Constant Cu/Ag in mantle pyroxenites, MORBs and OIBs - Implications for the formation of continental crust

ZAICONG WANG[1,2,*] YONGSHENG LIU[1], HARRY BECKER[2], ELIS HOFFMANN[2] AND CHUNFEI CHEN[1]

[1] School of Earth Sciences, China University of Geosciences, 388 Lumo Road, Hongshan District, 430074, Wuhan, China (*correspondence: wzc231@163.com)

[2] Freie Universität Berlin, Institut für Geologische Wissenschaften, Malteserstrasse 74-100, 12249 Berlin, Germany

Delamination of dense, sulfide-bearing pyroxenitic cumulates was proposed to explain the low Cu content and the evolved major element composition of continental crust from mantle-derived magmas, yet evidence for this hypothesis has been circumstantial. A corrolary of this hypothesis would be that mantle pyroxenites formed by delamination display elevated Cu contents compared to primitive basic magmas. Here we test this hypothesis by using new Cu and Ag concentration data on mantle pyroxenites (Balmuccia, Ivrea Zone; Hannuoba, N China Craton) and associated lherzolites. The mantle pyroxenites are wall rock reaction and mineral accumulation products of basic magmas in the mantle. The Cu and Ag contents in the pyroxenites partially overlap with those in basalts (40-200 µg/g Cu), but tend to be higher (Balmuccia, 87-484 µg/g Cu) or lower (Hannuoba, 15-120 µg/g Cu) than in basalts. The mean Cu/Ag of the pyroxenite suites (Balmuccia: 3800±1100, Hannuoba: 3100±900) are indistinguishable from those of fertile lherzolites (3500±1200), MORBs (3600±400) and OIBs (3200±100). Partitioning of Cu and Ag between sulfide melt and silicate melt is responsible for the limited fractionation of Cu and Ag and thus must be the predominant fractionation process of incompatible chalcophile elements in lithospheric and in the convecting upper mantle. It is clear that sulfide melt-silicate melt partitioning cannot explain the low Cu/Ag ratio of the continental crust (≈500), which is a factor of 7 lower than Cu/Ag in most of the upper mantle. Literature data on primitive and evolved arc basalt series shows a decrease of Cu/Ag from normal mantle values to values < 1000, as well as a decrease in Cu contents. These changes likely reflect fractionation of Cu-rich monosulfide solid solution during fractional crystallization of basic arc magmas, and thus support the existence of sulfide-bearing cumulates in the lower crust of arcs. Consequently, delamination of sulfide-bearing cumulates represents the most likely process to explain the low Cu/Ag in the continental crust. We also note that mantle pyroxenites and basalts analyzed to date display no evidence for the complementary high Cu/Ag expected for delaminated lower crustal cumulates from magmatic arcs. This might be due to the low mass fraction of cumulate material delaminated from the continents.