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Missing molybdenum in the magmatic record and its implications for constraining the composition of the continental crust

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Accurately constraining the molybdenum (Mo) isotope composition ($\delta^{98/95}$Mo) of Earth's major reservoirs is essential for understanding its evolution. Chondritic meteorites, show a homogeneous Mo isotope composition (average $\delta^{98/95}$Mo = -0.154‰), which is assumed to represent the initial composition of the bulk silicate Earth (BSE) [1]. The depleted mantle (DM) has a well constrained $\delta^{98/95}$Mo of -0.204 ‰ [1]. Although previous studies on the upper continental crust have confirmed its super-chondritic Mo isotope composition [2, 3], poor understanding of the middle and lower crust limits our knowledge of the $\delta^{98/95}$Mo of the bulk continental crust (CC), restricting the understanding of the mantle-crust evolution process.

Arc magmatic processes play a significant role in formation and evolution of the CC [4]. Examination of a continental arc crustal section should provide better constraints on the $\delta^{98/95}$Mo of the CC. We focus on samples from the Gangdese arc crustal section [5], in combination with a compilation of published Mo concentrations and $\delta^{98/95}$Mo of ultramafic-mafic, intermediate and felsic intrusions, representing lower, middle and upper CC, respectively. Mass balance calculations for several crustal depth models have been undertaken constraining the average $\delta^{98/95}$Mo of the bulk CC to -0.082 ‰, significantly heavier than the BSE. Mass balance calculations demonstrate Mo isotope composition of intrusions reliably represents that of the CC. Extensive extraction and recycling of the crust occurred during the late Archean [1]. The Mo isotope composition between the CC and the DM is balanced at present, indicating that new crustal growth and recycling into the mantle have reached secular equilibrium over the course of Earth's history.

Reference

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