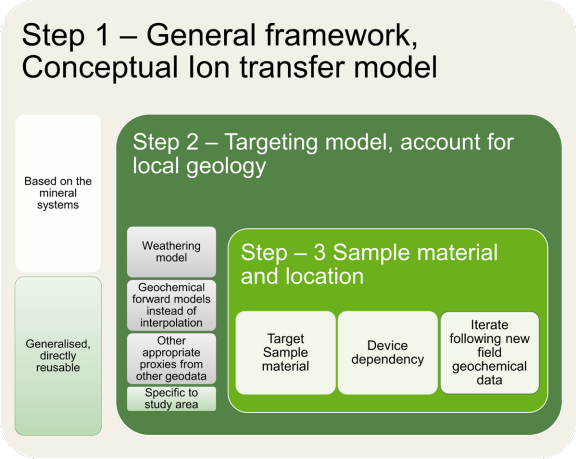
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Spatially Explicit Predictive Modelling to Enhance Detection of Subtle Surficial Geochemical Anomalies

MALCOLM ARANHA[1] AND SOLVEIG POSPIECH[2]

[1]Helmholtz-Zentrum Dresden-Rossendorf e.V.
[2]Helmholtz-Zentrum Dresden-Rossendorf, Institute for Resource Ecology, Bautzner Landstr. 400, DE-01328 Dresden, Germany



Exploration for deeply buried mineral deposits presents a critical challenge, as surficial geochemical signatures are often weak, discontinuous, and overprinted by complex regolith and glacial processes. Traditional geochemical survey designs rely on uniform grid-based sampling or heuristic strategies that may not adequately capture subtle anomaly patterns related to deep-seated ore systems. In this contribution, we explore the application of predictive modelling, initially developed for mineral potential mapping, to optimise surficial geochemical sampling strategies.

Predictive modelling frameworks integrate diverse geoscientific datasets to quantify spatial probabilities of mineralisation. By adapting these methods to surface sampling design, we generate spatially explicit models that highlight areas where subtle geochemical responses are most likely to be detectable. Key inputs include lithological, structural, and geophysical data, combined with surficial geology, pre-existing surficial geochemistry and geomorphological information that control secondary dispersion. A fuzzy overlay model is employed to predict zones of high sampling value, potentially accounting for structural controls, host-rock alteration, and glacial transport directions. These predictions are used to design flexible, non-uniform sampling grids that prioritise coverage in areas with the highest potential for capturing mineral-related anomalies.

The Saramäki deposit, located in Central Finland, is an Outokumpu-type volcanogenic massive sulfide (VMS) deposit where sulphide mineralisation is hosted in altered black schists and serpentinites, largely at depth, with only subtle, discontinuous geochemical anomalies detectable at the surface. The model output highlights favourable sampling locations potentially based on structural trap sites. The sampling locations will be tested during the upcoming field campaign, where freshly collected field geochemical responses from pXRF and LIBS data will be live-fed to the model to update it continuously.

If successful, this approach would facilitate the integration of geochemical data with other exploration layers, enabling iterative refinement of predictive models and sampling strategies as new data are acquired, while remaining cost-effective.

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