Mineralogical and chemical characterization of the Chevrillon Pluton and relationship with sedimentary hostrocks, Abitibi Subprovince, Chibougamau Region, Quebec

J. Huguet[1], L. Mathieu[1], P. Bédard[1] and P. Bedeaux[1]

[1]Centre d'études sur les ressources minérales, Département des sciences appliquées, Université du Québec à Chicoutimi, Chicoutimi, Quebec

PREAMBLE

Some sections of this report ('Regional context' and 'Lithological units' sections) are directly reproduced from the 2018 fieldwork report (Huguet et al., 2018). The introduction is also partly taken from that report and has been only slightly modified.

INTRODUCTION

This study was carried out north of the Town of Chibougamau as part of the Metal Earth initiative. The Chevrillon Pluton, in the northeastern part of the Abitibi greenstone belt (Superior Province), is located 5 km east of the northern end of the Metal Earth seismic transect that extends through the Chibougamau area. The small granodioritic intrusion was formed at the end of the Archean in the syntectonic Waconichi syncline. This fault-bounded sedimentary basin contains conglomerate deposits of the Chebistuan Formation (Opemisca Group). The geological setting of the pluton and its sedimentary hostrocks is comparable to that of the Kirkland Lake area, in the southern part of the Abitibi Subprovince. That area indeed displays a spatial and temporal association between conglomerate units of the Timiskaming Group deposited in syntectonic basins, in faults, and in late syenite and granodiorite intrusions.

However, the Timiskaming Group geological setting is associated with several gold deposits, whereas there is no known gold mineralization in the Waconichi syncline. This study has two main goals: 1) chemical characterization of the Chevrillon Pluton and its source to define the nature of the magma, an essential step I establishing a comparison with magmatism in the Kirkland Lake area; and 2) establishing the relationship between the Chevrillon Pluton and its sedimentary hostrocks, as well as the timing of its emplacement and its relationship to deformation events. The aim of the summer 2018 and 2019 fieldwork was to collect data and samples for laboratory analysis to provide answers to the questions raised by these objectives.

REGIONAL SETTING AND DEFORMATION (PREVIOUS WORK)

The Abitibi greenstone belt consists of an assemblage of Neoarchean volcanic and sedimentary rocks crosscut by many intrusive bodies. The Chibougamau area is bounded to the east by a northeast–southwest-striking deformation zone, which separates it from the Grenville Province, and to the north by the Barlow Pluton, which separates it from the Opatica Subprovince (Daigneault, 1991; Leclerc et al., 2011, 2017). The rocks in the Chibougamau area are generally of greenschist facies metamorphic grade,

and are also folded and faulted. However, the areas surrounding the intrusive bodies, such as the Barlow or Chevrillon plutons, show signs of higher grade amphibolite-facies metamorphism and deformation (Boudreault, 1977).

The stratigraphy of the Chibougamau area can be divided into two groups: the Roy Group and the Opémisca Group. The first corresponds to an assemblage of volcanic rocks divided into two cycles. The first cycle consists of the Obatogamau, and Waconichi formations, whereas the second cycle consists of the Bruneau, Blondeau and Bordeleau formations. The Opémisca Group, mainly composed of sedimentary rocks, unconformably lies atop the Roy Group (Daigneault and Allard, 1990). The mostly sedimentary Opémisca Group deposits lie within the core of the east–west-striking Chapais and Waconichi synclines (Leclerc et al., 2017). Within the synclines, the Opémisca Group consists of the Stella and Haüy formations, and the Chebistuan Formation, respectively (Allard and Gobeil, 1984). Finally, the numerous intrusive bodies in the Chibougamau area can be divided into two categories: the first corresponds to the tonalite-tronjdhemite-granodiorite (TTG) suite of the synvolcanic period, whereas the second one corresponds to intrusive bodies of the syn- to post-tectonic period (e.g., the Chevrillon Pluton granodiorite).

Three deformation events marked the Chibougamau area. The first deformation phase (D_1, synvolcanic period), of lesser importance, is expressed by north–south oriented folds associated with the emplacement of large-volume intrusions coeval with the Roy Group (e.g., the Chibougamau Pluton; Daigneault and Allard, 1983). The second deformation phase (D_2, north–south shortening) formed east–west regional folds associated to the regional foliation. Moving from the south to the north, this deformation formed the Chapais, Chibougamau and Waconichi synclines, as well as the Waconichi, Chibougamau and La Dauversière anticlines. The third deformation phase (D_3) manifests itself as a strike-slip motion along east–west oriented structures (Daigneault and Allard, 1984; Dimroth et al., 1986; Daigneault et al., 1990; Leclerc et al., 2017). Deformation events D_2 and D_3 occurred during the syntectonic period, which throughout the Abitibi Subprovince lasted from 2700 to 2670 Ma (Chown et al., 1992, 2002). However, in the Chibougamau area, the time interval associated with this event begins earlier and extends from 2707 to 2692 Ma (Dimroth et al., 1986; Daigneault et Allard, 1990).

