Linking Crustal Growth to Orogenic Gold and Ni-Cu-PGE Mineralization Using U-Pb Geochronology in Zircons in the Marmion Terrane (3.0 Ga), Western Superior Craton, Canada

Katarina Bjorkman,[1*] Yongjun Lu,[1] T. Campbell McCuaig,[1] Peter Hollings,[2] and Gary Beakhouse[3]

[1]Centre for Exploration Targeting and ARC Centre of Excellence for Core to Crust Fluid Systems (CCFS), School of Earth and Environment, The University of Western Australia, M006, 35 Stirling Highway, Crawley, WA 6009, Australia

[2]Centre of Excellence for Sustainable Mining and Exploration, Department of Geology, Lakehead University, Thunder Bay, Ontario, P7B 5E1.

[3]Earth Resources and Geoscience Mapping Section, Ontario Geological Survey, Sudbury, Ontario, P3E 6B5.

*E-mail, katarina.bjorkman@research.uwa.edu.au

Orogenic gold and Ni-Cu-PGE mineralization are linked to crustal evolution using U-Pb isotopes in zircons coupled with field investigations in the Marmion Terrane (MT; 3.02 – 2.68 Ga), south-central Wabigoon Superterrane (3.4 – 2.7 Ga), Western Superior Craton, Canada. Several lithotectonic domains comprise the MT, which is dominated by tonalite-trondjemite-granodiorite (TTG) intrusive complexes and gneisses with minor elongate Meso to Neoarchean greenstone belts. Much of the external boundaries of the MT are cryptic in geology and geophysics, obscured by post-tectonic plutons. The MT hosts Au, Ni-Cu-PGE, Zn-Cu-Ag and Fe mineralization.

Uranium-Pb age determinations by SHRIMP show that the MT preserves near-continuous magmatism with coupled greenstone growth from 3.02 – 2.68 Ga. Age peaks occur at ~2.685, 2.73, 2.93, and 3.0 Ga. Inheritance in some 2.93, 2.90 and 2.74-2.68 Ga granitic rocks indicates both reworking and magmatic addition at these times. Lack of measured inheritance in 3.0 and 2.78–2.83 Ga rocks suggests periods of crustal growth. Zircons from intrusions along the margins of the terrane, as well as along a proposed internal boundary, typically display more than one age population in addition to inherited xenocrysts and/or cores and increased disturbance resulting in lead loss and greater discordance. This reflects focusing of younger thermal events along terrane boundaries. The semi-continuous magmatism requires a tectonic mechanism such as ongoing subduction or a long-lived oceanic plateau which imply continuous recycling of crust versus slow to stagnant plates, respectively. Structural observations along the western MT boundary support subhorizontal compression at 2.7 Ga, which may support subduction at this time.

Gold occurs dominantly within the older phases proximal to steep age gradients of the TTG Marmion Intrusive Complex (MIC), including the 10.7 Moz Hammond Reef deposit, which is proximal to a postulated internal terrane boundary. In contrast to geochronology by TIMS, results of SHRIMP U-Pb isotopes show that the MIC contains phases aged 3.02, 2.93, 2.90, 2.89, 2.825, 2.74, and 2.68 Ga. Mapping the steepest age gradients and younger thermal events has potential to illustrate prospective lithospheric architecture for TTG-hosted gold mineralization.

Nickel-Cu-PGE mineralisation is localised in the gabbroic to monzodiorite phases of late mantle-derived intrusions (LMDI) with a Sanukitoid affinity, including the Campbell Zone of the Entwine Intrusive Complex (EIC). The LMDI cluster along proposed lithospheric breaks in the Marmion Terrane but occur throughout the Western and Eastern Wabigoon Terranes and the Quetico Basin. Measured inheritance >3.0 Ga northwest of the EIC has shifted the boundary with the Western Wabigoon Terrane

westward. Therefore ancient MT basement underlies the mineralised EIC, indicating that ancient terrane margins may be prospective architecture for Sanukitoid-hosted Ni-Cu-PGE. Future work will test if the Lac Des Illes Pd mine and Quetico Ni-Cu intrusions are also underlain by MT basement.

Analysis of Hf-O isotopes on the dated zircons is currently being pursued. These data will show the parts of the study area that are juvenile through time, allow discrimination of mixing between juvenile and older components, better pinpoint terrane boundaries and provide additional insight into relationships to Au, Ni-Cu-PGE, Pb-Zn, and Fe mineralisation.