Effects of Hydrous Alteration on the Distribution of Base Metals and Platinum Group Elements Within the Kevitsa Magmatic Nickel Sulfide Deposit

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Platinum group elements (PGE) and nickel are widely used as petrogenetic indicators in ore deposits and their host rocks, which have commonly been subjected to hydrothermal alteration, particularly in the case of Precambrian terranes and greenstone belts. These elements (PGE and Ni) are commonly assumed to be immobile in most conditions, especially during low temperature hydrothermal alteration. However, only a small number of studies have rigorously tested this assumption, and there is good evidence to indicate that PGE and Ni can be mobile under specific circumstances. The conditions favorable for hydrothermal modification of originally magmatic abundances of Ni and PGEs are poorly known, and very few studies to date have systematically investigated their mobility. This study aims to address that deficit by investigating distributions of these elements in fresh and unaltered rocks from a well-characterized, homogeneous disseminated sulfide orebody that has undergone a variety of styles of localized alteration.

The 2.06 Ma Kevitsa mafic-ultramafic intrusion, located in the Central Lapland greenstone belt, and host to disseminated Ni-Cu-(PGE) sulfide mineralization in its center, has been the subject of many studies, providing good constraints on its geometry, internal compositional variations in base metals and PGE, intensity and distribution of the various hydrothermal alteration styles, and on the main structures possibly affecting the system. Therefore, the Kevitsa Ni-Cu-(PGE) sulfide ore body provides an ideal natural laboratory to study the behavior of base metals and platinum group elements (PGE) during low temperature alteration.

The mineralization, which contains a range of Ni, Cu and PGE grades in texturally homogeneous disseminated ores, is affected by three main types of alteration (amphibole, serpentinite and epidote-rich), and is cross cut by various types of veins. The effect of the circulation of hydrothermal fluids on the distribution of base metals and PGE was studied at two different scales. Interrogation of an extensive deposit-wide assay database provided information on the deposit-scale (kilometer scale) effect of these different alteration styles. Whereas a detailed study, involving laboratory X-ray fluorescence (XRF), portable XRF and micro-XRF mapping of drill-core samples containing centimeter-scale cross-cutting veins provided information on the small scale (centimeter to decimeter scale) remobilization of base metals and PGE.

Combining the results of detailed-scale and mine-scale study leads to the conclusion that magmatic processes are the source of most of the variance observed. This study concludes that hydration and carbonation of the Kevitsa mineralized mafic-ultramafic intrusion did not significantly affect the distribution of Ni and PGE at scales larger than a few millimeter, and that Cu and Au are the only metals that are affected by small to large scale remobilization from centimeter to kilometer scale.