Iron and titanium:
a review of iron and ilmenite deposits in Québec

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For the past two years, the price of iron pellets has been skyrocketing. As noted by the Department in the Summary and Highlights of the Québec Mining Industry for 2004, producers Québec Cartier and IOC saw the price of iron pellets and concentrate rise by 21.2% and 22.33%, respectively. Worldwide reference prices for these two products reached historic highs in 2004. In response to this increase, many mining companies, large and small, have shown a growing interest in iron exploration. In Québec, most of the unmined iron deposits evaluated between 1950 and 1980 are held by several junior mining companies.

The rising price of iron ore and the promising outlook for the coming years have led to renewed interest in iron exploration in Québec. It has not attracted this much interest since the 1960s. A quick calculation of geological resources, based on the Department's mineral deposit records, indicates that Québec has inferred resources of more than 2 billion tonnes of ore. However, there are about twenty deposits with a grade of more than 30% Fe, with tonnages in excess of 100 million tonnes (PDF format, 737 kb - Available in French). Nearly half of these deposits are located in the area lying between Fermont and the Manicouagan reservoir. The sector north of the Labrador Trough, more specifically north of Baie-aux-Feuilles, also contains several major deposits. The Great Whale Iron (James Bay), Duncan (James Bay) and Albanel Lake deposits are also major Québec deposits. It should be noted, however, that the mineral resources of these deposits were assessed during the 1960s and no longer meet the 43-101 standard.

Companies intending to develop an iron deposit must take several factors into consideration:

- Iron market trends in the medium and long term. The iron market is cyclical and very sensitive to global economic fluctuations (e.g.: the price of oil and gas, economic crises, etc.).
- How far deposits are from major infrastructures. Companies mining deposits that are far from
existing infrastructures will face rapidly rising costs if they need to build new ones for shipping iron concentrate and pellets.

- The tonnage and grade of the deposit's iron ore. Though metamorphic iron deposits are interesting in terms of grain size and local concentrations of iron-oxide-rich horizons, the waste-to-ore ratio is generally high. In Québec and Labrador, production of iron concentrate (67% Fe) from ore at an average grade of 30% to 42% Fe requires concentration. This concentration leads to higher production costs than in Australia and Brazil, where most of the iron deposits mined are naturally iron rich, grading from 60% to 66%, and require little secondary concentration.
- In Canada, labour costs and operating costs are generally higher than for Australian and Brazilian mines. To be competitive on the world stage, iron mining companies in Québec and Labrador are making major efforts to reduce these costs.

In any case, certain major unmined iron deposits in Québec should be reassessed in compliance with the 43-101 standard. As was mentioned earlier, several factors will need to be considered before a new iron mine is opened outside of currently active sites in Québec and Labrador.

Iron and titanium deposits in Québec

Exploration for iron and titanium deposits and mining of ilmenite deposits has been going on for one hundred years in Québec. The development, in the 1940s, of blast furnace fusion technology made it possible to produce very pure iron and a slag in which titanium and undesirable elements were concentrated. Following these developments, exploration for ilmenite (and hemo-ilmenite) deposits flourished. The development of a purification process for the slag led to the creation of synthetic rutile, which has undergone spectacular development over the past 50 years and has become one of the most common mineral commodities in our lives.

The prospects for growth of the synthetic rutile market have been evaluated at 2% per year. However, because strong economic growth in China has led to a price increase, the titanium pigment market will also be growing more rapidly over the coming years. These new prospect for the synthetic rutile market are revitalizing exploration for iron and titanium deposits in Québec. In this context, here is a review of iron and titanium (ilmenite) deposits in Québec.

Geological setting

Iron and titanium mineralization is typically observed in anorthositic massifs and ultramafic intrusions. The mineralization consists of ilmenite and hemo-ilmenite associated with magnetite, which is sometimes titanium-bearing, spinel (hercynite), and, locally, apatite, rutile, iron and copper sulphides and silicates. Major mineral resources of ilmenite and magnetite occur in the form of heavy-mineral-rich layers known as black sand. Classification of the types of iron and titanium mineralization in the Moyenne-Côte-Nord (Mid-North-Shore) area was initiated by Perreault et al. (2002).

