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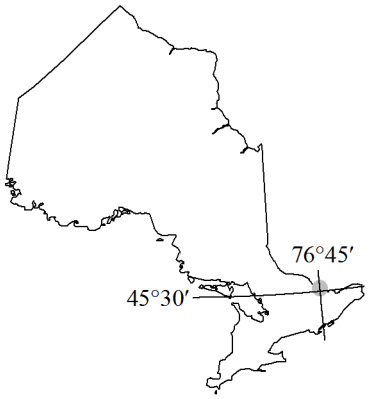
14. Project Unit 13-013. Geology and Mineral Potential of the Chenaux Gabbro, Northeastern Central Metasedimentary Belt, Grenville Province



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INTRODUCTION

The Chenaux gabbro intrusion encompasses approximately 30 km^2 and is centred at 45°33′30″N latitude and 76°42′W longitude (Figure 14.1). The intrusion lies mainly in Horton Township with the northwest corner and the western extension of the body in Ross Township. The Chenaux gabbro is identified on the regional bedrock geology map of Lumbers (1982b), and has received limited study in the past by Seguin and Brun (1984, paleomagnetism), Abdurahman (1989), major element geochemistry and gravity) and Pehrsson, Hanmer and van Breemen (1996, geochronology). The Chenaux gabbro has a prominent geophysical expression, forming both a regional aeromagnetic high and a Bouguer gravity high (Ontario Geological Survey 1999). Major element geochemical data reported in Abdurahman (1989) indicate that the Chenaux gabbro is a tholeiitic basalt of island-arc and calc-alkalic affinity. The age of emplacement of the intrusion is constrained by a U/Pb zircon upper intercept age of 1231±2 Ma (Pehrsson, Hanmer and van Breemen 1996).

This report describes the results of 4 weeks of detailed mapping related to the larger scale compilation work by Easton (this volume, Article 13). Overall, 51 samples from the Chenaux gabbro are to be analyzed for major and trace element geochemistry and examined in thin section. An additional 15 samples of crosscutting mafic dikes and amphibolite will also be analyzed. Regional samples of mafic rocks have been collected by Easton (this volume, article 13) and will be included as a part of this study.

ROCK TYPES

Easton (this volume, Article 13) describes the broader regional setting of the Chenaux gabbro. In brief, it occurs in a large, likely down-dropped, fault block. To the west, this block is in contact with highly deformed and metamorphosed gneisses that are cut by syenite intrusions, all located within the boundary zone between the Central Gneiss Belt and Central Metasedimentary Belt. The eastern margin of the fault block is in Quebec. The fault block is dominated by calcite and dolomite marbles that preserve relict stratigraphy and that have been subjected to middle to upper amphibolite-facies metamorphism. An early period of folding and development of metamorphic layering in the marbles appears to have occurred prior to emplacement of the Chenaux gabbro.

The Chenaux gabbro displays a map pattern best described as broad-scale compositional differentiation rather than possessing a well-defined stratigraphy. Igneous layering in the Chenaux gabbro is visible only on the outcrop scale (Photo 14.1A). Throughout the gabbro, there are crosscutting mafic dikes; some

Summary of Field Work and Other Activities 2013,
Ontario Geological Survey, Open File Report 6290, p.14-1 to 14-7.

