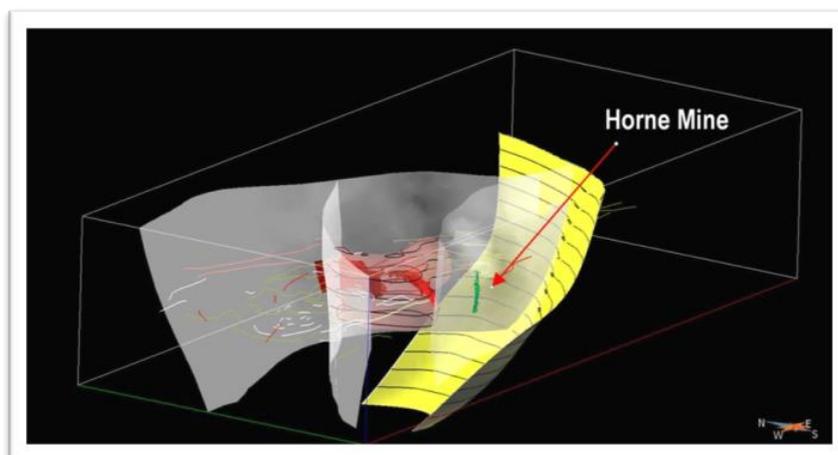




**GEOLOGICAL SURVEY OF CANADA  
OPEN FILE 7349**



**3D Geological Observation Data Base of the Archean Blake  
River Group, Horne Mine and Central Camp,  
Rouyn-Noranda, Québec**

E.A. de Kemp, L. Martin, E. Girard, K. Lauzière, J. Goutier, T. Monecke,  
P.-S. Ross, C. Dion, G. Bellefleur, E.C. Grunsky, B. Taylor, V. McNicoll,  
P. Mercier-Langevin, B. Dubé

**2013**



**GEOLOGICAL SURVEY OF CANADA  
OPEN FILE 7349**

**3D Geological Observation Data Base of the Archean Blake  
River Group, Horne Mine and Central Camp,  
Rouyn-Noranda, Québec**

E.A. de Kemp<sup>1</sup>, L. Martin<sup>2</sup>, E. Girard<sup>3</sup>, K. Lauzière<sup>3</sup>, J. Goutier<sup>4</sup>, T. Monecke<sup>5</sup>,  
P.-S. Ross<sup>6</sup>, C. Dion<sup>4</sup>, G. Bellefleur<sup>1</sup>, E. Grunsky<sup>1</sup>, B. Taylor<sup>1</sup>, V. McNicoll<sup>1</sup>,  
P. Mercier-Langevin<sup>3</sup>, B. Dubé<sup>3</sup>

<sup>1</sup> Geological Survey of Canada, Ottawa, Ontario, edekemp@nrcan.gc.ca

<sup>2</sup> Clifton Star Resources Inc., Duparquet, Québec (Previously with Xstrata Copper Canada, Timmins, Ontario)

<sup>3</sup> Geological Survey of Canada, Québec City, Québec

<sup>4</sup> Bureau de l'exploration géologique du Québec, Ministère des Ressources naturelles, Rouyn-Noranda, Québec

<sup>5</sup> Colorado School of Mines, Golden, Colorado, U.S.A.

<sup>6</sup> Institut national de la recherche scientifique, Québec City, Québec

**2013**

©Her Majesty the Queen in Right of Canada 2013

doi:10.4095/292911

This publication is available for free download through GEOSCAN (<http://geoscan.ess.nrcan.gc.ca/>).

**Recommended citation**

de Kemp, E.A., Martin, L., Girard, E., Lauzière, K., Goutier, J., Monecke, T., Ross, P.-S., Dion, C., Bellefleur, G., Grunsky, E.C., Taylor, B., McNicoll, V., Mercier-Langevin, P. and Dubé, B., 2013, 3D Geological Observation Data Base of the Archean Blake River Group, Horne Mine and Central Camp, Rouyn-Noranda, Québec; Geological Survey of Canada, Open File 7349. doi:10.4095/292911

## ABSTRACT

A 3D geospatial observational database has been compiled for the mineral prospective Archean (2704 -2695 Ma) Blake River Group, Noranda mining camp in Québec. It includes harmonized surface and subsurface geoscience data derived from public (Ministère des Ressources naturelles E-Sigeom and Geological Survey of Canada) and private (Xstrata, Falco-Pacific) databases. Included are a variety of data sets representing regional to mine scale 3D observations from drill core, outcrop, and mine workings with lithostratigraphic, structural, geochemical and geochronologic information. Geophysical gravity and magnetic survey compilations and seismic profiles across prospective regions of the Central Camp have been integrated into the 3D data store to support better 3D interpretation. A common lithostratigraphic classification and 3D structural data base provides value added information to support better trend analysis, 3D mapping and regional interpretation. The aim of this 3D data release is to provide modelling and mineral exploration constraints for enhancing the predictive capacity for targeting deeper hidden mineral resources in the Rouyn-Noranda region. Some preliminary 3D model examples are provided.

## INTRODUCTION

This digital data release product is an output from the Abitibi greenstone belt (AGB) project, a collaboration between the the Geological Survey of Canada (GSC), Géologie Québec of the Ministère des Ressources Naturelles and the Precambrian Geoscience Section (PGS) of the Ontario Geological Survey (OGS), as part of the Targeted Geoscience Initiative (Goutier et al. in prep, 2007, Ayer et al. 2008, 2007, 2006). One of the key aims of Targeted Geoscience Initiative is to stimulate mineral exploration in established mining areas as well as in frontier areas through strategic investment in geoscience research. Part of this investment was directed to field based studies within the Blake River Group metavolcanics from 2005 to 2010 (e.g., Ross et al. 2011a, 2008, 2007, Rogers et al. in press, 2010, Monecke et al. 2008, Mercier-Langevin et al. 2011, 2010, 2008, Dion and Rhéaume 2007), and included new geochronology (McNicoll et al., in press, Ross 2011b), geochemical data analysis (Grunsky in press, 2013, 2008), isotopic studies (Taylor et al. in press), geophysical analysis (Bellefleur 2007; Bellefleur et al. in press), and the compilation of historic data for Blake River Group in Québec. Complementing these activities was the development of a 3D GIS observational data base or 3D knowledge cube which is the contribution of this digital data release. (See Figure 1 for release coverage).

The Blake River Group is a richly endowed Archean (2704-2695 Ma) volcanic sequence which is host to 31 VMS deposits, 20 of which were historic producers within the Noranda Central Camp (Mercier-Langevin et al., 2011), with 5 of the largest Au bearing VMS deposits in the world including adjacent Doyon\_Bousquet-LeRonde deposits, with the giant Horne mine (54.3 Mt at 6.6 g/t Au and 2.22% Cu, 11.7 million ounces Au) (Dubé et al. 2007, Goutier et al. in prep., 2007). The Blake River Group has been the target of mineral explorationists for many years, with several private and public supported 3D modelling efforts in the area (Martin, Perron and Masson 2007, Marquis, Bois and McGaughey 2003, Fallara et al. 2006, 2004a, 2004b, Rabeau and Legault 2006). However to date there is no single 3D observational data base to support further investigations, and which could act as a common agreed upon set of geoscience constraints. These constraints are much needed to facilitate various conceptual structural and stratigraphic hypotheses underpinning new exploration models and strategies (e.g., Goutier et al. in prep., 2007, Daigneault and Pearson 2006, Mueller 2006). This data

release represents the first step towards achieving a longer range goal of developing a multi-scale, multi-parameter 3D structural and stratigraphic model for the purpose of predictive base metal exploration in the Noranda Central Camp and adjacent brownfields and greenfields regions.

## **PURPOSE AND SCOPE**

The sole purpose of this data release is to support future 3D structural and stratigraphic modelling focused on the Blake River Group volcanic stratigraphy. The purpose is not to provide a complete listing of all the geoscience information in the form of publications, descriptive data for all rock types of the area, or an inventory of all the analysis. These rocks host much of the base metal and gold mineralization in the area, and need to be better mapped in 3D in order to enhance our predictive capacity to do more challenging exploration at depth. The data has been converted for use in 3D GIS including the geology data, assay data from the region as well as historical mine plans of the Upper and Lower Horne mine. Also included are 3D sulphide bodies from industry for the whole Noranda Central Camp, which provides control on the 3D location, distribution, geologic context and shape characteristics of target bodies for future exploration activities.

This 3D data compilation is comprised mostly of observational data which has been acquired by geoscientists on the ground or in the core shack during the course of government or industry contracted investigations. Interpretive information such as regional fault dip estimations, regional structural and stratigraphic traces or form lines and the designation of structural domains have been included to support further interpretation, easier data manipulation and 3D modelling activities.

In addition to the geoscience data location references features are provided such as hydrographic, topographic and road network layers. Data is presented in a range of scales from detailed plan geology from the Upper and Lower Horne Mine, to regional compilations of outcrop lithology observations. Thematic content includes common volcanic lithostratigraphic classification for drill log descriptions and outcrop observations. Structural domains separate important fault blocks, which, along with planar structural observations, can be used to estimate local trends of target features with some subsurface dip estimates.

## **DATA DESCRIPTION**

This description provides a general overview of the regional data in this compilation and, also, the local, more closely spaced historic Horne Mine data. More detailed descriptions can be accessed in the appendix, and in many cases raw data can be retrieved from the sources such as E-Sigeom or in published references noted in the text.