Prospecting criteria

Apart from the size of showings and the presence of ilmenite and magnetite, geologists or prospectors must take several criteria into consideration in evaluating an iron and titanium showing.

For titanium showings, prospectors must consider:

- the type of ilmenite: hemo-ilmenite, ilmenite with hematite lamellae, ilmenite with magnetite lamellae or pure ilmenite;
- the TiO₂ grade of the ilmenite and of the rock;
- the presence of undesirable elements such as MgO, CaCO₃, Al₂O₃ and Cr₂O₃, which must be below the 2% mark.
- the presence of rutile in the mineralization, which increases the TiO₂ grade of the ore.
Apart from prospecting in the field (ilmenite is a black, very dense mineral), prospectors and geologists will need to use geophysical methods, such as magnetic and gravimetric surveys, and lake-bottom sediment or stream-sediment heavy mineral geochemistry to outline areas to be investigated. Though it is still expensive, a detailed gravimetric survey is very useful when the time comes to outline a mineralized body.

There are huge areas left to be explored in Québec. In addition to certain anorthosite massifs such as the Morin and Saint-Urbain massifs, which have been covered by intensive exploration programs in the past, the northern part of the Havre-Saint-Pierre Anorthositic Suite is a first-rate target. Once the road leading to the future hydroelectric generating stations of the Romaine project has been built, new areas will become accessible at a lower cost. An in-depth study of the nature of known iron and titanium mineralization in the Lac Saint-Jean Anorthositic Suite could reveal significant ilmenite reserves.

**Principal types of iron and titanium showings in Québec**

1. **Veins, dykes, clusters and tabular bodies of massive ilmenite (hemo-ilmenite) associated with andesine anorthosite**

   The Tio Mine is the best-known deposit in this class. Located near Havre-Saint-Pierre on the Mid-North-Shore, it is the only producing iron and titanium (hemo-ilmenite) mine in Canada. The deposit, mined as an open pit by QIT-Fer et Titane inc., is ranked first worldwide for its annual production of hemo-ilmenite and second for its mineral reserves. The latter are sufficient to allow fifty more years of operation.

   Proven reserves are evaluated at nearly 75 Mt at an average combined grade of 86.9% iron and titanium oxides, including 34.2% TiO₂, 27.5% FeO, 25.2% Fe₂O₃, 4.3% SiO₂, 3.5% Al₂O₃, 3.1% MgO, 0.9% CaO, 0.1% Cr₂O₃ and 0.41% V₂O₅. The other known hemo-ilmenite deposits are: Ivry in the Laurentides Region, the Coulombe, Bignell, Furnace and General Electric deposits of the Saint-Urbain Anorthositic Suite and the Lac Brûlé deposit of the Labrieville Anorthositic Suite ([PDF format, 1.5 Mb](#) - Available in French).

   Some tabular bodies of hemo-ilmenite, including the Big Island (Havre-Saint-Pierre Anorthositic Suite), General Electric, Coulombe Est and Coulombe Ouest deposits, contain rutile ([PDF format, 15.5 Kb](#)). The TiO₂ grade of these deposits is higher than normal.

2. **Dykes, clusters or masses of magnetite-, ilmenite- and apatite-bearing nelsonite, gabbro-norite and jotunite (ferrodiorite)**
The mineralization is associated with labradorite and andesine anorthosite as well as layered mafic igneous complexes. The principal ones are the Everett deposit, on the eastern margin of the Havre-Saint-Pierre Anorthositic Suite, and the Saint-Charles and Hache-Est deposits of the Lac Saint-Jean Anorthositic Suite.

