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NSERC-CMIC Mineral Exploration Footprints Project Contribution 049.

Footprint of the Canadian Malartic Gold Deposit, QC, Canada: Preliminary Evaluation of Mafic Dyke Alteration

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Abstract. The Pontiac Group meta-sedimentary rocks that host the Canadian Malartic gold deposit were intruded by numerous mafic dykes before the mineralization event(s). The mafic rocks were more reactive to hydrothermal fluids than the Pontiac sediments, which allows for a better characterization of fluid-rock interactions. A preliminary alteration halo of the Canadian Malartic deposit has been interpreted based on the alteration of the mafic dykes. Mineralogy evolves progressively from a distal amphibole-rich assemblage to a proximal (< 0.3 km) amphibole-biotite-quartz-chlorite-pyrite-carbonate mineral association. Petrophysical properties and geochemical signatures co-vary with the mineralogical observations and indicate a decrease in density (silica and carbonate alteration) and an increase in K_2O (potassic alteration) with decreasing distance from the deposit. Mineralogical, geochemical, petrophysical and hyperspectral data aid in distinguishing the alteration features (e.g., potassic alteration) and provide a combination of tools that can be used to define the alteration halos of similar systems.

Keywords. Deposit footprints, Distal alteration, Gold

1 Introduction

The Canadian Malartic gold deposit (over 14 Moz, past production and current resources; Helt et al. 2014) is located in the Abitibi Subprovince of the Superior Craton (Fig. 1). It is hosted mainly by metamorphosed sediments of the Pontiac Group, on the south side of the gold-rich Cadillac – Larder Lake fault system.

The alteration halo of this world-class epigenetic deposit is currently being investigated by the NSERC-CMIC Multidisciplinary Mineral Exploration Footprints project (*http://cmic-footprints.ca/*), which is using geological-structural-lithogeochemical-mineralogical-petrophysical-geophysical datasets to characterize the distal footprint of this deposit, to identify new exploration criteria, and to develop exploration methodologies.

The purpose of this communication is to report the results of one part of this project, which is aimed at using the degree of alteration of mafic dykes to better define the mineralization-related alteration halo.

2 Geological Setting

Gold mineralization at the Canadian Malartic mine was first described by Derry (1939) and Gunning and Ambrose (1940). Pontiac Group meta-sedimentary rocks, mafic dykes, and monzodiorite intrusions are the main host rocks, and have undergone potassic, pyritic, silica, and carbonate alterations during mineralization.

Derry (1939) reported two major structural fabrics in the area: an E-W to NE-SW trending S_1, and an NW-SE trending S_2 defined by biotite. The main mineralizing event is thought to have occurred during D_2 deformation (Derry 1939).

Subsequent studies by Sansfaçon et al. (1987), Fallara et al. (2000), and the TGI4 program have refined Derry's geological model. Helt et al. (2014) investigated alteration assemblages and fluid compositions and proposed that Canadian Malartic may represent a new type of intrusion-related gold deposit.

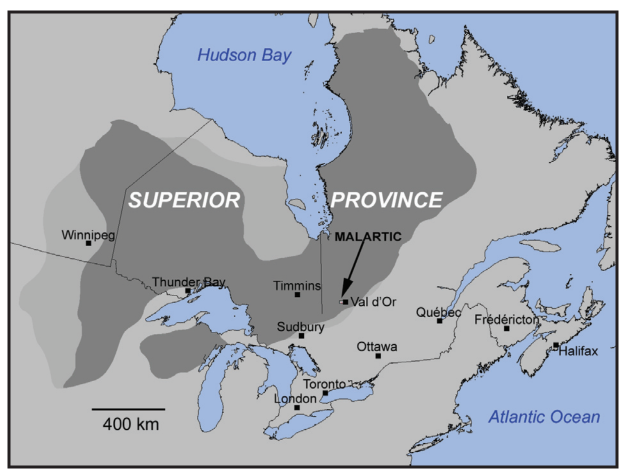

Figure 1. Map of the Superior Craton (outlined here from airborne magnetic datasets) showing the location of the Canadian Malartic gold deposit in the Québec part of the Abitibi Subprovince.

3 Methodology and Results

Numerous mafic dykes intruded the Pontiac Group sedimentary rock and the monzodiorites before the mineralization event. They are folded by F_2, display a biotite-actinolite S_2 cleavage, and have been affected by mineralization-related alterations. The mafic dykes are also present within the Piché Group, north of the Pontiac Group, where they intruded ultramafic rocks (Derry 1939).