## **REGIONAL DATA**

Drill core and outcrop data which form the bulk of the data set, were originally compiled from contributions from the E-Sigeom data base (Ministère des Ressources Naturelles du Québec) and Xstrata Copper Canada (previously Noranda Exploration) and through cooperation of Falco-Pacific who now largely maintain data and holds much of the exploration ground for the region (Northern Miner 2013). Surface mineral occurrence and deposit locations for context are included (Figure 2) along with reconstructed 3D geometries of the drill paths for regional and mine data using the collar and deviation logs (Figure 3). Information from the

descriptive tables of outcrop and drill core were decomposed into a hierarchy of lithostratigraphic codes using a similar methodology to the TGI Flin Flon mining camp 3D modelling project (Schetselaar et al. 2011), but with different content criteria (Figure 4). In this release, the final most general level of classification has eight descriptive classes for Blake River Group metavolcanics. These proved best for harmonizing the drill core (subsurface) and outcrop (surface) observations of the metavolcanic descriptions noted from current and past field studies (e.g., Ross et al. 2011a, 2011b, 2008, 2007, Rogers et al. in press, 2010, Péloquin, et al. 2001). Other parsed out information includes textural codes, metallic content, geochemical or structural information (see appendix for detailed database field descriptions) which can be used for more specific analysis.

Structural data (Figure 5) are compiled from E-Sigeom and Noranda / Xstrata contributions. They have been better organized and separated into ten structural domains and levelled to a Digital Elevation Model (DEM). Sub-surface dip estimates are also available from three point surface solutions or extracted from modelled local geologic surfaces. Primary bedding and tectonic foliation fabrics ( $S_0, S_1$ , and locally  $S_2$ ) are the main elements included. Surface trajectories of volcanic bedding and overprinting cleavage fabrics (Figure 6) are included along with interpretations from enhanced magnetic and DEM imagery (Figure 7). In addition one regional lithoprobe transect and 2 high resolution seismic profiles are included as Gocad files (Figure 8).

Geochronology data represent a partial compilation of published data for the region, listed in E-Sigeom and other sources (Lafrance et al. 2005) and also recently obtained GSC ages from the TGI project (McNicoll et al. in press). Only data derived from U/Pb analyses from zircons in Blake River Group volcanic rocks or younger sedimentary rocks in the study area were compiled. There are 87 date estimates included. For a complete listing see McNicoll et al. (in press) (Figure 9).

A set of four reference curves (labelled 2701, 2699, 2698, 2697) are developed by combining the geochronologic data with bedding trajectories and younging information for felsic volcanic rocks (Figure 9,10). These felsic units are labelled relatively within each structural domain from 1 to 5, oldest to youngest. These curves provide chronostratigraphic estimates delineating the locus of volcanic successions which can be used to support broad correlations within fault blocks and potentially across major faults. This will improve in accuracy as new age data and better structural modelling are undertaken in 3D. Several other data sets have been included from current and previous studies including geophysical and geochemical data, derivative property models, lithology simulations as well as modelled geologic objects from the Central Camp (Figure 11-16). These are all described in the appendix under Gocad/SKUA projects.



Figure 1 - Extents of observational data (~ 48°N,79° 30'W - 48.°30'N,78°W) covered in this release. See Appendix for exact spatial geographic and UTM coordinates of corner points. Black lines indicate regional faults.



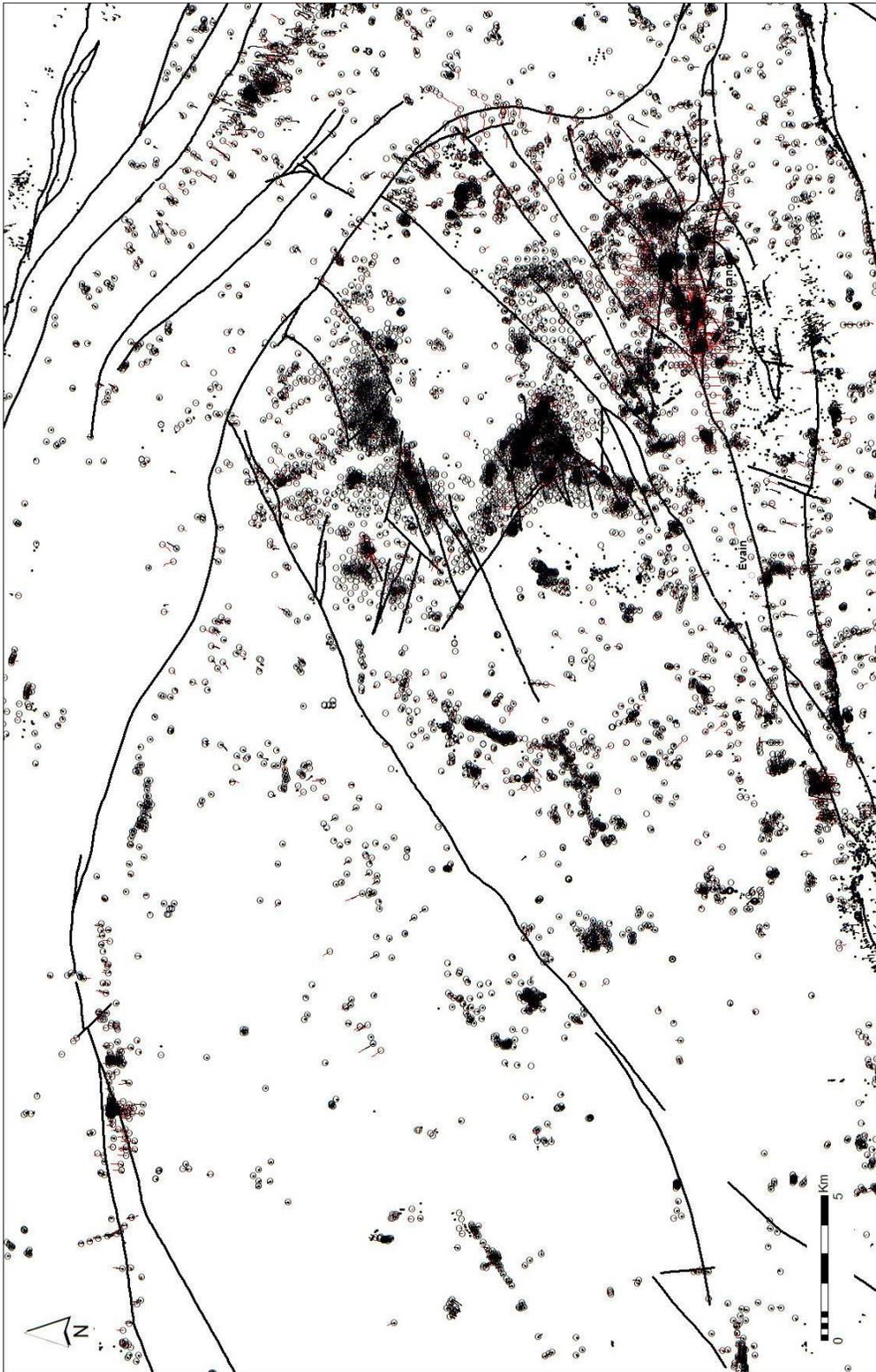


Figure 3 - Drill hole distribution from industry (open circles and red projected drill paths) and E-Sigeom (black dots and black projected drill paths).

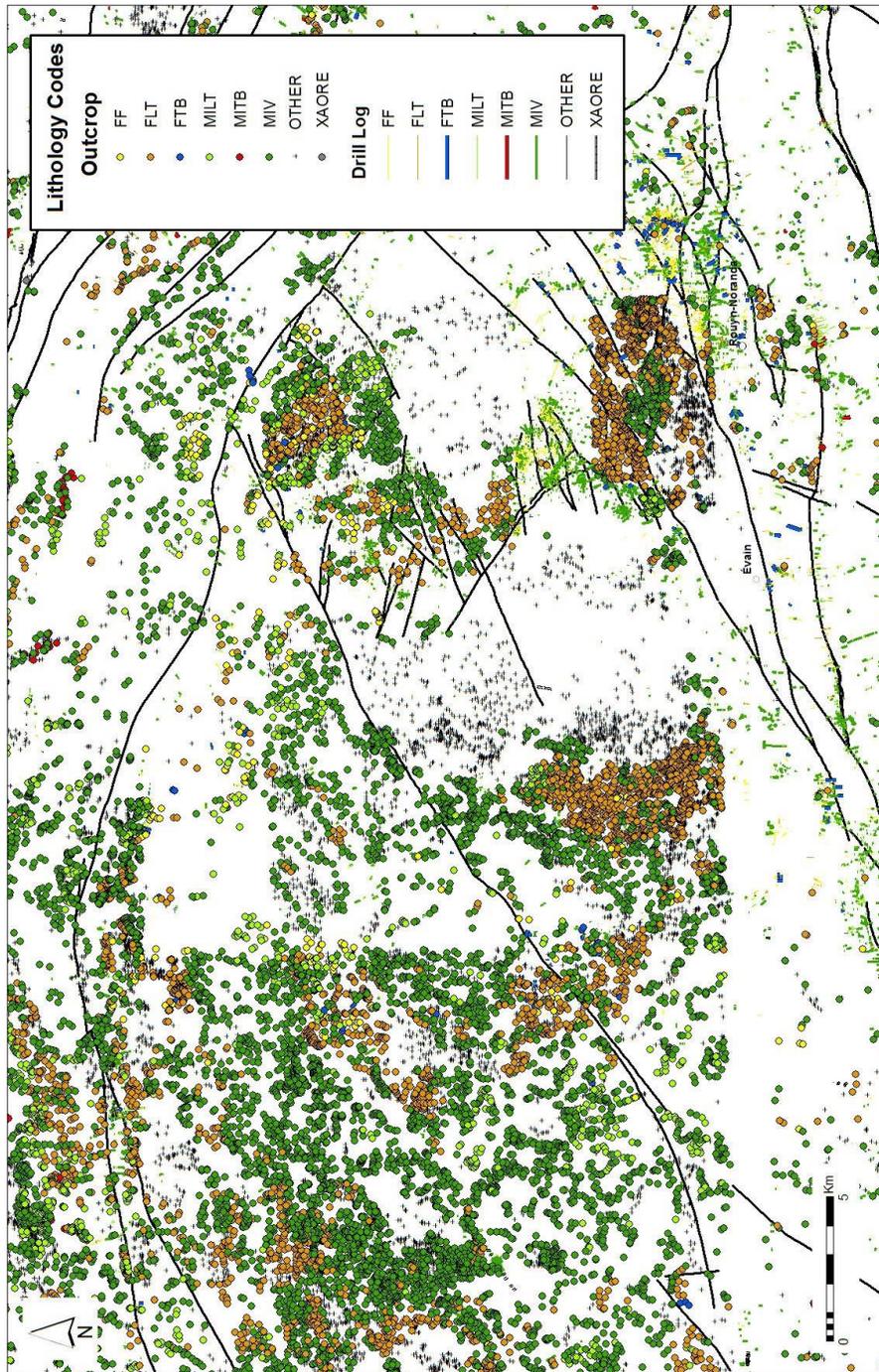


Figure 4 - Classified volcanic rocks (see Appendix 4 for detailed descriptions of codes) at surface (coloured circles) and subsurface (coloured curves). Codes are; **FF** = Felsic Flow, **FLT** = Felsic Lapilli Tuff, **FTB** = Felsic Tuff Breccia, **MILT** = Mafic to Intermediate Lapilli Tuff, **MITB** = Mafic to intermediate Tuff Breccia, **MIV**= Mafic to Intermediate metavolcanics, **Other** = non-volcanic and volcanic clastic rocks, **XORE** = Exhalite or local sulphide mineralized rocks.

