# Structural setting, mineralogical characteristics and geochemical footprints of bandediron-formation-hosted gold mineralization in the Geraldton area, Ontario Canada









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Ressources naturelles

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### Introduction

The Beardmore-Geraldton Greenstone Belt (BGB) is a transitional terrane between the granite-greenstone Wabigoon and the sedimentary Quetico subprovinces (Fig. 1). It comprises three metavolcanic (NVU: northern, CVU: central, SVU: southern metavolcanic units) and three metasedimentary (NSU: northern, CSU: central, SSU: southern sedimentary units) panels that are all fault-bounded (Fig. 2). The volcanic units represent back-arc (NVU), arc (CVU) and oceanic crust (SVU) environments from north to south (Tomlinson et al. 1996). The metasedimentary units represent different facies of a southward prograding clastic wedge from alluvial fan or braid-plain (NSU), through subaqueous fan and/or prodelta (CSU) to submarine fan and/or basinplain environments (SSU) (Williams 1987; Devaney and Williams 1989). The deformation history of the belt started with D₁ thrusting, which is thought to be responsible for the accretion of the metavolcanic and metasedimentary units driven by the northward motion of the oceanic crust - island arc Wawa subprovince. It was followed by D2 north-south compression and D<sub>3</sub> dextral shearing (Lafrance et al. 2004). During the past century, over 4.1 million oz of gold (Mason and McConnell 1982) have been produced from several mines mostly located in the SSU (Pye 1952; Horwood and Pye 1955; Mason and White 1986).

## Main goals

As part of the Targeted Geoscience Initiative-4 Lode Gold program of National Resources Canada, this project aims to:

- Determine the structural and stratigraphic setting of the deposits
- Determine the characteristics and geochemical footprint of the gold mineralization and the associated hydrothermal alteration
- Place the mineralization in the tectonic evolution process of the belt

