

## Assessing magmatic volatile flux in ancient VMS systems

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The Troodos ophiolite hosts the on-land analogue for mafic, Cu-Zn (Cyprus-type) volcanogenic massive sulfide (VMS) mineralisation. Sulfide geochemistry and sulfur isotope analyses from 20 VMS deposits across the entire ophiolite highlight variations in ore forming processes that were previously undetected.

Laser ablation ICP-MS analysis of pyrite (n=1570) and chalcopyrite (n=200) from Troodos VMS show a significant enrichment in magmatic volatile elements in some VMS relative to modern seafloor analogues (e.g. TAG).

Sulfur isotope ( $\delta^{34}\text{S}$ ) analysis of sulfides (n=206) indicate that sulfur is sourced primarily through thermochemical seawater sulfate reduction and the leaching of igneous lithologies. However, we note significant variation between individual VMS deposits ranging from +8.0‰ to -3.4‰  $\delta^{34}\text{S}$  in pyrite. Such low  $\delta^{34}\text{S}$  values in pyrite have not been recorded in Troodos VMS or any ancient mafic hosted VMS deposit to our knowledge.

A sulfur isotope signature  $<0\%$  in pyrite is inconsistent with leaching of igneous lithologies (0-1‰) or the thermochemical reduction of Cretaceous seawater sulfate (17-18‰) as the primary source of sulfur. Furthermore, pyrite is enriched in elements with a magmatic volatile affinity like Se, Te and Au, demonstrating a robust link between magmatic volatile influx and the enrichment of Te, Se and Au in mafic VMS.

During the immature stage of hydrothermal sulfide accumulation VMS are enriched in Te, Se and Au with a  $\delta^{34}\text{S}$  signature  $<0\%$  that is progressively overprinted with a seawater signature during deposit maturation. This suggests that during the initial stages of VMS formation, in mafic supra-subduction zone VMS systems that metals are sourced primarily from a magmatic volatile phase and not solely through the leaching of igneous lithologies.