The Sept-Îles Layered Complex (PDF format, 7.2 Kb) contains several layers of magnetite and a significant horizon of nelsonite (magnetite-, ilmenite- and apatite-bearing rock). The Arnaud Township nelsonite horizon has reserves of 107.8 Mt with an average grade of 6.19% P₂O₅ and 8.41% TiO₂ (McCann 1998).

3. Dykes and horizons of leuconorite and ilmenite-magnetite-bearing norite with veins and clusters of hemo-ilmenite

The mineralization is present in labradorite and andesine anorthosite massifs. It is generally not very extensive and has no real economic potential.

4. Horizons, clusters and dykes of massive titaniferous magnetite and magnetite-bearing melanogabbro

The mineralization is associated with labradorite-bearing anorthosite and layered mafic igneous complexes. Ilmenite is present in the mineralization in variable amounts. The TiO₂ grade of the mineralization lies between 1 and 20%. The Magpie deposit on the North Shore and the Hervieux-Ouest, Hervieux-Est, Schmoo (De La Blache Anorthositic Suite), Saint-Charles (Lac Saint-Jean Anorthositic Suite), Desgrobois and Saint-Hyppolyte (Morin Anorthositic Suite) deposits are examples associated with labradorite-bearing anorthositic suites. The Magpie deposit (1 to 4) is one of the largest titaniferous magnetite deposits in the world with proven reserves of 187.93 Mt and probable reserves of 629.667 Mt (Perreault et al. 2002).

The massive magnetite layers of the Sept-Îles layered igneous complex and the Doré Lake layered igneous complex (PDF format, 5.5 Kb), an Archean bedded anorthositic intrusion (Daigneault and Allard, 1990), are subeconomic to economic sources of iron, titanium and vanadium. In the case of the Doré Lake Complex, the magnetite is vanadium bearing. However, mining is impeded by metallurgical problems for the iron and titanium and market problems for the vanadium.

References
2005-2006 Departmental Program
Maximizing impacts from exploration activities in Québec

Robert Marquis
Direction de Géologie Québec

Over the next few years, the Ministère des Ressources naturelles et de la Faune will be continuing its efforts to maximize impacts from exploration investments. Though work on knowledge acquisition has been put on hold for a year, work relating to geoscience knowledge has by no means come to a standstill. In 2005-2006, the Department will concentrate on producing new exploration targets derived from processing and integrating data from its databank.

The Department will therefore be defining roughly one hundred exploration targets using the databank. It will also produce documents describing promising new exploration sectors. It should be noted that, when 155 exploration targets were revealed in that way last March, 31 were immediately the subject of mineral title applications.

The Service géologique de Québec will be working on a few projects focusing on Ni-Cu-PGE mineralization in the Mauricie Region, architectural stone in the Côte-Nord Region, peatlands and crushed stone. There will be verification field trips in preparation for the regional syntheses. The Service géologique du Nord-Ouest, meanwhile, will be prioritizing projects already begun in areas targeted as having an impact on the Copper Plan, such as the Blake River Group, the Grenville Front, the area east of Matagami and the Urban-Barry Belt. In partnership with the Université du Québec en Abitibi-Témiscamingue, it will also continue to work on integrating public databases to produce unified 3D models of geology, geophysics, and geochemistry.

Géologie Québec's 2005-2006 program will also lead to producing new syntheses in the form of promotional documents, compilation maps and topical reports that relate to several active mineral exploration sectors. Therefore, several topical maps, relating to stratigraphy, mineral deposits, structure and metamorphism, will be produced for the Far North regional synthesis project. Another major synthesis covers the entire eastern portion of the Grenville Province. Maps of the Labrador Trough will also be updated. In Abitibi, projects underway will make it possible to provide the Department's clientele with new compilation maps at a scale of 1:250 000 and 1:500 000, with study reports and with mineral potential maps suggesting new exploration targets based on the integration and development of available public data.
Discovery of sapphirine in Québec far north: a diamond indicator mineral?

