Molybdenum isotope systematics of exhumed oceanic crust as a probe of slab dehydration

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Fluids derived from subducting slabs have a major influence on arc magmatism and global elemental fluxes. The amount and exact source of these key fluid fluxes, however, is much debated. Molybdenum (Mo) isotopes show promise for tracing the origin of fluids in subduction zones for two reasons. First, high-pressure experiments show that Mo mobility is sensitive to the redox conditions of slab-derived fluids [1]. Second, recent studies [2-4] show that many arc lavas are enriched in Mo with $\delta^{98/95}Mo_{NIST\ 3134}$ higher than values of the primitive mantle [5], depleted mid-ocean-ridge basalts [6] and typical oceanic sediments [2]. The high $\delta^{98/95}Mo_{NIST\ 3134}$ in some arc lavas has been inferred to reflect Mo fractionation during dehydration of the subducting slab [2,3]. In this study we use Mo isotope ratios to examine the nature of fluid loss recorded in two suites of exhumed eclogites (and associated blueschists). These samples show $\delta^{98/95}Mo_{NIST\ 3134}$ varying from close to typical mantle (-0.2‰) to values some 0.8‰ isotopically lighter. This range of $\delta^{98/95}Mo_{NIST\ 3134}$ is positively correlated with Mo/Ce. We demonstrate that rutile, the principal host of Mo in the slab, fractionates Mo between the fluid and residual solid. In order to sufficiently fractionate Mo, a large flux of oxidised fluid is required. Such a fluid flux is greater than possible from dehydration of the subducted, altered crust and so makes a strong case for the role of oxidised fluids liberated by dehydration of underlying slab serpentine. This process additionally accounts for the high $\delta^{98/95}Mo_{NIST\ 3134}$ observed in some, fluid-dominated arc lavas.

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