ALTERATION OF MANTLE SULFIDES: THE EFFECTS OF OXIDATION AND MELT INFILTRATION IN A KILBOURNE HOLE HARZBURGITE XENOLITH

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Sulfides, while often present in volumetrically minor amounts (< 0.1 modal %; e.g.[1]) in the mantle, impart a strong control over many of the highly siderophile and strongly chalcophile elements, with the mass balance of some elements, such as Os, being almost completely controlled by heterogeneously distributed sulfide grains[2][3]. Hence, processes that re-distribute sulfides and / or alter their composition can have profound effects on the information preserved within them regarding primary mantle processes. Different generations of interstitial sulfide may partly or completely re-equilibrate with one another or may be exposed to open-system processes which mobilize and / or precipitate sulfides[4]. In mantle xenoliths in particular, supergene weathering at the Earth's surface can oxidize sulfide to soluble sulfate, and its removal affects the primary highly siderophile and strongly chalcophile element abundances [6].

Here we present the initial results from a study of mantle sulfides (n = 24) recovered from a single harzburgitic xenolith from Kilbourne Hole, NM. Large compositional differences are observed in the sulfides even at the scale of a single xenolith. Mono-sulfide solid solution has exsolved into two Fe-Ni-rich phases, one with a significantly larger Ni content for a given Fe abundance. Occurrences of Cu-rich sulfides are rare, but where present Cu can account for up to 22 weight % of the sulfide. Critically, no fresh, unaltered sulfides were recovered and in all of the sulfides there is evidence for at least two secondary processes. EDS mapping of the sulfides reveals pervasive but incomplete oxidation in all of the grains; Raman spectroscopy reveals this oxide to be goethite. In addition, there is also evidence for the interaction of many of the sulfides with a volatile-rich silicate melt. This melt has removed all evidence of the original sulfide mineralogy in some areas of the sulfide grain, leaving other areas virtually untouched. The degree of oxidation and sulfide-melt interaction varies from slight to almost complete alteration amongst the 24 sulfide grains. Critically, in some grains, the melt infiltration, which could be due either to metasomatism before the xenolith was entrained or occurred during transport to the surface, appears to cross-cut some of the oxidation features, i.e. at least some of the oxidation features appear to pre-date the melt-rock interaction. This makes it difficult to attribute all of the oxidation to supergene weathering and suggests that some of the oxidation occurred before melt-rock interaction and must therefore have occurred within the sub-continental lithospheric mantle.

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