Sandrine Cadéron
Direction de Géologie Québec

A fragment of breccia containing sapphirine has been discovered in the Troie Complex in the Archean Minto Subprovince, located in the northeastern part of the Superior Province. The area (Peters Lake, NTS 24M) was mapped by the Department during summer 2001 as part of the “Grand Nord” (Far North) project. Sapphirine, a rare mineral that had never been documented in the Canadian craton, is a deep blue ferromagnesian silicate which, when in equilibrium with quartz, characterizes rocks formed under ultrahigh pressure and temperature conditions.

Various geothermobarometers have been used to estimate the conditions under which the assemblages observed in the Peters Lake area were formed. They yielded high temperatures (755 - 1260 °C) and pressures (7.5 – 14 kbars), revealing that formation occurred at great depth (24 - 46 km). These new results, much higher than existing values, make it possible to propose new hypotheses for the tectonothermal evolution of the Archean crust in this part of the Superior Province. The presence of this high-pressure mineral in the Troie Complex could open the Peters Lake area to diamond exploration, since geochemical anomalies that could indicate the presence of kimberlites have already been mentioned in the Department's work.

Regional geology

The Troie Complex is dominated by synmagmatic felsic plutonic rocks containing volcanosedimentary inclusions, metamorphosed to granulite facies. The Douglas-Harbour Domain is composed of a tonalite-trondhjemite complex (Faribault-Thury) and is intruded into the 2740–2726 Ma Troie enderbitic complex. A breccia in the core of the Troie Complex contains a heterogeneous population of xenoliths in an enderbitic matrix. One of the xenoliths has sapphirine + plagioclase (and/or potassium feldspar) symplecticit surrounding sillimanite and cordierite crystals.

References

For more information about work carried out by the Ministère des Ressources Naturelles et de la Faune in this area and on the formation of sapphirine, please see the following article which has just been published in a special volume of the Canadian Mineralogist.
Assessment of Abitibi's massive sulphide potential: enthusiastically welcomed by the industry!

Daniel Lamothe
Direction de Géologie Québec

Publication of the study dealing with the Abitibi volcanogenic massive sulphide potential (EP 2005-01) was eagerly awaited. Results of the study were disclosed on March 7, 2005, during the Prospectors and Developers Association of Canada (PDAC) convention in Toronto. Most visitors were impressed by the extensive and consistent coverage of the work.

Geoscience data from Abitibi greenstone belts was reprocessed using an innovative approach, the steps of which are explained in detail in report EP 2005-01. Results are presented in a user-friendly manner and the document contains an impressive number of intermediate vector and raster files (more than 24 GB).

The general map, at a scale of 1:500,000, and 120 base metal potential assessment maps, at a scale of 1:50,000, are available on CD in PDF format. Easily accessible using an index map, they show:

- variations in potential resulting from the combination of 26 parameters used in the study;
- highly favourable zones for massive sulphides;
- the position of the unclaimed portions of the zones (at the time the study was carried out).

The unclaimed portions represent 155 targets, hyperlinked to a descriptive database.

One month after publication of the results, 31 of the proposed targets had been claimed and are now covered by a total of 412 mineral titles. Furthermore, each company with mineral titles touching a highly favourable (or promising) zone received a letter mentioning the existence of the zone on its property.

Chances are that publication of the English version of the study in May 2005 will result in additional claims being filed on remaining available targets (EP 2005-02).

2005 Symposium on Mines and the Environment

From May 15 to 18, 2005, the 2005 Symposium on mines and the environment was held in Rouyn-Noranda. The event drew more than 200 participants from across Canada and abroad. The objectives of this kind of symposium are to share the most recent information in terms of mining and the environment and to discuss practical experiences, in order to find solutions that reconcile profitability of mining operations and environmental protection. The Department is therefore proud to have been involved at the organizational level and in presenting technical sessions. The proceedings of the 2005 Symposium will be available soon.
Figure 1 - Subdivisions géologiques et localisation des principaux gisements de fer (> 100 Mt et > 25 % Fe = grands symboles; <100 Mt et Fe > 20 % = petits symboles). Les différentes couleurs du symbole des anciennes mines renvoient aux types de gîtes de fer.

