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Miscellaneous Release—Data 345

Geochemistry of the Mesoproterozoic Wolfcamp Lake basalts, northwestern Ontario

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This publication can be downloaded from
http://www.geologyontario.mndm.gov.on.ca/mndmaccess/mndm_dir.asp?type=pub&id=MRD345

This digital data release includes whole-rock and trace element analyses for 34 samples from the Mesoproterozoic Wolfcamp Lake basalts of the Midcontinent Rift, northwestern Ontario. The geochemical data are provided in a Microsoft® Excel® 2010 (*.xlsx*) workbook file. A general description of the units sampled is also provided. These results form part of an Honours BSc thesis study that was a collaborative project between Lakehead University and the Ontario Geological Survey.

This release comprises 1 Microsoft® Excel® 2010 (*.xlsx*) workbook file that consists of 2 worksheets. Worksheet "Geochemical Data" includes major and trace element geochemical data, brief sample descriptions, and location data provided in Universal Transverse Mercator (UTM) co-ordinates in Zone 16, NAD83. Worksheet "Abbreviations" contains explanations for all of the abbreviations used in worksheet "Geochemical Data". All analyses were performed at the Geoscience Laboratories, Ontario Geological Survey, Sudbury, Ontario. Analytical methods are described in detail in the GeoLabs brochure, which is included on this release.

Files on this Release

MRD345_Readme.pdf	(this document) Summarizes the geochemistry results, provides a brief interpretation of the data and includes field notes of the rocks sampled for this study.
MRD345_Geochemistry.xlxs	Contains results of the major and trace element geochemical analysis, brief sample descriptions, and location data.
2015 Geo Labs Brochure.pdf	Geoscience Laboratories' schedule of fees and services, providing information on the analytical methods used by Geoscience Laboratories for this study.

Summary

This readme file summarizes the geochemistry results and provides a brief interpretation of the data. A total of 34 samples were collected from surface exposures in order to characterize the petrology and geochemical footprint of the Wolfcamp Lake basalts and place them within the context of the North American Mesoproterozoic Midcontinent Rift (MCR).

The Wolfcamp Lake basalts have been linked with other MCR volcanic rocks, such as the Coubran Lake basalts and the Osler Volcanic Group along the north shore of Lake Superior. The Wolfcamp Lake basalts are exposed in 2 main areas bisected by the Trans-Canada Highway (Highway 17) northwest of Marathon, Ontario. They are surrounded by syenite and other alkaline intrusive rocks of the Coldwell Complex (Walker et al. 1993). The entire package of basalt is exposed in an area approximately 2 km wide (east-west) and 4 km long (north-south). There is one large exposure northeast of the Trans-Canada Highway east of Wolfcamp Lake and a second exposure south of the highway. The latter crops out as large cliffs, railway cuts and outcrops on the north shore of Lake Superior near Port Munroe. Flow thicknesses are generally 2 to 4 m with variations present locally. The main rock type consists of basalt flows that are dominantly ophitic or subophitic. The mineralogy is dominated by feldspar (primarily plagioclase), olivine and pyroxene. Alteration minerals, including hornblende, sericite, chlorite, biotite and opaque minerals (primarily magnetite), are present in all samples at concentrations from 3% up to 40%.

All of the samples of the Wolfcamp Lake basalts show very consistent trace element geochemistry with ocean-island basalt (OIB) characteristics on primitive mantle normalised extended element diagrams. On these diagrams they are characterised by negative zirconium, hafnium and titanium anomalies, but with no negative niobium anomalies.

The Wolfcamp Lake basalts are broadly similar to the nearby Courban Lake basalts (Cundari et al. 2012), but when compared in detail to the Coubran Lake basalts, the Wolfcamp Lake basalts lack the strong negative niobium anomaly displayed by the Coubran Lake basalt types A and B, which have been interpreted to be the result of crustal contamination (Cundari et al. 2012). The Wolfcamp Lake basalts also have lower Mg numbers and Ni and Cr contents than the Coubran Lake basalts, indicating that the former are more evolved (Cundari et al. 2012, 2016). This suggests that the Wolfcamp basalts are uncontaminated MCR magmas despite their more evolved compositions.