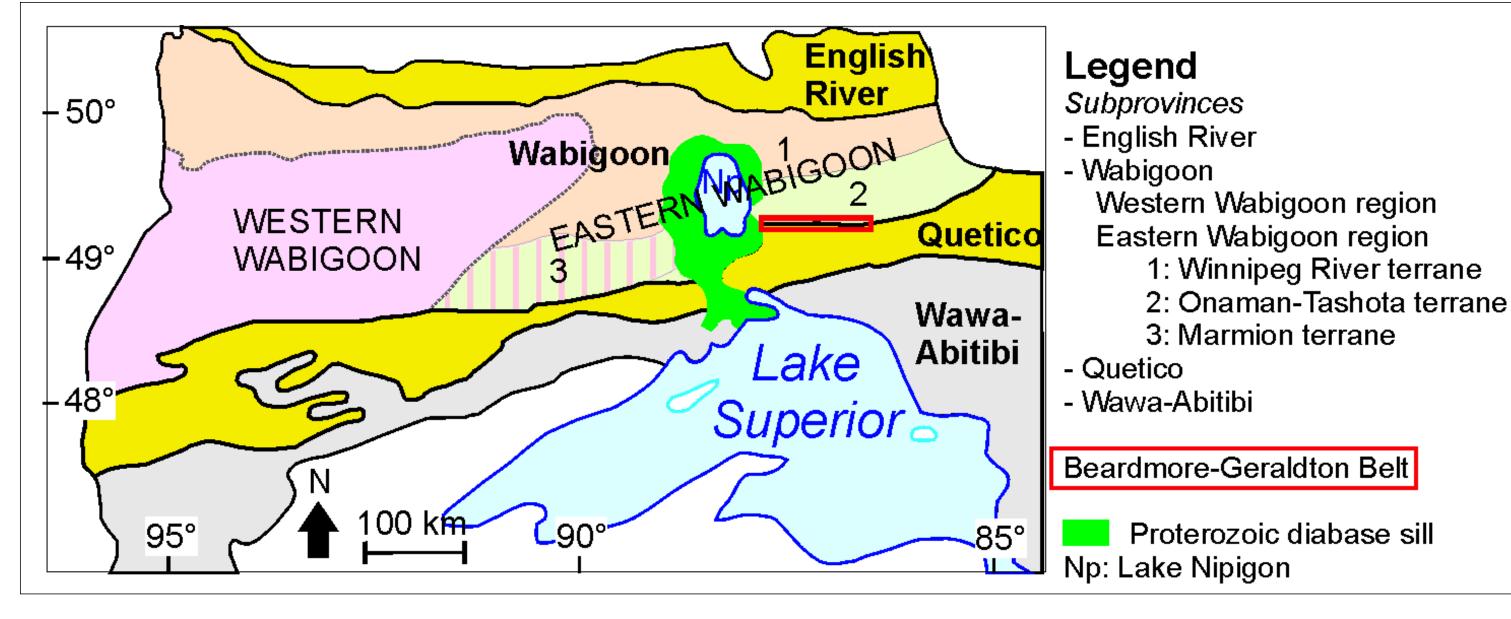


Figure 1. Location of the Beardmore-Geraldton Belt on the map of SW Superior