Field observations and structural relationships of auriferous quartz veins, Finlay-McKinlay Outcrop, southern Lynn Lake Greenstone Belt, Trans-Hudson Orogen, Manitoba

Daniel Thomson, Kevin Ansdell

Department of Geology, University of Saskatchewan, Saskatoon, Saskatchewan, Canada,

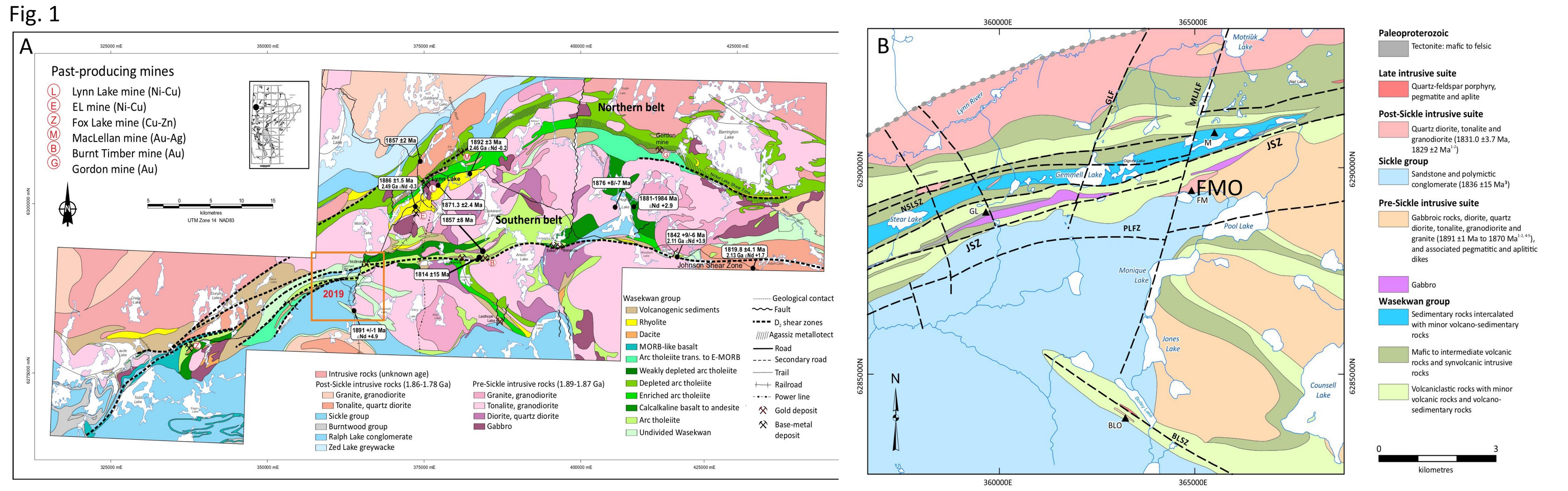
Daniel@Thomsons.ca

Project Background and Objectives:

The Lynn Lake Greenstone Belt (LLGB) in the Paleoproterozoic Trans-Hudson Orogen (northern Manitoba) is divided into two east-west trending volcanic belts separated by felsic intrusive rocks. The LLGB has had a rich exploration and mining history for gold and base metals and hosts several orogenic gold deposits including the old MacLellan, Farley Lake, and Burnt Timber mines. Ongoing exploration in the region by Alamos Gold Incorporated has recently focused on the Finlay-McKinlay Outcrop (FMO), which lies within the southern section of the LLGB. The aim of this project is to develop a better understanding of the evolution of the rocks and veins in the Finlay-McKinlay outcrop and their relationship to the overall development of the LLGB and other gold deposits in the area.

Location and Geological Setting:

Fig. 1



A: The LLGB is located in the Reindeer Zone of the Paleoproterozoic Trans-Hudson Orogen in northern Manitoba. It consists of two main northwest-southeast striking, steeply dipping belts composed of submarine, tholeiitic to calc alkaline, mafic volcanic, and volcaniclastic rocks separated by felsic intrusive rock. The regional metamorphic grade is upper greenschist to amphibolite facies (Yang, 2019, MB Geol. Surv., Rep. Activities, p10-29)

