# NSERC-CMIC Mineral Exploration Footprints Research Network: Data Integration for the Next Generation of Mineral Exploration Models

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## OUTLINE

*The objectives of the Mineral Exploration Footprints Network are to: 1) enhance the ability of the Canadian mining industry to recognize the "footprints" of ore systems from high-grade cores to most distant cryptic margins, 2) develop methods that truly integrate (not just layer) the multi-scale 3D geological-structural-lithological-mineralogical-geochemical-petrophysical-geophysical data that define ore system footprints, and 3) develop workflows to assist researchers and industry explorationists to more effectively interact to accomplish these goals. Multi-disciplinary teams from 18 Canadian universities and 23 mining companies are defining the hydrothermal-magmatic footprints of the Canadian Malartic disseminated Au deposit, the McArthur River and Millennium U deposits, and the Highland Valley porphyry Cu deposit. New and reprocessed/QAQC-controlled geological, structural, whole-rock geochemical, mineral chemical, hyperspectral, petrophysical, geophysical, and multi-media surficial data have been collected for each site along cross and long sections. The new data were collected from the same samples in order to facilitate comparison of different data types and data integration. All data have been interrogated within self-consistent 3D Common Earth Models (CEMs) that allow researchers to define which parameters are most useful in identifying deposit footprints. Cutting-edge data analytics not normally used in mineral exploration have been used determine spatial data clusters and to generate rules defining how the data interact to identifying subtle footprint characteristics. Joint and constrained geophysical inversions have been developed to separate hydrothermal footprint signatures from background lithologies, using not only petrophysical data, but proxies derived from other data sets. The results have been combined within CEM space to define new exploration indices. Although method development work has been restricted to data dense rock volumes centered on cross- and long sections through the research sites, allowing researchers to maximize recognition of interrelationships between commonly disparate data sets (e.g., potential field versus point data), the results will then be applied to more sparsely populated rock volumes in order to recognize and understand the full extent of the ore system footprints. To date the "composite"hydrothermal-magmatic footprints have been defined in 2D at the Canadian Malartic and Highland Valley sites and in three dimensions at the Millennium-McArthur site. At Canadian Malartic multiple alteration halos have been defined using geochemical-mineral chemical-hyperspectral-petrophysical data not only in the host metasedimentary rocks, but also in associated mafic dikes, which provide a greater geochemical contrast and are therefore a more sensitive indicator of ore-related alteration. At Millennium innovative processing techniques are being developed to extract physical property information from legacy 3D-3C seismic data to identify alteration and vertical structures, and fusion of geochemical and 3D pole-pole resistivity data will characterize how host rock resistivity varies as a function of alteration intensity and mineralization. At Highland Valley feldspar staining, visible-near IR spectral analysis, multi-element ICP analysis, and petrologic methods have been integrated with detailed geologic-structural-vein mapping to extend the known alteration footprint out to ~10 km from the mineralized centres. NSERC-CMIC Exploration Footprints Network Contribution #105.*