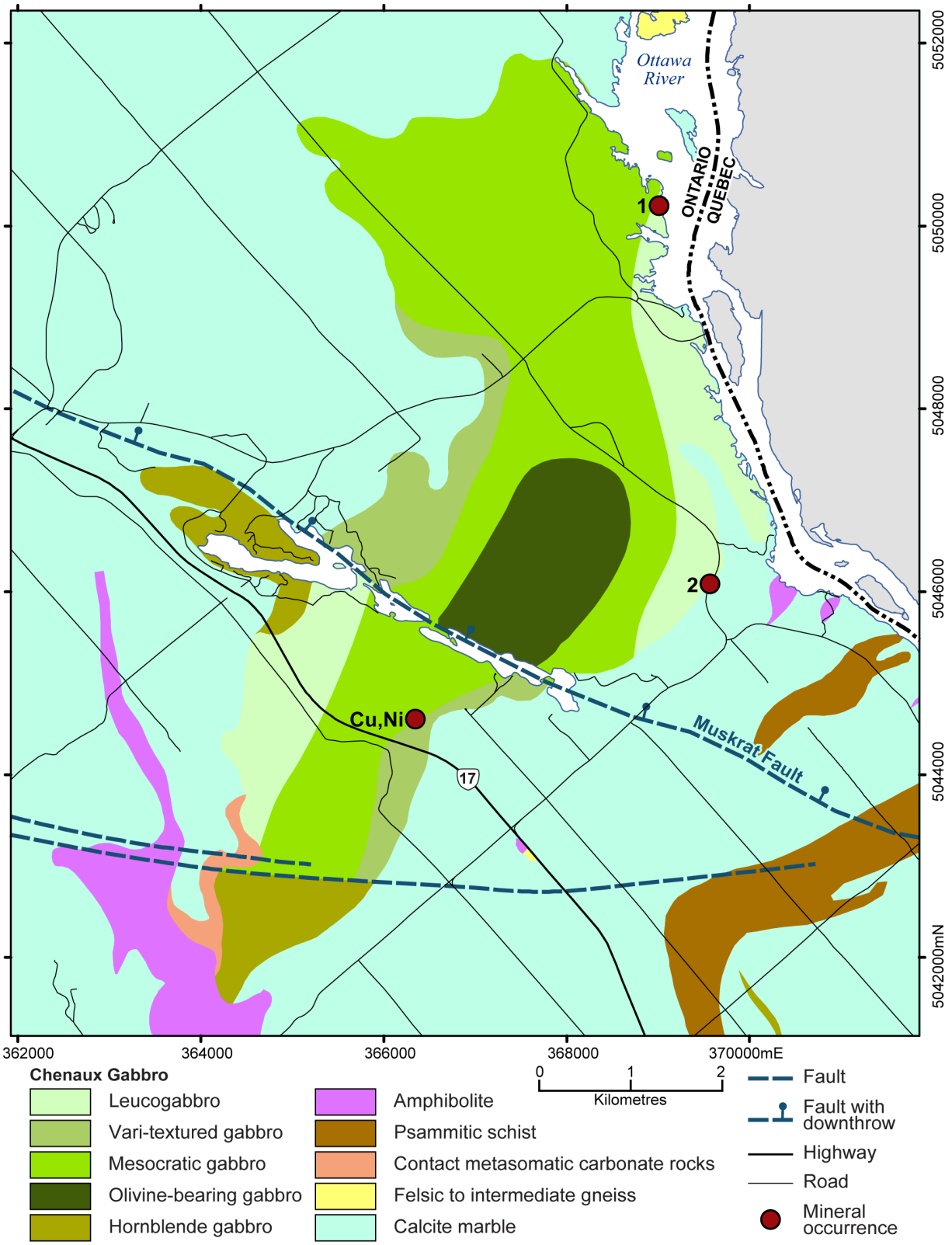

Figure 14.1. Preliminary geological map of the Chenaux gabbro, showing the main units within the gabbro as well as the location of previously identified mineral occurrences. Chenaux gabbro subdivisions are from this study; regional geology and faults are *from* Lumbers (1982b). Numbers 1 and 2 refer to iron occurrences listed in Table 14.1. All UTM co-ordinates are NAD83, Zone 18.

