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Preliminary results on the Physical Volcanology of Komatiites of the Prince Albert Group within the Prince Albert Hills, Melville Peninsula, Nunavut

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Introduction

This M.Sc. study is a part of the Melville Peninsula Project (MPP), one of a number of geo-mapping projects that were initiated under the Federal Government Geo- mapping for Energy and Minerals (GEM) Program in 2008. More specifically, the study builds on previous geological mapping by the Geological Survey of Canada conducted by Shau (1975) and Frisch (1982) within the Prince Albert Hills of western Melville Peninsula, Nunavut. The purpose of this project is to better define and characterize the physical volcanology and stratigraphy of a portion of the Archean komatiitic succession in the Prince Albert Hills within the Prince Albert Greenstone Belt.

This will be accomplished through:

❶ Establishing the volcanic facies and litho/chemo-stratigraphy of this succession;
❷ Geological mapping at various scales in order to illustrate the volcanic architecture and potential lava pathways;
❸ Determining the mechanisms of emplacement for the komatiitic succession (extrusive and/or intrusive).

Overall this study should provide a better understanding of Archean komatiite volcanism and to determine the Ni-Cu-(PGE) potential of the Prince Albert Hills succession.

In order to achieve these objectives, fly camps were established in the summer of 2010 to examine the komatiite-bearing succession. Detailed mapping focused on the best-preserved, differentiated komatiitic units located within the southwest portion of the Prince Albert Group (PAG).

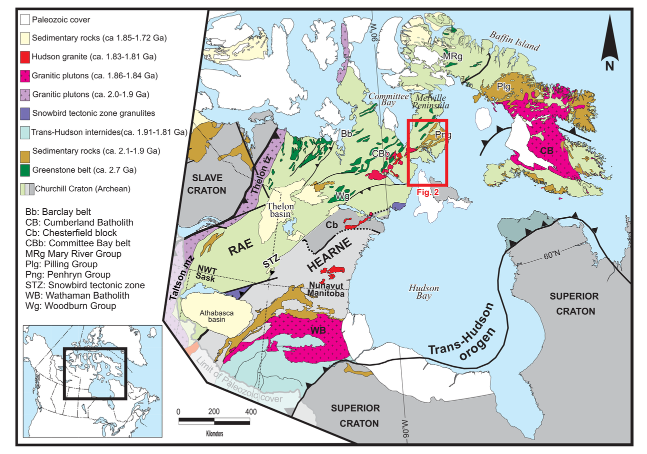


Figure 1. General geology of the western Churchill Province showing location of Melville Peninsula (after Berman et al., 2010).

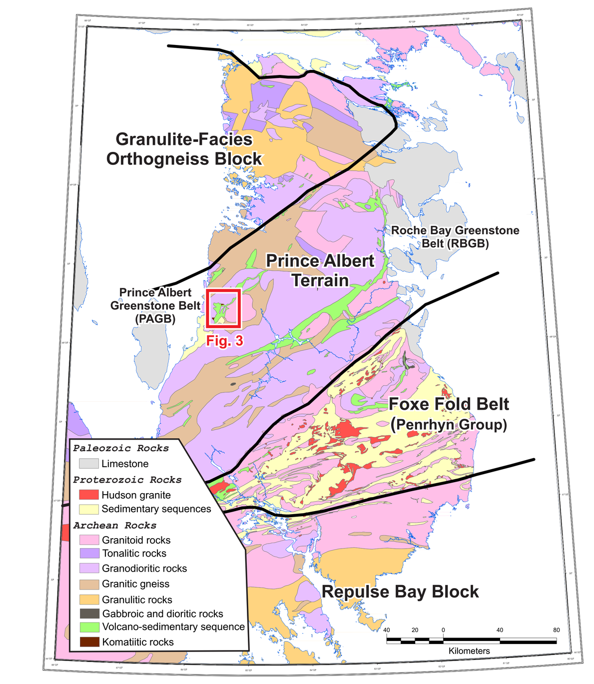


Figure 2. Geological overview of Melville Peninsula showing the four main lithotectonic domains and location of the western PAG (modified from Skulski, OF 5577, in prep).

