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Identification of appropriate depth interval of high resolution targeting till data in Finland for mineral exploration

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The targeting till geochemical data set of Finland was collected during 1970s by the Geological Survey of Finland (GTK). It covers central Lapland, some areas in Ostrobothnia and eastern Finland. Targeting till geochemistry survey samples comprise soil samples collected by GTK along sampling lines in 1971–1983 and the point density of soil sampling varies between 6–12 samples/km². The line interval is 500–2000 metres, and the point interval 100–400 metres. In total, there are 385 000 samples and from those samples, 191 559 locate in the Central Lapland. The samples were collected using percussion drilling with a flow-through bit and the sampling depth varies greatly, having on average 2 metres, where the maximum depth is 25.3 metres, and the minimum depth is 0.1 metres. A size fraction < 0.063 mm was sieved from the samples, and the concentrations of 17 chemical elements were analysed with an emission quantometer (EKV). As this data set contains elemental concentration for different depths, the aim of this study was to find the best suitable depth interval for finding orthomagmatic deposits. Thus, specific area from central Lapland was selected to study the depth profile of the samples. After data pre-processing, elements with acceptable quality were selected for further analysis emphasising on the elements those associate with orthomagmatic deposits. Then two methods for choosing the appropriate depth intervals were used. First, by detecting changes in both variance and/or mean. Second, choosing one metre intervals. These were then compared to see which method results in better outcome. For this comparison fuzzy logic was first used. Selected elements for fuzzy logic and their membership function were based on the detected correlation between elements by performing principal component analysis (PCA). Furthermore, PCA determined elements groups. Three groups were recognised, these were 1) Mg-Cr-Ni, 2) Fe-Cu-Co with inverse Na-K values, and 3) Mn-V-Ti. Based on predicted maps generated in ArcGIS 10.8.1 for identified depth intervals, the depth range 1.7m to 3.6m demonstrated the highest potential to detect orthomagmatic mineral deposits. Compared to one metre interval approach where 2 m interval demonstrates the highest potential for deposits. Receiver operating characteristics (ROC) and area under the curve (AUC) were ultimately used to determine which of these approaches had the highest potential for exploration.