Additional details on the geochemistry and geological significance of the Wolfcamp Lake basalts can be found in Davis (2016), Davis, Hollings and Cundari (2016), and Cundari et al. (2016).

Acknowledgments

The work reported herein forms part of an Honours BSc thesis study conducted by Sarah Davis (Lakehead University) and supervised by Dr. Pete Hollings (Lakehead University) and Rob Cundari (Ontario Geological Survey). This study was a collaborative project between Lakehead University and the Ontario Geological Survey. The authors thank the Geoscience Laboratories, GeoServices Section, Ontario Geological Survey (OGS) in Sudbury for in-kind support in the analysis of rock samples for whole rock geochemistry.

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FIELD NOTES

NOTE: Field work was done by Rob Cundari, all field descriptions are taken directly from R. Cundari's field notes. All UTM co-ordinates are in Zone 16, NAD83.

Section One: Vertical Cliff

WL-RC-01 is possibly from a different, overlying flow than 02 and 03 (speculative).

Samples WL-RC-04 through WL-RC-15 are from a transect from top to bottom of a near vertical sequence of flows. The exposure is present on the east side of Wolfcamp Lake and is approximately 15 to 20 m high. Material in the majority of the section is fractured and/or jointed at relatively sharp angles. This sequence of samples is likely stratigraphically lower than samples WL-RC-01 to 03. Flow contacts were not always clear, and appear to be tilted to the south (or possibly just "draped" at that locality, giving a tilted appearance). Samples represent individual flows, dike features or material adjacent to later syenite intrusions. A set of 2 prominent syenite dikes crosscut the flows on the north end of the cliff sections. Sample WL-RC-14 was collected with the goal of testing any possible interaction between the volcanic rock and the syenite. Note that sample WL-RC-14 lies stratigraphically between WL-RC-11 and WL-RC-12.

WL-RC-01 - 541658E 5405575N

Fine-grained, massive, grey-blue volcanic rock; no relict textures. Outcrop on southwest facing cliff. Three samples taken at this locality. WL-RC-01 is highest in succession.

WL-RC-02 - 541658E 5405575N

Fine-grained, massive, grey-blue volcanic rock with small 2 cm plagioclase laths or phenocrysts. Sample taken from top of 2.5 m high, competent cliff face approximately 5 m below WL-RC-01

WL-RC-03 - 541658E 5405575N

Fine-grained, massive, grey-blue volcanic rock. Sample taken from bottom of 2.5 m high cliff face, approximately 2 m below WL-RC-02

WL-RC-04 - 541674E 5405406N

Fine-grained, massive, grey-blue volcanic rock; no relict textures. Sample taken near top of cliff sequence (approximately 1 m below top of exposure and 1 m above possible flow contact.

WL-RC-05 - 541674E 5405406N

Sample taken from laminated or layered material. Possibly an interbedded sediment but more likely a fractured flow top? Very fractured and/or fissile material. Syenite "bleb" intruded along upper contact between "bedded" material and overlying, massive flow.

WL-RC-06 - 541674E 5405406N

Fine-grained, grey-blue. Sample taken from small, 10 to 30 cm wide dike that appears to feed thin tabular flow or sill (tabular flow or sill not sampled as it was not accessible).

WL-RC-07 - 541674E 5405406N

Fine-grained, massive, grey-blue volcanic rock. Sample taken from lower portion of a thick, approximately 3 m thick flow adjacent to a small dike (WL-RC-06).

WL-RC-08 - 541674E 5405406N

Fine-grained, massive, grey-blue volcanic rock. Sample taken from very top of flow; separate from and immediately below WL-RC-07.

WL-RC-09 - 541674E 5405406N

Fine-grained, massive, grey-blue volcanic rock. Sample taken from middle of flow, approximately 2 m below WL-RC-08.