B. The Finlay-McKinlay outcrop is in the Gemmell Lake region of the southern Lynn Lake Belt. It is an intrusive body that intrudes the volcaniclastic Wasekwan group rocks to the north, which are in structural or unconformable contact with conglomerate of the Sickle Group to the south. Regional scale structures include the Johnson Shear Zone , a kilometer to the north, and the younger Motruk Lake-Jones Lake fault to the west of the outcrop. The Wasekwan Group volcanics are approximately 1890 Ma in age, whereas the intrusion, and Sickle Group are significantly younger (ca. 1835 Ma). (Yang, 2019, MB Geol. Surv., Rep. Activities, p10-29)

Methods:

The field work for this project was undertaken during the summer of 2020 while employed by Alamos Gold inc. The outcrop was cleaned and gridded for mapping, during which 273 structural measurements were taken including host rock fabric, joints, quartz veins, and shear zones. 10 hand samples and 40 channel samples were taken from the outcrop and sent for whole rock 4-acid ICP-AES, and Lithium Borate Fusion ICP-MS geochemical analysis at ALS. 16 polished thin sections were prepared for investigation by transmitted and reflective light microscopy. A combination of this structural, geochemical and petrographic analysis is being used to help understand the origin and paragenesis of the rocks in the outcrop.

Outcrop Description:

The FMO consists of a medium grained, weakly foliated, biotite and hornblende-bearing quartz diorite/granodiorite host rock. The dominant foliation in the host rocks is considered to be the regional S2 fabric which strikes predominantly SW-NE and dips steeply to the NW. Shear zones have a similar SW-NE strike and also dip steeply to the NW. Brittle behaviour in the FMO is evidenced by two intersecting orthogonal joint sets, one striking SW-NE and steeply dipping from 70-90 degrees and the other cross cutting joint set trends NW and steeply dips to the SW. Quartz veins present in the FMO predominately strike to the NNE and steeply dip from 75-90 degrees. Many of these quartz veins have irregular shapes and pinch and swell along strike. The crosscutting relationship between veins is complex. A major 0.5 m wide quartz vein strikes SW-NE through the northwest area of the outcrop. This vein appears to act as a northern boundary of the quartz veins with most occurring between this structure to the north and the Sickle conglomerates to the south of the outcrop. The veins have a milky white colour with fractures running parallel to their length. The fractures are filled with a dark-coloured tourmaline and small amounts of sulphides, primarily of pyrite. The orientation of the quartz veins and joint fractures (Fig 3) are similar, which suggests a likely relationship between the formation of the joint fractures and quartz veins. It is possible the brittle fracturing of the host rock provided space for the infiltration of silica-bearing hydrothermal fluids which deposited the quartz veins. Interaction between these fluids and the host rock caused the formation of alteration halos up to 6 cm wide in the host rock. These halos are highlighted by an increase in biotite, tourmaline, chlorite, and carbonate. The gold mineralization is disseminated through the quartz veins as assay samples return values with mostly undetectable levels of gold, whereas a few yield gold concentrations of between 4 ppm and 18 ppm.

