Project 2002-4: Analysis of gold-bearing vein systems

Several CONSOREM projects carried out during previous programs are grouped under the theme “gold-bearing vein systems”. Three phases or sub-projects are defined in Project 2002-4, whose common goal was to provide analytical and prediction tools to locate gold-bearing vein systems on a regional scale and to constrain their geometry on a local scale.

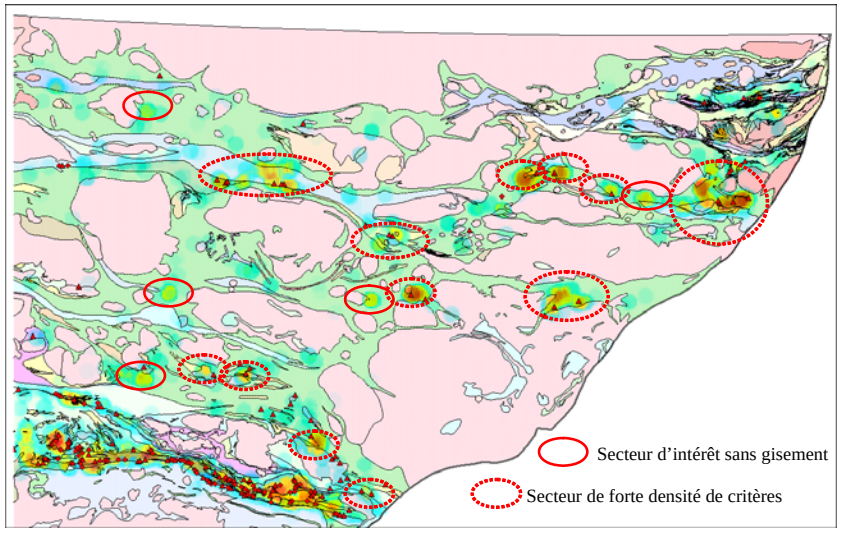
Project 2001-8 on orogenic Au deposits established some characteristics of this deposit type in the Abitibi. However, the creation of mineral potential maps for this type of mineralisation must be considered in terms of favourability criteria. **Phase A** of the project focused on this aspect.

In **phase B**, a paleopressure study based on the UDEC geomechanical modeller was carried out in the Val-d’Or – Malartic area and, more locally, at the Sigma mine.

Phase C examines the geometry of the vein systems located within the intrusions. The study aimed to document the nature of the organisation of the vein systems with respect to the shape and nature of the intrusive bodies, then to document the effects of a deformation and changes made to the original geometry.

Project 2002-4A: Analysis of gold-bearing vein systems – Orogenic Au

The orogenic Au phase of the study is part of the SPCPM project (*Système de Production de Carte de Potentiel Minéral*) of the *Ministère des Ressources naturelles et de la Faune* (MRNF), Quebec. The purpose of the present study is to provide a statistical picture of recurrent patterns in orogenic deposits to identify significant parameters for their eventual integration into and weighting for an orogenic gold model in Quebec.



Geological map of the Abitibi showing areas of interest identified using density of favourable criteria.

SIGEOM, a metallogenic database, was the data source. The database was processed to make it easier to interrogate in a SIRS. Gold-bearing bodies were selected if the mineralisation was definitely or probably orogenic in origin.

The database was analysed for a variety of parameters based on several topological and spatial criteria, namely: 1) distance from the Cadillac Fault; 2) North (NVZ) vs. South volcanic zone (SVZ); 3) proximity to major EW and NW fault families as well as their intersections; 4) lithological group; 5) type of gold-bearing body: occurrence, showing, deposit or mine. The chosen database parameters were: 1) total tonnage in metric tonnes of gold for deposits and mines; 2) lithological units; 3) alteration minerals; 4) gangue minerals; 5) metallic minerals; 6) metallic mineral assemblage; 7) orientation of the mineralised structure.

Some conceptual features were also considered. For example, the NVZ is almost ten times larger in surface area than the SVZ, but has a history of gold production that is almost ten times less. A distinctive

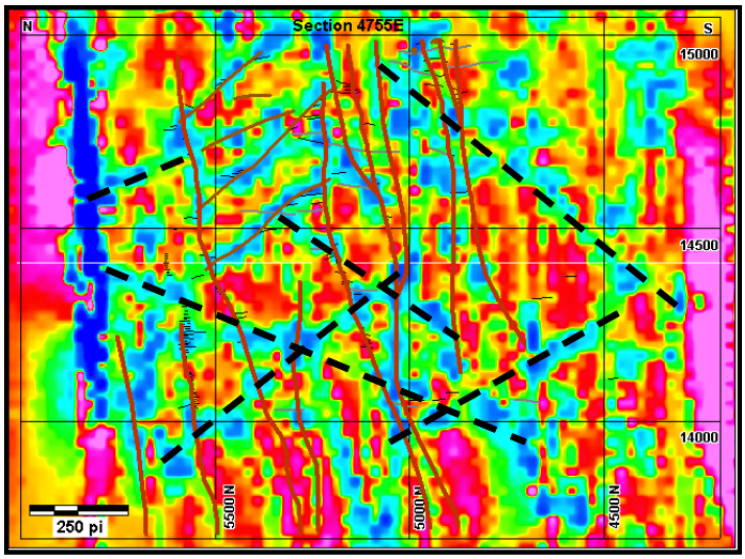
feature of the SVZ is the presence of ultramafic rocks. Ultramafic rocks are well-known for hosting some very large orogenic deposits such as Timmins (ON) and Kargoorlie (AUS).

