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THE CRITICAL ROLE OF MINERALS IN THE CARBON-NEUTRAL FUTURE

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ABSTRACTS

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Magma fertility in Brothers submarine volcano

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Submarine arc hydrothermal systems are considered to be modern analogues of fossilised volcanic-hosted-massive-sulfide deposits (VHMS) on land and also present similarities to shallow parts of porphyry-Cu and epithermal-Au deposits also occurring on land. Although there are numerous studies investigating the potential of a magma to form an economic deposit, known as "magma fertility", on arc magmas in subaerial systems, there is limited related information on submarine systems. The Brothers active submarine volcano, situated along the Kermadec arc, is one of the most well-studied systems and actively forming Cu-Zn-Au-rich black smoker chimneys (Cu_{max}= 36 wt.%). Recent studies suggested that Brothers represents a high sulfidation deposit on the seafloor with evidence for a magmatic input possibly due to an underlaying porphyry-Cu deposit providing a fertile source for metals and magmatic volatiles.

Here we investigate the source and transport of Cu and Au as well as the magma efficiency to concentrate these metals in order to produce the known VHMS deposit at Brothers. Bulk metal contents from newly acquired fresh dacitic samples collected from the caldera wall by an ROV yield ranges for Cu = 1.4-40 ppm and Au = 0.6-1.5 ppb, comparable to other known porphyry-related magmatic systems. Meanwhile, magmatic sulfides (≤500 µm), found in the lavas and in unusually sulfide-rich enclaves (~20 area%), are composed of mainly pyrrhotite and chalcopyrite (Cu<24 wt.%) and often show sulfide-oxide replacement textures. Preliminary results suggest that although sulfides have sequestrated metals in depth, rendering the residual magma Cu-Au-poor, sulfide dissolution in shallower levels, lead to metal release back to the system causing a later metal enrichment of the exsolving fluids. Future LA-ICP-MS on melt inclusions will help constrain better the initial Cu and Au contents of the system.

Ore-forming conditions at the Gorno MVT district, Lombardy, Italy

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The stratabound, carbonate-hosted Pb-Zn-Ag (± fluorite ± barite) deposits of the Gorno mining district extend over ~600 km^2 in the Orobic Alps, Lombardy, Northern Italy. The district has classically been described as an "Alpine-type" Pb-Zn deposit, a subclass of Mississippi Valley Type (MVT) deposits. Its genesis is still debated. Multiple events affected the Lower Carnian stratigraphic succession, resulting in variable styles of host rock alteration and sulfide mineralization. High-grade sulfide ore is hosted in the 5-10 m thick basal unit of the Gorno Formation, consisting of a laminated marl and siltstone lithozone, historically known as "black shales". Other major orebodies are hosted in the 50-100 m thick Breno Formation, composed of light-coloured, thick-bedded peritidal limestones and in the 20-50 m thick Calcare Metallifero Bergamasco, composed of dark-coloured, medium-bedded peritidal limestones.

In situ U-Pb isotope analyses were performed on sulfide-associated carbonates, revealing an average lower intercept age of 229.2 ± 2.9 Ma, i.e. slightly younger than the depositional age of the host rock (~237-232 Ma). This represents the first geochronological data for the district, indicating mineral deposition during early diagenesis at relatively shallow burial depth. Microthermometric data from sphalerite and fluorite suggests an evolution from high salinities (up to ~25 eq. wt% NaCl) towards lower salinities (typically <10 eq. wt% NaCl). The homogenization temperatures do not vary significantly, ranging between ~80 and 120 °C and do not show a correlation with salinity. Additionally, micro-Raman spectroscopy revealed the presence of methane in primary fluid inclusions.

The spatial association of sulfide bodies to organic-rich shales supports a lithological control of ore deposition. Clay-rich beds with organic carbon or associated hydrocarbons are hence proposed to have acted as reactive barriers that caused reduction of the metal-bearing hydrothermal fluids migrating along fault and fracture systems.