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The effects of high-grade metamorphism and anatexis on Mo stable isotopes: Insights from the Ivrea-Verbano lower crustal terrain

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Over the last decade, our understanding of the factors controlling the redox-sensitive Mo stable isotopic system during high-temperature geological processes has significantly improved. Yet, major unknowns remain, hindering its full potential as a tracer for silicate Earth differentiation processes. In particular, the behavior of Mo isotopes within the lower continental crust remains unconstrained since no associated terrains or xenoliths have been measured thus far. Here we investigate the effects of high-grade metamorphism and anatexis on the redistribution of Mo isotopes within the continental crust. We use samples from the Ivrea-Verbano Zone, and more specifically the Kinzigite Formation, an amphibolite to granulite facies terrain interpreted as an exhumed section of lower continental crust. The Kinzigite Formation preserves a rich record of dehydration and melting during prograde metamorphism of both sedimentary and igneous basaltic protoliths, and is therefore a prime locality for the task.

Preliminary results show that, for each type of protolith investigated, the $\delta^{98/95}$Mo of granulite facies rocks are systematically lower than that of their amphibolite facies counterparts, with values decreasing from +0.05‰ to -0.34‰ for metasediments and -0.33‰ to -0.56‰ for metabasites. The measurement of one leucosome from the amphibolite facies units (Mo = 46 ng/g; $\delta^{98/95}$Mo = +0.15 ‰) revealed low Mo content and no significant isotopic difference compared to its protolith (Mo = 218 ng/g; $\delta^{98/95}$Mo = +0.05‰). In contrast, a leucosome from the granulitic section has higher Mo content and a heavier isotopic composition (Mo = 109 ng/g; $\delta^{98/95}$Mo = -0.15‰) than the associated restite (Mo = 51 ng/g; $\delta^{98/95}$Mo = -0.56‰). In essence, Mo isotopes do not appear to be fractionated by dehydration during amphibolite facies metamorphism (production of supercritical fluids), while anatexis and melt extraction under granulite facies conditions seem to preferentially mobilize and, ultimately, deplete heavy Mo isotopes from the lower continental crust. If these results are representative, lower crustal processes might induce significant redistribution of Mo isotopes between different layers of the continental crust. Further analyses should refine these interpretations.