Fig. 2

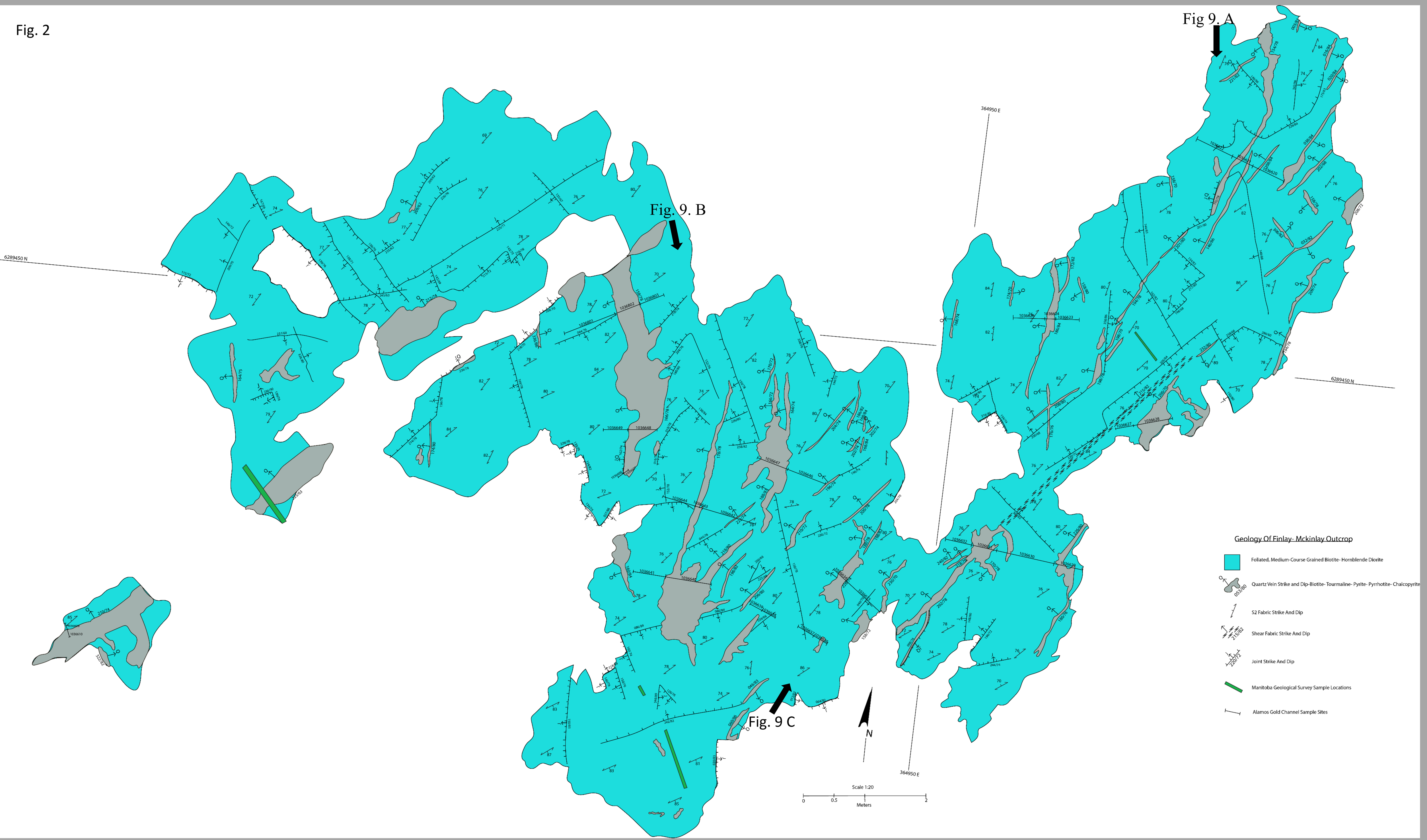
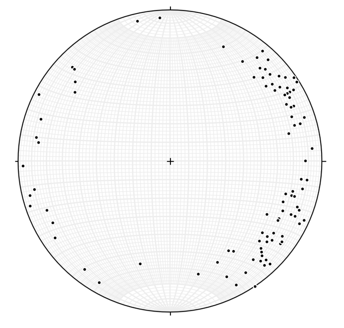
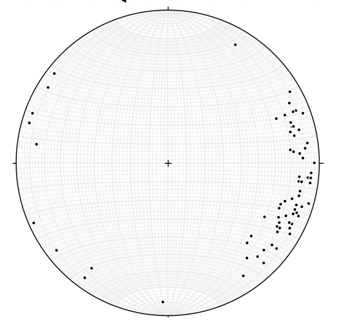