Province. Modified after Thurston 2002.

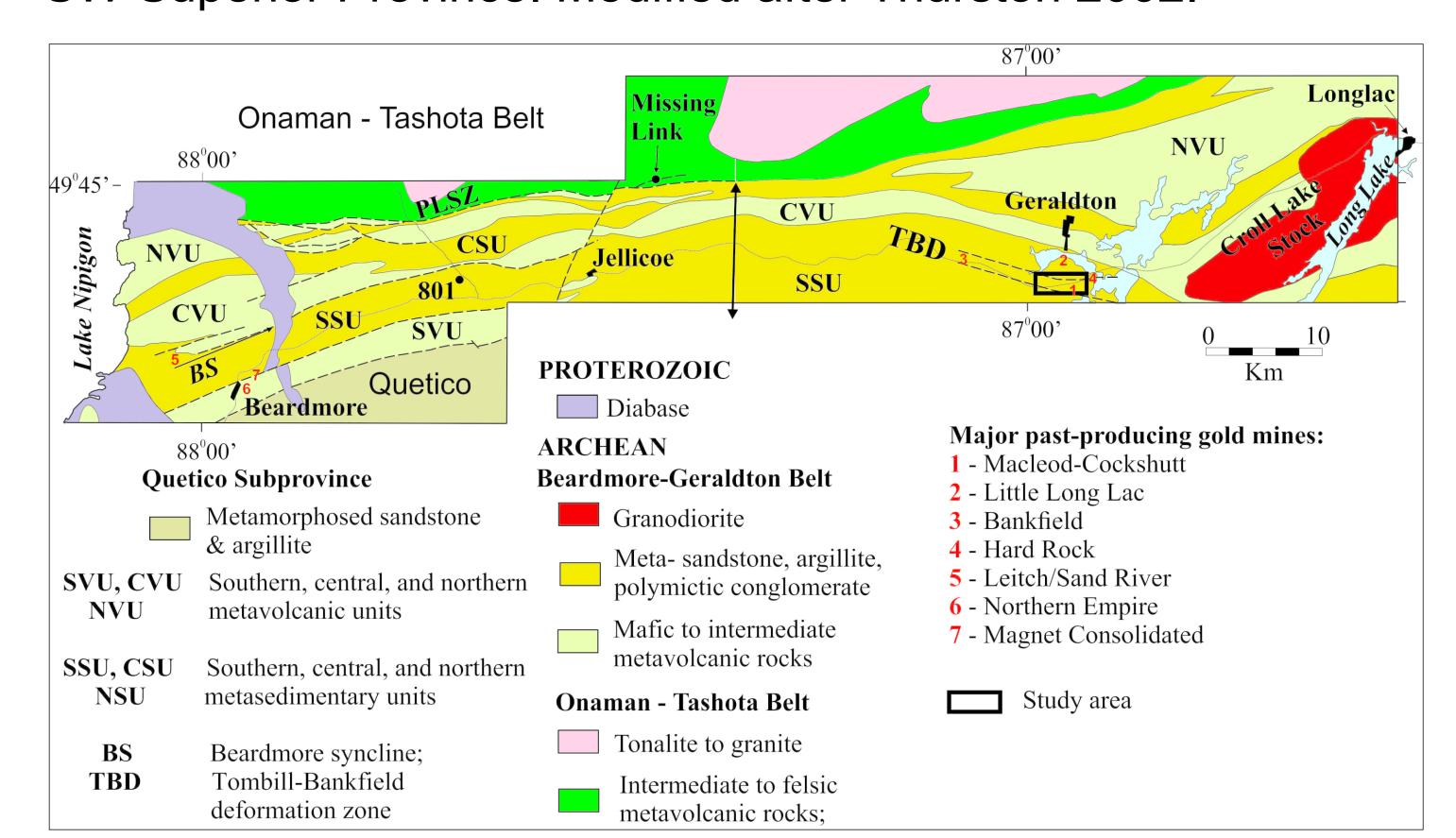
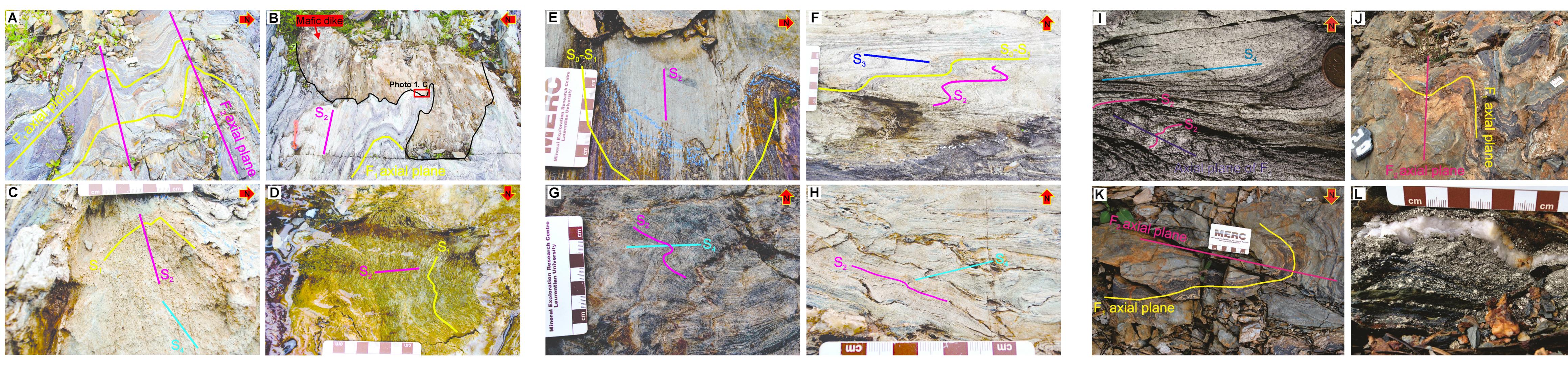