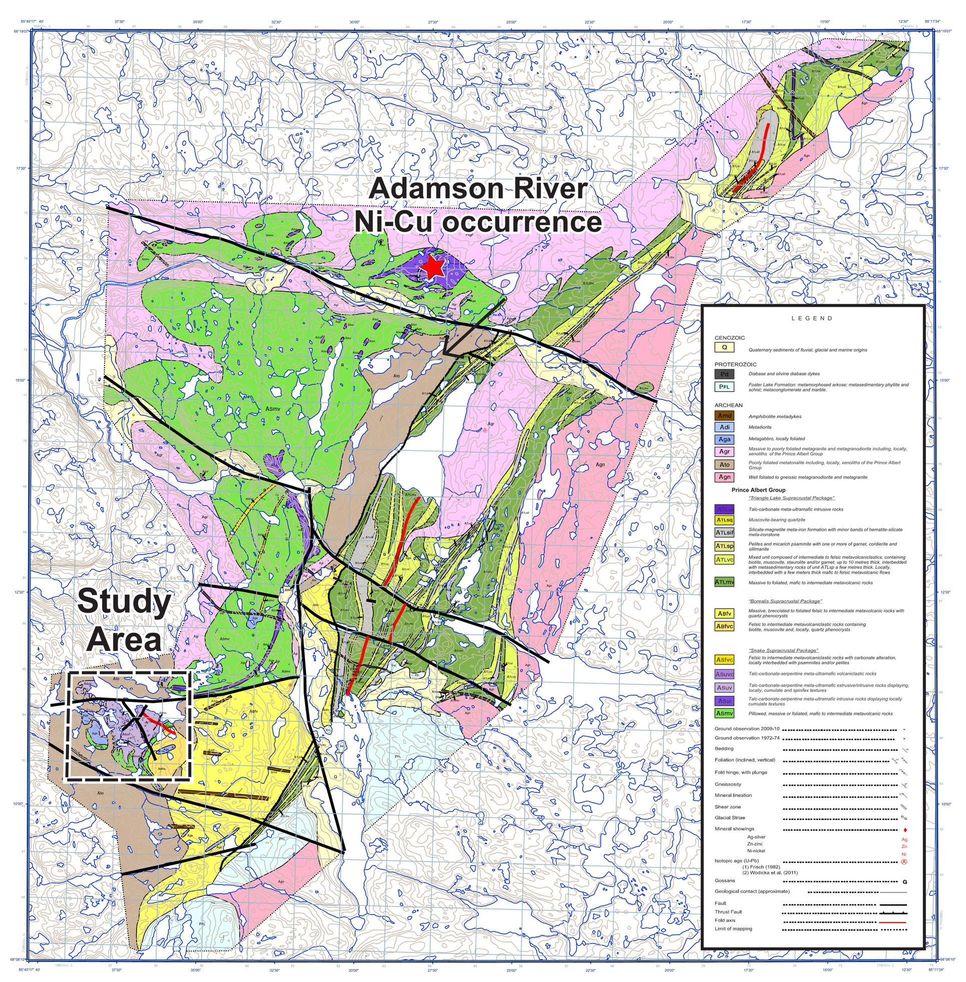


Figure 3. Geological map of the southern part of the Prince Albert Greenstone Belt showing the location of Figure 4 (thesis area) (after Machado et al., 2011).

Geological Setting

Melville Peninsula is located in the north-central part of the Rae Craton within the western Churchill Province (**Figure 1**). It is a collage of polymetamorphic and polydeformed Archean cratons including the Rae, Hearne, and Meta Incognita cratons. The Archean cratons are unconformably overlain by Paleoproterozoic sedimentary sequences, and are intruded by various Proterozoic magmatic suites.

Komatiitic rocks represent a significant component of the PAG, which forms a semi-continuous, NE-trending Archean supracrustal succession of metavolcanic and metasedimentary rocks located on each side of Committee Bay within the Rae Craton, Nunavut (**Figure 1**).

Melville Peninsula comprises four contrasting lithotectonic subdivisions (Nadeau et al., 2010: **Figure 2**):

❶ Northern Granulite-facies Orthogneiss Block;
❷ Meso-Neoarchean Prince Albert terrain;
❸ Paleoproterozoic Penrhyn Group cover sequence as in the Foxe Fold belt;
❹ Repulse Bay block located across the Lyon Inlet boundary zone to the far south.