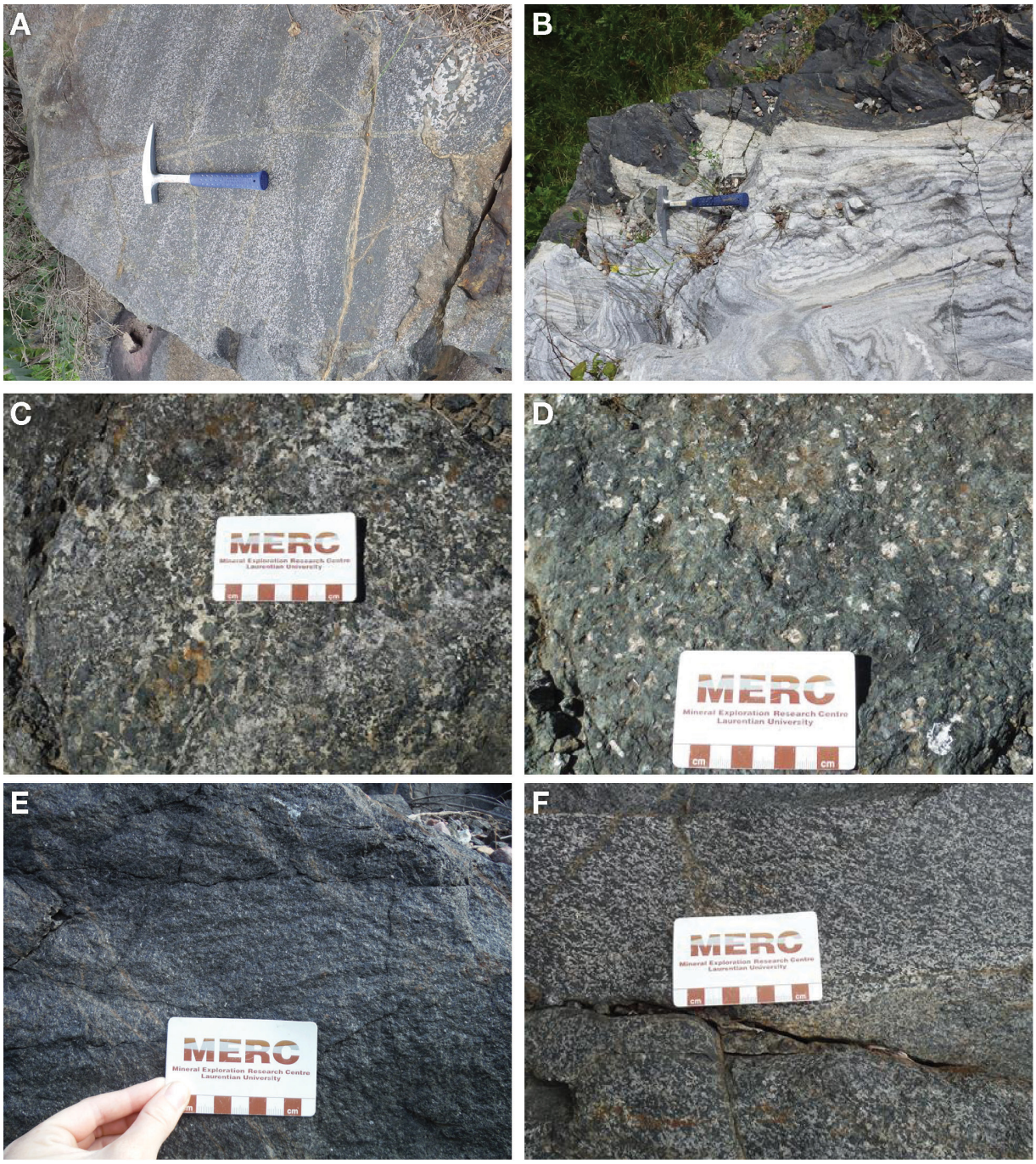

Photo 14.1. A) Primary igneous layering within the Chenaux gabbro. Hammer handle points south and is 32 cm long. Roadcut on the south side of Highway 17 (UTM 365219E 5044804N). **B)** Contact between the Chenaux gabbro and calcite marble displaying disharmonic folding. Hammer handle points south and is 32 cm long. Roadcut on the south side of Highway 17 (UTM 364907E 5045299N). **C)** Close-up view of vari-textured and vari-grained Chenaux gabbro, looking south. Outcrop on the south side of the gas pipeline right-of-way west of Garden of Eden Road (UTM 365842E 5043799N). **D)** Very coarse-grained and strongly amphibole-altered melanocratic Chenaux gabbro, view to the southwest. Outcrop is on the south side of the gas pipeline right-of-way west of Garden of Eden Road (UTM 365909E 5043753N). **E)** Homogeneous and weakly foliated medium-grained mesocratic Chenaux gabbro, view to the north. Roadcut on the north side of Highway 17 (UTM 365956E 5044413N). **F)** Lineated and foliated Chenaux gabbro, view to the north. Roadcut on the north side of Highway 17 (UTM 364941E 5045302N). All UTM co-ordinates are NAD83, Zone 18.

appear to be genetically related to the gabbro, whereas others may be related to the Grenville dike swarm (*circa* 590 Ma: Kamo, Krogh and Kumarapeli 1995). Five main gabbro subtypes were identified in the field: mesocratic gabbro, vari-textured gabbro, leucogabbro, hornblende gabbro and olivine-bearing gabbro (*see* Figure 14.1). Directly surrounding the Chenaux gabbro, the host rock is dominated by lower amphibolite grade calcite marble with lesser quantities of dolomite marble, psammitic schist, contact metamorphosed carbonate rocks, intermediate gneiss and amphibolite (*see* Figure 14.1).