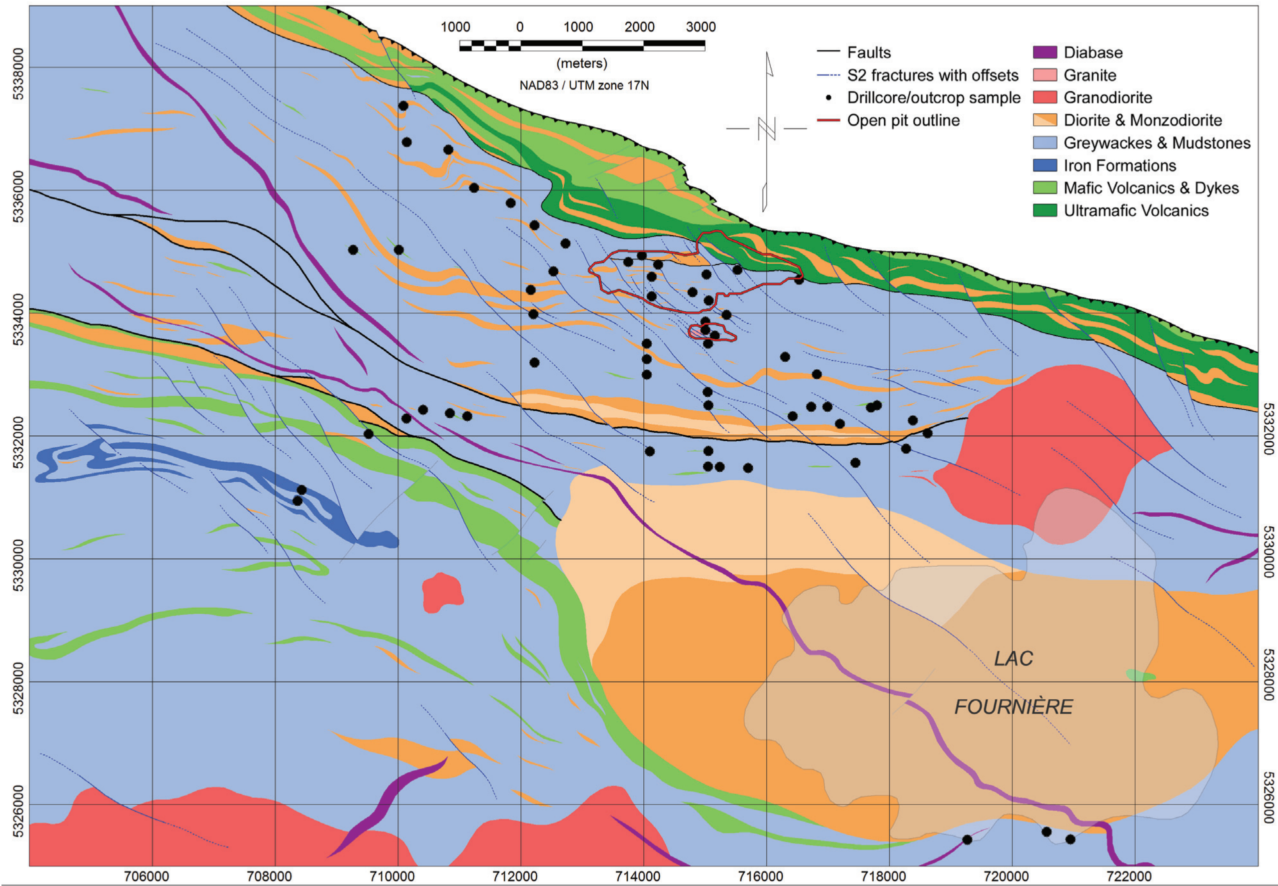

Figure 2. Geological map of the Canadian Malartic area (based on airborne geophysical surveys and outcrop database from Derry 1939; Gunning and Ambrose 1940; Sansfaçon et al. 1987; Fallara et al. 2000; unpublished data from Canadian Malartic Corporation; and data from this study). Black dots show the location of mafic dyke samples and the red line represents the outline of the Canadian Malartic mine.

Competency and chemical contrasts between the mafic dykes and their host rock affect gold distribution. Gold grades are higher in the vicinity of mafic dykes within the Piché Group, as they are more competent than ultramafic rocks, but gold grades are not significantly higher in the mafic dykes within the Pontiac Group (Derry 1939), as they are less competent than meta-sedimentary rocks. However, the mafic rocks are more reactive to the hydrothermal fluids than the Pontiac sediments (greywacke, siltstone and mudstone), and may therefore be better able to characterize the fluid-rock interactions from the proximal (ore zones) to the distal parts (footprint) of the ore system.

In this work, the mineralogy, whole rock geochemistry and petrophysical attributes of 96 mafic dykes from outcrops and drillcore have been determined over a 280 km² area around the deposit (Fig. 2).

3.1 Mineralogy

The mineralogy of the mafic dykes was investigated by thin-section analysis and by XRD. Mineralogy evolves progressively from a distal amphibole-rich assemblage to a proximal biotite-carbonate-quartz-chlorite-pyrite mineral association. Hyperspectral analyses (shortwave infrared, SWIR, and thermal infrared, TIR) of drill core and outcrop samples indicate that this method can be used to identify these changes in mineralogy.

3.2 Whole Rock Geochemistry

Portable-XRF data and conventional lab-based whole-rock geochemical data (XRF, Na_2O_2 fusion + ICP, Aquaregia + ICP) have been acquired on the same samples, and define a whole-rock geochemical halo that corresponds to the mineralogical halo. For example the K_2O content of the mafic dykes increase toward the gold deposit, which is consistent with potassic alteration being associated with gold mineralization (Derry 1939).

3.3 Petrophysics

Petrophysical properties were measured on the same samples that were used for mineralogical and geochemical investigations. Densities decrease toward the gold deposit, which corresponds with silica and carbonate alteration.

4 Discussion and Final Remarks

A preliminary alteration halo of the Canadian Malartic deposit has been defined based on mineralogical, geochemical, and petrophysical characteristics.

Not only are the dykes more susceptible to mineralization-related alteration, they also define critical relationships between magmatism, deformation, hydrothermal alteration, and gold mineralization.

Hyperspectral, mineralogical, geochemical, and petrophysical data aid in distinguishing the alteration features and provide a combination of tools that can be used to define and target the alteration halos of similar systems.

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