Geophysical Research Abstracts,
Vol. 11, EGU2009-11319, 2009
EGU General Assembly 2009

Assessment of hydrothermal processes associated with Proterozoic mineral systems in Finland using self-organizing maps.

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An increasingly urgent challenge in mineral system analysis is to extract relevant information from diverse datasets, and to effectively discriminate between "hydrothermal noise" and alteration and structures that may relate to significant mineralization potential. The interpretation of geophysical data is notorious for the problem of ambiguity in defining source dimensions and geometry. An additional issue, which also applies to geochemical and hyperspectral datasets, in terrain that has been overprinted by several tectonic, metamorphic and hydrothermal events, is that while anomalies represent the sum of geological processes affecting an area, we are usually interesting in extracting the signals diagnostic of a mineralizing event. Spatial analysis using weights of evidence, fuzzy logic and neural networks have been widely applied to mineral prospectivity assessment in recent years. Here however, we present an alternative, albeit complementary approach, based on the concept of self-organizing maps [1], in which natural patterns in large, unstructured datasets are derived, correlated and readily visualized, provides an alternative approach to analysis of geophysical and geochemical anomalies and integration with other geological data.

We have applied SiroSOM software to airborne and ground magnetic, EM and radiometric data for two mutually adjacent areas in eastern Finland that have superficially similar structural architecture and geophysical expression, yet differ significantly in terms of mineral system character: (1) the Outokumpu Cu-Co-Zn-Ni system, hosted by metamorphosed serpentinites and their hydrothermal derivatives, which are usually highly magnetic due to both magnetite and pyrrhotite; (2) the Hammaslahti Cu-Zn system, hosted by coarse-clastic turbidites intercalated with mafic volcanics and graphitic pelites having characteristically intense magnetic and EM responses. Although the initial stage of the analysis is unsupervised, ongoing iteration and reflection on the significance of clustering allows progressive refinement and enhancement of subtle differences, leading to delineation of specific areas whose attributes correspond closely to those associated with known mineralization. In the Hammaslahti test area, there appears to be good agreement between the results of the SiroSOM evaluation with areas currently targeted as prospective on the basis of a priori geological knowledge.

[1] Kohonen, T., (2001): Self-Organizing Maps. 3rd Extended Edition, Springer Series in Information Sciences, Vol. 30, Springer, Berlin, Heidelberg, New York, 1995,1997, 2001.