Lithological units in the study area

The Chevrillon Pluton is described as a small (11 km by 8 km), massive and homogeneous microcline-phyric granodiorite pluton emplaced between the end of the syntectonic period and the syntectonic period (Duquette, 1982), It is characterized by a quartz-microcline-plagioclase assemblage, with rare chloritized biotite and amphibolite grains. It contains variable amounts of titanite, apatite, zircon, ilmenite and magnetite (Sabourin, 1956). The intrusion is bounded to the north, northwest and west by three small homogeneous intrusive bodies of similar composition. Their relationship to the Chevrillon Pluton remains undefined. A 1.6 km halo of amphibolite-facies contact metamorphism surrounds the Chevrillon Pluton in the Chebistuan Formation sedimentary rocks (Sabourin, 1956). Mapping done in the area surrounding the Chevrillon Pluton shows that it is bounded to the north, northeast and northwest by Chebistuan Formation sedimentary rocks but that it crosscuts the Bordeleau and Bruneau formations in the south (Daigneault and Allard, 1990).

The Chebistuan Formation is the stratigraphic equivalent of the Stella and Haüy formations, which have been observed in the Chapais syncline, south of the Town of Chibougamau (Allard et al., 1979). The Chebistuan Formation consists of polygenetic conglomerate, arkosic sandstone and argillite like those of the Stella Formation, and also contain andesitic lava similar to that of the Haüy Formation. The Stella Formation consists of polymictic conglomerate, arkosic sandstone and argillite. This formation has been dated at 2704 ±2 Ma, which corresponds to the maximum age of conglomerate deposition based on a U-Pb zircon age obtained by isotope dilution-thermal ionization mass spectrometry analysis (ID-TIMS;

Leclerc et al, 2012). The conglomeratic Haüy Formation yielded a maximum depositional age of 2691 ±2.9 Ma (ID-TIMS U-Pb on detritic zircons; David et al., 2007). The ages of these two formations are therefore not precisely constrained but indicate that they are younger than ca. 2690 Ma. The Chevrillon Pluton has been preliminarily dated at 2693 ±1.7 Ma (M. Hamilton, unpublished data, 2018). Thus, the relationship of the Chevrillon Pluton to deformation is particularly significant since determining the age of the pluton will aid in closing the tectonic window associated with deformation.

WORK COMPLETED

Over and above the stations described during the 2018 field season, four new stations were studied during the 2019 field season as part of an M.Sc. research project. One station is in the southern part of the Western Satellite and is in fact the only one not located on the margin of this small intrusive body. The three other stations are in the western part of the Northwestern Satellite, which has to date not been described, whether during the 2018 field season or in the geological literature (Figure 1). The work then focused mainly on characterizing the lithological units and structures associated with the Chebistuan Formation west of the Western Satellite.

Western Satellite

The description of the outcrop matches the one made of this outcrop last year. Macroscopic study indicated that the rock of this satellite is consistently the same throughout, from its core to its outer margins. It consists of feldspath (65%), quartz (25%), biotite (4%), chlorite (2%) and rare amphibole (2%). It hosts rare feldspar-phyric crystals that do not exceed 0.5 cm in size and make up only 2% of the rock. The ferromagnesian minerals in this rock are aligned along a plane with direction values varying between N270 and 280, and dipping 75° toward the north. No inclusions were observed on this outcrop.

Northwestern Satellite

The coarse-grained rock of the Northwestern Satellite consists of an assemblage of feldspar (40%), quartz (20%), biotite, chlorite and rare amphibole (20%), as well as banded feldspar-phyric crystals 1 cm^2 in basal section that make up approximately 20% of the rock. This rock hosts inclusions similar to those in the Chevrillon Pluton and the Northern Satellite described last year. This intrusion contains grey, rounded, coarse-grained inclusions reaching up to 30 cm in length. These inclusions consist of amphibole, feldspar and chlorite, with rare feldspar-phyric crystals of the same size as those observed in the hostrocks. A second type consists of black, angular inclusions with finer crystals than the grey inclusions and consisting mainly of amphibole and chlorite. Field observations indicate that the inclusions measure no more than 10 cm in length. Unlike the Chevrillon Pluton and its other satellites, Northwestern Satellite rock is massive and displays no alignment of ferromagnesian minerals.

CHEBISTUAN FORMATION

The main objective of the 2019 summer field work was to better characterize the large sedimentary basins of the Chibougamau area. One of the areas of interest is thus located in the Waconichi sedimentary basin, west of the Western Satellite The typical assemblage of the Chebistuan Formation consists of polygenic conglomerate and sandstone units affected by east–west, subvertical regional foliation. However, in this area, the rocks in question consist of alternating units of sandstone, silt and mudstone but host no conglomerate. In addition, regional foliation no longer strikes east–west but is now mainly

oriented N330 with subvertical plunges in the southern part of the area, while the dip varies between 50 and 60° in the northern part.