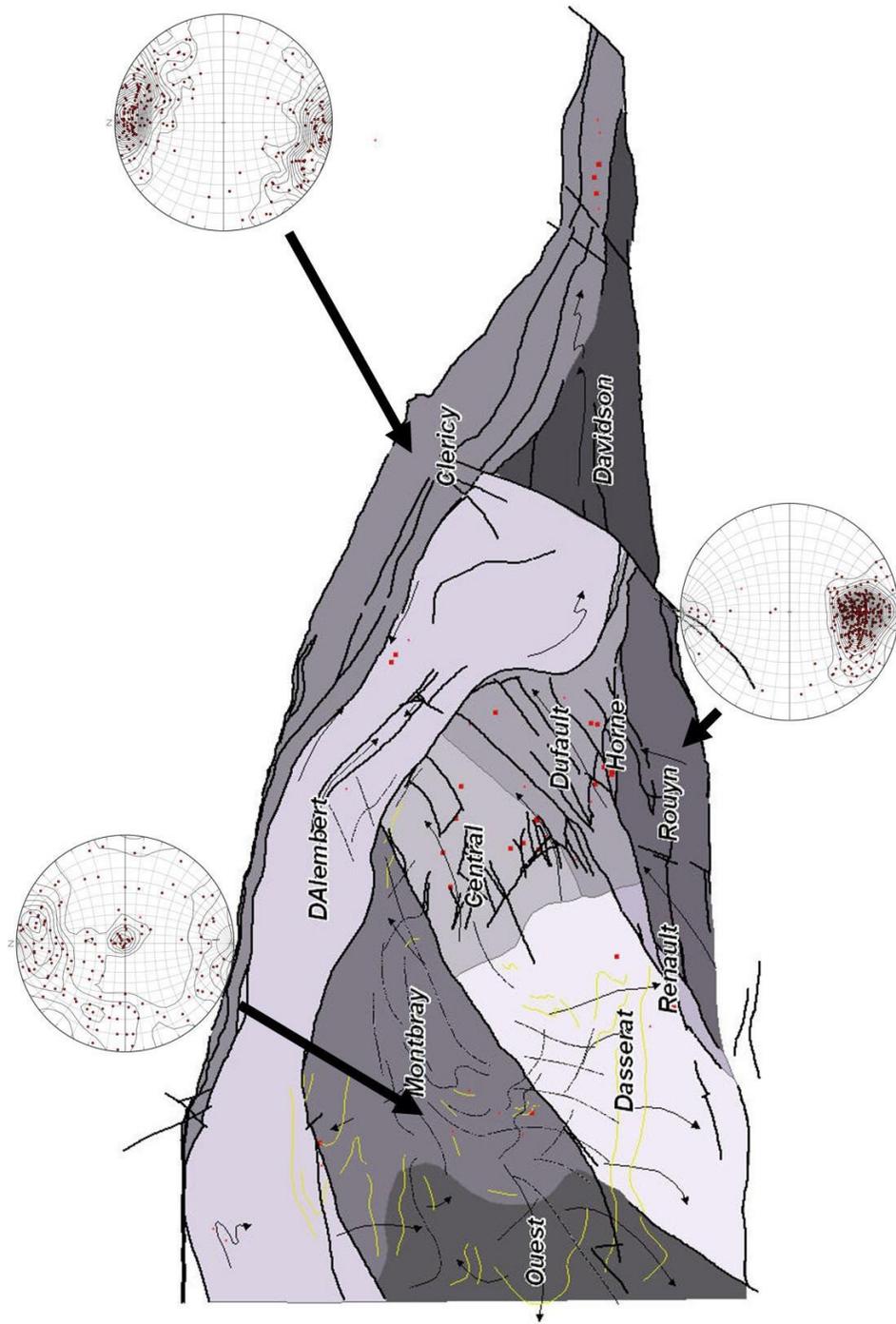


Figure 5 - Structural domains with statistical lower hemisphere plots for poles to  $S_0$ .



Figure 6 –Structural information  $S_0$ ,  $S_1$  observations (from E-SIGEOM), estimated fabric trajectories, fold axis and major fault dip estimations.

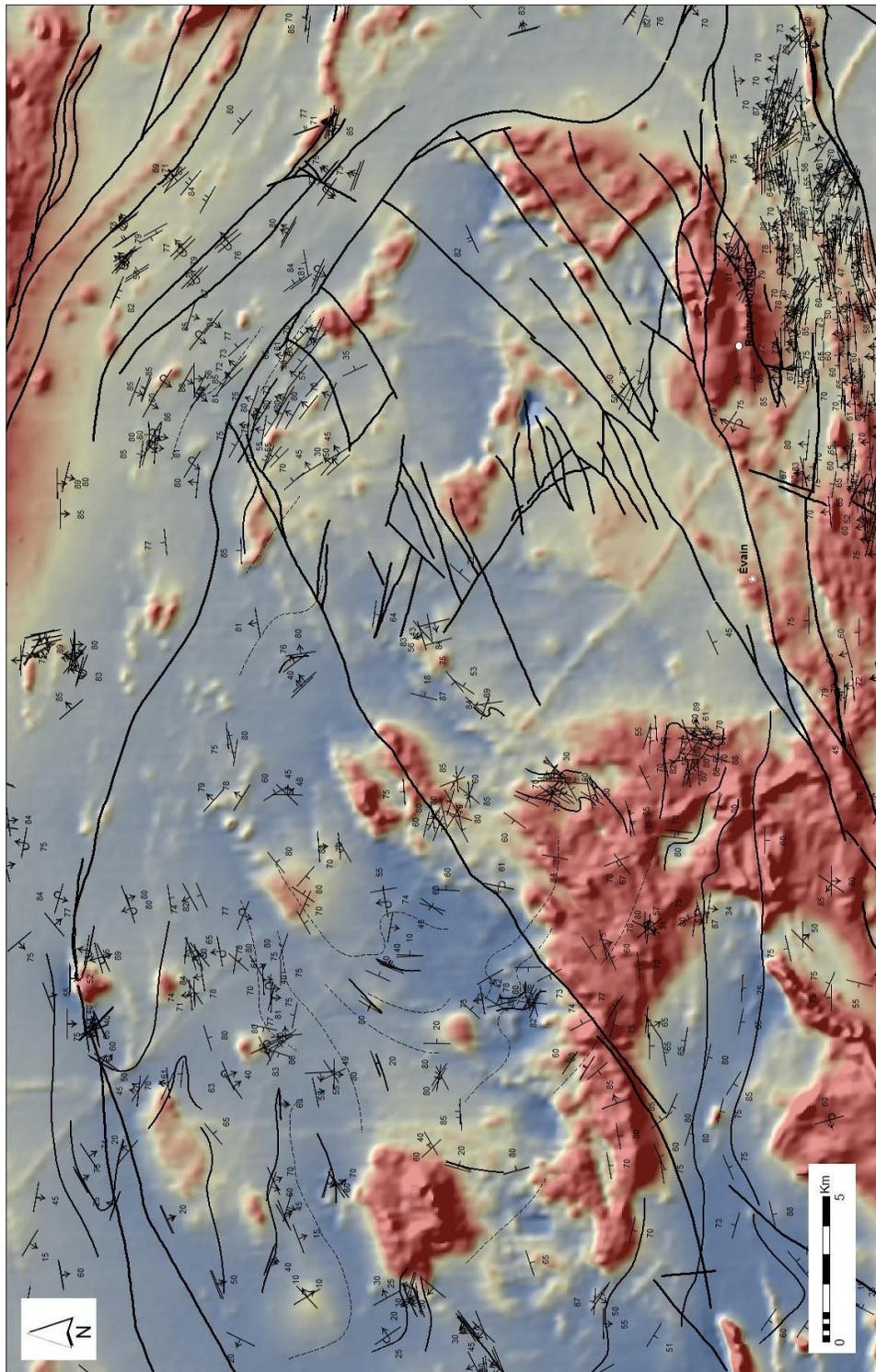


Figure 7 - Example of 2D GIS integration of geophysics (total field shaded magnetics) and structural data. (Geophysical data courtesy of Xstrata Copper Canada).