Summary: Project 2002-4A	
Objectives	• To obtain analytical and predictive tools for locating gold-bearing vein systems on a regional scale and to constrain their geometry on a local scale. • To determine a geological model that would allow the MRNF to create mineral potential maps.
Results	• Production of cumulative density maps of favourable criteria for showings and deposits; • Identification of areas with the greatest potential.
Tools and Innovations	• Integration of favourable parameters for orogenic gold mineralisation.

Project 2002-4B: Analysis of gold-bearing vein systems using UDEC

The geomechanical modelling software called UDEC can model and quantify tectonic paleopressure zones in 2D. The objective of this project was to evaluate the spatial relationship between the pressure zones predicted by the software and the position of the orogenic gold deposits in the Val-d'Or and Malartic areas. However, knowledge about the geology and geometry of the mineralised zones is better understood on the scale of a mine. In addition, paleopressure modelling by sections (in the σ1 – σ3 plane) is more appropriate because this section is where major deformations take place in a shortening regime. For this reason, some of the modelling using UDEC was carried out on a section located at the centre of the Sigma deposit.

For the purposes of the UDEC software, it is assumed that 1) the tectonic and lithostatic pressures affecting a rock mass cause fluid migration from high to low-pressure zones; 2) orogenic gold in the Abitibi was emplaced towards the end of the Kenoran orogeny in a dextral transpressional regime; and 3) the present day geometry of the architecture (lithology and faults) is more or less similar to the one prevailing during the gold deposit formation.



Section at the top of Sigma mine showing variation in tectonic pressure with the location of known gold-bearing veins (red lines) and potential veins to be targeted (dashed black line). Areas of low pressure = dark blue; areas of higher pressure = pink.

Regionally, the relationship between the orogenic gold deposits and calculated pressures is not clear. In fact, in the Val-d'Or and Malartic areas there seem to be as many mines in high-pressure zones as in the low-pressure ones. However, there is a consistency when the pressure is examined on the scale of a hydrothermal system (~10 km). With the exception of the Belmoral mine, all mines are located in low-pressure zones near steep gradients in the Val-d'Or area. However, mines in and around the

Bourlamaque Pluton are usually located in the higher pressure zones. Lastly, the Sigma-Lamaque deposit is located in the centre of an over 5 km wide low-pressure zone. The location of a few mines in the highest pressure zones could be explained by the fact that some faults played a more important role than pressure.

The sectional results from the Sigma mine are conclusive. The correlation between low-pressure zones and greater than 1.5 g/t Au is virtually systematic. The model shows low-pressure zones located outside the traditional mineralised corridors of the mine and at the intersections of structures. The model also generates coupled low-pressure zones (Andersonian-type) parallel to the *north-dipper* and the *flats* (*south-dipper)* corridors. These zones correspond to the existing, newly identified or unobserved corridors. It is also evident that structural control is more important than the competence of the diorites.

Summary: Project 2002-4B	
Objectives	• To obtain analytical and predictive tools for locating gold-bearing vein systems on a regional scale and for constraining their geometry on a local scale. • To use the geomechanical modeller software UDEC in the Val-d'Or and Malartic regions to target areas favourable for orogenic gold mineralisation.
Results	• Results applicable regionally: deposit are located as much in low-pressure zones as in the highest pressure zones. • Paleopressure zones come into their own when considered on the level of hydrothermal systems (a 10 km radius) and incorporated into a mineral potential map. • The use of UDEC by section in the Sigma mine clearly shows a link between low-pressure zones and high gold values.
Tools and Innovations	• Predictive model for orogenic mineralisation on a deposit scale.

Project 2002-4C: Spatial arrangement of veins associated with intrusive complexes

Load gold mineralisation is commonly associated with intrusive bodies that can simply play the role of favourable host for the fracturing and for the circulation of hydrothermal fluids. However, there is a class of deposits that shows evidence of a more genetic relationship with the magma that forms the intrusion (*intrusion-related systems*).

This third phase of the project for analysing gold-bearing vein systems was carried out to document examples of load gold deposits genetically associated with intrusive complexes and to define the main characteristics of this type of mineralisation. Intrusions associated with these mineralised systems form multiphase complexes such as batholiths, plutons, domes or dike swarms and sills.

The age of the emplacement of the mineralisation and its intrusive host is variable (from the Archean to the Tertiary). Tonnage and grade are very variable, but generally, most of the known deposits are high tonnage/low grade and are extracted from open pit mines. Gold veins are usually associated with other types of mineralisation such as dissemination zones, stockwork or veinlets, skarn or stratiform ore bodies.

Mineralisation can be found both within the intrusive complexes and in the host rocks. However, it seems that the mineralisation is richer in the host rocks than in the intrusion. The only well documented example where the mineralisation seems to match the petrographic changes of the host intrusion is the Timbarra deposit in Australia. The mineralised zones are associated with coarse-grained units within the intrusive complex, whereas the finer-grained units, characteristic of the peripheral areas of the intrusion, are not mineralised.

The gold veins are usually surrounded by a zoned hydrothermal alteration halo. The mineralogical assemblage of the halo is a function of the primary composition of the hydrothermal fluids, but mostly of the lithological composition of the footwall and hangingwall. Generally, intrusive rocks are characterised by an alteration rich in sericite, K-feldspar, albite and quartz; however, carbonates, chlorite and sulphides can predominate in association with other lithologies.

The geometry of the veins is very variable and depends mostly on the attitude of the brittle or ductile fault zones formed during / after the emplacement of the intrusions. It can also depend on deformation and metamorphism prior to their emplacement. Lastly, the gold-bearing veinlets frequently form fractured, brecciated and/or boudinaged lenticular bodies.

Summary: Project 2002-4C	
Objectives	• To provide analytical and predictive tools to locate gold-bearing vein systems on a regional scale and to constrain their geometry on a local scale. • To document the characteristics of gold-bearing vein mineralisation associated with the intrusions.
Results	• Literature review