An attempt to quantify element mobility during hydrothermal alteration in Bergslagen with a regional least altered database, Sweden

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The Bergslagen district in central Sweden hosts iron oxide, base metal sulphide deposits as well as less common ore types including Bastnäs-type REE-deposits. Most of the deposits are hosted by a bi-modal (dominantly felsic) volcanic succession and with interbedded limestone units. Many of the deposits are surrounded by strong, regional hydrothermal alteration in the country rock. It is believed that these hydrothermal alteration zones are genetically related to the ores and that they have served as source for metal-rich fluids, leaching certain elements from the country rocks, at least in some of the deposits (De Groot and Baker 1983; Lagerblad and Gorbatschev 1985; Jansson and Liu 2020). Investigations into mass change during hydrothermal alteration commonly use mass balance calculations comparing altered rocks with least altered equivalents to quantify metal depletion during hydrothermal alteration. Critical to this is the identification of least altered samples from the same area and rock-type. However, in many areas where hydrothermal alteration is intense, unaltered, or even "least altered" samples are difficult to find and furthermore, different definitions of least-altered rocks are used in the literature which causes a problem for reproducibility and comparison of the alteration styles in different areas.

This study presents a regional least altered sample database with 134 high quality, low detection limit major and trace element geochemical analyses of metavolcanic and granitic samples which were selected based on a clear set of criteria. The dataset includes samples from western Bergslagen (Hjulsjö area), Utö, the Riddarhyttan area Falun (Kampmann et al., 2017), Garpenberg (Jansson et al., 2013) and Sala (Jansson, 2022). The Hjulsjö area is particularly well suited due to good exposure of relatively low metamorphic grade (greenschist) felsic volcanic rocks, and variable degrees of Na-, K- and Mg-style hydrothermal alteration. It has been the location for a number of previous studies of hydrothermal alteration (i.e., De Groot & Baker 1983; Hallberg, 2003). The area also highlights the relationship between felsic volcanic rocks and co-magmatic granites that can help approximate a least altered felsic volcanic compositions in areas where least altered equivalents of the felsic volcanics are lacking (Hallberg, 2003; Kampmann et al., 2017).

The geochemical compositions of the least altered dataset reveals a consistent magmatic differentiation trend across all studied areas, supporting the notion of a magmatic source of similar composition across the Bergslagen district. A comparison of background metal concentrations in the different regions shows geographical variations. Interestingly western Bergslagen where relatively few and small polymetallic sulphide deposits have been found stands out with particularly low background base metal concentrations. This may suggest that differences in primary fertility of different volcanic centers in Bergslagen presented a first order control on the composition and abundance of ore deposits in the region.

References

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