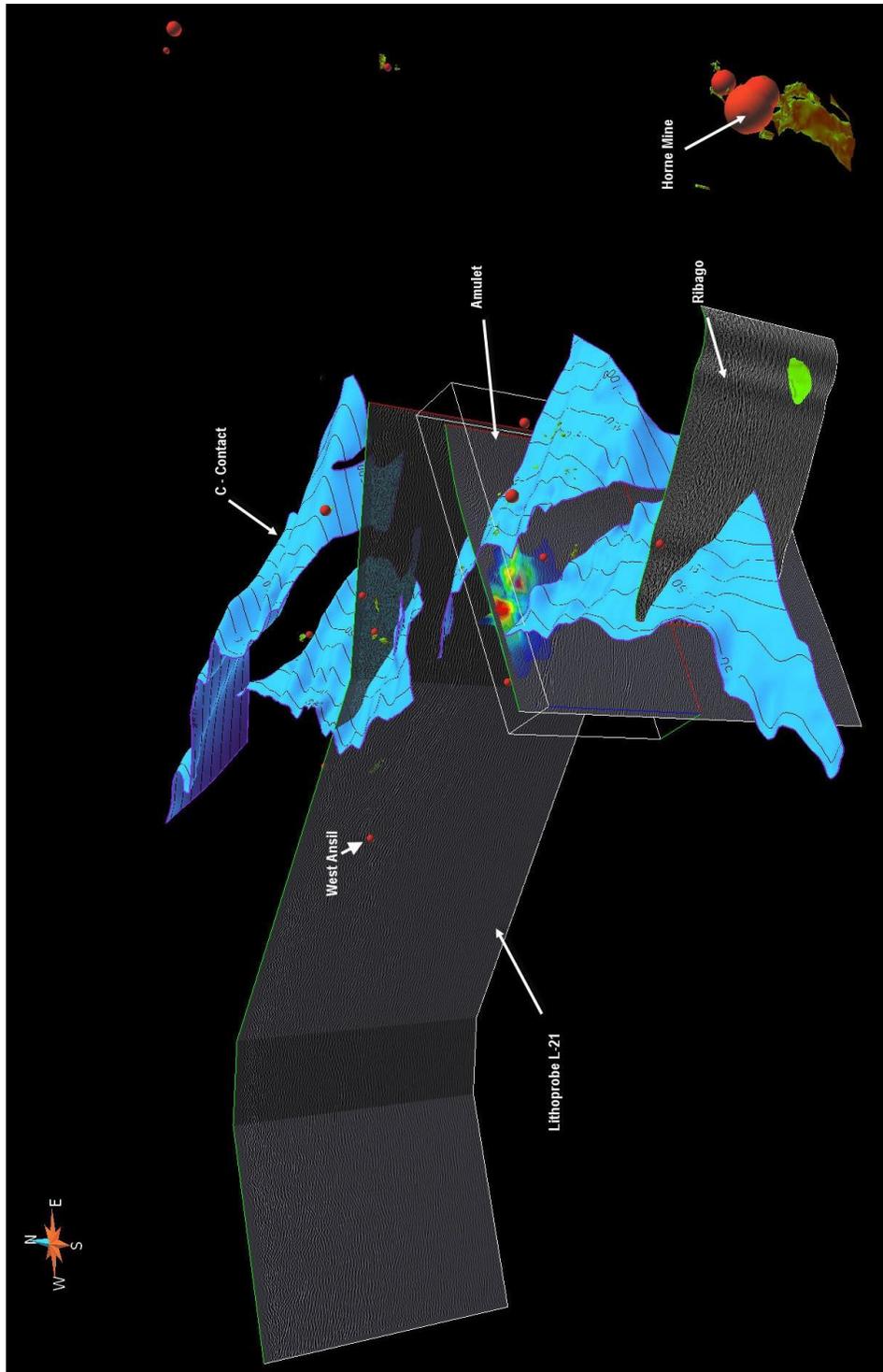


Figure 8 - Snap shot of 2D seismic lines processed by the Geological Survey of Canada in context of the Noranda Central Camp (Bellefleur et al. in press, Bellefleur et al. 2007, Perron G. and Calvert, A. J., 1998). Red balls indicate relative historical ore production. Geochemical integration study along the Amulet line and the C-Contact Exhalite horizon modelled by Noranda and Xstrata Copper Canada for reference.

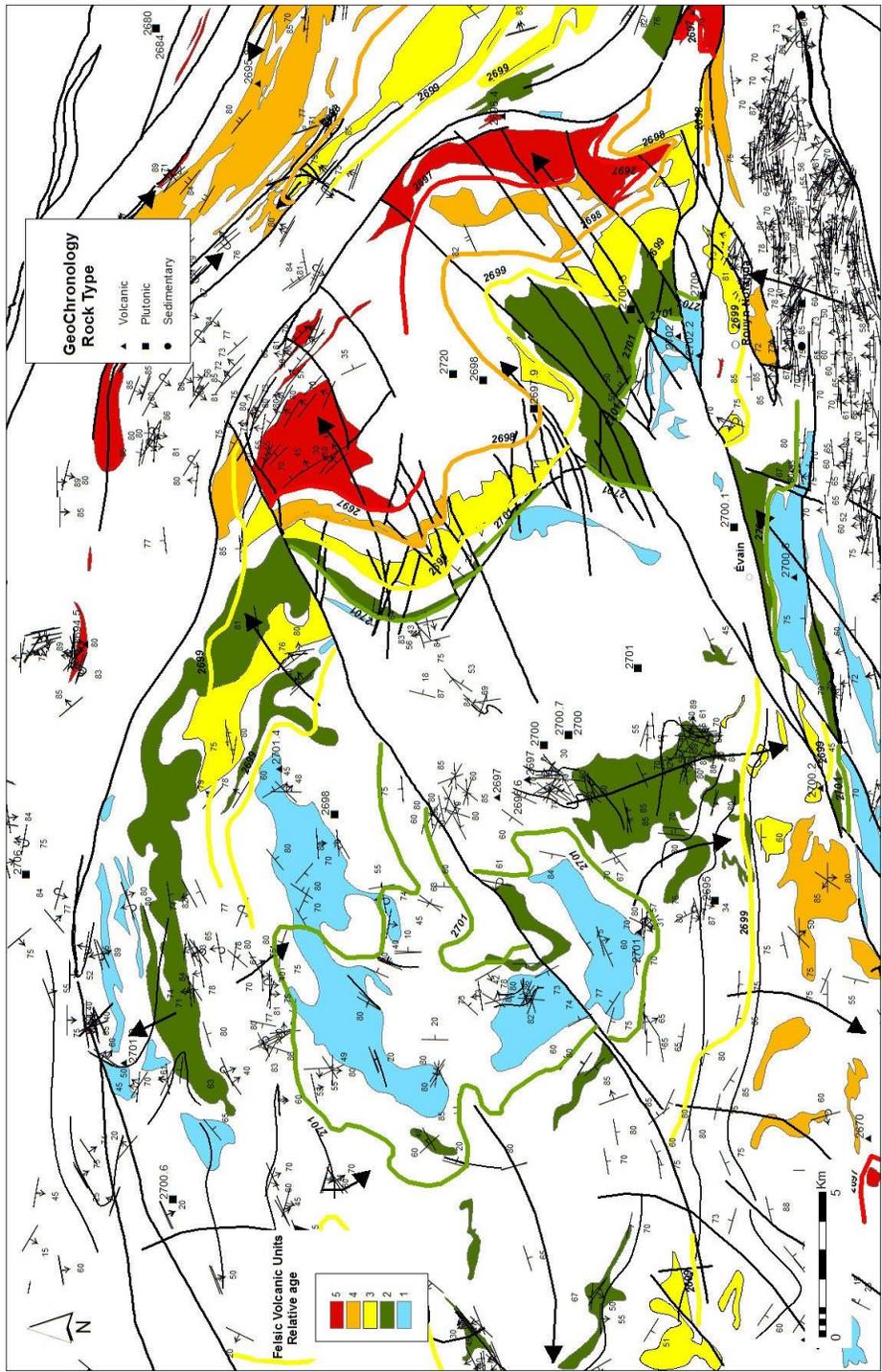


Figure 9 - Relative age classification of felsic volcanic units, U/Pb ages for various rock types and regional younging directions, indicated by arrows.

