Snow geochemistry as a mineral exploration tool – Example from Saramäki Cu-Co-Zn deposit, eastern Finland

Pertti Sarala

Oulu Mining School, University of Oulu, 90014 Oulun yliopisto, Finland
pertti.sarala@oulu.fi

One of the newest sample materials used in mineral exploration is snow. Exogenic geochemical signal formed into the snow can be used in analysis of the elemental composition of underlying bedrock and tracing the potential mineralizations in the bedrock (e.g., Taivalkoski et al. 2019). The method is based on the so-called Mobile Metal Ion (MMI) theory, in which metal ions from mineralisation in the bedrock migrate through the surficial part of the bedrock and transported cover. In summer, metal ions accumulate in the surficial soil horizons although some part continue migration into the air together with carbon dioxide and water vapour as well as various volatile hydrocarbons. Even in winter, the movement continues, but the gases and ions accumulate in the bottom layers of snow cover (in the areas where snow cover exists), where they adhere and bind to snow crystals.

The lower part of the snow cover serves as the best ion binding layer, since the geochemical signal accumulation time is the longest, and the upper layers of snow protect against atmospheric contamination during the winter. In addition, the lowest layer is in contact with the ground and is affected by gases and heat from the underlying soil and bedrock. In the northern regions, snow covers the ground surface for several months a year, so the method is usable on moderately large areas of the Northern Hemisphere and mountainous areas. Snowfall and snow properties are regionally constant, which provides a good basis for extensive and comparable geochemical exploration.

During the winter 2022-2023 snow geochemistry was tested in a sulfide Cu-Co-Zn mineralization in Saramäki, eastern Finland. The mineralisation is a fault-controlled, hydrothermally altered, vein-type and/or VMS-type deposit which is within ultramafic rocks related to the Outokumpu association (GTK 2024). The deposit has small suboutcrop under till cover, but the main body (thickness 5-15 m) is dipping towards east in 25º angle. In this snow geochemistry project two sampling lines were planned to cross transversally the deposit in 200 m distance. The first line crossed the suboutcrop part of the deposit, and the second line in the area where the deposit should be located about 100 m depth from the surface. Snow sampling was carried out three times for one winter period: 1st time at the end of December after about 1 month since the permanent snow was coming to the area, 2nd at the end of February, i.e., about three months from the beginning of snow season, and 3rd time in the middle of April. In each times samples were collected from the bottom part (10-20 cm from the soil surface) and during the other two times also from upper snow layer (30-40 cm). Snow samples were collected directly into acid-treated plastic cans and stored and also delivered to the laboratory as frozen. Samples were analysed using HR-ICP-MS analyser in the mineralogical laboratory of the Geological Survey of Finland in Espoo.

Preliminary results clearly indicate that the known Cu-Co-Zn deposit is seen snow geochemistry. For example, Cu, As, Fe, Pb, S, Ti concentrations are the highest above the sulfidic deposit in both lines during each sampling periods. Particularly, sulfur gave nice anomalous pattern on top of the deposits. Furthermore, there was also strong elevation of the element concentration over the fault structure separate from the sulfidic deposit in the bedrock. The results also prove that the concentrations are clearly lower in the higher level of snow (i.e., 30-40 cm) than the lower layer. This confirm the assumption that the best sampling layer for snow samples to get the strongest geochemical signal is the lower part (10-20 cm) of the snow package. In addition, pH value patterns support the geochemical patterns.

There are also evidences that certain hydrocarbons in the snow can be used in tracing the mineralization in the bedrock (Taivalkoski et al. 2019). For this testing the replicate snow samples were collected and stored to be analyzed for hydrocarbons. This is still waiting confirmation for the extra funding. The project has got funding from the R.H. Renlund's Foundation.

References

GTK (2024). Saramäki - Mineral deposit report. Geological Survey of Finland. Available at: https://tupa.gtk.fi/karttasovellus/mdae/raportti/113_Saram%C3%A4ki.pdf

Taivalkoski, A., Sarala, P., Lahaye, Y., Lukkari, S. & Sutherland, D. (2019). Snow in mineral exploration - examples and practices in glaciated terrain. Journal of Geochemical Exploration 200, 1-12. doi:10.1016/j.gexplo.2019.01.006