Two major coherent greenstone belts occur on Melville Peninsula and they have been interpreted as part of the PAG, the Roche Bay greenstone belt to the east and the Prince Albert Hills to the west (Nadeau et al., 2010). The western PAG can be described as a highly metamorphosed and deformed succession of volcanic and sedimentary rocks. The metavolcanic rocks are dominated by basalts, but rhyolite and dacites are abundant, and the ultramafic rocks are described as being lavas and/or intrusions. The metasedimentary rocks are dominantly pelitic schists, and quartz-bearing magnetite iron formations (Frisch, 1982; Machado et al., 2011: **Figure 3**).

Structural and Stratigraphic Relationships

A geological map (**Figure 4**) at 1:10,000 scale of this area was produced, as well as numerous detailed sketches to document textural variations within the differentiated komatiitic units. Primary volcanic structures and textures (i.e., polyhedral jointing, flow-top breccias) are sparse within the differentiated and undifferentiated komatiitic units, except for the well-developed flow lithofacies located in the western portion of the map area (**Figure 6A, Plates 1A and 1B**). Within this komatiitic flow, facing direction obtained by fining spinifex and a polyhedral flow-top breccia indicate that it is overturned and that south of the fault strata young in a northeast- eastern direction. The latter is consistent with the regional fold pattern within the lower PAG package, and was also described at other localities outside the map area (Machado et al., 2010; 2011). However, the rarity of primary volcanic features in komatiitic units located north of the fault suggests that some may be intrusive (**Figure 6B, Plates 2A and 2B**).

Mapping in the southern most komatiitic zone (**Figures 3, 4**) indicates two dominant foliations: an earlier sub vertical, west-northwest- southeast-trending foliation (S1), and a strong, northeast-southwest striking foliation with a sub vertical dip (S2) that corresponds to the most recent phase of deformation. The S1 foliation is most apparent within the western portion of the map area; while the later S2 foliation is most dominant in the eastern map area. Primary bedding measurements in the volcaniclastic and differentiated komatiitic units define an open syncline that is truncated by a northwest striking fault. South of this fault, a drag fold occurs on the south limb of the syncline. The axial planes of the syncline and drag fold have orientations that are sub-parallel to the fault and the S1 foliation. This fault cross-cuts all units except the bounding tonalitic intrusion.