Fig. 3

Poles To Joints N= 101



Poles To Quartz Veins N=78



Poles to Fabric S2 N= 95

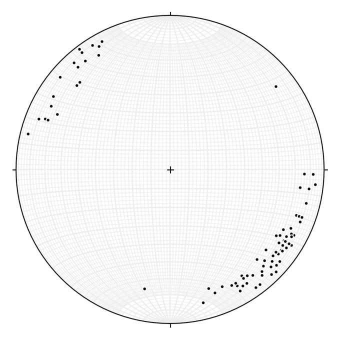


Fig. 4

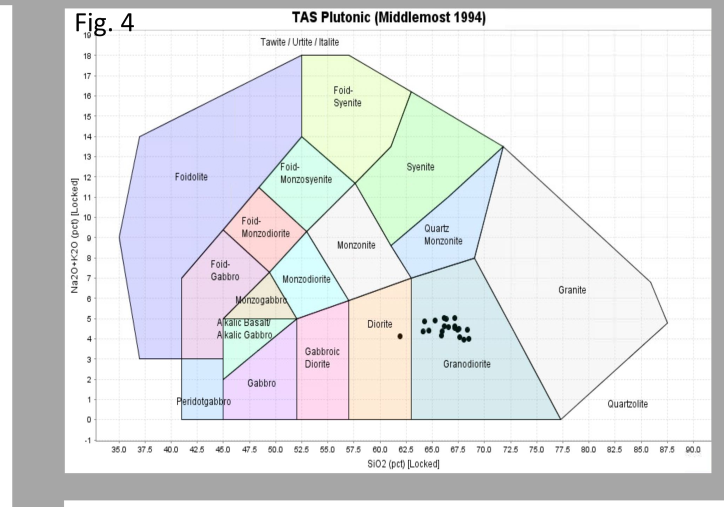


Fig. 5

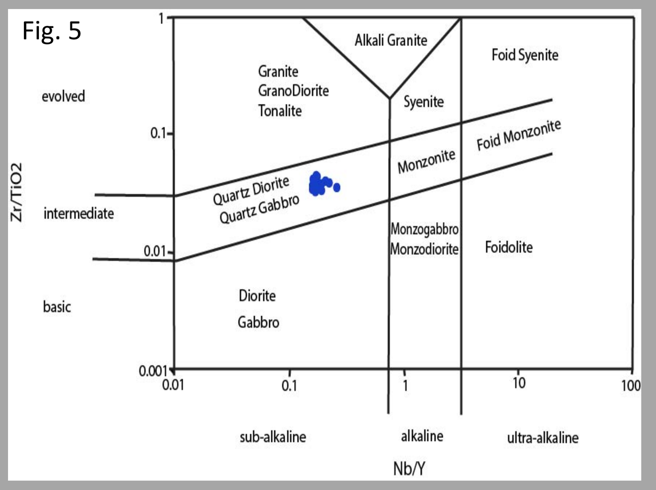


Fig. 6

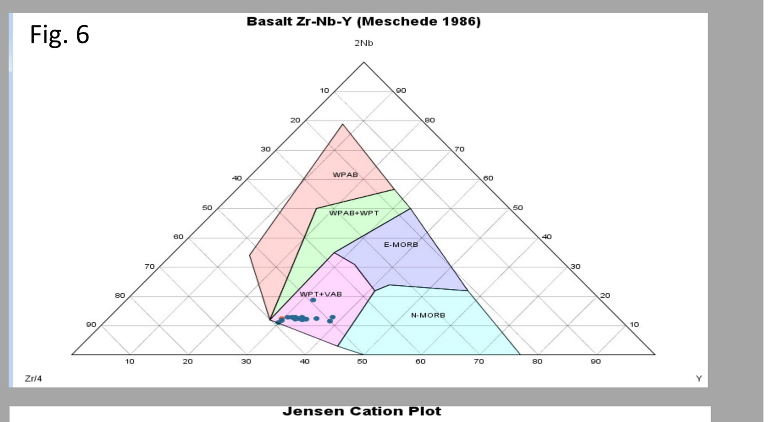


Fig. 7

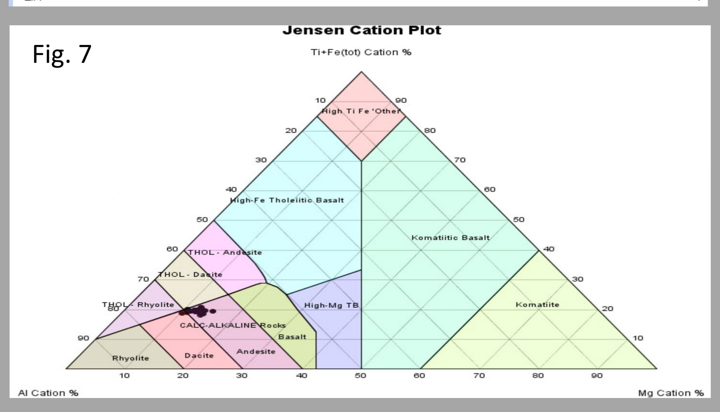
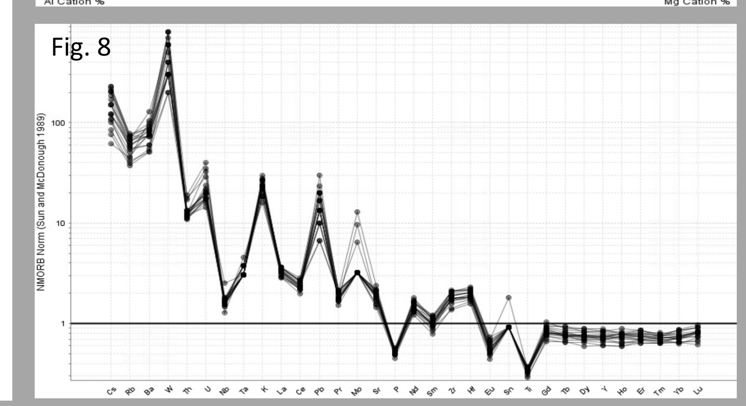


Fig. 8



Geochemistry:

Based on major elements, the host rock to the veins could be classified as a granodiorite (Fig. 4), but as the rocks have been metamorphosed and potentially affected by the hydrothermal fluids that formed the quartz veins then immobile elements (Zr, Ti, Y, Nb) may yield a more appropriate rock classification. Fig. 5 suggests that the host rock is more intermediate in composition and is better described as a quartz diorite .

