Saskatchewan Geological Society Lecture

Friday, October 20, 2017

METALLOGENY AND MAGMATISM OF THE 1.1 Ga MID-CONTINENT RIFT

Dr. Peter Hollings

2017-2018 Howard Street Robinson Lecturer, Mineral Deposits Division, Geological Association of Canada

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Artful Dodger, 1631 – 11th Avenue, Regina

Lunch: 11:45 am
Meeting Talk: 12:15 to ~1:00 pm
For lunch, the cost is:
S.G.S Members: $15.00
Student Members: $5.00
Non-members: $20.00
For those members not having lunch, the talk is free.
Please contact Mike Thomas at mike.thomas@sasktel.net or 306-457-7002
by 12:00 pm, Wednesday, October 18 if you plan on having lunch.

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*Dr. Hollings will be giving a 2nd talk to U. of Regina Geology at 3:00 pm that same afternoon. Contact Tsilavo Raharimahefa for location, tsilavo.raharimahefa@uregina.ca.

ABSTRACT

The ~1.1 Ga Midcontinent Rift (MCR) is widely accepted to have formed above an upwelling mantle plume. Recent geochemical and geochronological studies have revealed a previously unrecognized complexity that has implications for the petrogenesis, metallogeny and origin of the rift.

The MCR is host to a wide range of mineralization styles, including both hydrothermal and magmatic systems (Miller and Nicholson, 2013). MCR-related hydrothermal deposits include: 1) native copper and silver deposits in basalts and interflow sedimentary rocks (e.g., Keweenaw Peninsula, Michigan; 2) stratabound copper sulfide and native copper in clastic sedimentary rocks (e.g., White Pine Mine, Michigan); 3) copper sulfide veins and lodes hosted by volcanic rocks (e.g., Coppercorp Mine, Ontario; and 4) polymetallic, silver-bearing veins around Thunder Bay (e.g., Silver Islet, Ontario). MCR-related hydrothermal activity is also thought to have remobilized pre-existing metals in older rocks, generating lead-zinc-barite veins and uranium-bearing veins and breccias northeast of Thunder Bay. Magmatic deposits in MCR igneous rocks include: 1) low-grade Cu-Ni-PGE sulfide deposits hosted by predominantly gabbroic rocks of the Duluth and Coldwell complexes (e.g., Mesaba, Nokomis, Minnesota; Marathon, Ontario); 2) stratiform, PGE-enriched “reef” intervals in layered mafic intrusions (e.g., Seagull, Ontario; Tamarack, Minnesota), 3) high-grade, Ni-Cu-PGE-bearing sulfide deposits in ultramafic intrusions (Eagle Mine, Michigan; Current Lake, Ontario); 4) Ti-Fe(-V) oxide-rich ultramafic intrusions in the Duluth Complex (e.g., Longnose and TiTac deposits, Minnesota); 5) U-REE in diatremes and carbonatites (e.g., Dead Horse Creek and Prairie Lake complexes, Ontario); and 6) Cu-(Mo)-bearing breccia pipes (e.g., Tribag deposits, Ontario).

Geochronologic data, published in the past 10 years, have yielded significantly older ages than previously recognized (ca. 1120 Ma; Heaman et al., 2007, Hollings et al., 2010 and Dunlop, 2013). This implies that MCR magmatism spans at least 30 million years (i.e., ca. 1120 to 1090 Ma) and possibly longer, considerably longer than is typical for the Large Igneous Provinces (LIPs) which are characterized by short-duration magmatism (less than 1–5 My; Ernst et al., 2013). Recent, detailed geochemical studies have shown that the intrusive and extrusive rocks of the MCR north of Lake Superior comprise a complex suite of rocks derived from a heterogeneous mantle source. Early, PGE-mineralized ultramafic intrusions are among the most geochemically and isotopically primitive rocks in the MCR, although the olivine chemistry of those rocks suggests a parental magma with 8-10 wt% MgO (e.g. Goldner, 2011); younger mafic intrusions are less commonly mineralized. The geochemical evolution of magmatism in the northern MCR suggests that source of magmatism for the rift became more depleted through time.

The long duration of MCR magmatism, the absence of primary ultramafic magmas and the lack of a radiating dike swarm collectively suggest that a passive rifting model may be more appropriate for the rift. According to this model, rifting of the Superior Craton, possibly in response to a newly recognized global LIP event, enabled upwelling of material underplated by earlier plume events thought to have been centered in the vicinity of the present-day Lake Superior (e.g. the Marathon LIP, Halls et al., 2008). Ongoing research seeks to elucidate the timing, nature and tectonic setting of MCR magmatism and its associated mineral deposits.

BIO

Dr. Hollings completed his Ph.D. at the University of Saskatchewan in 1998 where he investigated the geochemistry of the 2.7-3.0 Ga Uchi Subprovince from Red Lake to Pickle Lake. During a two-year NSERC funded postdoctoral fellowship at CODES Dr. Hollings participated in a multi-disciplinary research project investigating the genesis of giant copper-porphyry deposits in Chile. As a faculty member at Lakehead University since 2001, Dr. Hollings is continuing his research into the relationship between igneous petrogenesis and mineralisation in Northwestern Ontario, the Philippines and S America. He has published more than 75 peer-reviewed papers on these topics. Hollings is currently the Chair of the Department of Geology and Director of the Centre of Excellence for Sustainable Mining and Exploration, both at Lakehead University. He was appointed an Associate Editor of Mineralium Deposita in 2017.