Mesocratic Gabbro

The mesocratic gabbro unit is typically homogeneous and medium grained (Photo 14.1E). Sub-ophitic textures are visible where there is fresh exposure along roadcuts and, in some cases, amphibole coronas can be seen surrounding pyroxene crystals. The unit ranges from massive to moderately foliated and lineated with varied magnetic susceptibility, generally 17 x 10^{-3} SI units.

Vari-textured Gabbro

Vari-textured and vari-grained gabbro is typically leucocratic and more rarely mesocratic (Photo 14.1C). Grain size ranges from fine to very coarse grained. This rock unit appears to be primarily present along the margins of the intrusion, proximal to the contacts with the calcite marble (*see* Figure 14.1). The variation in texture and grain size is interpreted to be the result of fluid–rock interaction during the intrusion of the Chenaux gabbro into the surrounding marble units.

Leucogabbro

Plagioclase-rich medium- to coarse-grained leucogabbro is concentrated along the northeast and southwest contacts of the intrusion (*see* Figure 14.1). Generally the rock is homogeneous, although there are some instances where coarser grained dikes and dikelets of anorthositic gabbro crosscut the leucogabbro unit. Much of the leucogabbro has thin veneers of calcite marble structurally overlying it, especially in the southwest portion of the intrusion. The leucogabbro unit is interpreted to be representative of the roof of the intrusion, where plagioclase would have accumulated during differentiation.

Hornblende Gabbro

The hornblende gabbro appears to be a product resulting from the introduction of water-rich fluids during metamorphism of all the above-mentioned rock types. In this unit, hornblende has completely replaced the pyroxene and possibly the olivine crystals. Relict textures are commonly visible, and the gabbro is generally medium to coarse grained and, more rarely, vari-textured. The distribution of this rock type will be better understood upon analysis of thin sections and whole rock geochemistry. There are several areas outside the areas identified in Figure 14.1 as hornblende gabbro where amphibole replacement of mafic minerals is complete, but their distribution is localized (e.g., Photo 14.1D).

Olivine-Bearing Gabbro

The center of the Chenaux intrusion was difficult to access due to the topography and swamps. The few samples that were taken from the middle of the intrusion north of the Muskrat fault appear to have olivine contents ranging from 5 to 15%. Much of the olivine appears to have been partially replaced by amphibole, or has amphibole or orthopyroxene corona reaction textures. These rocks are typically medium grained and melanocratic.

Other Mafic Rocks

There is an older fine- to medium-grained amphibolite that is strongly deformed and cut by the younger Chenaux gabbro. It occurs south of the gabbro and is folded around the lower contact of the gabbro (*see* Figure 14.1). Multiple small, discontinuous bodies of amphibolite, some garnet bearing, were encountered along the Ottawa River where they cut the marbles; these amphibolites are all likely related. Furthermore, 2 sets of small mafic dikes were observed: one generally more leucocratic and north trending, the other is more magnetic and east trending. The east-trending dikes may be related to the $590\ ^{+2}/_{-1}$ Ma Grenville dike swarm, which is typically highly magnetic and has a tholeiitic composition (Kamo, Krogh and Kumarapeli 1995). Detailed petrographic and geochemical analysis will aid in the classification of these mafic units.

STRUCTURAL GEOLOGY

The Chenaux gabbro has likely been affected by both the Shawinigan (1190 to 1170 Ma) and the Ottawan orogenies (1080 to 1020 Ma) (Easton 1992; Carr et al. 2000) after arc amalgamation within the Composite Arc Belt. In addition, the Cobden area, including the Chenaux gabbro, has been affected by Paleozoic and Mesozoic normal faulting related to development of the Ottawa–Bonnechere graben system (e.g., Lumbers 1982a).

