Geometallurgical Domains in a Gold Deposit: Example of the Whale Tail Deposit, Amaruq Project, Nunavut

Floriane Guillevic (UQAC-CERM), Lucie Mathieu (UQAC-CERM), Marjorie Simard (Agnico Eagle Mines), Aurélie Chopard (Agnico Eagle Mines)

INTRODUCTION

The current mining paradigm forces mining companies to exploit more and more refractory ores with complex mineralogy. Generally, the distribution of gold in a deposit is characterised by geologists (exploration phase) while metallurgists focus on physical and chemical characteristics of the rocks to optimize gold recovery (pre-feasibility phase). However, an early understanding of gold recovery parameters and of environmental impacts would provide a competitive advantage to a mining company. This could be achieved by geometallurgy investigations, which integrated several disciplines of the geosciences to relate mineral recovery and environmental impacts to the mineralogical constraints. Ore processing is then optimized by the use of geometallurgical domains, which are zones with homogeneous mineralogical assemblages associated with specific metallurgical and/or environmental characteristics.

MASTER PROJECT

Goal :

Developing a method, using the Whale Tail deposit of Agnico Eagle Mines, Amaruq project, to create geometallurgical and geoenvironmental domains using data from the exploration phase of the project.

Objectives :

1) To complete a petrographic and metallographic characterization of the Whale Tail deposit

2) To correlate exploration data with metallurgical and environmental data. The results demonstrate the potential of geometallurgy to improve the feasibility of a mining project and to limit its environmental impact.
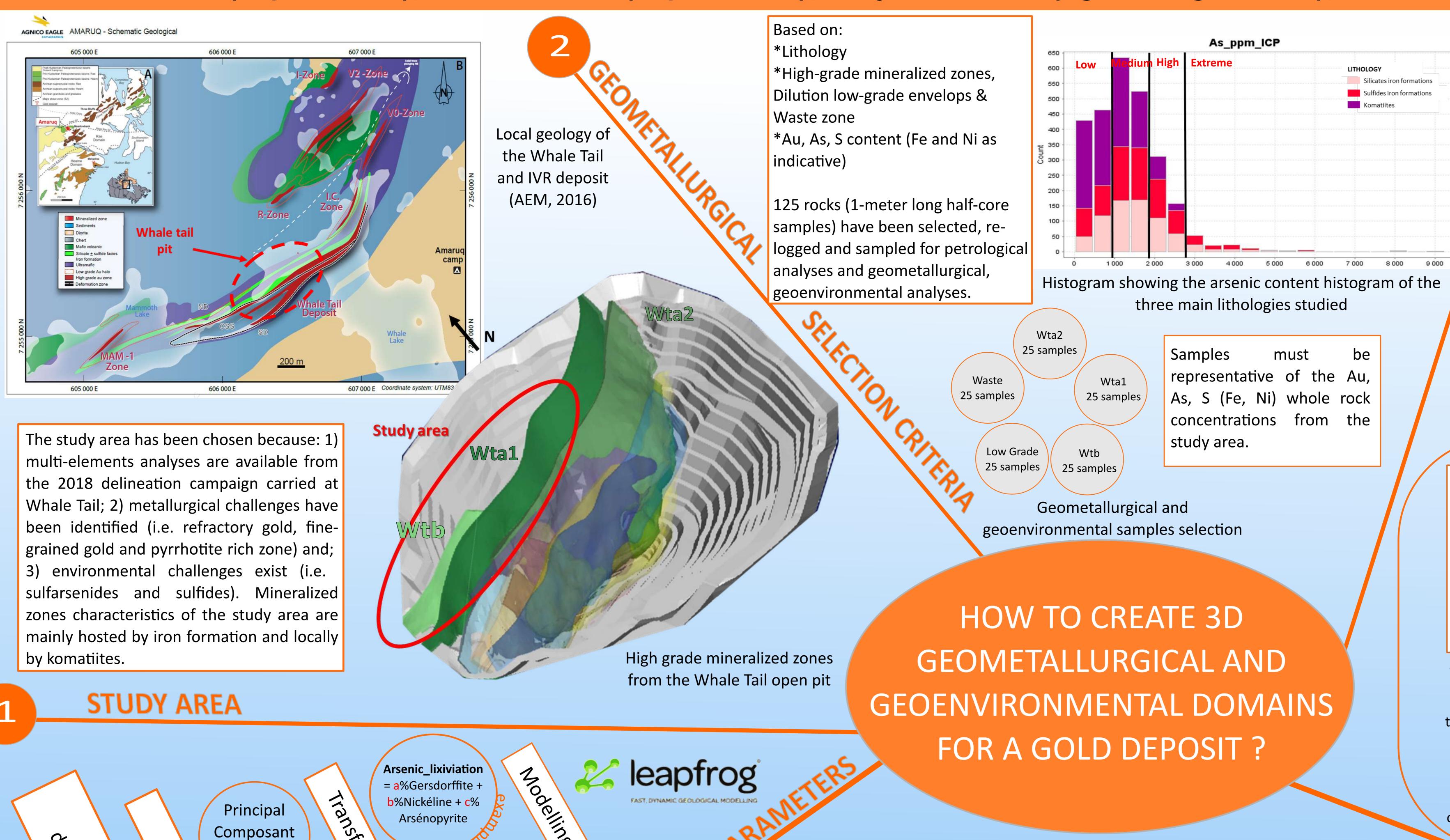
DISCUSSIONS & PRELIMINARY CONCLUSIONS

Gold recovery is mainly impacted by gold grade - positive relationship between grade and recovery.

