Alteration and Mineralization of the Southwest Zone at the Troilus Gold-Copper Deposit, Quebec: Implications for a Revised Genetic Model

T. Enno[1*], B. Hylands[2], L. L. Van Loon[1], N. R. Banerjee[1]

[1]Department of Earth Sciences, Western University, London, ON, Canada, [2]Troilus Gold Corporation, Toronto, ON, Canada, *tenno@uwo.ca

Introduction

- **The Troilus Gold-Copper Deposit** is located in the **Frôtet-Evans Greenstone Belt, Opatica Subprovince, Superior Province, Quebec.**
- **Two styles of mineralization** have been recognized at the deposit; a "**disseminated" gold-copper,** and "**vein-hosted" gold** style [1]**.**
- **Conflicting metallogenic models** have been proposed for the deposit including **Archaean porphyry, orogenic, and mixed genetic origin**.
- The **Southwest Zone (SWZ) is a promising new gold target** being explored by Troilus Gold Corporation. Higher degrees of alteration, shallow mineralization, large quantities of magnetite, and structural environments differ the SWZ from former mine workings.
- Present study of the Troilus Deposit aims to:
  - **Characterize host rocks and mineralization** in the SWZ and compare results to observations made at the former mine site.
  - Understand the **mechanisms responsible for gold and gold-copper mineralization** on the deposit scale with the goal of proposing a wholistic metallogenic model for the Troilus Deposit.
  - **Define structural and geochemical targets** of mineralization for the continued exploration of the Troilus Deposit and surrounding region.

Local Geology

- The Troilus Deposit is comprised of **mafic to felsic volcanics** that are intruded by a central body of diorite and felsic dikes, with late granite plutons bordering the deposit to the east (Fig. 1).
- Mineralization lies within a structural corridor 2km thick and over 20km in length [2].

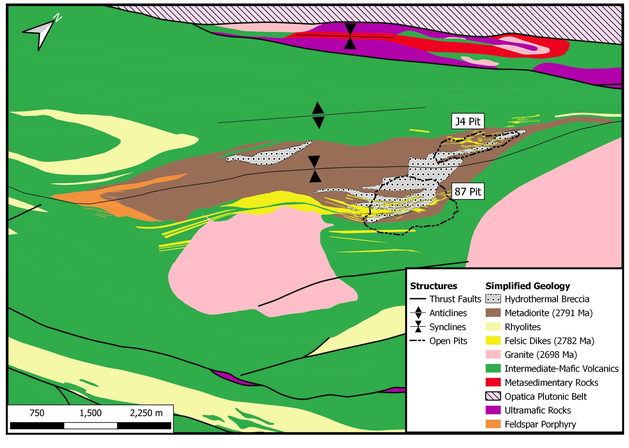

Figure 1: Local geology of the Troilus gold-copper deposit showing simplified geology and outlines of mined pit shells.

Sample Procedure

- **20 NQ drill core samples** (Fig. 2) were collected from each major lithotype of the SWZ and prepared at Western University and Precision Petrographics Ltd**.**
- Samples representing **least-altered, most-altered,** and **high-grade** rock were selected from each lithotype to study alteration, mineralization, and structure.
- Sample pulps were sent to ALS laboratories for 65-element analysis of major and trace elements.

Figure 2: NQ drill core collected from the Troilus mine site.

Results and Discussion

Petrography

- **7 lithotypes** identified corresponding to a **basaltic footwall** with a bimodal sequence of **mafic to felsic volcanics** in the **hanging wall.** Intrusive bodies of **diorite** and **felsic dikes** were also interpreted.
- **Thermal zonation** of oxides to sulphides and gold was interpreted in the SWZ.
- **Gold mineralization** found in **quartz-chlorite veins,** along **sulphide grain boundaries,** and as **inclusions in pyrite** (Fig. 3)**.**
- Spatial association of **potassic alteration** with **disseminated mineralization** focused in **intermediate-mafic** units. Deposition of gold is interpreted to have occurred by **host rock sulphidation**.
- **Chlorite** is spatially associated with **vein-hosted style.**

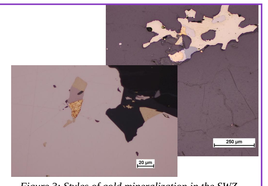

Figure 3: Styles of gold mineralization in the SWZ.