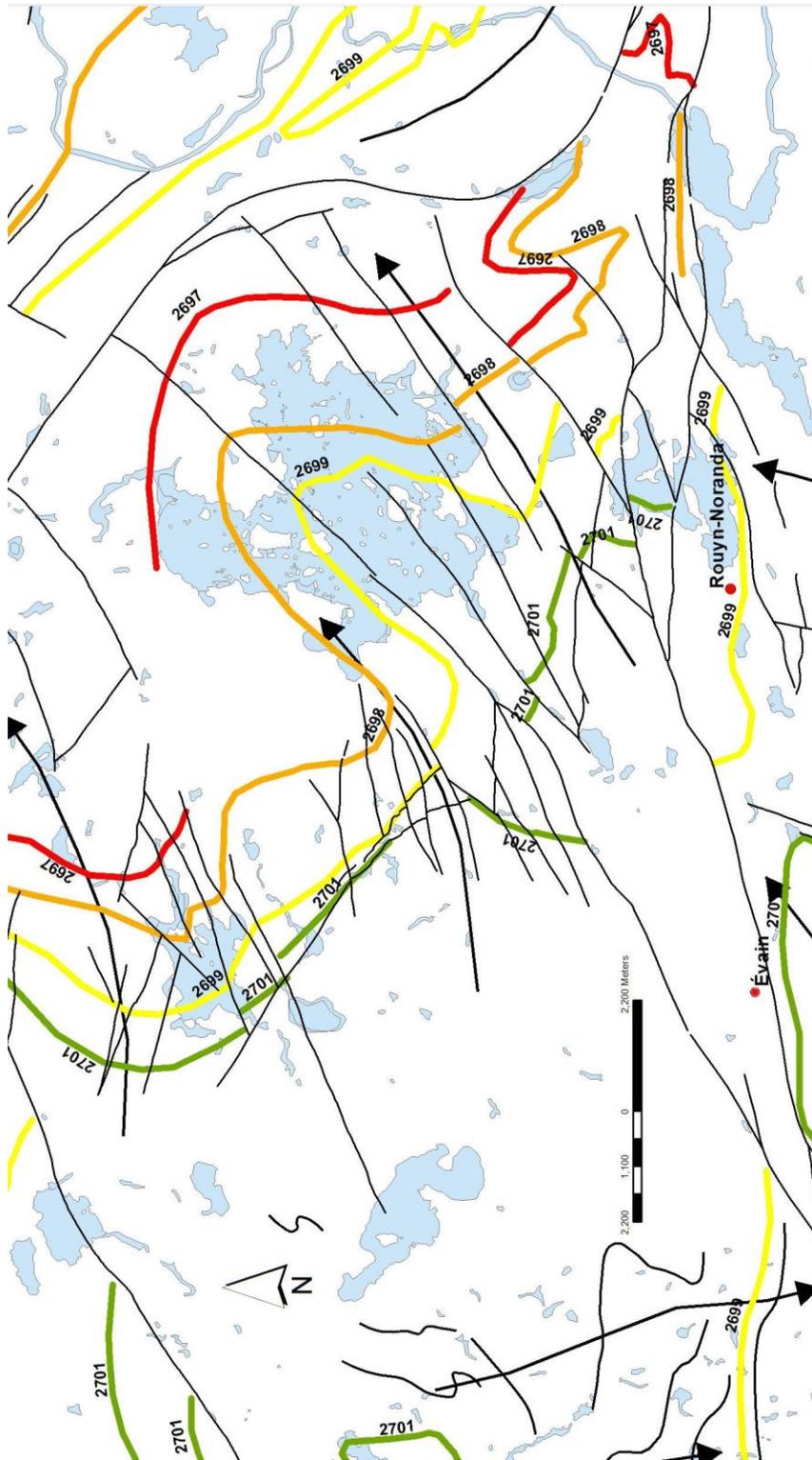


Figure 10 - Map illustrating chronostratigraphic traces and faults (black lines) present in the eastern portion of Figure 9.

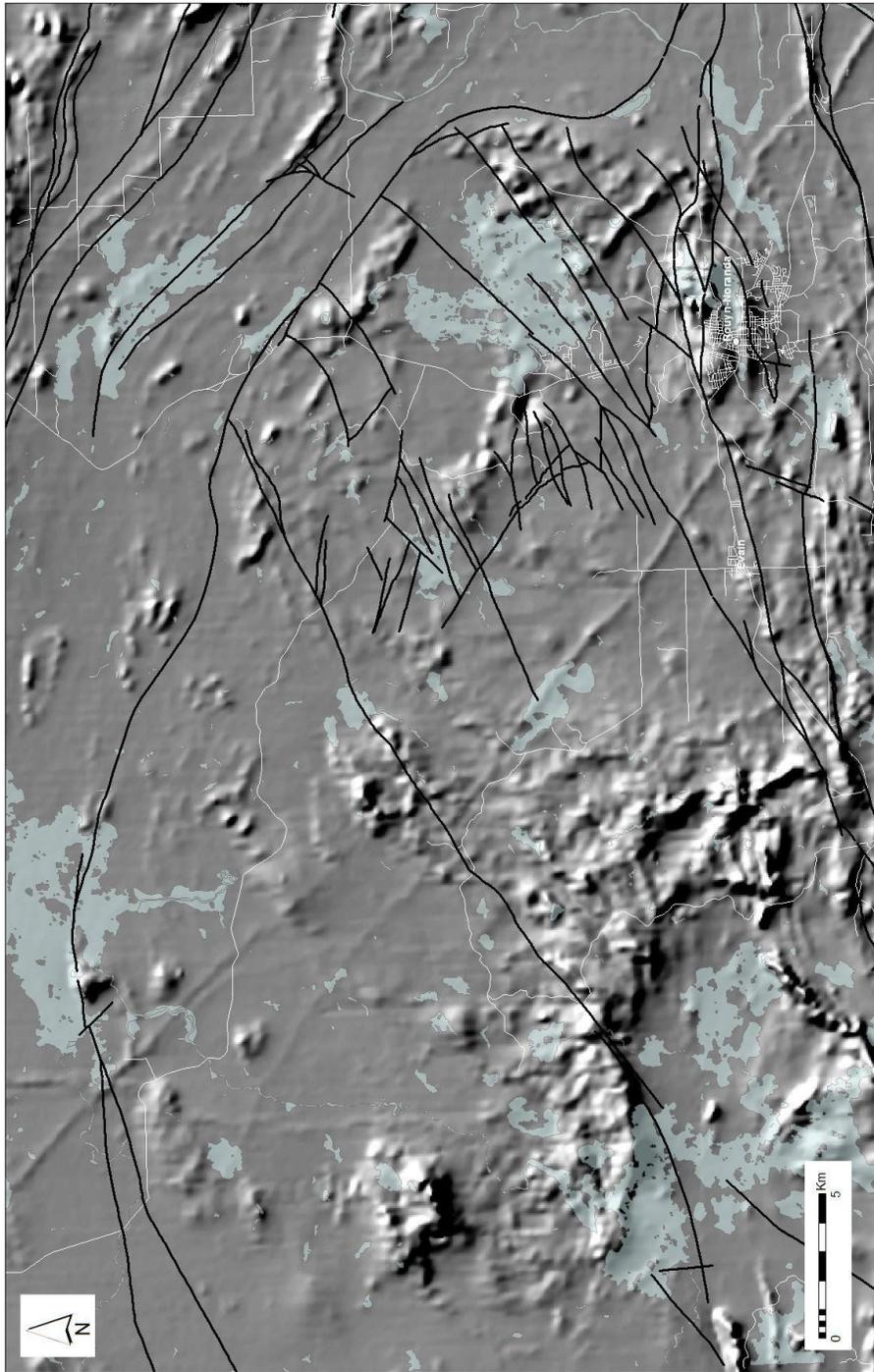
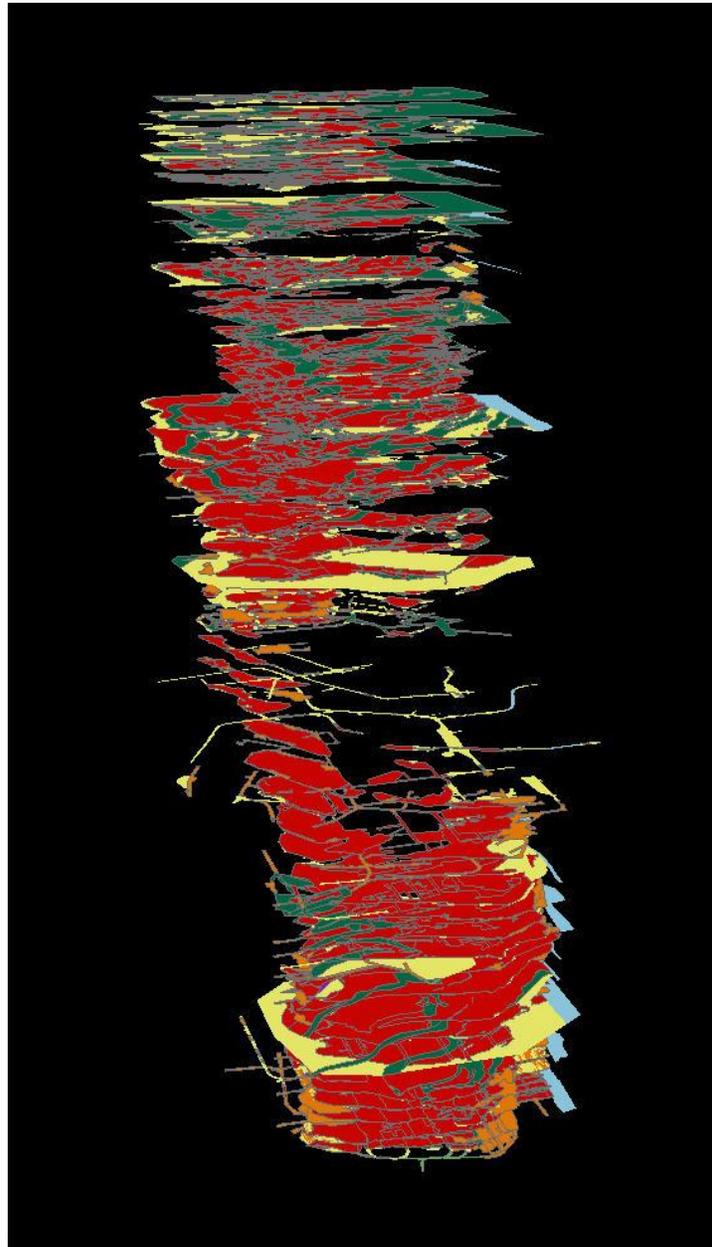


Figure 11 - General reference layers for relating data sets to ground features, in this case hydrography and the road networks facilitate locating features on the shaded total field magnetic data from a Megatem® survey (data provided courtesy of Xstrata Copper Canada).

## HORNE MINE DATA

Original mine level plans (Figure 12) with geology and assay data for Cu and Au for the Upper and Lower Horne Mine, in the local mine grid coordinate, system were digitized and organized in a geodatabase. These data were also re-projected and regionally levelled to match features in UTM NAD83 Zone 17 (see appendix for MINE to UTM conversion details). Included in this detailed sub-set are volcanic and intrusive contacts, faults, dip observations and metal distribution. Cu and Au assay values in weight percent and ounces per ton, respectively, are stored in .\of7349\Geology\Observations\Historical and can be analyzed and viewed in 3D with the map file .\ArcGIS\Horne\_Data\_2013.sxd.



