Goldschmidt 2022 Abstract
https://doi.org/10.46427/gold2022.12610

Hydrothermal alteration in the upper crust of the Oman ophiolite: a 2D view below the seafloor

LARRYN W. DIAMOND

Institute of Geological Sciences, University of Bern

Presenting Author: diamond@geo.unibe.ch

Ongoing research in the upper crust of the Semail ophiolite is providing new insights into water–rock interaction at and deep below the seafloor. Re-mapping has confirmed the proto-arc origin of the ophiolite, where early MOR-type sheeted dykes and extrusives were covered by almost an equivalent volume of post-spreading-axis tholeiites and boninites. Satellite infrared images have yielded a >1000 km^2 map of the extent and intensity of several types of pervasive rock-matrix alteration. Spilite alteration due to reaction with heated seawater vastly dominates, in which ~80–100 vol.% of the rock matrix altered. Semail is thus the most intensely altered Tethyan ophiolite and is far more altered than most in-situ oceanic crust. This intensity may reflect heat retention by the thick (1–3 km) pile of extrusives, all of which erupted within just 1 Ma.

Epidosite alteration and its low-T Fe^{3+}-pumpellyite equivalent overprint the spilites, defining snaking fluid upflow paths with long subparallel segments up to 1 km^2 in cross-section, reaching from the base of the sheeted dykes to the top of the extrusives. However, their collective volume is merely ~2% relative to the spilites. Reactive transport simulations show that these flow paths enabled extreme fluid focusing at the crustal scale, with water/rock ratios of 700–40,000. Epidosite-forming fluids are apparently chemically evolved versions of spilite-forming fluids. All the dated epidosites are of post-axial age, suggesting that this evolution required an unusually thick, hot volcanic pile.

The role of alteration fluids in forming seafloor sulphide deposits is evident from elemental analyses of primary fluid inclusions trapped along fluid upflow paths at 1.5–3.5 km below the seafloor. Epidosite-forming fluids contain too little Fe and Cu to be plausible feeders of black-smoker vents. Hypersaline fluids exsolved from plagiogranite stocks are metal-rich, but too little of this fluid was released to explain the metal inventory in the known Semail sulphide deposits. In contrast, deep spilite-forming fluids at ~400–440 °C contain more Fe and Cu than modern black-smoker fluids. The abundance of spilite-forming fluids readily accounts for the metals in the deposits and therefore they are identified as the ore-bearing fluids.