Notez que l’évaluation des ressources minérales de ces gisements ne sont pas conforme à la norme canadienne 43-101 sur l’information concernant les projets miniers.
Dykes and horizons of leuconorite and ilmenite-magnetite-bearing norite with veins and clusters of hemo-ilmenite.

Horizons, clusters and dykes of massive titaniferous magnetite and magnetite-bearing melanogabbro.

Veins, dykes, clusters and tabular bodies of massive ilmenite (hemo-ilmenite)

Table 1

<table>
<thead>
<tr>
<th>No.</th>
<th>Name of the Deposit</th>
<th>Location</th>
<th>Iron-Magnetite</th>
<th>Alkali-Gabbro</th>
<th>Rock</th>
<th>Mineralogy</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Lac de Témiscamingue</td>
<td>M/11</td>
<td>45.5% Fe, 72% TiO₂</td>
<td>25% Fe₂O₃, 0.17% V</td>
<td>Norite</td>
<td>Anorthosite, Pyroxene, PO, CP</td>
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<tr>
<td>2</td>
<td>Lac Mouchet</td>
<td>M/12</td>
<td>51.5% Fe, 25% TiO₂</td>
<td>21% Fe₂O₃</td>
<td>Norite</td>
<td>Anorthosite, Pyroxene, PO, CP</td>
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<tr>
<td>3</td>
<td>Lac Biron</td>
<td>M/10</td>
<td>39.2% Fe, 16.3% TiO₂</td>
<td>23.5% Fe₂O₃</td>
<td>Norite</td>
<td>Anorthosite, Pyroxene, PO, CP</td>
</tr>
<tr>
<td>4</td>
<td>Lac de Témiscamingue</td>
<td>M/11</td>
<td>45.5% Fe, 72% TiO₂</td>
<td>25% Fe₂O₃, 0.17% V</td>
<td>Norite</td>
<td>Anorthosite, Pyroxene, PO, CP</td>
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<tr>
<td>5</td>
<td>Mine Bignell</td>
<td>M/10</td>
<td>35.2% Fe, 36.2% TiO₂</td>
<td>29.8% Fe, 32.8% TiO₂</td>
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<td>RL, PY</td>
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<tr>
<td>6</td>
<td>Mine Marquis</td>
<td>M/10</td>
<td>37.5% Fe, 37% TiO₂</td>
<td>35.3% Fe, 36% TiO₂</td>
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<td>RL, PY</td>
</tr>
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<td>7</td>
<td>Mine Bouchard</td>
<td>M/10</td>
<td>36.9% Fe, 32.9% TiO₂</td>
<td>1.68% SiO₂</td>
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<td>PY</td>
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<td>Mine du Lac St-Paul</td>
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<td>36% Fe, 29% TiO₂</td>
<td>28% Fe, 25% Fe₂O₃</td>
<td>Anorthosite</td>
<td>RL, PY</td>
</tr>
<tr>
<td>9</td>
<td>Mine du Lac St-Paul</td>
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<td>36% Fe, 29% TiO₂</td>
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<td>RL, PY</td>
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<td>Mine Jeanne</td>
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<td>35.7% Fe, 38.2% Fe</td>
<td>0.10% CrO₂, 0.10% MgO</td>
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<td>RL, PY</td>
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<td>11</td>
<td>Mine des Rochers</td>
<td>M/11</td>
<td>35.3% Fe, 36% TiO₂</td>
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<td>12</td>
<td>Mine de la Côte</td>
<td>M/11</td>
<td>35.3% Fe, 36% TiO₂</td>
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<td>Anorthosite</td>
<td>RL, PY</td>
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<tr>
<td>13</td>
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<td>14</td>
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<td>15</td>
<td>Mine de la Côte</td>
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<tr>
<td>16</td>
<td>Mine de la Côte</td>
<td>M/11</td>
<td>35.3% Fe, 36% TiO₂</td>
<td>28% Fe, 25% Fe₂O₃</td>
<td>Anorthosite</td>
<td>RL, PY</td>
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Note: and Table of iron and titanium showings in the Grenville Province.
<table>
<thead>
<tr>
<th>No</th>
<th>Prospect/Habitat</th>
<th>PR/MB</th>
<th>Anorthosite</th>
<th>MG HG MD</th>
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<tr>
<td>74</td>
<td>Prospect/Melting</td>
<td>-</td>
<td>-</td>
<td>Anorthosite</td>
</tr>
<tr>
<td>75</td>
<td>Anomalie O12M3 22 O/12 - Anorthosite -</td>
<td>44.2 % FeO and 3.52 % TiO₂,</td>
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<tr>
<td>76</td>
<td>Lac Raudot 22 O/12 - Gabbro / Anorthosite -</td>
<td>50.25 % Fe and 6.37 % Ti (V, Cr, Ni)</td>
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<tr>
<td>77</td>
<td>Mille 82.1 22 P/04 - Gabbro -</td>
<td>36.47 % Fe, 1.22 % TiO₂ and 0.01 % Cr (grab sample).</td>
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<td></td>
</tr>
</tbody>
</table>

