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Ferric iron systematics of coexisting silicate and oxide minerals in hydrated metaperidotites with progressive subduction

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Hydrated metaperidotites convey large amounts of mineral-lattice bound water to subduction zone depths exceeding ~ 50 km [1] and exhibit a high capacity to oxidize other reservoirs, quantified by their redox budget [2]. With progressive subduction, hydrated metaperidotites undergo dehydration, and current models postulate a dominant partitiontioning of the redox budget into the dehydration fluid which is thought to represent the oxidizing agent for arc magmas [3]. However, recent studies challenge this paradigm, stating that the oxidation state of subducted hydrated metaperidotites is commonly too low to stabilize oxidized species in the dehydration fluid [4, 5].

To address this controversy surrounding redox budget cycling, we have undertaken a comprehensive study on Fe^{3+} – Fe^{2+} systematics in bulk rocks and silicate mineral separates formed upon metaperidotite dehydration, because iron is the most abundant, redox-sensitive element in these rocks. Metaperidotite samples from the central Swiss Alps were characterised in detail for their petrogenesis and preserve mineral assemblages formed upon antigorite breakdown (olivine + chlorite + orthopyroxene ± magnetite ± rare hematite). Antigorite dehydration product rocks are further distinguished into three groups based on fO_2 (expressed relative to the QFM buffer): highly (QFM + 3.5), moderately (QFM + 3.0) and weakly oxidized (QFM + 1.0). Bulk rock ^{57}Fe Mössbauer spectroscopy data reveal that from highly to weakly oxidized conditions, 35 – 4% of the total Fe is Fe^{3+}, with silicate minerals hosting 6 – 100% of the bulk Fe^{3+}. Mössbauer data on mineral separates identify chlorite as the main silicate Fe^{3+} carrier with 35% Fe^{3+} in one highly oxidized sample and 15% Fe^{3+} in one moderately oxidized sample, before orthopyroxene (~ 2% Fe^{3+}) and olivine (< LOD – 1% Fe^{3+}). Following antigorite dehydration, a large fraction of the redox budget hence remains rock-bound and is subducted further, possibly accounting for comparatively oxidised source domains in the convecting mantle.

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