Discrimination diagrams for volcanic and granitoid rocks, particularly those using immobile elements, suggest that the host rock is calc-alkaline and formed in a volcanic arc environment (Fig 6, 7). This is consistent with the patterns exhibited in MORB-normalized trace element variation diagrams (Fig 8), which have enriched incompatible elements and negative Nb and Ti anomalies, typical of rocks generated in arcs. Overall, the host rock to the veins in the FMO is typical of many of the igneous rocks that formed in the Lynn Lake greenstone belt during subduction and closure of the Manikewan ocean.

Fig. 9.

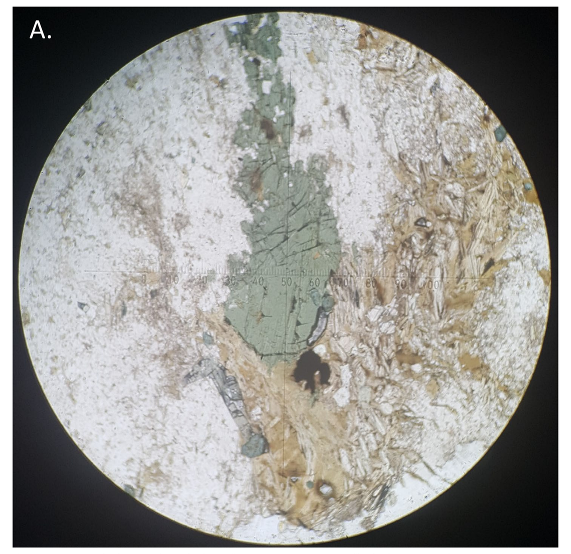
A. View of the Gridded Outcrop looking south

B. View of the Gridded outcrop looking South East

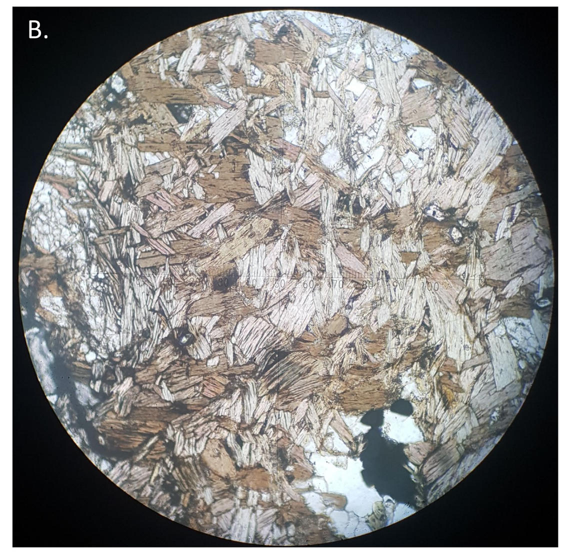
C. View of the Gridded outcrop looking North

Fig. 10.

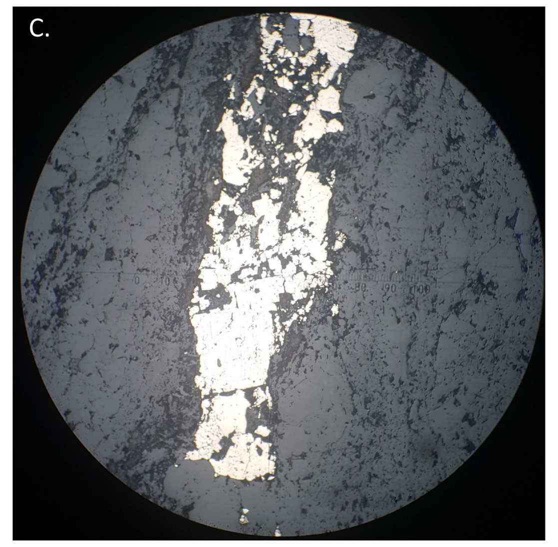
Petrography:



