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Critical raw materials in VMS deposits

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important for environmental and sustainable technologies (e.g. renewable energy industries). These metals include, among others, V, Co, Ga, Ge, In, Sb, Sb, Bi, and the PGE together with other elements e.g. Ag. They commonly occur at low concentrations in volcanic-associated massive sulfide (VMS) and Broken-Hill-Type (BHT) deposits and can potentially be extracted as a by-product. To assess the potential viability of this, it is essential to gain deeper knowledge on how and where the CRM are hosted in sulfide deposits, with which major sulfide minerals they are associated and how they occur in these sulfides (e.g. solid solution versus micro- or nano-inclusions).

Many previous studies were limited to either specific sulfide minerals, specific types of ore deposits or a limited range of elements of interests. Within this study we analyzed a total of 26 trace elements in all coexisting sulfide minerals in 10 samples from 7 deposits resulting in over 700 LA-ICP-MS spot analyses and additional LA-ICP-MS trace element maps.

It is well established that the source for the metals in VMS deposits is the host rock and this is a major control on the sulfide assemblages deposited. While hydrothermal fluids involved in the formation of VMS deposits associated with mafic and ultramafic rocks are enriched in Cu, Fe, Co, Se, and Ni, fluids in back-arc and volcanic arc settings are enriched in Pb, As, Sb, and Ag. On land mined VMS deposits are (almost always) metamorphosed and high pressure and temperature conditions can cause recrystallization processes including the redistribution of trace elements among different sulfide phases. During the metamorphic process, fluids can modify the existing sulfide assemblage and lead to the depletion or enrichment of specific trace elements (e.g. high transport potential for Co in metamorphic fluids).

Our results show that concentrations of critical raw metals in VMS deposits are highly controlled by the host rock. Metasomatic fluids can lead to an enrichment of specific trace elements, e.g. Co, at high metamorphic grade.