain relative low-grade and small scale of Cu-Au mineralization as seafloor massive sulfide deposits at Mariana trough, compared with those at Mariana arc fronts and at other arc-proximal settings such as eastern Manus basin.

[1] Brounce et al. (2014) Journal of Petrology 55(12): 2513-2536; [2] Pearce et al. (2005) Geochemistry, Geophysics, Geosystems, 6(7); [3] Jenner et al. (2015) Geochemistry Geophysics Geosystems, 16(5): 1490-1507; [4] Jenner (2017) Nature Geoscience 10, 524–529