Timing mismatch between VMS deposits and footwall epidosite alteration in the Semail Ophiolite

L. W. DIAMOND[1*] AND S.GILGEN[1]

[1]Institute of Geological Sciences, University of Bern, Baltzerstrasse 3, CH-3012, Switzerland (*correspondence diamond@geo.unibe.ch)

Epidosites (rocks metasomatically transformed to epidote + quartz + accessory hematite or magnetite) are thought to be products of extreme rock–water interaction and metal leaching deep in hydrothermal convection cells under active spreading ridges in mafic oceanic lithosphere [1] [2]. Discharge of the hydrothermal fluid on the seafloor produces volcanogenic massive sulfide (VMS) deposits. Thus, according to this genetic model, every VMS deposit is under-lain by epidosites at the base of the sheeted-dike complex.

The eastern margin of the Semail Ophiolite, Oman, constitutes a tilted section through a thick Sheeted Dike Complex (SDC) overlain by comagmatic ridge-related basalts (Geotimes and Lasail Units), in turn capped by younger supra-subduction zone basalts erupted in a nascent forearc setting (Alley and Boninitic Alley Units [3] [4]). All four volcanic units host VMS deposits [4]. Three small epidosites were previously known in the ophiolite [5], all situated at the base of the SDC in accord with the genetic model. However, our recent field work has identified dozens of other epidosite bodies up to 1 km^2 in extent, situated throughout the SDC and the Geotimes and Lasail lavas. Their cross-cutting relations with respect to dated magmatic and tectonic features show that all but one of them formed during the supra-subduction-zone volcanism at 95–94 Ma, some 1.5 Ma after cessation of ridge-related volcanism and formation of the SDC. The one exceptional epidosite formed during off-axis, transitional late-spreading (Lasail) volcanism. Thus, none of the epidosites is demonstrably synchronous with the main oceanic spreading event marked by formation of the SDC and the comagmatic Geotimes lavas, which host abundant VMS deposits. This clear mismatch in timing conflicts with the current genetic model and therefore questions the genetic relationship between footwall epidosites and the source rocks for metals in basalt-hosted VMS deposits.

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