* PR = Proven reserves, RB = Probable reserves, UR = Unknown reserves, GR = Geological resources.
** AP = Apatite, BN = Bornite, Cr = Chrome, CP = Chalcopyrite, HC = Hercynite, HM = Hematite, IM = Ilmenite, MG = Magnetite, PO = Pyrrhotite, PY = Pyrite, RL = Rutile, SL = Spinel, SH = Sapphirine, USL = Ulvospinel.

Italic = site located outside of the map.
### Table 2

<table>
<thead>
<tr>
<th>No.</th>
<th>Name of the Deposit</th>
<th>NTS</th>
<th>*Reserves / Resources</th>
<th>Host Rock</th>
<th>**Other Minerals</th>
<th>Grades</th>
</tr>
</thead>
<tbody>
<tr>
<td>78</td>
<td>Hall River</td>
<td>22 J/02</td>
<td>-</td>
<td>Gabbro / Anorthosite</td>
<td>HC, PO</td>
<td>40 % Fe, 21 % TiO$_2$, 8 % SiO$_2$, 0.06 % P and 0.06 % S (samples).</td>
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<tr>
<td>79</td>
<td>Riv. Ste-Marguerite</td>
<td>22 J/02</td>
<td>-</td>
<td>Gabbro / Anorthosite</td>
<td>SL</td>
<td>55.1 % Fe, 12.42 % Ti, 1.52 % SiO$_2$ and 0.049 % P.</td>
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<td>80</td>
<td>Rivière des Rapides (canton Arnaud)</td>
<td>22 J/02</td>
<td>108 Mt UR</td>
<td>Nelsonite</td>
<td>AP, HC, IM, OL</td>
<td>8.45 % TiO$_2$ and 6.23 % P$_2$O$_5$.</td>
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<tr>
<td>81</td>
<td>Chute à l'Outarde</td>
<td>22 J/08</td>
<td>-</td>
<td>Gabbro / Anorthosite</td>
<td>-</td>
<td>54.99 % Fe, 18.12 % TiO$_2$, 0.075 % P$_2$O$_5$, 0.08 % S (Massive ore).</td>
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<tr>
<td>82</td>
<td>Gagnon deposit</td>
<td>22 J/08</td>
<td>-</td>
<td>Anorthosite</td>
<td>SL</td>
<td>28.37 % Fe, 18.62 % TiO$_2$, 12.08 % SiO$_2$, 8.29 % Al$_2$O$_3$ (two samples).</td>
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<tr>
<td>83</td>
<td>Mine Molson (closed)</td>
<td>22 J/08</td>
<td>0.36 Mt RB</td>
<td>Gabbro</td>
<td>-</td>
<td>52.84 % Fe, 24.52 % TiO$_2$, 0.25 % S, 3.86 % P$_2$O$_5$ (Max. values of 6 samples).</td>
</tr>
</tbody>
</table>