WL-RC-10 - 541674E 5405406N

Fine-grained, massive material. Sample taken from vertical dike (approximately 60 cm wide).

WL-RC-11 - 541674E 5405406N

Fine-grained, massive, grey-blue volcanic rock. Sample taken from around bluff, approximately 3 m lower in stratigraphy from WL-RC-09.

WL-RC-12 - 541674E 5405406N

Fine-grained, massive, grey-blue volcanic rock. Sample taken from lowermost exposed material on presently exposed section of cliff.

WL-RC-13 - 541666E 5405393N

Fine-grained, massive, grey-blue volcanic rock. Sample taken from separate outcrop, approximately 15 m south and lower in stratigraphy than WL-RC-12. Rock appears more bulbous and less angular than samples above. More primitive?

WL-RC-14 - 541674E 5405406N

Samples taken from volcanic material directly adjacent to the crosscutting syenite dike. Sampled to test interaction with syenite (elevated light rare earth elements?). Stratigraphically in between samples WL-RC-11 and WL-RC-12.

WL-RC-15 - 541677E 5405129N

Fine-grained, massive, grey-blue volcanic rock; large outcrop on road east of Wolfcamp Lake with small seams of syenitic material throughout. Possibly same (or close to same) stratigraphic level as WL-RC-13.

Section Two: Railroad Traverse

Samples WL-RC-16A though WL-RC-23B represent a transect from west to east along the rail line. The rail line cuts across the southern portion of the Wolfcamp Lake volcanic rocks south of Highway 17. Sampling starts on the west end of the Wolfcamp Lake volcanic rocks, just north of Craddock Cove. Volcanic material is generally homogenous (fine-grained, grey-blue in colour) and variably amygdaloidal with a greater abundance of amygdules present toward the tops of flows. Flows appear to be westward dipping toward the western extent of the unit, becoming relatively flat-lying towards the centre and generally thinner and eastward dipping toward the eastern extent of the unit. A syenite dike and “blebs” intrude the volcanic rocks along fractures and flow contacts and appear to be more abundant toward the western portion of the unit. Carbonate material was also observed locally at flow contacts. Two large-scale faults bisect the unit. Volcanic rocks appear more altered, fractured and structurally disturbed adjacent to these structures. Be careful with stratigraphic interpretations of

samples adjacent to these structures as relative position of flows may be affected. Care should also be taken between groupings of samples where flow contacts were certain.

WL-RC-16A - 540847E 5402326N

Two distinct flows present at this locality (WL-RC-16A and 16B). Flows dip approximately 10° southwest. Samples taken from upper flow, approximately 1 m above contact with lower flow. Minor amygdules present (approximately 4 mm diameter).

WL-RC-16B - 540847E 5402326N

Sample taken from the upper portion of the lower flow. Exposure is heavily weathered (tough to find fresh material). Abundant amygdules.

WL-RC-17A - 541068E 5402451N

Four possible, successive flows present here although lower flow (sample WL-RC-17D) not definitive (i.e., no obvious contact between WL-RC-17C and 17D). Located approximately 300 m east of WL-RC-16B. Likely stratigraphically lower than WL-RC-16A and 16B. Samples taken from uppermost flow in exposure. Individual flows appear to be approximately 3 to 4 m thick and dip approximately 10° west-southwest.

WL-RC-17B - 541068E 5402451N

Sample taken from middle of flow, a fine-grained, massive, grey-blue volcanic rock; amygdules present toward top of flow (chlorite and actinolite). Syenite dike intruded along flow contact.

WL-RC-17C - 541068E 5402451N

Lower in sequence than WL-RC-17A and 17B. Sample taken approximately 20 m east of WL-RC-17B and likely successively lower than 17B. Flows present east of this location appear to flatten out with exposure present for approximately 200 m. This area represents “cusp” of unit where flows present west of here dip west and flows present east of here dip east.

