Alteration and mass balance calculation at the Rävliden North VMS deposit, Skellefte district, Sweden

Filip Simán[a], Nils Jansson[a], Tobias Hermansson[b], Foteini Liwicki[c], Mac Fjellerad Persson[b], and Erik Nordfeldt[b]

[a]Department of Civil and Environmental Engineering, Luleå University of Technology, Luleå, Sweden, filip.siman@ltu.se; nils.jansson@ltu.se; [b]Exploration Department, Boliden Mineral AB, Boliden, Sweden, tobias.hermansson@boliden.com; [c]Department of Computer Science, Electrical and Space Engineering, Luleå University of Technology, Luleå, Sweden, foteini.liwicki@ltu.se

Mass balance calculations of mobile elements in hydrothermally altered zones is a powerful means for understanding alteration processes and vectoring in on mineral deposits (MacLean & Barrett 1993). However, its successful application is subject to uncertainties and several sources of error, such as, 1) sampling errors, 2) analytical errors, 3) choice of least-altered samples, 4) the robustness of the fractionation line, and 5) the certainty in the determination of precursor compositions. This study aims to gauge the effects of these errors on calculated mass changes, using the 1.9 Ga Rävliden North volcanic massive sulphide (VMS) deposit in the Skellefte district, Northern Sweden, as a case study.

The Rävliden North VMS deposit is a recent Zn-Pb-Ag-Cu discovery in the Palaeoproterozoic Skellefte district. A regional lithostratigraphic contact between the metavolcanic Skellefte group (SG) rocks and metasiliciclastic Vargfors group (VG, Allen et al. 1996) rocks is recognised at Rävliden North. Regionally, VMS deposits occur at this contact, hence it is crucial for mineral exploration. However, the contact is complex due to polyphase deformation and recognising lithofacies is difficult due to alteration and amphibolite facies metamorphism.

Stratigraphically, the Rävliden North deposit is located in the lower portion of the Rävliden formation in the top of the SG. The host rocks are Qz-Ser schists and locally graphitic phyllite, where the former has a rhyolitic precursor. Lithogeochemistry suggest that these are calc-alkaline rhyolites with volcanic arc signatures. However, significantly, the footwall and hanging wall rhyolites show differences (Rhy III and Rhy I), and both are different from stratigraphically deeper undifferentiated SG rhyolites (Rhy II). Rhy III has higher Al_2O_3/TiO_2 ratio than Rhy I, and Rhy II has lower Zr/Al_2O_3 and Zr/TiO_2 than both Rhy I and Rhy III. The upper portion of the Rävliden formation comprises a complex volcanosedimentary succession with different facies of metaandesite, metadacite and metarhyolite overlain by breccia-conglomerates with clast populations originating from underlaying lithologies.

The alteration envelope to the deposit is zoned with an inner strong to intense Chl±Tlc alteration and calc-silicate assemblages, and an outer moderate to intense Qz-Ser alteration. To gauge the effects of the aforementioned errors, this study tests different scenarios for parameter 3) and quantifies the confidence of mass balance calculations that is a function of errors 1), 2), 4) and 5).

Selecting least-altered samples is commonly done qualitatively and with arbitrary lithogeochemical criteria, leading to variation in what is considered least-altered. This study defines key alteration minerals (Qz, Ser, Cal, Chl and Tlc) and assesses their abundance on a five-grade scale. For different scenarios, more or less tolerance on this scale can be permitted. As for lithogeochemical criteria, the tolerance for Na depletion and loss on ignition is adjusted.

By testing different scenarios for least-altered sample choice and following error propagation with confidence intervals at each stage in mass balance calculation, the different mass changes in the Rävliden North stratigraphy can be mapped. In doing so, these error sources can be managed to improve ore vectoring.

References

Allen, R.L., Weihed, P. & Svenson, S., 1996: Setting of Zn-Cu-Au-Ag Massive Sulfide Deposits in the Evolution and Facies Architecture of a 1.9 Ga Marine Volcanic Arc, Skellefte District, Sweden. *Economic Geology 91*, 1022–1053.

MacLean, W.H. & Barrett, T.J., 1993: Lithogeochemical techniques using immobile elements. *Journal of Geochemical Exploration 48*, 109–133.