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Miscellaneous Release—Data 370

Geochemical Analyses of Rocks in the Central Wabigoon Superterrane, Northwestern Ontario

by K.E. Bjorkman and P. Hollings

This publication can be downloaded from
http://www.geologyontario.mndm.gov.on.ca/mndmaccess/mndm_dir.asp?type=pub&id=MRD370

This digital data release consists of brief sample descriptions, location data and whole-rock analytical data for 282 rock samples collected as part of the PhD thesis by the senior author at the University of Western Australia (Bjorkman 2017). The descriptions and data are provided as 1 Microsoft® Excel® 2013 (*.xlsx*) workbook (with 4 worksheets for sample descriptions and locations; major element data; trace element data; and abbreviations), and 2 portable document format (*.pdf*) files (analytical quality-control data; and readme (this document)). The results are summarized in this readme document. Location data are provided in the Universal Transverse Mercator (UTM) projection and grid system, Zone 15N, North American Datum 1983 (NAD83). Rock samples were analyzed by the Geoscience Laboratories, Ontario Geological Survey, Sudbury, in 3 separate batches. The data are available on 1 CD.

The following files are provided.

MRD370_Central-Wabigoon-Superterrane_Geochemistry.xlsx consists of 4 worksheets.

- "Table 1 sample descriptions" worksheet contains information about 279 samples collected by the senior author in 2013 and 2014 for whole-rock geochemical analyses as part of the PhD thesis study. This worksheet also contains sample identification ("Sample ID"), sample description ("Rock Name", "Rock Suite", "Description") for each sample collected, and the sample location data ("Longitude", "Latitude", "UTM Easting", "UTM Northing", and "Terrane"); Universal Transverse Mercator (UTM) co-ordinates are provided in North American Datum 1983 (NAD83), Zone 15N.
- "Table 2 major elements" worksheet contains 292 whole-rock major oxide geochemical analyses (including analyses of 11 sample splits) acquired from samples collected as part of this study. The geochemical analyses were performed using wavelength dispersive X-ray fluorescence (XRF) spectrometry at the Geoscience Laboratories (Geo Labs), Ontario Geological Survey, Sudbury. Analyses were conducted using method code XRF-M01; the lower detection limit for each analyte is included.

“Table 3 trace elements” worksheet contains 293 whole-rock and assay geochemical analyses (including analyses of 11 sample splits) acquired from samples collected as part of this study. The geochemical analyses were performed at the Geoscience Laboratories (Geo Labs), Ontario Geological Survey, Sudbury. The methods used, lower detection limit for each method, and reported units for each method are included for each element listed.

“Abbreviations” worksheet provides an explanation of the abbreviations and analytical methods used in the “Table 1”, “Table 2” and “Table 3” worksheets.

MRD370_QualityControlData_Table4.pdf describes the quality control results of the duplicate samples analyzed for whole-rock geochemistry by the Ontario Geological Survey Geoscience Laboratories.

Abbreviation used in *MRD370_QualityControlData_Table4*	**Definition**
DUP	duplicate
ICP-AES	inductively coupled plasma atomic emission spectrometry
ICP-MS	inductively coupled plasma mass spectrometry
ID	identifier
INST	in-house standard (followed by abbreviated identifier of the standard)
INTL	international standard (followed by abbreviated identifier of the standard)
ppb	parts per billion
ppm	parts per million
SP	after sample ID indicates a separate split of the sample
Std	standard
wt.%	weight percent

Summary of Results

The bimodal geochemistry and dome-and-keel structure of granite–greenstone terranes of Archean cratons contrasts with the chemistry and structure of post-Archean terranes (e.g., Kamber 2015). Consequently, a long-standing debate continues over the generation of Archean crust (e.g., Bédard 2018). Source compositions, geodynamic and magmatic processes leave a physiochemical fingerprint on igneous rocks. Therefore, as the main constituents of Archean cratons, the geochemistry of felsic to intermediate intrusive rocks have the potential to shed light into crust formation processes and source compositions.

This digital data release is a compilation of whole-rock geochemical analyses for 282 bedrock samples in, and proximal to, the central Wabigoon superterrane in northwestern Ontario. The rocks were collected during the 2013 and 2014 field seasons as part of the senior author’s PhD thesis, which focussed on a chemical and isotopic investigation into the crust–mantle evolution of the western Superior craton. Sampling targeted felsic to intermediate intrusive rocks, but also included geochemical analyses of several metavolcanic and metasedimentary samples and several types of mineralization, including orogenic gold, magmatic-hosted copper-nickel-cobalt-platinum group elements (PGE), and base metal zinc-copper-lead-silver. Sampling density reflects a) regional spaced coverage of felsic to intermediate intrusive rocks to enable meaningful spatial interpolation, and b) more detailed coverage of complex areas with potential to unveil the crust–mantle evolution and metallogenic endowment. Geological descriptions of the study area are reported in Bjorkman et al. (2013, 2014).

