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The effect of oceanic crust alteration on the global W budget

RAMON REIFERÖTHER, **CARSTEN MÜNKER** AND FLORIAN KURZWEIL

University of Cologne

Presenting Author: c.muenker@uni-koeln.de

Tungsten (W) behaves as a highly mobile element in the global geochemical cycle. Yet, its behaviour during hydrothermal alteration on the ocean floor has long remained unexplored. To assess the behaviour of W during oceanic crust alteration, we studied the behaviour of W and other highly incompatible elements such as U, Th or Ta in samples from IODP drillholes covering representative sections of altered oceanic crust. Lavas and intrusives from upper basaltic oceanic crust exhibit W/Th as high as 1.4, indicating an up to 10 fold enrichment of W relative to fresh MORB [1]. Tungsten enrichment is clearly linked to hydrothermal activity. In comparison to upper oceanic crust, rocks from the lower oceanic crust, i.e., abyssal peridotites and gabbros exhibit an even stronger W enrichment, with W/Th as high as 200, corresponding to a W enrichment factor of more than 100. These observations indicate that altered oceanic crust is a major sink in the global geochemical cycle of W that also significantly contributes to the W enrichment observed in subduction zone lavas. To elucidate the origin of the excess W in altered oceanic crust, we performed stable W isotope measurements on selected samples. Samples from the upper oceanic crust exhibit $\delta^{186/184}$W close to the modern mantle value of +0.085 ± 0.019 ‰ [2], whereas abyssal peridotites display larger alteration tending to lower $\delta^{186/184}$W as low as -0.117. The lighter W isotope composition can be attributed to distinct styles of alteration. We regard seawater as an unlikely source of the W enrichment, as seawater exhibits a distinct, high $\delta^{186/184}$W of ca. +0.55 [3,4], which should have shifted the $\delta^{186/184}$W W isotope composition of igneous rocks towards higher values during oceanic crust alteration. Hence, high-T hydrothermal redistribution of W and its enrichment near the seawater interface is the most likely process that can account for the observed, largely mantle-like W isotope patterns.

[1] König et al *et al.* (2011) GCA **75**, 2119-2136. [2] Kurzweil *et al.* (2019) GCA **251**, 176-191. [3] Fujiwara *et al.* (2020) Chem. Geol. **555**, 119835. [4] Kurzweil et al. (2021), this meeting.