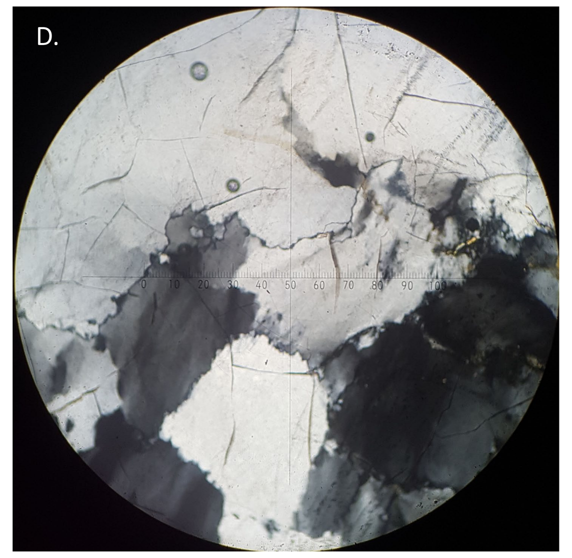
A. Hornblende-biotite-quartz-feldspar in quartz diorite host rock (PPL, FOV – 4.5 mm)



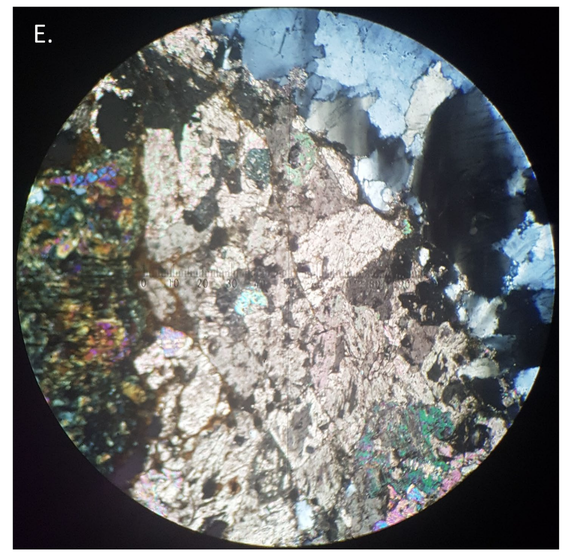
B. Biotite-rich alteration zone in quartz diorite host rock (PPL, FOV – 4.5 mm)



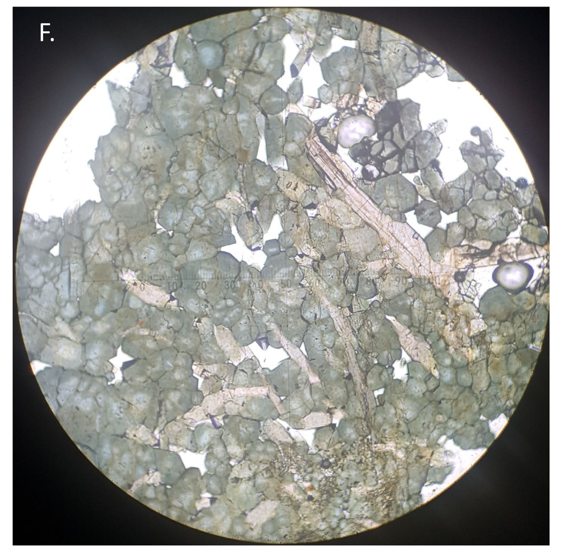
C. Pyrite in quartz diorite host rock (RL, FOV – 4.5 mm)



D: Sutured boundaries of quartz and undulose extinction suggests recrystallization in a quartz vein (XPL, FOV – 4.5 mm)



E. Carbonate Quartz Veins. (XPL, FOV – 4.5 mm)



F: Tourmaline-rich zone within quartz vein (PPL, FOV – 4.5 mm)

Summary:

The FMO is underlain by a calc alkaline quartz diorite that formed in a volcanic arc setting related to subduction in the Paleoproterozoic Trans-Hudson Orogen. The rocks have been metamorphosed to greenschist facies, and brittle-ductile deformation has generated shear zones, and ultimately steeply-dipping conjugate joint sets and associated quartz veins. The concentration of veins in this outcrop may be related to the competency contrast between the host rock and the Sickle group rocks to the south of the FMO. In conclusion, the FMO represents an excellent example of a metamorphic rock hosted orogenic gold deposit and further analysis may show it to be an economic source of minable gold.

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