Gold is mainly observed with arsenopyrite-loellignite and pyrrhotite assemblages and is also observed as microinclusions in gersdorffite.

Gersdorffite is rapidly destabilize in the secondary environment as confirmed by SFE tests. This sulfarsenures is less abundant in iron formations (<0.5%) than in komatiites (<1%).

The result of geometallurgical and geoenvironmental tests is in agreement with more conventional metallurgical and environmental tests.

1 — STUDY AREA

Local geology of the Whale Tail and IVR deposit (AEM, 2016)

The study area has been chosen because: 1) multi-elements analyses are available from the 2018 delineation campaign carried at Whale Tail; 2) metallurgical challenges have been identified (i.e. refractory gold, fine-grained gold and pyrrhotite rich zone) and; 3) environmental challenges exist (i.e. sulfarsenides and sulfides). Mineralized zones characteristics of the study area are mainly hosted by iron formation and locally by komatiites.

High grade mineralized zones from the Whale Tail open pit

2 — GEOMETALLURGICAL SELECTION CRITERIA

Based on:
*Lithology
*High-grade mineralized zones, Dilution low-grade envelops & Waste zone
*Au, As, S content (Fe and Ni as indicative)

125 rocks (1-meter long half-core samples) have been selected, re-logged and sampled for petrological analyses and geoenvironmental, geometallurgical analyses.

Histogram showing the arsenic content histogram of the three main lithologies studied

Samples must be representative of the Au, As, S (Fe, Ni) whole rock concentrations from the study area.

Wta2 25 samples
Waste 25 samples
Wta1 25 samples
Low Grade 25 samples
Wtb 25 samples

Geometallurgical and geoenvironmental samples selection

3 — MINERALOGICAL STUDY & METAL DEPORTMENT

Gold distribution

A) Pyrrhotite (Fe_7S_8) and arsenopyrite (FeAsS) with gold inclusions; A1) zoom on gold inclusions associated with loellingite ($FeAs_2$) and hessite (AgTe) (sample CAEXD604486); B) gold microinclusions located at the contact between pyrrhotite and its magnetite rim (sample CAEXD604493); C) iron formation with pyrrhotite and arsenopyrite replacing iron silicates.
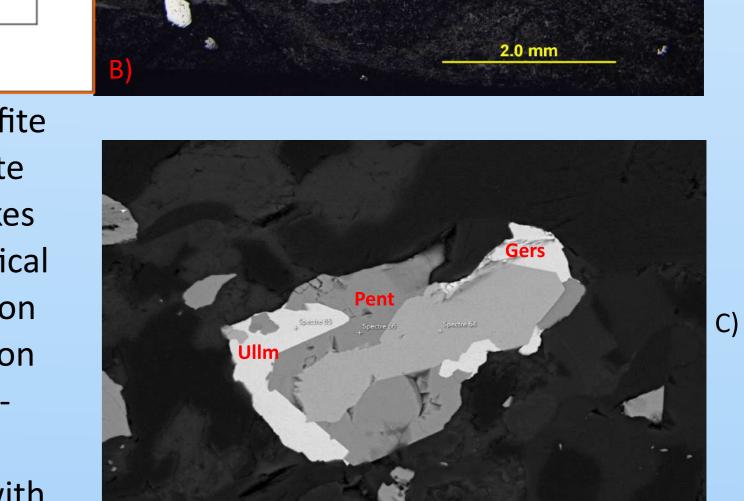
Sulfoarsenides distribution

A) Time resolved laser ablation spectra for a gersdorffite (NiAsS) grain located in komatiite. The results indicate that gersdorffite contains Co, Fe and Sb, that gold takes the shape of microinclusions (i.e. invisible with an optical microscopy); B) disseminated gersdorffite: B1) zoom on gersdorffite grain that was photographed after ablation laser analysis; C) komatiite sample showing the talc-serpentine-carbonate-chlorite assemblage that is common in this lithology; D) gersdorffite associated with pentlandite and ullmannite.

HOW TO CREATE 3D GEOMETALLURGICAL AND GEOENVIRONMENTAL DOMAINS FOR A GOLD DEPOSIT ?

CORRELATION BETWEEN MINERALOGY AND TESTS PARAMETERS

determined by tests and mineralogy

KEY DRIVERS
Statistics tools
Principal Composant Analysis
Transfert functions
Linear regression
Modelling

$$Arsenic\_lixiviation = a\%Gersdorffite + b\%Nickéline + c\%Arsénopyrite$$

$$Gold\_recovery = a\%Arsenopyrite + b As\_ppm - c Pyrrhotite + ...$$

Micro cyanidation test
Rejects lab 75 µm

Geometallurgical test
Geoenvironmental test

GEOMETALLURGICAL AND GEOENVIRONMENTAL TESTS

Gold head assays vs percentage of gold recovery after micro-cyanidation test

Gold recovery

Arsenic concentration from selected samples vs As leaching after shake flask extraction test (SFE)

Metal leaching

NAG test
PN-PA essay
Synthetic Precipitation Leaching Procedure (SPLP)
Shake Flask Extraction test (SFE)