* RB = Probables reserves, UR = Unknown reserves.
** HC = Hercynite, PO = Pyrrhotite, SL = Spinel.
<table>
<thead>
<tr>
<th>No.</th>
<th>Name of the Deposit</th>
<th>NTS</th>
<th>*Reserves / Resources</th>
<th>Host Rock</th>
<th>**Other Minerals</th>
<th>Grades</th>
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<tbody>
<tr>
<td>84</td>
<td>Armitage Extension</td>
<td>32 G/16</td>
<td>-</td>
<td>Gabbro / Anorthosite</td>
<td>-</td>
<td>3960.60 ppm V, 40.10 % Fe and 7.4 % Ti (Grab samples and channels from trenches).</td>
</tr>
<tr>
<td>85</td>
<td>Baie Magnétite (nord et sud)</td>
<td>32 G/16</td>
<td>270 Mt PR</td>
<td>Gabbro / Anorthosite</td>
<td>-</td>
<td>27 at 30 % Fe and 1% Ti.</td>
</tr>
<tr>
<td>86</td>
<td>Lac Armitage</td>
<td>32 G/16</td>
<td>-</td>
<td>Anorthosite</td>
<td>-</td>
<td>8.34 % Ti, 44.55 % Fe and 5137 ppm V (drill cores and channel samples).</td>
</tr>
<tr>
<td>87</td>
<td>Vanadium-Lac Doré</td>
<td>32 G/16</td>
<td>450 Mt TR</td>
<td>Gabbro / Anorthosite</td>
<td>-</td>
<td>3 % Ti and 896.3 ppm V (drill cores).</td>
</tr>
<tr>
<td>88</td>
<td>Île Portage (Nord et Sud)</td>
<td>32 G/16</td>
<td>0,38 Mt TR</td>
<td>Gabbro / Anorthosite</td>
<td>-</td>
<td>Up to 57.8 % Fe and 1.4 % Ti.</td>
</tr>
<tr>
<td>89</td>
<td>Lac Doré - extension NE</td>
<td>32 H/13</td>
<td>-</td>
<td>Gabbro / Anorthosite</td>
<td>-</td>
<td>46.93 % Fe, 7.91 % Ti and 0.49 % V.</td>
</tr>
</tbody>
</table>

PR = proven reserves, TR = Total reserves.
** AP = Apatite, HC = Hercynite, IM = Ilménite, OL = Ottrelite, V = Vanadium.
Location of the Troie Complex in the Superior Province
Geological map of the lac Peters area

**ARCHÉEN**
- Suite de Léridon
  - Granite à biotite
- Complexe de Faribault-Thury (CFT)
  - Granite à biotite
  - Tonalite, Trondhjémite
  - Métabasaltes amphibolitises

**PROTÉROZOÏQUE**
- Roches supracrustales et gabbro

**Complexe de Troie (CT)**
- Monzonite porphyrique
- Gabbronorite
- Granite à quartz bleu
- Granite à Schlieren
- Suite enderbitique
- Métabasaltes au faciès granulite
- Métasédiments au faciès granulite

**Complexe de Qimussinguat (CQ)**
- Gabbronorite
- Suite enderbitique
- Métabasaltes au faciès granulite

**Zones de cisaillement ductile**
Microphotographs of textures in the sapphirine-bearing xenolith from the Troie Complex

(a) Sillimanite porphyroblast replaced by sapphire + plagioclase symplectitic textures.
Microphotographs of textures in the sapphirine-bearing xenolith from the Troie Complex

(b) Cordierite + biotite replaced by sapphirine + K-feldspar symplectitic textures.