Lithogeochemistry

- **Shift in tectonic environment** from footwall to hanging wall sequences**. From an E-MORB environment to an island arc. Stratigraphic tops** of volcanic sequences are located to the **northwest** (Fig. 4).
- Corresponding shift in magmatic affinity recorded in the Y vs Zr plot. **Footwall** volcanics of **tholeiitic** affinity shift towards **transitional** and **calc-alkaline** affinities towards the **hanging wall** (Fig. 5).

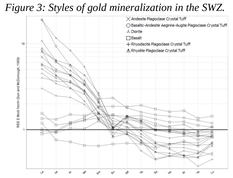

Figure 4: E-MORB normalized plot of Sun and McDonough (1989) showing a MORB footwall sequence transitioning into an island arc hanging wall sequence.

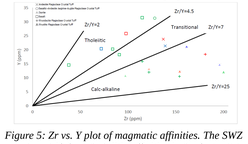

Figure 5: Zr vs. Y plot of magmatic affinities. The SWZ records a shift from tholeiitic affinities in the footwall to calc-alkaline affinities in the hanging wall. Blue icons are least-altered, red are most-altered, and green are high grade.

Synchrotron micro X-ray Fluorescence (SR-µXRF)

- **Shear-hosting of gold mineralization** indicated by chlorite mineral fish along the margins of quartz-chlorite veins (Fig. 6).
- Gold is invariably associated with silver, and occasionally copper in vein-hosted style of mineralization.

Lab-based micro X-ray Fluorescence (µXRF)

- Partial transposition of early quartz veins into the plane of foliation provides evidence of the disseminated style of mineralization being structurally controlled prior to regional deformation (Fig. 7).

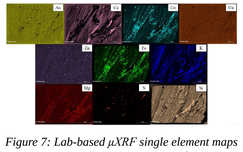

Figure 7: Lab-based µXRF single element maps displaying a partially transposed, auriferous quartz vein in andesite.

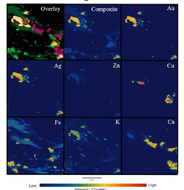

Figure 6: SR-µXRF maps of vein-hosted gold mineralization. Scale bar (bottom) is equal to 200µm. In overlay map, Fe is green, Au is yellow, Cu is orange, Ag is red, Ca is pink, Zn is purple, and Ca is pink. Au, Ag, and Zn are closely associated. Cu and Ca are commonly near Au, Ag, and Zn, although there are areas of Au-Ag-Zn that contain no Cu or Ca.

Paragenesis

- Pre-mineralization
  - Tholeiitic basalts in MORB environment
  - Tectonic shift towards an island arc environment with the onset of bimodal, calc-alkaline volcanism
- Stage 1: "Disseminated Au-Cu Mineralization"
  - Structurally controlled, orogenic type mineralization deposited through sulphidation of mafic-intermediate host rocks during prograde greenschist-amphibolite conditions
  - Gold-copper mineralization along quartz veins. Gold associated with sulphide grain boundaries.
- Peak Amphibolite Metamorphic Conditions
  - Remobilization of Au±Cu, concentrated in structural traps
- Stage 2: "Vein-hosted Au Mineralization"
  - Deposition of Au under retrograde greenschist conditions.
  - Shear hosted, quartz-chlorite vein swarms.
  - Structurally controlled by competent intrusive bodies such as felsic dikes.

Conclusions

Mineralization

- Multiple stages of structurally controlled mineralization separated by peak metamorphic conditions.
  - Disseminated mineralization was likely controlled structurally and geochemically by host rock sulphidation.
  - Likely remobilization and introduction of gold during both stages of mineralization.
- The SWZ likely represents a **lower structural level** of the Troilus Deposit compared to former mine workings.

Implications for Exploration

- There is a strong potential for mineralization to be encountered at depth at the former mine site. Deeper drilling could encounter similar mineralization seen at the SWZ.
- Regional mapping of shear zones should be performed to target structural corridors containing vein-hosted mineralization.
- Structural traps such as competent syn-deformational intrusive units should be mapped. Such structures may have trapped gold that was remobilized during metamorphism.

Acknowledgment

We would like to thank Troilus Gold Corporation for access to the mine site, their hospitality and continued support of our research.

References

[1] Fraser, R., 1993, The Lac Troilus Gold-Copper Deposit, Northwestern Quebec: A Possible Archean Porphyry System: Economic Geology, v. 88, p. 1685-1699.

[2] Goodman, S., Williams-Jones, A. E., and Carles, P., 2005, Structural Controls on the Archean Troilus Gold-Copper Deposit, Quebec, Canada: Economic Geology, v. 100, p. 577–582.