Figure 2. Regional geological map of the Beardmore-Geraldton Belt. Modified after Lafrance et al. 2004. PLSZ: Paint Lake shear zone.

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# Structural mapping and alteration onserved on the Headframe and OPP exposures

Key features of structural, mineralization and alteration history are exposed on the Headframe and OPP outcrops which have played key role to refine the deformation history of the Beardmore-Geraldton Belt and to establish the relative timing of the hydrothermally active periods - including the gold mineralization event(s) and various alterations - with respect to the structural evolution. Both exposures are located in the SSU, on the north limb of the Hard Rock anticline which is a regional-scale F<sub>2</sub> fold. Banded iron formation, interlayered mudstone, quartz-feldspar porphyry and mafic dikes are exposed on them.



**Figure 3.** Field photographs of the "Headframe" (A-C, E-K) and "OPP" (D, L) exposures in Geraldton. **A)** Tight F₁ folds refolded by S-shaped F₂ fold and overprinted by axial planar S<sub>2</sub> foliation in iron formation, sedimentary rocks and mafic dike. Red rectangle shows the location of the Fig. 1.C photograph. C) Previously unrecognized penetrative S<sub>1</sub> foliation axial planar to F<sub>1</sub> fold and folded by F<sub>2</sub> folds and overprinted by axial planar S<sub>2</sub> foliation that is parallel to S<sub>3</sub> and oblique to S<sub>4</sub> foliation in the mafic dike. **D)** On the "OPP" exposure, previously unrecognized S<sub>1</sub> foliation is folded by S-shaped F<sub>2</sub> folds and overprinted by S<sub>2</sub> foliation axial planar to F<sub>2</sub> fold in quartz-feldspar porphyry dike. **E)** F<sub>2</sub> fold with only one strong, axial planar foliation folded by S-shaped F<sub>3</sub> fold and overprinted by axial planar S<sub>3</sub> foliation that is typically subparallel to S<sub>2</sub>. G) S<sub>3</sub> or composite foliation folded by Z-shaped F<sub>4</sub> folds and overprinted by S<sub>4</sub> foliation axial planar to Z-shaped F<sub>4</sub> folds does not display S-shaped folding. I) S<sub>4</sub> foliation overprints S-shaped F<sub>3</sub> folds. The diameter of the coin is 19 mm. **J)** Strongly iron-carbonate—altered rock folded by F<sub>1</sub> and refolded by S-shaped F<sub>2</sub> fold assumed to partially surround and partially overprint banded iron formation. K) Quartz-iron-carbonate vein folded by F₁ and refolded by F₂ folds in banded iron formation. L) Semi-massive pyrite replacement representing the Au mineralization associated with quartz-carbonate veins in iron formation.

## Characteristics and host rocks of the gold mineralization

The semi-massive sulfide replacement is folded by F<sub>2</sub> folds, suggesting pre- or early D<sub>2</sub> Au deposition.

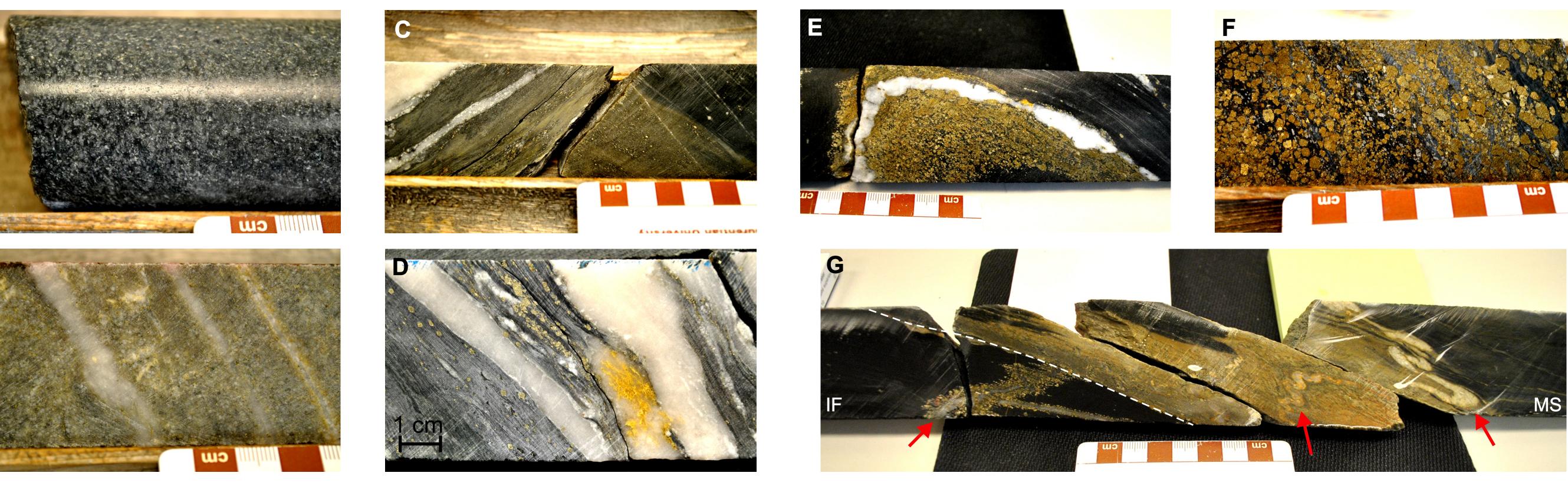
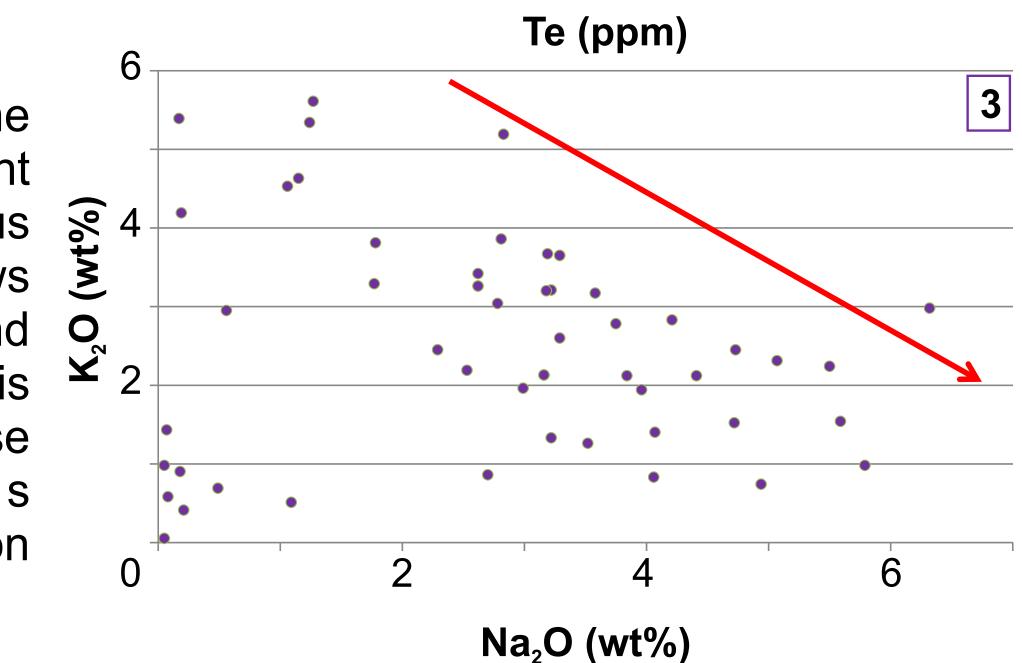


