Chalcophile geochemistry of the Ni-Cu-PGE mineralised 2.05 Ga conduits in the Karasjok Greenstone Belt, northern Norway

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The Karasjok Greenstone Belt (KGB) extends from the Norwegian coast in the north into Finland, where it is called the Central Lapland Greenstone Belt (CLGB). This belt represents one of the most substantial Palaeoproterozoic volcano-sedimentary formations within the Fennoscandian Shield (Hanski and Huhma, 2005). Within the CLGB, numerous ore bodies are present, particularly magmatic Ni-Cu-PGE deposits linked to a magmatic event around 2.05 Ga. Notable examples include the Kevitsa, Sakatti, Lomalampi and Hotinvaara deposits. These deposits are associated with komatiitic magmatism, resulting in mineralisations within both intrusive conduits and extrusive counterparts. However, past research indicates that the komatiites in the Karasjok region display lower concentrations of chalcophile elements compared to the Finnish belt segment (Fiorentini et al., 2011). This suggests that the melts equilibrated with sulphides en route, again implying a potential for unidentified mineralisations associated with the conduit system. In the Karasjok region, several smaller bodies, such as the Karenhaugen (c. 0.04 km^2), Porsvann (c. 0.3 km^2) and Gállojávri (c. 2.3 km^2) intrusions, exhibit anomalous Ni-Cu-PGE contents. Recent dating confirms the age of the Gállojávri and Porsvann intrusions to be around 2.05 Ga (Hansen et al., 2023; Orvik et al., 2022b). Petrogenetic modelling suggests that Gállojávri served as a conduit for local komatiites, a scenario likely applicable to Karenhaugen and Porsvann (Orvik et al., 2022a). In this study, we present chalcophile geochemistry for the 2.05 Ga intrusive bodies and whole rock S isotopes for the Gállojávri intrusion in the KGB. After adjusting for silicate fractionation, unmineralised rocks exhibit enrichment in chalcophile elements compared to mantle background values, indicating the potential of a prospective system. The Karenhaugen and Porsvann intrusions show enrichment with respect to mantle-normalised $(Cu/Pd)_N$ ratios, with medians of 0.20 and 0.16, respectively. In contrast, Gállojávri is slightly depleted with a median $(Cu/Pd)_N$ of 2.32. All intrusions show S/Se-ratio ranges below mantle values, but low S content and Se detection limits may affect the results. For the Gállojávri intrusion, whole rock $\delta^{34}S$ ranges from 1.5 to 4.0‰. The lower-than-mantle S/Se-ratios and mantle-overlapping $\delta^{34}S$-ratio of Gállojávri are challenging to reconcile with significant S addition from country rocks. However, high sulphide-to-silicate ratios (i.e., R-factors) may obscure contamination effects. In Cu vs. Pd plots, the intrusions follow two different trends. The Karenhaugen and Porsvann intrusions align with a trend suggesting formation from a mantle source initially enriched in Pd, while Gállojávri follows a trend indicating either a slightly depleted source or the removal of cotectic sulphides before emplacement. We favour the latter scenario, as it aligns with previous models suggesting significant lower-crustal fractionation before Gállojávri's emplacement. This suggests that the Porsvann and Karenhaugen conduits represent more efficient transport of enriched melt to the upper crust. Our findings highlight that small-scale intrusions with characteristics supporting a dynamic conduit-like system should be considered as potential exploration targets within the KGB.

References

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