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Linking Vegetation Geochemistry to Buried Ore Systems through High-Resolution Isotopic Analysis: Insights from Sr and Pb isotopes on volcanogenic massive sulfide (VMS) deposit at the Saramäki, Finland

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Identifying concealed/deep-lying mineral deposits from surface medium remains challenging, as geochemical indicators may reduce in strength with increasing depth and be hidden by complex overlying cover terrains. The DeepBEAT project (Deep exploration BoostEd by Advanced Exploration Technologies) addresses this challenge by developing next-generation, environmentally responsible geochemical exploration strategies that are tightly integrated with geophysical data, mineral systems analysis, and societal considerations. The principal aim is to improve the sensitivity, precision, and interpretive framework of geochemical signals in surface media particularly vegetation, soil/till, and biological materials to detect the distal and proximal geochemical footprint of concealed ore systems.

Queen's University (Canada) contributes to DeepBEAT by advancing biogeochemical and isotopic methods to enhance the sensitivity and interpretation of surface geochemical signals. Using Triple Quadrupole ICP-MS (TQ-ICP-MS), ultra-trace elemental and isotopic analyses are performed on vegetation samples. These methods are tested across three different mineral systems. In this study, we focus on the Saramäki volcanogenic massive sulfide (VMS) deposit.

Employing Sr and Pb isotope methods in surface media, including vegetation, may provide an effective approach for detecting concealed mineral systems, as isotopic signatures of hydrothermal fluids and metal sources can be transmitted through overburden and recorded in near-surface environments [1,2]. In VMS deposits, Sr isotopes help trace the source of ore-forming fluids and their interactions with surrounding rocks during hydrothermal alteration, while Pb isotopes serve as potential tracers of crustal and mantle processes. Vegetation (biogeochemical) sampling is a well-established and efficient method for mineral exploration. Analyzing Sr and Pb isotopes in surface plant samples provides a non-invasive, environmentally friendly, and cost-effective way to explore buried deposits, improve vectoring toward ore systems, and reduce exploration risk prior to drilling. DeepBEAT project is funded by the European Union's Horizon Europe research and innovation actions programme under Grant Agreement 101177617.[1] Cameron, E. M., Hamilton, S. M., Leybourne, M. I., Hall, G. E. M., & McClenaghan, M. B. (2004), Finding deeply buried deposits using geochemistry, *GEEA*4, 7–32.[2]Kyser, K., Lahusen, L., Drever, G., Dunn, C., Leduc, E., & Chipley, D. (2015). Using Pb isotopes in surface media to distinguish anthropogenic sources from undercover uranium sources. Géoscience, 347(5-6), 215-226.