Figure 4. A) Least altered, non-mineralized quartz-feldspar porphyry dated at 2694Ma. B) Gold mineralization is associated with the formation of pervasive carbonate - sericite ± pyrite alteration surrounding quartz-carbonate veins in quartz-feldspar porphyry. C) Gold mineralization is characterized by strong sericite-carbonate-pyrite alteration in the immediate selvages of quartz-carbonate±gold veins in mudstone to sandstone. D) Large flake of native gold in quartz-carbonate vein surrounded by sericite alteration halo. E) Few cm-wide, auriferous sulphidic alteration halo composed of semi-massive pyrite surrounding quartz-carbonate vein in magnetite-bearing iron formation. F) 35-40 % fine- to coarse-grained pyrite-arsenopyrite-sericite alteration halo of quartz-carbonate veins in iron formationbearing mudstone to sandstone. G) Folded quartz-carbonate gold vein showing narrow pyritic alteration selvages in iron formation (IF) and pervasive sericite alteration halo in mudstone to sandstone (MS) host rock. This sample indicates that the nature and intensity of the alteration associated with gold in the iron formation (IF) - and the mudstone-to-sandstone (MS) are strongly influenced by protolith composition and formed during the same mineralization event.

## 1,000 As (ppm) Chart 1. shows that Au is related to the presence of As as suggested by the frequent occurrence of arsenopyrite in auriferous \$\angle 4\rightarrow\$ alteration assemblages. Chart 2. shows ≥ the positive correlation between Te and Q Au. Y axis of Chart 1 and Chart 2 is $\stackrel{\checkmark}{\sim}$ 2 identical. Chart 3.: K2O values increase with decreasing Na<sub>2</sub>O contents likely representing the sericite alteration of feldspar.



#### Conclusions

The Au mineralization is characterized by sericite ± carbonate ± chlorite and pyrite ± arsenopyrite alteration haloes surrounding quartz-carbonate ± gold veins. Te and As are enriched in Au mineralized samples. Newly recognized, local sinistral shear (D<sub>3</sub>) overprints mineralization as well as  $D_2$  structures, but occurred prior to the late dextral transcurrent shear ( $D_4$ ). The quartz-feldspar porphyry yielded an age of 2694 Ma which is also the maximum age for both the gold mineralization and D₁ deformation event.

Alteration geochemistry

10,000

1,000

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