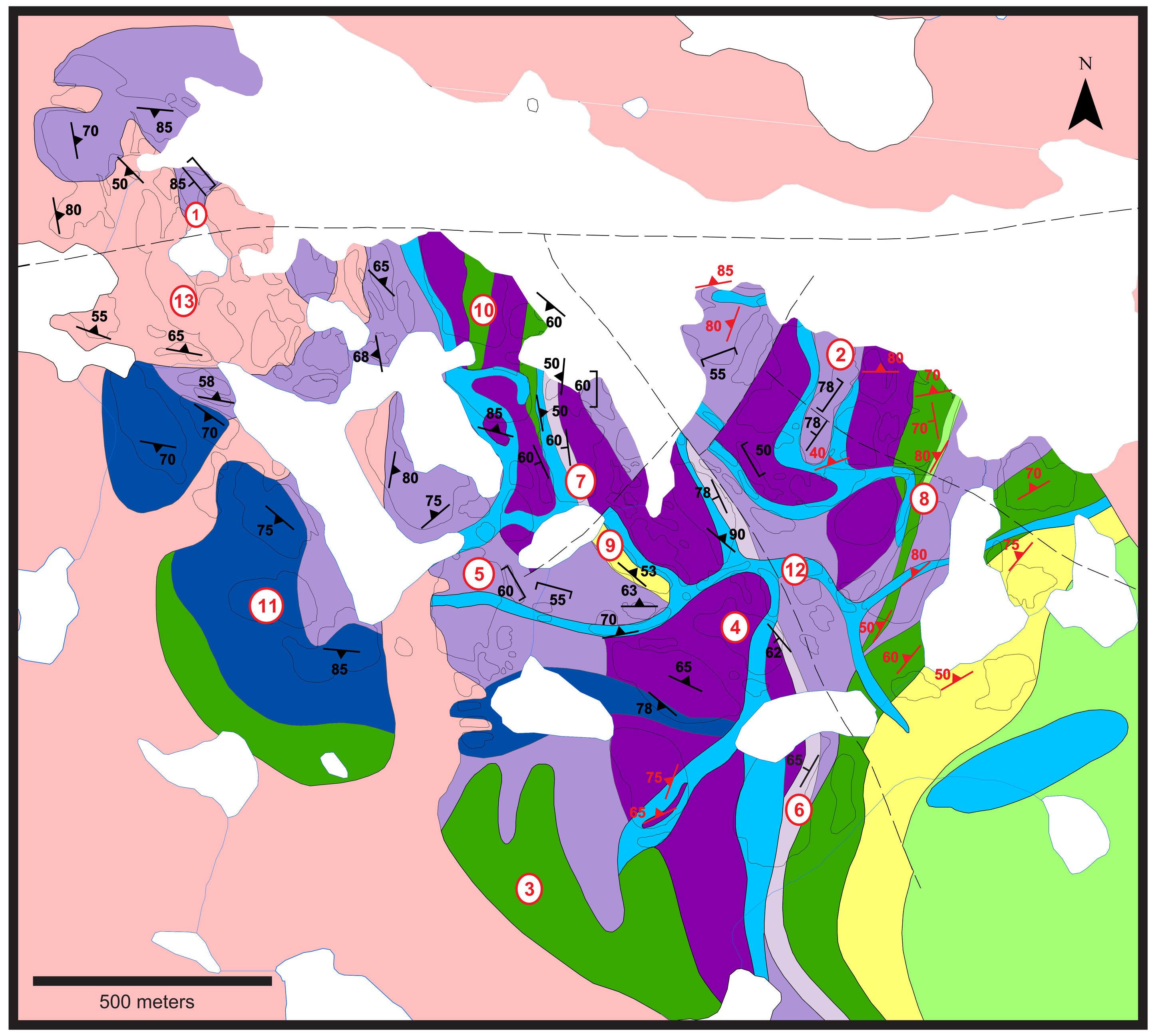


Figure 4. Preliminary geological map of the study area within the western Prince Albert Hills, Nunavut.

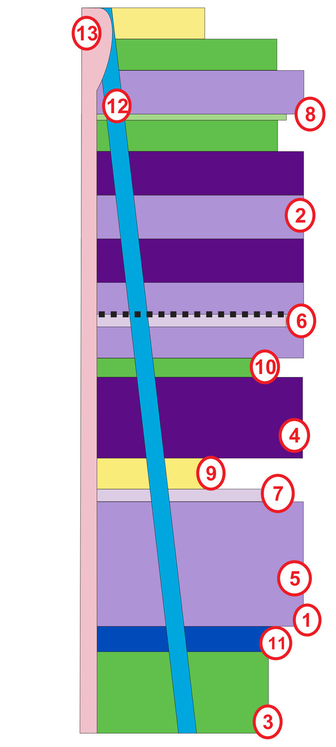


Figure 5. Stratigraphic column of study area (**Figure 4**).

Plate 10. Aphanitic, dark green, massive mafic intrusive lithofacies.

Based on top indicators and the fold pattern, the komatiitic flows are underlain by earlier mafic volcanic flows (**Plate 3**). The komatiitic succession is composed undifferentiated (massive; **Plate 4**) and differentiated (massive/spinifex; **Plates 5A, 5B, 5C**) komatiitic units intercalated with felsic to ultramafic volcaniclastics (**Plates 6, 7, 8, 9**) and mafic intrusions (**Plates 10, 11**). These units are cross-cut by massive gabbroic dykes (**Plate 12**), which in turn are cross-cut by late tonalitic intrusions (**Plate13**) (see **Figure 7**).

