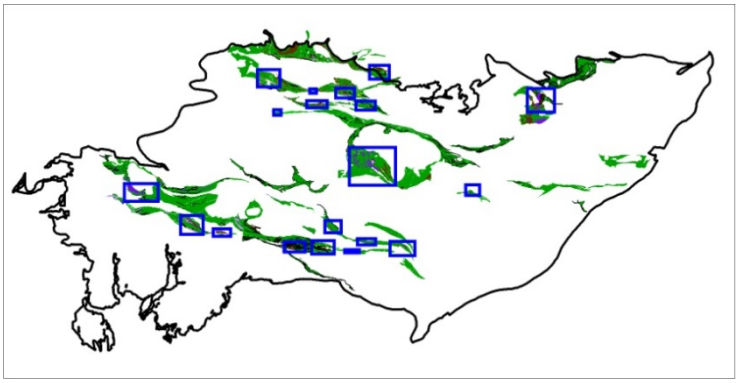
2010-04: Conceptual re-evaluation of VMS exploration models in the Abitibi Subprovince

This project aimed to develop new strategies for volcanogenic massive sulphide (VMS) deposits in the Abitibi. Traditionally, VMS exploration in the Abitibi was based on the bimodal mafic-type deposit model associated with rhyolites, chlorite-sericite alterations and isolated geophysical conductors. However, more than 90 % of the Abitibi volcanic rocks are mafic or ultramafic, leaving a very large area largely unexplored. Therefore, the project was to establish the possibility of finding VMS deposits in mafic contexts (mafic-type VMS) and in mafic-sedimentary rocks (pelitic-mafic-type VMS). The project was also to develop exploration strategies and identify favourable areas or targets.

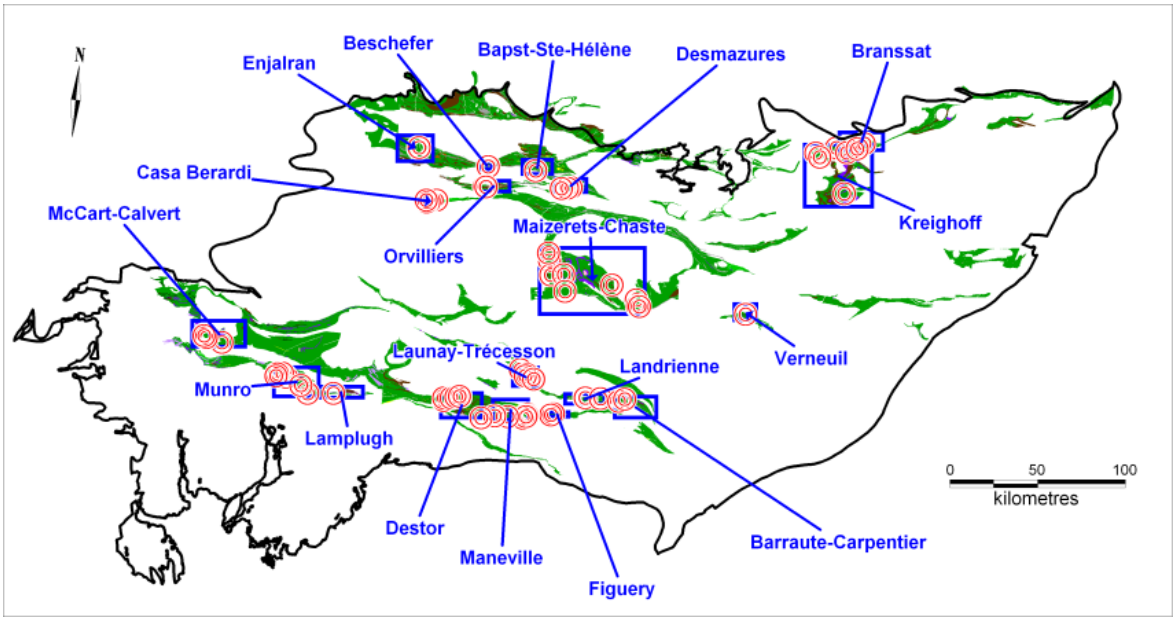


Map showing favourable units (green) and favourable areas (blue rectangles) for mafic-type VMS exploration in the Abitibi Subprovince (black outline).

Part A: mafic-type VMS

The revision of the metallogenic model for the mafic-type of deposit helped identify key elements for establishing an exploration strategy. The mafic-type VMS is associated with fore-arc basins, back-arc basins or intra-arc basins where primitive mantle-source volcanism dominates (N-MORB, arc tholeites and komatiites). The magma is from axial magma chambers (mafic/ultramafic intrusions, high percentage of sills and dikes) and is associated with quartz-chlorite alterations.

The targeting method developed is carried out in three different stages. First, in a tectonic evolution context, the mafic/ultramafic composition of the sequences and the chemistry of the volcanics led initially to the production of a map of favourable units across the Abitibi (Figure above). Areas with a high percentage of mafic/ultramafic intrusions, sills and dikes were then located within the favourable units because they could represent emission sources capable of generating fertile high-temperature hydrothermal systems (Figure above). As a final step, direct targets (MEGATEM or Input anomalies) were identified by combining several information layers in the MapInfo software: the map of favourable units, faults, mafic/ultramafic intrusions, Input anomalies, deposits and occurrences (all modified from SIGÉOM and OGS databases), MEGATEM anomalies (SIGÉOM, Xstrata and Virginia), and silicified and chloritised basalts that were identified using the mass balance calculation approach from modeled precursors of CONSOREM. The above exercise identified 67 direct exploration targets for mafic-type VMS in Abitibi (Figure below).