A)

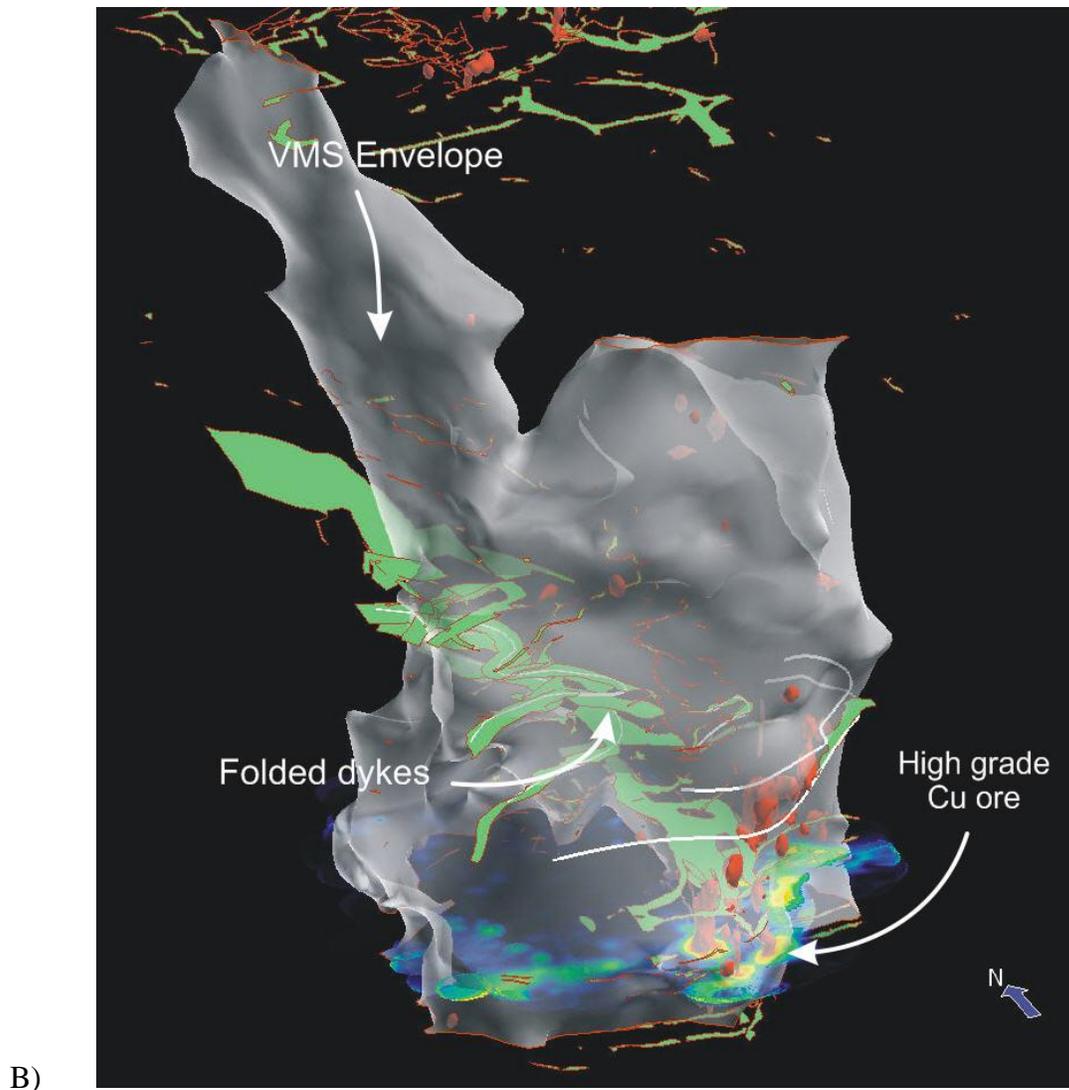


Figure 12 - A) Detailed Horne Mine level plans, B) Example of 3D geology integrated with Cu assay data from the Lower Horne Mine (see de Kemp 2010 p. 121 for details).

### **GOCAD 3D DATA**

Preliminary regional and local mine scale 3D models are included in this release (Figures 13-16). However they are recommended to be used as examples of what could be done with geomodelling tools such as Paradigm GOCAD®, but have not been checked for consistency with all the data sets listed in this release.

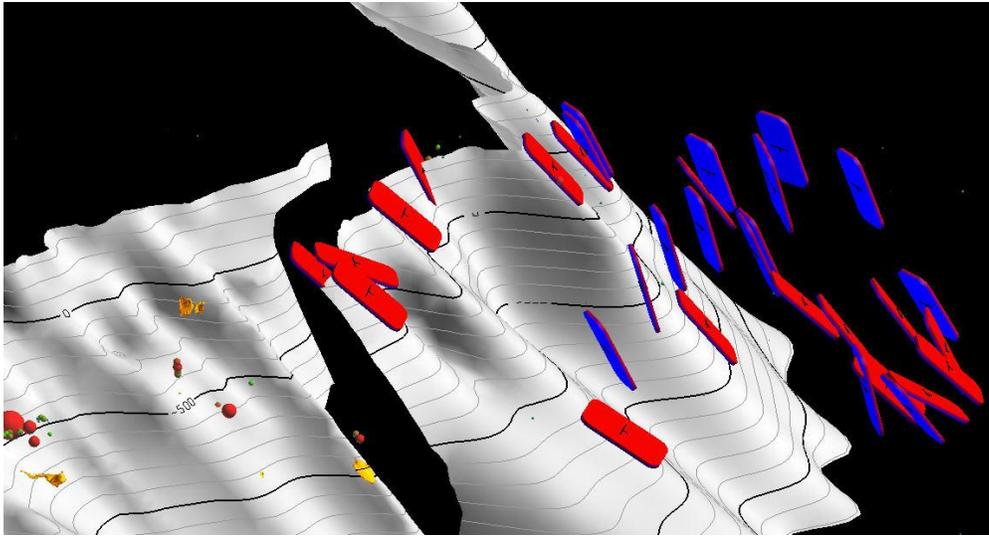


Figure 13 - Example of structurally contoured, dipping exhalite (C-Contact) horizon demonstrating faulting and folding with: ore bodies (small copper coloured bodies), alteration indicators from normative corundum estimations (high and low values indicted by large red and small green spheres, respectively), bedding ( $S_0$ ) dip indicators extracted from sub-surface contact solutions using drill core markers. Central Noranda Camp 3D horizon and whole-rock geochemical data courtesy of Noranda / Xstrata Copper Canada.

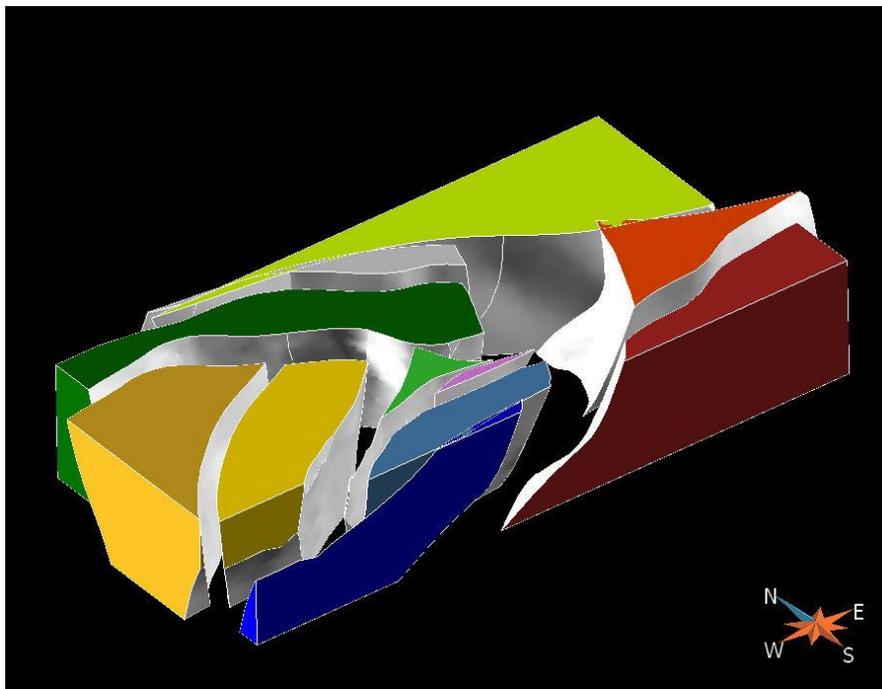


Figure 14 - Generalized regional Gocad/SKUA fault block model of Noranda Camp and adjacent regions.