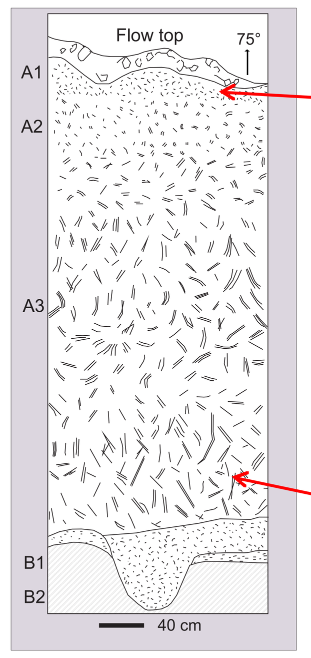


Figure 6A. Textural variations in differentiated komatiitic units from northwestern part of thesis area.

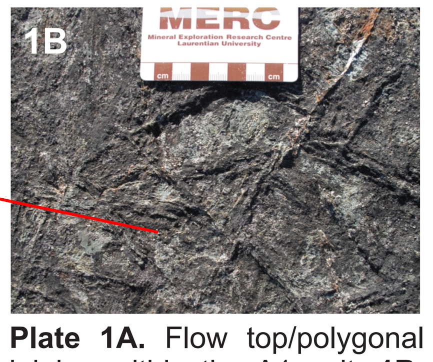


Plate 1A. Flow top/polygonal joining within the A1 unit; **1B.** Coarse platy spinifex of the A2 (spinifex) unit.

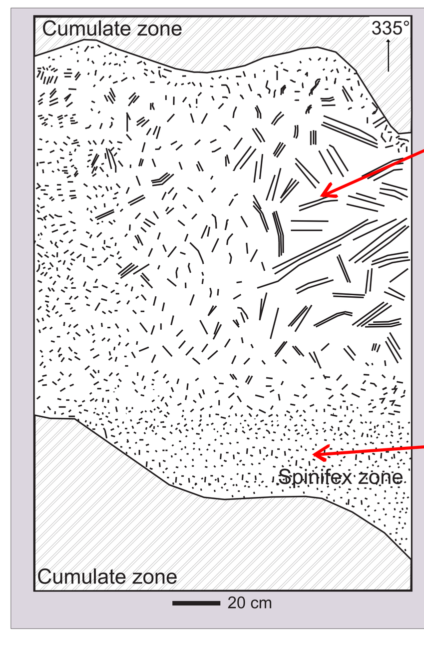
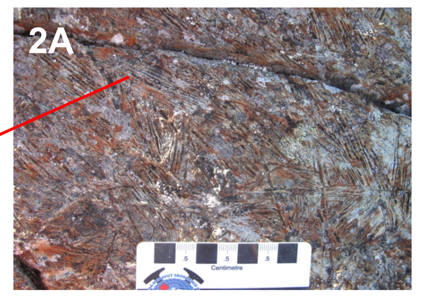


Figure 6B. Symmetrical spinifex growth (finer at margins) within a komatiitic sill.



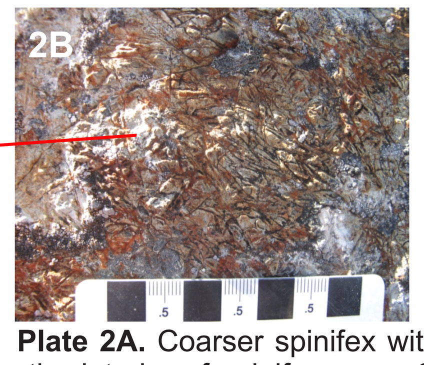


Plate 2A. Coarser spinifex within the interior of spinifex zone; **2B.** Finer spinifex along spinifex zone margins.

Lithofacies

Plate 3. Medium-dark green, mafic volcanic unit showing deformed pillows.

Plate 4. Massive, orange-brown weathering undifferentiated komatiitic unit.

Plate 5A. Weathering accentuates the orange-brown cumulate zone and grey-green spinifex zones within a differentiated komatiite unit.

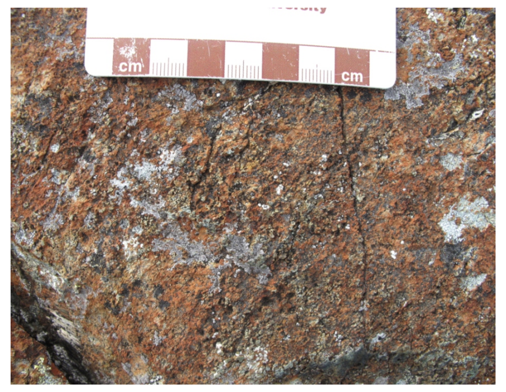


Plate 5B. Details of a cumulate zone within a differentiated komatiitic unit.

