

Metamorphic study of a portion of the Grenville Front

Sandrine Cadéron¹, Patrice Roy¹, Daniel Bandyayera¹, Kamal N. M. Sharma¹

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ABSTRACT

The Ministère des Ressources naturelles et de la Faune began, in 2003-2004, a new study on the Grenville Front. This study included the yearly production of two new 1 : 50 000 geological maps, the characterization of all mineralized occurrences and a tectono-metamorphic synthesis. The main purpose of this multidisciplinary study is to document the metamorphosed equivalents of the Archean volcanoclastic belts from the Abitibi Sub-Province within the Grenvillian Parautochthonous.

This document presents the first results of the metamorphic synthesis carried out in the context of this study. It includes two complementary sections which will further our understanding of the spatiotemporal evolution of the mineralizations in conjunction with the tectono-metamorphic evolution of the mapped lithologies. This regional metamorphic synthesis aims at determining the pressure and temperature conditions of the metamorphosed supracrustal rock belts of the Abitibi in the Grenvillian Parautochthonous. Our understanding of the regional thermodynamic evolution of these belts is important in order to better comprehend the nature of the mineralizations located in these high-grade metamorphic terranes (amphibolitic to granulitic). Historically, Québec's mining industry has focused mainly on low-grade metamorphic terranes (greenschist and lower amphibolite facies). The development of new exploration tools will facilitate exploration in high-grade metamorphic terranes.

This regional metamorphic study is based on the sampling of metabasites and metasediments from the Chibougamau area, along NW-SE transects from the Superior Province into the Grenvillian Parautochthonous. The previously recognized metamorphosed occurrences of economic minerals, as well as new occurrences discovered during the 2003 summer work, were also sampled. The analytical methodology is characterized by four steps: 1) a detailed petrographic study, 2) a determination of the mineral chemistry by electronic microprobe, 3) a total and partial rock analysis for base and precious metals, 4) an analysis of the sulphides by scanning electronic microscopy (SEM). These were followed by two data treatment methods for 1) the estimation of pressure-temperature (P-T) conditions and 2) the age dating of the various metamorphic events.

Preliminary results presented in this document are derived from mapping work carried out in the summer of 2003 in the Lac Lagacé and Lac Charron areas. The results include isograd interpretations, mineral chemistry determinations and calculations of pressure-temperature (P-T) conditions undergone by the metabasites. The isograds follow the large regional faults and reveal that the metamorphic gradient increases from the Superior Province towards the Grenvillian Parautochthonous, progressing from the lower amphibolite facies to the granulite facies. The mineral chemistry of the garnets and amphiboles within the metabasites reveals the same tendency. The grossular-almandine (Ca-Fe) composition of the garnets is characteristic of a pressure increase, whereas the amphibole's TiO₂ content is indicative of a temperature increase. The P-T conditions evolve from the Superior Province into the Grenvillian Parautochthonous. To the North-West, the metabasites were affected by maximum conditions of 5 ± 1 kbar and 647 ± 50 °C, and minimum conditions of 4 ± 1 kbar and 617 ± 50 °C. Pressure conditions obtained at the Grenville Front are around 10.3 to 5.1 ± 1 kbar and temperature conditions vary between 801 and 462 ± 50 °C. The transitional zone, where relics of primary structures can still be observed, was subjected to P-T conditions ranging from 13.3 to 4 ± 1 kbar and of 714 to 535 ± 50 °C. The Grenvillian Parautochthonous was affected by the highest P-T conditions with a maximum of 17 ± 1 kbar and 874 ± 50 °C and a minimum of 8.5 ± 1 kbar and 690 ± 50 °C.

From an economic standpoint, preliminary analytical results of garnets from metamorphosed alteration zones surrounding volcanogenic massive sulphide-type (VMS) showings are characterized by a marked manganese enrichment near the sulphides. Additionally, the titanium concentration in amphiboles is indicative of the syn- or tardi-metamorphic nature of the remobilization of sulphides. These preliminary results support the proposition of several working hypotheses on the relative chronology and the characterization of typical chemical tracers of VMS-type mineralizations in high-grade metamorphic terranes.

