New insights into sulfur-rich mantle metasomatism at Bultfontein, Kimberley

CHARLOTTE JACKSON[1]* AND SALLY GIBSON[1]

[1]Department of Earth Sciences, University of Cambridge, Downing Street, Cambridge, CB2 3EQ (*correspondence: cj340@cam.ac.uk)

Metasomatised regions of Earth's sub-continental lithospheric mantle potentially represent a large volatile reservoir. Nevertheless, the mechanisms involved in the storage and upward transport of volatiles such as C and S, from the convecting mantle and/or subducting slabs, are poorly understood. We have carried out a systematic micro-analytical study of a suite of sulfide-rich mantle peridotites from the Bultfontein diamond mine, Kimberley. EDS mapping of large (>2mm), interstitial base metal sulfides in the Bultfontein xenoliths has identified distinct Ni-rich regions (pentlandite). The Ni-rich sulfides are adjacent to olivine with Ni poor rims (<0.2 wt% NiO). Diffusion profiles between the protolith olivines and adjacent sulfides are used to estimate the timing of the S-rich metasomatic event. The presence of large unequilibrated olivine indicates that Ni-sulfides were introduced immediately prior to kimberlite emplacement. The calculated composition of melt in equilibrium with metasomatic clinopyroxenes in the Bultfontein sulphide-bearing peridotites shows a strong correlation to high-density carbonatitic fluids trapped in diamonds. This association is extended by the wealth of metasomatic sulfides in the Bultfontein xenoliths. Moreover, Ni-rich sulfides (~25 wt%) are the most common mineral inclusion in peridotitic diamonds, implying that diamonds crystallise from a S-saturated fluid. Many studies attribute the metasomatism at Bultfontein to silicate melts associated with the kimberlite, but we explore the possibility of metasomatism by reactive percolation of a volatile-rich agent with carbonatitic affinity. The S-rich nature of the metasomatism and the correlation with diamond high-density fluids has great implications for the transport of volatiles from the deep mantle to shallow regions of the craton.