Plate 5C. Details of a spinifex zone within a differentiated komatiitic unit.

Plate 6. Fine-grained, finely layered ultramafic volcaniclastic tuff.

Plate 7. Moderate to densely packed. Coarse, ultramafic volcaniclastic unit.

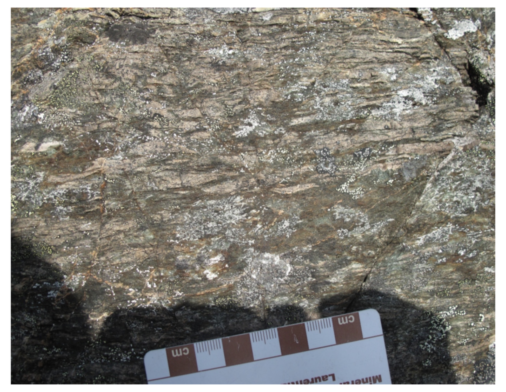


Plate 8. Intermediate fine-medium grained volcaniclastic.

Plate 9. Light grey, fine grained, quartz megacrystic, felsic volcaniclastic unit.

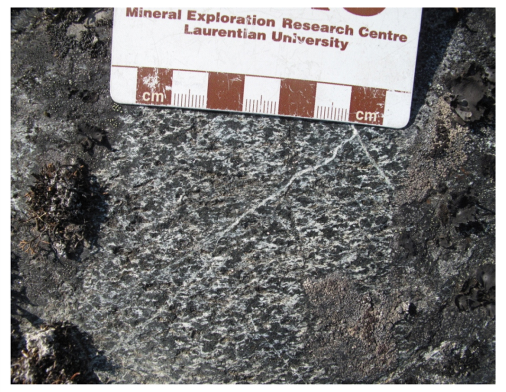


Plate 11. Medium-grained, medium green, foliated gabbroic intrusion.

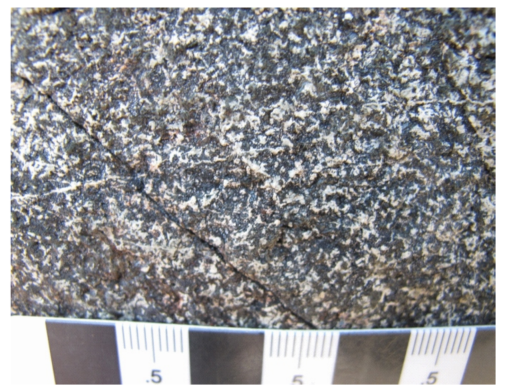


Plate 12. Medium-grained, dark green, massive gabbroic intrusion.

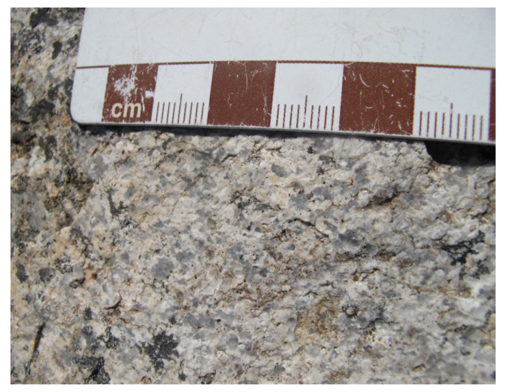


Plate 13. Medium-grained, massive homogeneous tonalite.

Economic Potential

A new Ni-Cu discovery was made during the 2010 mapping program. The discovery, referred as the Adamson River occurrence, occurs as massive to semi massive sulfides at the base of a cumulate textured komatiitic unit where it is in contact with a gabbro and/or mafic volcanic unit. Assays grades up to 7.9 % nickel were obtained from grab samples (Houlé *et al*., 2010). This new discovery, plus the recognition that komatiitic flows occur within the map area, as illustrated in **Figure 4**, suggests that the PAG may have the potential to host new Ni-Cu mineralization.

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