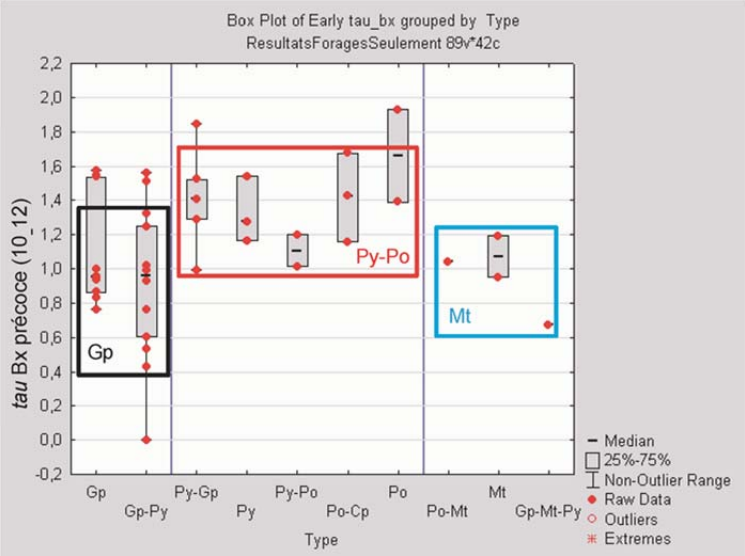


Location of the 67 targets corresponding to MEGATEM or Input anomalies for mafic-type VMS exploration in the Abitibi Subprovince. The 19 favourable areas are identified by blue rectangles.

Project 2010-04 part A: Summary	
Objectives	• To assess the potential for mafic-type VMS deposits in the Abitibi. • To develop an exploration strategy. • To identify exploration areas or targets.
Results	• Exploration methodology. • New maps showing favourable units and favourable areas. • Identification of 67 direct targets in the Abitibi.
Innovations	• Identified targets for a non-traditional type of deposit in the Abitibi. • Transferred the metallogenic model and observations about actual hydrothermal systems to an exploration method for Archean rocks in the Abitibi.

Part B: pelitic-mafic-type VMS

Pelitic-mafic-type deposits are associated with supra-subduction basins that contain abundant sedimentary rocks of deep-water origin. The problem for exploration in this setting is that alteration of the sedimentary rocks is still poorly understood and most of the sedimentary basins in the Abitibi are characterised by regional linear geophysical conductors consisting of hundreds of electromagnetic anomalies. Therefore, direct targets are difficult to identify.



Box and whisker plot of the *tau* constant of the secondary Bx field for the early channels 10-12. The values of the constant help discriminate significantly the conductors rich in sulphides (Py-Po) from conductors rich in graphite (Gp) and magnetite (Mt).

The proposed approach was to characterise the signature variations of the regional linear MEGATEM conductors in the Abitibi in order to differentiate anomalies caused by sulphides as opposed to graphite. This innovative approach studies the conductors longitudinally instead of along the flight path (perpendicular), with the aim to compare the anomalies to each other rather than to the background noise.

The method consists of establishing possible correlations between the geological and geophysical characteristics (mag, dB/dt, B-field, *tau*, Tee, conductivity). In order to achieve this the drill logs were re-read to describe the nature (graphite, pyrite, pyrrhotite, chalcopyrite, sphalerite, magnetite), the percentage and the thickness of the conducting bodies. Principal component analysis from 6 linear conductors (253 anomalies and 44 drill holes) established a link between a high percentage of pyrrhotite and a strong signal from the Bx-field of channel 1 and a weak signal from the Bx-field of channel 4 (with respect to pyrite, graphite and magnetite). The possible control of surface deposit types on this observation remains to be tested.

The *tau* Bx constant of the early channels 10-12 was calculated as part of this project. It also allows the discrimination of dominant pyrite-pyrrhotite anomalies from graphite and magnetite (Figure attached). Channels 1 to 5 (“on-time” channels) are generally never looked at during the surveys because they are synchronous with the primary pulse generated and there is a lot of background noise. However, the results appear to suggest that studying them could lead to a significant breakthrough in identifying the nature of the electromagnetic conductors.

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Project 2010-04 part B: Summary	
Objectives	• To assess the potential for pelitic-mafic-type of VMS deposits in the Abitibi. • To develop an exploration strategy. • To identify exploration targets or areas.
Results	• Observation of correlations between the geological and geophysical characteristics. • Identification of distinctive characteristics between sulphide conductors and graphite conductors to establish an exploration strategy.
Innovations	• Longitudinal rather than perpendicular analysis of anomalies (comparison of anomalies to each other instead of to the background noise). • Study of channels 1 to 5 (on-time) that are never looked at. • Study of Tau Bx constant for early channels 10-12.
Special Collaboration	• Michel Allard, Xstrata Zinc.