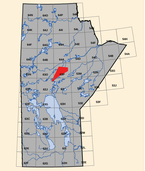
Results from bedrock mapping in the Pikwitonei granulite domain, central Manitoba

C.G. Couëslan (Manitoba Geological Survey) and J.A. Macdonald (University of Manitoba)

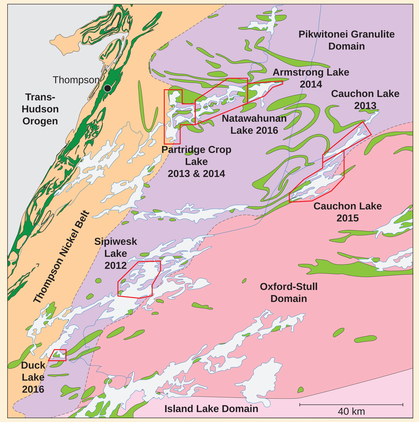


Regional Geology

The Pikwitonei granulite domain (PGD) is situated along the northwestern margin of the Superior province of Manitoba. It is bounded to the north and west by the Superior boundary zone, and to the southeast by the granite-greenstone belts of the Superior province. The northern and western boundaries are defined by the limit of tectonic and metamorphic overprint of the Trans-Hudson Orogen, while the southeast boundary is defined by an orthopyroxene-in metamorphic isograd.

The PGD is dominated by tonalitic gneiss with minor belts/domains of mafic granulite, which made up the roots of an orogenic zone at ca. 2.7–2.6 Ga. The rocks were buried to depths of 26–33 km and heated in excess of 750 °C. The granulite-facies metamorphism obscured the protolith of many of the rocks in the region. Because of this the PGD has historically seen little exploration activity. Although mineral exploration can be challenging in high-grade metamorphic domains, granulite domains in Australia are host to several world-class mineral deposits such as Broken Hill, the largest lead-zinc mine in the world.

A project to re-map portions of the PGD with emphasis on protolith interpretation has been ongoing since 2012. Mapping has been conducted on Cauchon, Sipiwesk, Duck, Armstrong, Natawahunan, and Partridge Crop lakes, and has demonstrated the presence of volcanic and sedimentary rocks that can be correlated with economically prospective rocks from the adjacent Oxford-Stull domain. In addition, economically prospective supracrustal rocks have been recognized that do not correlate with any known sequences in the Superior province of Manitoba.



Volcanogenic massive sulphide potential

Evidence for subaqueous mafic volcanism is relatively common in the PGD. Pillowed basalt is recognized on Cauchon and Duck lakes where the rocks are of lower strain and metamorphic grade. Local bands of iron formation are intercalated with basalt in all of the map areas and indicates exhalative sedimentation was contemporaneous with volcanism. Local zones within the volcanic rocks are enriched in ferromagnesian and aluminous minerals such as anthophyllite, cordierite, garnet, and aluminosilicates, and are interpreted as zones of sub-seafloor hydrothermal alteration. In all cases, the high-grade, peak metamorphic mineral assemblages and deformation fabrics indicate that hydrothermal alteration occurred prior to high-grade metamorphism. The volcanic package on Cauchon Lake appears to be correlative with the VMS prospective Oxford Lake group of the northwestern Superior Province.

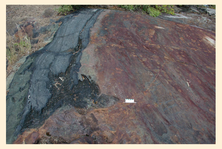
Cauchon Lake

Pillowed basalt flows in the southern basin of Cauchon Lake.

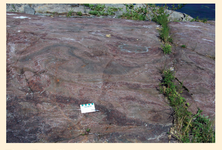
Band of sulphidic exhalite in basalt. Similar rocks have returned assays with up to 472 ppm Cu, 637 ppm Zn, and 180 ppb Au.

Garnet- and sillimanite-rich schist interpreted as a zone of intense chlorite-sericite alteration of a volcanic protolith. An assay of an adjacent gossan yielded 2170 ppm Cu and 324 ppm Zn.

Partridge Crop Lakes



Gossanous zone in mafic volcanic rocks yieled an assay of 819 ppm Cu.



Garnetite in Fish Bay likely represents a zone of quartz-chlorite alteration; a gossanous portion yielded an assay of 593 ppm Cu.

Preserved boudin of basalt in an orthopyroxene- and cordierite-rich rock that likely represents a zone of intense chlorite alteration.

Sipiwesk Lake

Iron formation hosted in mafic volcanic rocks in central Sipiwesk Lake.

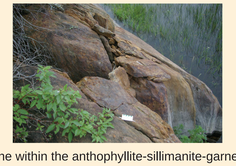
Orthopyroxene porphyroblasts in a cordierite-rich groundmass. This rock likely represents a zone of intense chlorite alteration.

Duck Lake

Pillowed basalt intruded by granite dikes on the Nelson River.

Locally discordant anthophyllite schist hosted in pillowed basalt. The schist may represent an intensely chlorite altered, fluid conduit.

Anthophyllite-sillimanite-garnet-biotite schist hosted in basalt. The schist likely represents a zone of chlorite-sericite alteration.



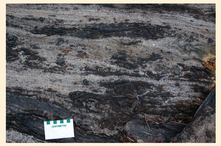
Gossanous zone within the anthophyllite-sillimanite-garnet-biotite schist.

Orogenic gold

Pervasive carbonate alteration of two different ages can be found in the PGD. Archean alteration occurs in several outcrops of the mafic volcanic rocks in southern Cauchon Lake, where there is also local evidence for attenuated quartz-carbonate vein stockworks. This style of alteration is commonly associated with orogenic gold mineralization, and the close proximity of the mafic volcanic rocks with a potential terrane-bounding fault could make this area favourable for orogenic gold mineralization. The alteration is interpreted to be Archean in age because it is overprinted by high-grade metamorphic assemblages and deformation fabrics.