**Blake River structural-stratigraphic model - 2010 Realization 1**

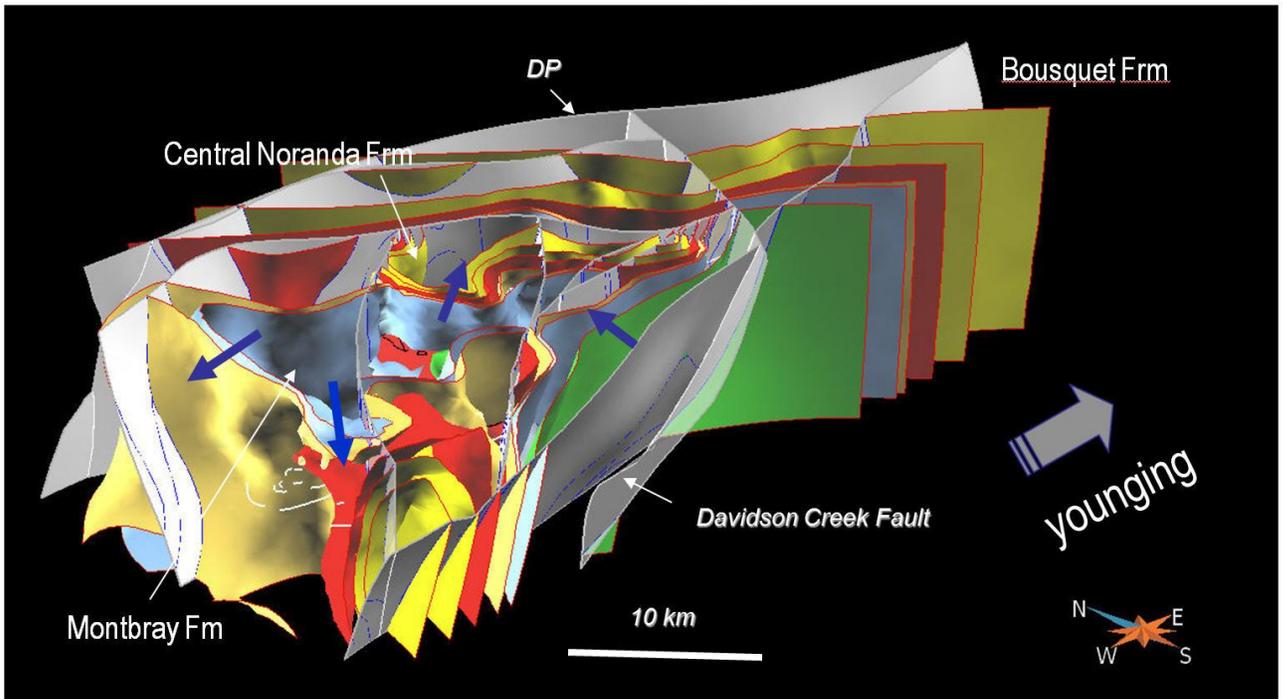


Figure 15 - Stratigraphic-structural Gocad/SKUA model example. Coloured surfaces indicate stratigraphic horizons and white surfaces indicate faults depicted in figure 14.

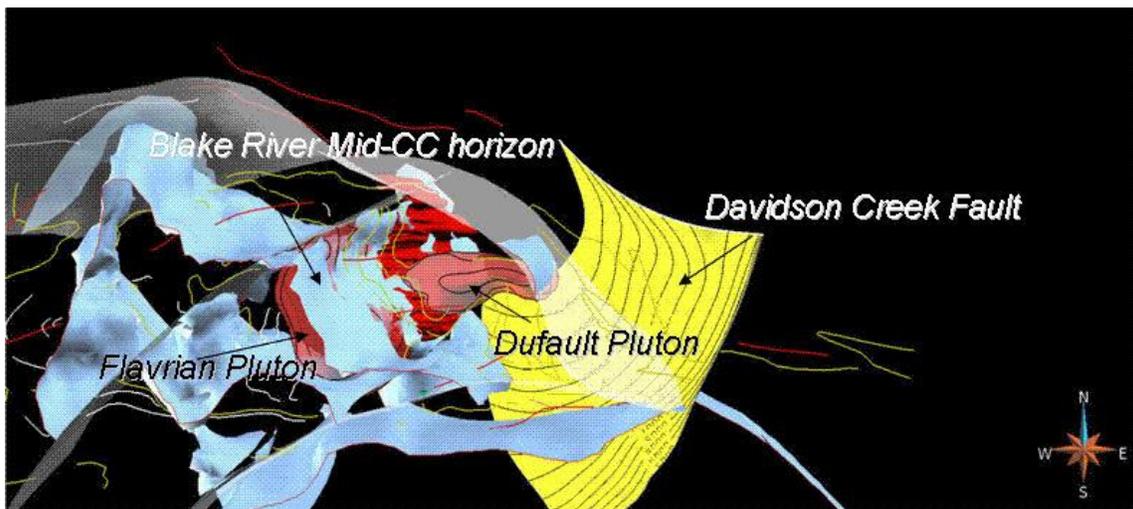


Figure 16 - Detail of 3D model with Mid Central Camp (Mid-CC) horizon in blue; late listric Davidson Creek fault in yellow, Flavrian and Dufault plutons in light red and contoured at 100 meters, C-Horizon exhalite as a corrugated, red, east-plunging surface in centre of model.

## CONCLUSIONS

This 3D data release is a comprehensive compilation of the critical geoscience constraints needed for consistent development of 3D models in the Rouyn-Noranda region. Bringing together many types of surface and subsurface observations in a harmonized lithostratigraphic scheme and placing these in a common 3D reference frame, with structural and geochronologic constraints, is a significant achievement. Through this integration, the data can be leveraged to better contribute to the ongoing knowledge asset that will grow in value as it is consulted, added to and reconciled with all interpretive products (maps, cross-sections and 3D models), both public and private.

## ACKNOWLEDGMENTS

Many thanks to Falco-Pacific and Xstrata Copper Canada for kindly providing the historical data contained in this release and for the reviewers suggestions for improving this manuscript. Thanks also to the Gocad Research Consortia for supporting the 3D modelling activities through the use of Paradigm GOCAD/SKUA® software. Support from ESRI Canada through joint development of the 3D Drill Core loader application for ArcGIS and ArcScene is greatly appreciated. On-going technical and research support was generously provided by Mira Geoscience. Thanks to Ernst Schetselaar for valuable and timely advice on linear referencing of drill core data and use of hierarchical reclassification schemes.

## REFERENCES

- Ayer, J.A., Dubé, B. and Calhoun, R.F., 2008, The Abitibi Greenstone Belt: Update of the Targeted Geoscience Initiative III Abitibi Project, the Deep Search and the Discover Abitibi Initiative Projects, Summary of Field Work and Other Activities 2008, Ontario Geological Survey, Open File Report 6226, p.3-1 to 3-8.
- Ayer, J.A., Dubé, B., Ross, P.-S., Beakhouse, G.P., Berger, B.R., Bleeker, W., Brouillette, P., Chapman, J., Diné, E., Dion, C., Dumont, R., Fowler, A.D., Friedman, R., Gibson, H.L., Goutier, J., Grunsky, E.C., Hamilton, M.A., Hannington, M.D., Houlé, M.G., Keating, P., Kontak, D., Laurin, J., Layton-Matthews, D., Leshner, C.M., McNicoll, V.J., Mercier-Langevin, P., Monecke, T., Moulton, B.J.A., Paradis, S.J., Percival, J.A., Peter, J.M., Potvin, J., Roy, M., Sharman-Harris, E., Taranovic, V., Taylor, B.E., Thurston, P.C., Trowell, N.F., Van Breemen, O., Veillette, J.J., Wilson, R. and Wing, B.A., 2007, The Abitibi Greenstone Belt: Update of the Precambrian Geoscience Section Program, the Targeted Geoscience Initiative III Abitibi and Deep Search Projects Summary of Field Work and Other Activities 2007, Ontario Geological Survey, Open File Report 6213, p.3-1 to 3-44.
- Ayer, J.A., Dubé, B., Goodfellow, W., Ross, P.-S., Bleeker, W., Taylor, B.E., Peter, J.M., Grunsky, E.C., Hillary, B., Thurston, P.C., Berger, B.R., Houlé, M.G., Beakhouse, G.P., Trowell, N.F., Snyder, D.B., McNicoll, V.J., Keating, P., Percival, J.A., Mercier-Langevin, P., Lauziere, K., Paradis, S.J., Goutier, J., Dion, C., Pilote, P., Legault, M., Monecke, T., Dumont, R., Brouillette, P., Gosselin, P., Van Breemen, O., 2006, The Abitibi Subprovince: An Update on the Goals and Preliminary Results of the Precambrian Geoscience Section, Targeted Geoscience Initiative III and Deep Search Projects pp. 4:1-4:19; in Summary of Field Work and Other Activities 2006, Ontario Geological Survey, Open File Report 6192, p.32-1 to 32-6
- Bellefleur, G., Eric de Kemp, E.A., Goutier, J., Allard, M., and Adam, E., Seismic Imaging of the Geological Framework and Structures Related to Volcanogenic Massive Sulfide Deposits in the Archean Rouyn-Noranda District, Québec, Canada, Economic Geology, Vol. 109, in press.
- Bellefleur, G., de Kemp, E., Goutier, J. and Allard, M. 2007. A new look at the geological framework of the central Noranda camp, Quebec from industry high-resolution seismic profiles; Geological Survey of Canada, Current Research 2007-C5, 9p.
- Daigneault, R. and Pearson, V., 2006. Physical volcanology of the Blake River caldera complex: a new interpretation of an old structure; in The komatiite-komatiitic basalt-basalt association in oceanic plateaus and calderas: physical volcanology and textures of subaqueous Archean flow fields in the Abitibi greenstone belt, Geological Association of Canada, Field Trip A3, p.62-72.

