The copper isotope composition of the continental crust

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Copper isotopes are a potentially powerful tool for investigating a wide variety of geological processes due to the siderophile and chalcophile nature of Cu, and the sensitivity of Cu isotopes to complexing ligand, phase behaviour and redox state [1]. However, a limitation in such endeavours is the lack of robust isotopic characterisation of the Earth's continental crust. Here we use new bulk rock Cu isotopic analyses of various upper and lower crustal lithologies to calculate an average Cu isotopic composition for the bulk continental crust (CC). We have utilised two suites of lower crustal xenoliths from Australia to constrain the lower continental crust and granitoids from Scotland, Greenland, Nigeria and Nepal to represent the upper continental crust.

The lithologies display a large spread in δ^{65}Cu with the most extreme values found in the S-type granitoids and lower crustal xenoliths. Overall, this range is much wider than seen in previously measured crustal igneous rocks [2]. For the lower crustal xenoliths, assimilation of altered upper crustal material into a fractionating magma can explain some of the variation in δ^{65}Cu in the samples. Other causes of δ^{65}Cu heterogeneity throughout the continental crust are magmatic differentiation, metasomatism and/or the presence of isotopically light oxide or sulphide phases.

We calculate the average composition of the CC weighted by lithology as $\delta^{65}\text{Cu} = +0.25 \pm 0.24‰$ (2sd). This is somewhat heavier than estimates for both Bulk Silicate Earth (BSE; based on mafic lithologies) and Bulk Earth (BE; based on meteorite analyses) values [3]. The overall heavy isotope enrichment relative to Earth's mantle implies that Cu isotopes appear to be fractionated during the formation of continental crust. Our measurement of isotopically light, Cu-rich sub-arc mantle pyroxenites suggest that sulphide accumulation in this setting could be a culprit.

[1] Moynier et al. (2017) Rev. Mineral. Geochem. 82, 543–600 ; [2] Li et al. (2009) Chem. Geol. 258, 38-49 ; [3] Savage et al. (2015) Geochemical Perspectives Letters 1, 53-64.