Paleoproterozoic chlorite-sericite-carbonate alteration is present on Natawahunan Lake, where it overprints various rock types along Hudsonian shear zones. The shear zones appear to be related to a major fault that runs the length of the Grass River channel through Natawahunan Lake.

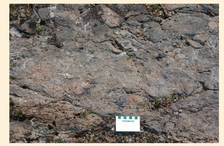
Cauchon Lake



Impure marble with fragments of basalt is interpreted as a zone of pervasive carbonate alteration. Assays yield up to 128 ppb Au, 259 ppm As, and 39 ppm W.

Metamorphosed and attenuated quartz-carbonate vein stockwork in komatiite. Assays returned up to 605 ppm As and 917 ppm W.

Natawahunan Lake



Pervasive replacement of wacke by chlorite+sericite+carbonate. Local quartz veins are present above and left of the scale card.

Mafic boudins replaced by iron carbonate and chlorite.

A discriminative study of genetically diverse carbonate rocks from central Manitoba

Author: James A. Macdonald
Advisor: Dr. Anton Chakhmouradian

University of Manitoba

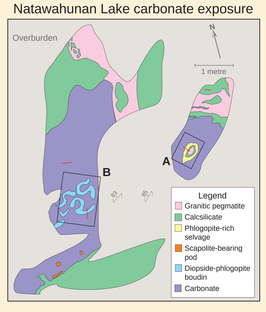
Introduction

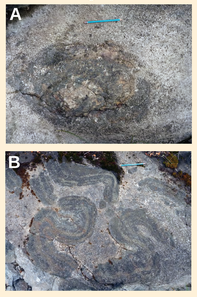
Carbonatites are a rare type of igneous rock composed of over 50% modal carbonate, which can provide a unique glimpse into mantle processes. Identification of carbonatites can be difficult, especially in heavily deformed terranes, as they are often confused with other types of carbonate rocks, such as altered basalts, hydrothermal veins, or reworked sedimentary rocks. Furthermore, carbonatites can be confused with other alkaline rock types, such as kimberlites, which may have significant economic or exploratory implications. Proper identification and classification of these rocks is essential, and relies on a combination of textural observations, isotope and trace-element analysis. This study will examine samples from seven different occurrences of carbonate rocks located in the Pikwitonei granulite domain and Superior boundary zone of Manitoba.

Ojectives and methodology

The aim of this study is to determine the origin of carbonate rocks collected by the author in collaboration with the Manitoba Geological Survey (MGS) in the summer of 2016. Petrographic examination of the rocks will be conducted to determine their textural and mineralogical characteristics and detect any textural relations which may be diagnostic of igneous, metamorphic or hydrothermal-metasomatic processes. Stable carbon and oxygen isotope values and trace-element ratios of carbonate minerals will be used to identify the source of these samples, whether crustal, fluid- or mantle-derived. Known occurrences of igneous and crustal carbonates will be compared to this data to help further constrain the nature of the studied samples. The carbonate compositions will be correlated to whole-rock data to identify the most probable potential carbonatites among the seven localities studied.

Natawahunan Lake carbonate exposure





Sketch of a carbonate outcrop on Natawahunan Lake. Boxes mark the locations of the outcrop photos.

Acknowledgments

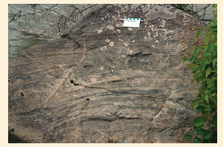
The authors thank E. Anderson and N. Brandson (MGS) for providing logistical support; L. Chackowsky and M. Pacey (MGS) for GIS expertise; and Wings Over Kississing for air support. A. Chakhmouradian (University of Manitoba) is thanked for providing his expertise and enlightening discussions both on and off the outcrop. Thanks to C. Bohm (MGS), V. Guevara (Virginia Tech), and T. Martins (MGS) for their involvement and contributions to this project.

Magmatic ore deposits

Ni-Cu-PGE

Ultramafic rocks with local, disseminated sulphide are present on Armstrong Lake. These rocks are tentatively identified as komatiite flows, and are associated with both siliceous and sulphidic sediments, the assimilation of which could have resulted in sulphur saturation and the formation of Ni-Cu-PGE mineralization.

Armstrong Lake



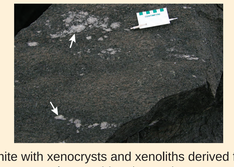
Komatiitic rocks on Armstrong Lake with assay results of 1320 ppm Ni and 2500 ppm Cr.

Ti-Fe-V

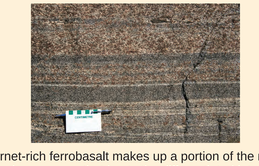
The upper Nelson River area is known for its anorthositic gabbro complexes and Ti-Fe-V potential. Several differentiated gabbro intrusions occur along the Nelson River above Duck Lake. The intrusions consist of layered gabbro to leucogabbro with minor pyroxenite. The pyroxenite locally contains xenocrysts and xenoliths derived from the leucogabbro suggesting a dynamic magma chamber. The intrusions are hosted in pillowed to massive basalt and ferrobasalt. The ferrobasalt units can contain up to 2.5% TiO_2, 21.1% Fe_2O_3, and 470 ppm V. If similar magmas fed the differentiated intrusions, there could be significant potential for Ti-Fe-V mineralization.

Duck Lake

Leucogabbro on the Nelson River above Duck Lake.



Pyroxenite with xenocrysts and xenoliths derived from the leucogabbro (arrows).



Garnet-rich ferrobasalt makes up a portion of the mafic volcanic sequence that hosts the differentiated intrusions. Simliar rocks contain up to 2.5% TiO_2, 21.1% Fe_2O_3, and 470 ppm V.