WL-RC-17D - 541068E 5402451N

Flows continue east and are generally flat-lying with localized dips and troughs. Sample likely from lower flow relative to WL-RC-17C but no definitive contact observed. Fine-grained, grey-blue with reddish stain. Abundant amygdules. NOTE: major structure present just east of WL-RC-17D outcrop. Flows and samples east of WL-RC-17D may be out of sequence (be careful).

WL-RC-18A - 541254E 5402805N

Flows are difficult to distinguish. Major apparent bedding appears to dip east. Syenite material is abundant through outcrop (dikes, wisps, blebs and veinlets). Sample is very amygdaloidal (small, quartz and/or /calcite infilling). Watch for geochemical variances. Samples WL-RC-18A, 18B and 18C are systematic, approximately 40 m apart from west to east. Flow contacts are not obvious through this section. Flows appear to dip westward so sample 18A through 18C represent samples up section.

WL-RC-18B - 541265E 5402833N

Sample from approximately 40 m east of previous. Fine-grained, homogenous, very fresh volcanic material.

WL-RC-18C - 541290E 5402851N

Sample from approximately 40 m east of previous sample. Fine-grained, homogeneous, very fresh volcanic material.

WL-RC-19A - 541532E 5402890N

Outcrop on north side of rail line. No distinct flow contacts but a "stepped" ridge suggests that there may be a flow contact here. No measurable dip. Sample from higher than WL-RC-19B. Fine-grained, homogenous, very fresh volcanic material with small (approximately 4 mm chlorite-filled amygdules). Abundant syenite material present throughout outcrop as wisps and veins.

WL-RC-19B - 541532E 5402890N

Samples from lower ledge, approximately 2 m below WL-RC-19A representing possible lower flow. Fine-grained, fresh volcanic material. Abundant syenitic material present throughout outcrop as wisps and veins.

WL-RC-20 - 541629E 5402898N

Approximately 100 m east of previous samples. Isolated outcrop with no flow contacts present. Fine-grained, homogenous, fresh volcanic material, amygdaloidal. NOTE: crossed over major, northwest-trending structure that trends along east side of main Wolfcamp Lake basalt unit. This structure represents the more easterly of the two structures. Generally, material between the two structures appears to have a great syenitic and/or potassic influence and/or alteration.

WL-RC-21 - 542016E 5402850N

Approximately 80 m of exposure. Flows appear very thinly bedded (approximately 20-30 cm) and steeply dipping approximately 40° east. Material is heavily fractured with abundant syenite veins and dikes with potassic fluid alteration. Sample is taken from thickest flow toward the centre of the exposure. Fine-grained, unaltered, very fresh volcanic material.

WL-RC-22 - 542065E 5402835N

Outcrop approximately 40 m east of previous sample. Distinct, heavily fractured flow present between WL-RC-021 and 022 but appeared too altered to sample. Outcrop dips approximately 45° east. Sample is from an approximately 60 cm thick competent flow with little alteration.

WL-RC-23A - 542252E 5402830N

Sample is from uppermost part of a 5 m thick flow (of the 2 obvious flows present). Massive, fine-grained, volcanic rock. Joints appear steeply dipping. Tough to distinguish flows due to jointing apart from the 2 main obvious flows sampled.

WL-RC-23B - 542252E 5402830N

Sample from massive, fine-grained, flows beneath distinct contacts between upper massive flow (WL-RC-23A).

Section Three: Other Samples

WG-RC-01 - 536917E 5404810N

Sample taken from the south side of Highway 17. Western gabbro. Intruded into Coldwell Complex centre II syenite. Possibly a gabbroic plug. Breccia zone present immediately west of sample location, breccia has a syenite matrix.

WG-RC-02 - 525079E 5404783N

Middleton copper occurrence (MDI42D15SE00016). Western gabbro sample west of the Little Pic River fault.

LP-RC-01 - 527493E 5405523N

Little Pic River (magmatic) breccia. Coldwell Complex centre II nepheline syenite matrix hosting possible volcanic fragments. Sample taken from fine-grained, mafic volcanic-looking fragment that is vesicular or amygdaloidal. No syenite material present on sample (clean volcanic fragment).