The Muskrat fault, which cuts the centre of the Chenaux gabbro along Coldingham Lake and Catherine Lake, has been attributed to the Ottawa–Bonnechere graben system (Lumbers 1982a). Previous workers (Lumbers 1982b; Russell and Williams 1985) have suggested that the northern block was downthrown relative to the southern block, or gave no indication of the throw direction on this segment of the fault. To the south, and most notably on the west side of the Chenaux gabbro, there are abundant shallowly dipping calcite marbles structurally overlying the gabbro, which have been interpreted as roof pendants by Abdurahman (1989). This suggests that much of the Chenaux gabbro to the south of the Muskrat fault is just barely unroofed, and may explain the high abundance of leucogabbro found in this part of the intrusion, because the leucogabbro is associated with the contact. This relationship, however, only makes sense if the Muskrat fault is south-side-down. Alternatively, there could have been 2 stages of movement along the Muskrat fault: an early south-side-down movement allowing for uplift and erosion of the Chenaux gabbro in the northern block, which was followed by younger, north-side-down movement.

The intensity of deformation is varied within the Chenaux gabbro. Much of the gabbro is massive, but there is a north-northwest-striking, steeply dipping, tectonic foliation developed at the centre of the intrusion in the olivine-bearing gabbro. South of the Muskrat fault, the foliation is north- to northeast-striking and also steeply dipping (Photo 14.1F). This foliation is oriented parallel to the contact of the intrusion and is associated with disharmonic folds in the surrounding calcite marble (Photo 14.1B). Within the gabbro and the adjacent calcite marble there are small-scale, steeply dipping shear zones that strike dominantly to the east and south. It is likely that the multiple deformation events listed above do not manifest themselves clearly within the Chenaux gabbro, because the gabbro is rheologically more competent than the surrounding calcite marbles. Pehrsson, Hanmer and van Breemen (1996) suggested that emplacement of the Chenaux gabbro occurred syntectonically during northwest-directed overthrusting; however, this scenario has yet to be confirmed during the current mapping program.

Table 14.1. Main mineral occurrences present in the Chenaux gabbro (data *from* Carter, Colvine and Meyn 1980).

Occurrence	Number in Figure 14.1	Commodities	Best Historic Value	Host Rock
Ottawa River occurrence MDI31F10SE00019	1	Fe, Ti (V)	29.78% FeO, 17.23% TiO_2, 0.63% V_2O_5, 0.10% NiO	Chenaux gabbro
Ross Township iron occurrence MDI31F10SE00018	2	Fe	Not Available	Magnetite and specular hematite vein cutting calcite marble and Chenaux gabbro

ECONOMIC GEOLOGY

Oxide Mineralization

One of the primary goals of this project is to determine the mineral potential of the Chenaux gabbro. Only 2 oxide mineral occurrences are present in the Chenaux gabbro (Carter, Colvine and Meyn 1980): an iron occurrence along the Ottawa River just south of Portage du Fort; and another iron, titanium and minor vanadium occurrence in Lot 22, Concession 7 of Horton Township (Table 14.1). Neither site was located by field party personnel, nor were they located by Carter, Colvine and Meyn (1980). Nonetheless, even though their locations may be uncertain, both occurrences are consistent with field observations indicating an abundance of magnetite-ilmenite oxide minerals within the Chenaux gabbro. The oxide minerals tend to occur as segregations and are not uniformly distributed throughout the gabbro. This uneven distribution explains in part the highly varied magnetic susceptibility readings obtained from the gabbro, which range from 1 to 130 $\times 10^{-3}$ SI units. Metamorphism also results in lower magnetic susceptibility in the more recrystallized parts of the intrusion. The northern part of the Chenaux gabbro appears to have the greatest concentration of oxide minerals and would be the most prospective area for economic titanium and secondary vanadium mineralization.

Sulphide Mineralization

Lumbers (1982b) indicates a nickel-copper occurrence in the Chenaux gabbro, roughly 300 m north of Highway 17. Just to the south of this occurrence, at the west end of a 350 m long roadcut in the Chenaux gabbro on Highway 17, is a 3 to 5 m wide zone containing abundant blebby and disseminated sulphide minerals, predominantly pyrrhotite, hosted within vari-textured gabbro. Preliminary assay results from 2 samples collected from this zone are 77 and 68 ppm Co, 64 and 107 ppm Cu, 31 and 34 ppm Ni, respectively; no gold, platinum or palladium was detected in either of the samples. Blebby and disseminated sulphide minerals, predominantly pyrrhotite, were also sampled within finer grained dikes cutting the Chenaux gabbro. Analysis of additional results from samples taken this season is required to more fully evaluate the sulphide mineralization potential for the Chenaux gabbro.

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