SUMMARY

Summer 2019 mapping showed that the Northwestern Satellite consists of homogeneous rock similar to that of the Chevrillon Pluton and the Northern Satellite. The ferromagnesian minerals in the rock of this intrusion display no alignment and it therefore shows no evident signs of deformation. Based on field observations, the Chebistuan Formation does not consist only of conglomerate and sandstone but also contains silt and mudstone, suggesting a depositional environment other than fluvial in certain areas of the basin. Thus, the Waconichi Syncline is not homogeneous and could consist a number of different basins. Future work will seek to better characterize this sector based on the data collected in 2018 and 2019. Study of the depositional basins in the Kirkland Lake area has revealed the presence of wacke and argillite facies (Hyde, 1980) similar to those observed in the Waconichi Syncline.

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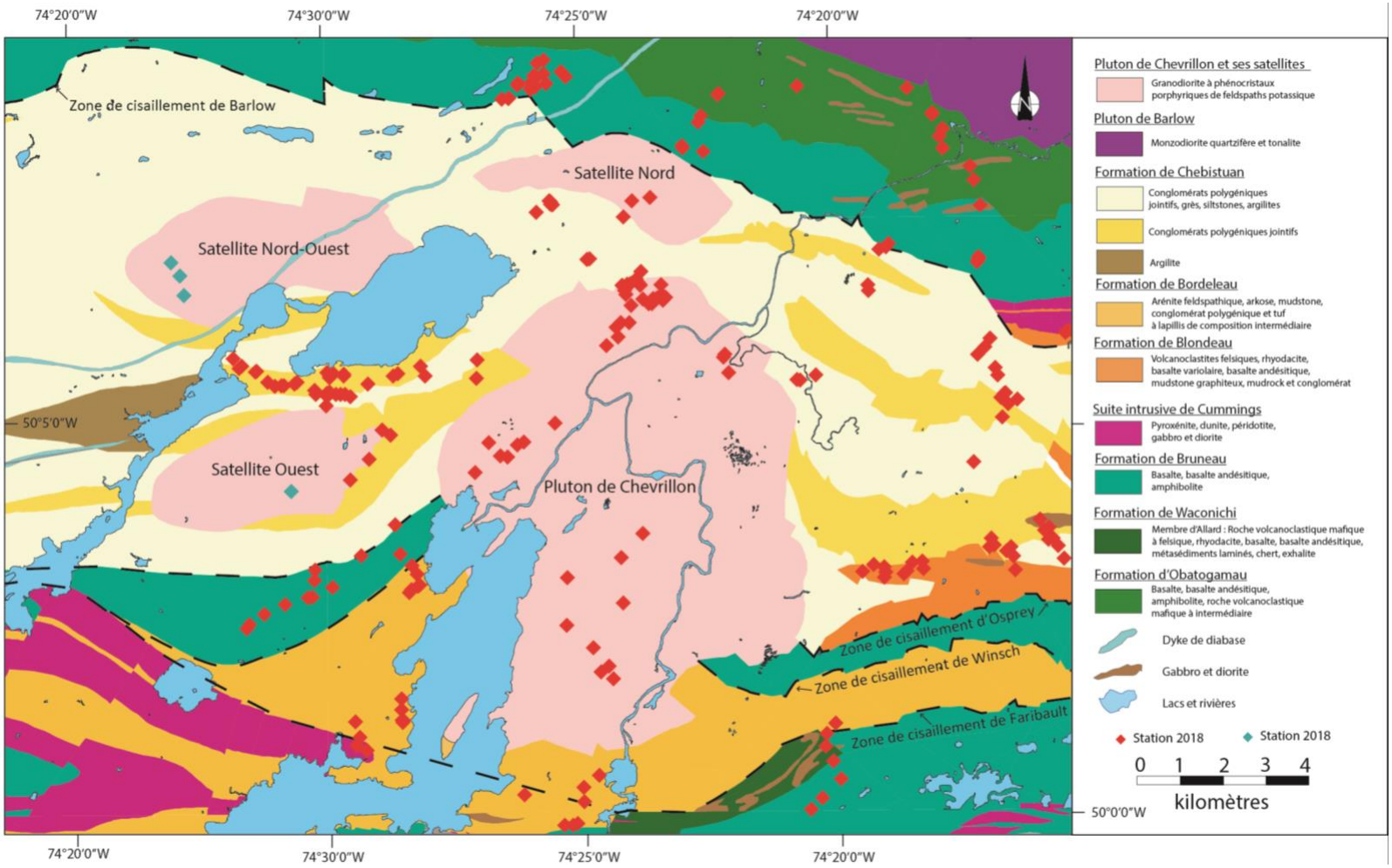

Figure 1. Geology of the study area showing the location of the stations sampled during summer 2018 and 2019 mapping (SIGÉOM, 2018).