The spatially comprehensive geochemical data set of felsic to intermediate intrusive rocks of the Wabigoon superterrane, western Superior Province, reported herein, highlighted 3 broad felsic to intermediate intrusive rock suites: i) the tonalite–trondhjemite–granodiorite (TTG) suite, ii) the late granite-to-granodiorite suite, and iii) the sanukitoid suite (*see* Chapter 3 *in* Bjorkman 2017). The TTG suite in the study area has a broad range in trace element geochemistry, suggesting a range in melting and/or fractionation depths from garnet-stable pressures, indicated by strongly fractionated heavy rare earth elements (HREE), high Sr/Y and high sodium; to plagioclase-stable pressures, indicated by shallow to flat HREE patterns, lower sodium and aluminum and lower

Sr/Y. The TTG rocks with a garnet signature do not show correspondingly high Mg number, and nickel and chromium contents. This chemistry favours TTG generation at varied depths with little mantle contribution.

In contrast to the pre-tectonic TTG suite, the high-potassium post-tectonic sanukitoid suite has very high compatible (e.g., Mg, Ni, Cr) and incompatible (e.g., REE, large ion lithophile elements (like Sr, Ba, Pb)) element abundances. In spite of rock compositions that range from diorite to syenogranite, sanukitoid rocks show tightly grouped patterns on multi-element diagrams, with steep REE and very high Sr/Y. The steep REE (including steep HREE) and high Sr/Y suggest garnet-present and plagioclase-absent melting and/or early fractionation. Highly compatible element abundances suggest a mantle contribution. High PGE contents and occasional layers of increased copper-nickel-PGE sulphides make sanukitoids a target for magmatic sulphide ores.

The high-potassium post-tectonic granite-to-granodiorite suite shares some similarities to the sanukitoid suite, with large variations in rock type and in MgO and SiO_2. However, rocks of the granite-to-granodiorite suite have distinct trends from sanukitoids on Al_2O_3 versus SiO_2 and La/Sm versus SiO_2 diagrams. They also have negative Eu/Eu*, high Rb/Sr, high thorium and uranium contents, and low CaO and MgO contents compared to sanukitoid rocks. Low CaO and negative Eu/Eu* suggest plagioclase-present melting and /or fractionation. Higher Rb/Sr, and thorium and uranium contents support a petrogenesis that involves infracrustal melting, which is also inferred from TTG inclusions observed in the field.

The geochemistry of these rocks samples, when mapped spatially, highlights the distribution of the 3 rock suites outlined, with high-potassium, magnesium, nickel and chromium of the post-tectonic (ii and iii) suites standing out against the pretectonic TTG (i) suite. Moreover, structurally significant boundaries, such as major faults and interpreted terrane margins, are highlighted by transitions in the chemical data, suggesting such boundaries demark changes in melting depths, and acted as fluid pathways to concentrate magmas at the craton scale.

The geochemical data of the igneous rocks reported herein were integrated with multi-isotopic measurements in zircons to investigate Archean crust formation as part of the senior author's PhD thesis (*see* Bjorkman 2017). The links between the crust–mantle evolution and mineral system distribution of the western Superior Province were also investigated to highlight possible predictive tools for ore targeting (Bjorkman et al. 2015). Magmatic sulphide mineralization is found proximal to interpreted terrane boundaries. Gold mineralization is localized along terrane boundaries, but also is also found internal to terranes, proximal to major secondary faults.

Acknowledgments

The rocks analyzed herein were collected as part of the senior author's (KEB) PhD thesis (2013–2017) at The University of Western Australia (Bjorkman 2017). The thesis investigated the crust–mantle evolution through time and space using a combination of geochemical and multi-isotopic analyses of igneous rocks within or proximal to the Wabigoon superterrane, western Superior Province, northwestern Ontario.

The Ontario Geological Survey funded all whole-rock geochemical analyses (Project Unit 13-030) reported herein. The field work expenses for 2013 were covered by the Australian Research Council Centre of Excellence for Core to Crust Fluid Systems (Research Program 2: Genesis, transfer and focus of fluids and metals). A Graduate Research fellowship granted by the Society of Economic Geologists Foundation Inc. supported 2014 field work. The University International Stipend (UIS) and UIS top-up scholarships funded living costs for KEB.

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