Controls on the localization and timing of mineralized intrusions within the ca. 1.1 Ga Mid-Continent Rift system

DA Liikane[1] , W Bleeker[2], M Hamilton[1], S Kamo[1]

[1]Department of Earth Sciences, University of Toronto, Toronto, Ontario; [2] Geological Survey of Canada, Ottawa, Ontario;

The 1.1 billion-year old Mid-Continent Rift (MCR) represents one of the largest and best-preserved Precambrian intra-continental rift systems, dominating the geology of the Lake Superior region. The failed rift comprises thin basal sediments, a major flood basalt sequence and associated mafic to ultramafic intrusions, and a final sequence of rift-filling sediments. The MCR is host to the second largest layered intrusion in the world (Duluth Complex), which contains significant low-grade mineralization of Ni-Cu-Co and platinum group elements (PGEs), and possibly reef-style PGE mineralization. Numerous mineralized intrusions are associated with the MCR on both sides of the border (e.g., Coldwell Complex near Marathon, Ontario, Tamarack near Duluth, Minnesota, Eagle near Marquette, Michigan), with many actively being explored by a number of companies. Major scientific questions to be resolved as part of this new PhD thesis project include: 1) What processes and structures are responsible for the localization of mineralized intrusions within the MCR, and 2) how do these intrusions relate temporally and spatially to the overall evolution of the MCR and its various magmatic pulses. The key to answering these research questions lies in the synthesis of new fieldwork, geochemistry, geophysics, tectonic studies, and, importantly, high resolution U-Pb geochronology. Modern high-precision U-Pb geochronology, on single, chemically-abraded magmatic zircon crystals, offers the potential to radically improve overall age accuracy and provide sub-million-year age resolution. This has the capability to resolve, with high fidelity, the ages of different intrusive pulses and temporally link them to distinct stages of the flood basalt sequence and to the overall rift evolution. It may also establish a temporal framework for the Ni-Cu-PGE prospectivity of MCR intrusions, whereby mineralized intrusions may be precisely linked to specific intervals of time (temporal vector) throughout the life of MCR magmatism. Furthermore, if there proves to be a relationship between age and geographic distribution of mineralized intrusions, this could be used as a spatial vector for mineral exploration.