- de Kemp, E.A., Monecke, T., Sheshpari, M., Girard, E., Lauzière, K., Grunsky, E., Schetselaar, E.M., Goutier, J., Perron, G., Bellefleur, G., 2011, 3D GIS as a support for mineral discovery, *Geochemistry: Exploration, Environment, Analysis*, Volume 11, 2011, pp. 117-128.
- Dion, C., Rhéaume, P., 2007. Stratigraphie de la partie occidentale du Groupe de Blake River. (Québec), MRNF, report ET 2007-03, 29 p.
- Dubé, B., Gosselin, P., Mercier-Langevin, P., Hannington, M. and Galley, A. 2007, Gold-rich volcanogenic massive sulphide deposits; in *Mineral deposits of Canada: a synthesis of major deposit-types, district metallogeny, the evolution of geological provinces, and exploration methods*, Geological Association of Canada, Mineral Deposits Division, Special Publication 5, p.75-94.
- Fallara, F., Legault, M., and Rabeau, O., 2006, 3-D integrated geological modeling in the Abitibi subprovince (Québec, Canada): Techniques and applications: *Exploration and Mining Geology*, v. 15 (1-2), p. 27-42.
- Fallara, F., Legault, M., Cheng, L. Z., Rabeau, O., and Goutier, J., 2004a, Modele 3D Geo-integre d' un Segment de la Faille de Porcupine-Destor, *Synthese Metallogenique de Duparquet (phase 1/2)* MRNFP Report 3D 2004-01.
- Fallara, F., LaFrance, B., Cheng, L. Z., Boudrais, G., Cote, J., Bedard, N., Lei, Y., Dube, B., and Galley, A. G., 2004b, Modele 3D Geo-integre de la Formation de Bousquet, Zone Volcanique sud de la sous-province de l'Abitibi, Québec: MRNFP Report 3D 2004-04.
- Goutier, J., Dion, C., Ross, P.-S., Lafrance, B., Legault, M., McNicoll, V., and Mercier-Langevin, P., *Lexique stratigraphic du Groupe de Balke River en Abitibi*, Ministère des Ressourcesnaturelles et de la Faune : Report ET, in preparation.
- Goutier, J., Monecke, T., Ross, P.-S., Dion, C., 2007. Volcanoclastites du Groupe de Blake River et implications pour les SMV. Ministère des Ressources naturelles et de la Faune, MRNF, report GM 63072, 22 p.
- Grunsky, E.C., in press. Predicting Archean Volcanogenic Massive Sulfide Deposit Potential from Litho-geochemistry: Application to the Abitibi Greenstone Belt, *Geochemistry: Exploration, Environment, Analysis*.
- Grunsky, E.C., 2008, Compilation and Interpretation in the Blake River Group, Abitibi Subprovince, Ontario and Quebec, Summary of Field Work and Other Activities 2008, Ontario Geological Survey, Open File Report 6226, p. 6-1 to 6-11.
- Hillary, E M and Grunsky, E. C., 2010, Compilation of reanalysis and new analyses of litho-geochemistry - Abitibi greenstone belt, Ontario and Quebec: geological survey of Canada, Open File 6623.
- Jensen, L. S., 1976, A new cation plot for classifying subalkalic volcanic rocks: Ontario Geological Survey Report MP 66, 22 p.
- Jobin, D., Dion, C. and Keating, P., 2008, Gravity Maps of the Blake River Group, Québec, 1:100,000 scale, Geological Survey Open File 5981, and Ministère des Ressources du Québec DPV 2008-39.
- Lafrance, B., Davis, D.W., Goutier, J., Moorhead, J., Pilote, P. , Mercier-Langevin, P., Dubé, B., Galley, A.G., and Mueller, W.U., 2005, Nouvellesdatations isotopiques dans la portion québécoise du Groupe de Blake Riveret des unités adjacentes: Ministère des Ressources Naturelles, Faunes et Parcs du Québec Report RP 2005-01, 15 p.
- Péloquin, A.S., Verpaest, P., Ludden, J.N., Dejou, B., and Gaulin, R., 2001,La Statigraphie du Groupe du Blake River Ouest, Ceinture de l' Abitibi, Québec: Ministère des Ressources Naturelles du Québec Report ET98-03, 37 p.
- Perron, G., and Calvert, A.J., 1998, Shallow, high-resolution seismic imaging at the Ansil mining camp in the Abitibi greenstone belt: *Geophysics*, v. 63, p. 379-391.
- Perron, G., and Calvert, A. J., 1998, Shallow, high-resolution seismic imaging at the Ansil mining camp in the Abitibi greenstone belt: *Geophysics*, v. 63, p. 379-391.
- Marquis, R., Bois, D., and McGaughey, J., 2003, Quantitative Geology Using 3D Common-Earth Modelling: PDAC Open Session: New OPortunities in familiar places, PDAC Annual Convention, Toronto, Canada, March 12, 2003, p. 5.
- McNicoll, V., Goutier, J. , Dubé, B. , Mercier-Langevin, P., Ross, P.-S. , Dion, C., Monecke, T. , Legault M., Percival, J., and Gibson, H., U-Pb Geochronology of the Blake River Group, Abitibi Greenstone Belt, Québec, and Implications for Base Metal Exploration, *Economic Geology*, v. 109, in press.
- Mercier-Langevin, P., Goutier, J., Ross, P.-S., McNicoll, V., Monecke, T., Dion, C., Dubé, B., Thurston, P., Bécu, V., Gibson, H., Hannington, M., Galley, A., 2011. The Blake River Group of the Abitibi Greenstone Belt and its unique VMS and gold-rich VMS endowment. Geological Survey of Canada, Open File 6869, 61 p.

- Mercier-Langevin, P., Ross, P.-S., Dion, C., Goutier, J., Dubé, B., 2010. Geology of the Inmont (Robb-Montbray) zone 3 stripped outcrop. GSC Open File 6546, 1 p.
- Mercier-Langevin, P., Ross, P.-S., Lafrance, B., Dubé, B., 2008. Volcaniclastic rocks of the Bousquet scoriaceous tuff units north of the LaRonde Penna mine, Doyon-Bousquet-LaRonde mining camp, Abitibi Greenstone Belt, Quebec. Geological Survey of Canada, Current Research 2008-11, p. 1-19
- Monecke, T., Gibson, H., Hannington, M., & McNicoll, V., 2011. Felsic host-rock successions of the VMS deposits in the Noranda Camp. In: P. Mercier-Langevin, J. Goutier, P.S. Ross, V. McNicoll, T. Monecke, C. Dion, B. Dube, P. Thurston, V. Becu, H. Gibson, M. Hannington, & A. Galley (eds.) The Blake River Group of the Abitibi Greenstone Belt and its unique VMS and gold-rich VMS endowment. Geological Survey of Canada Open File 6869: 27-39.
- Monecke, T., Gibson, H., Dubé, B., Laurin, J., Hannington, M.D. and Martin, L., 2008, Geology and volcanic setting of the Horne deposit, Rouyn-Noranda, Québec: initial results of a new research project; Geological Survey of Canada, Current Research 2008-9, 16p
- Northern Miner, 2013, Falco finds gold in Horne's old data DAILY NEWS, Apr 15, 2013.
- Martin, L., Perron, G., Masson, M., 2007, Discovery from 3D Visualization and Quantitative Modelling, In "Proceedings of Exploration 07: Fifth Decennial International Conference on Mineral Exploration" edited by B. Milkereit, 2007, p. 543-550
- Mueller, W. 2006. A new interpretation of the Blake River Group, Abitibi greenstone belt: the importance of volcanological facies mapping and the discovery of a megacaldera; Geological Association of Canada, Volcanology and Petrology Division, Ashfall, v.62, p.10-13.
- Rabeau, O., and Legault, M., 2006, Étude métallogénique et modélisation 3D de la Faille de Cadillac dans le secteur de Rouyn-Noranda. MRNFP RP 2006-03. 8 p.
- Rogers, R., Ross, P.-S., Goutier, J., Mercier-Langevin, P., in press. Using physical volcanology, chemo-stratigraphy and pyrite geochemistry as tools for VMS exploration outside of mining camps in the Blake River Group, Abitibi Subprovince. Economic Geology
- Rogers, R., Ross, P., Goutier, J. and Mercier-Langevin, P., 2010, Volcanology and geochemistry of the Mafic to intermediate volcanic rocks of the Blake River Group between lakes McDiarmid and Hébécourt, Abitibi, Subprovince, RP 2010-08(A)
- Ross, P.-S., Goutier, J., Mercier-Langevin, P., Dubé, B., 2011a. Basaltic to andesitic volcaniclastic rocks in the Blake River Group, Abitibi Greenstone Belt: 1. Mode of emplacement in three areas. Canadian Journal of Earth Sciences 48, 728-756.
- Ross, P.-S., McNicoll, V., Goutier, J., Mercier-Langevin, P., Dubé, B., 2011b. Basaltic to andesitic volcaniclastic rocks in the Blake River Group, Abitibi Greenstone Belt: 2. Origin, geochemistry, and geochronology. Canadian Journal of Earth Sciences 48, p. 757-777.
- Ross, P.-S., Goutier, J., McNicoll, V.J. and Dubé, B. 2008. Volcanology and geochemistry of the Monsabrais area, Blake River Group, Abitibi greenstone belt: implications for volcanogenic massive sulphide exploration, Geological Survey of Canada, Current Research 2008-01, 18p.
- Ross, P.-S., Percival, J.A., Mercier-Langevin, P., Goutier, J., McNicoll, V.J. and Dubé, B., 2007, Intermediate to mafic volcaniclastic units in the peripheral Blake River Group, Abitibi greenstone belt: origin and implications for volcanogenic massive sulphide exploration; Geological Survey of Canada, Current Research 2007-C3, 25p.
- Schetselaar, E., Currie, M., Pehrsson, S., Devine, C. and Mwenifumbo, J. 2011, 3D Drill Hole and Geologic Map Database of the Flin Flon Mining District, Manitoba and Saskatchewan, Open File 6650, 1 CD-ROM.
- Späth, H., 2004, Fitting affine and orthogonal transformations between two sets of points, Mathematical Communications 9 , p. 27-34 .
- Taylor, B.E., de Kemp, E.A. , Grunsky, E. , Martin, L., Maxwell, G. , Rigg, D., Goutier, J., Lauziere K., and Dube, B., Three-dimensional visualisation of the Archean Horne and Quemont Au-bearing volcanogenic massive sulfide hydrothermal systems, Blake River Group, Québec, Economic Geology, v. 109, in press.

## APPENDIX 1

### Data Table of Contents OF\_7349.zip Digital Release

See .\of7349\

- **Open File 7349 Report in Acrobat® format: 'OF7349.pdf'**
  - **Appendix 1 - Table of contents**
  - **Appendix 2 - Horne Mine to UTM coordinate conversion details**
  - **Appendix 3 - MS Access® relational database descriptions**
  - **Appendix 4 - ESRI® 3D file 3D geodatabase descriptions**
  - **Appendix 5 - GOCAD / SKUA project and supporting 3D data files**
- **readme.txt**

See .\of7349 \Docs

- **Horne\_Mine\_3D.pdf - Example of Lower Horne mine model from figure 11  
(3D Acrobat® PDF)**
- **BR\_2013.pdf - Example of regional 3D model from figure 15  
(3D Acrobat® PDF)**
- **Gocad/SKUA project files .\of7349/3D**

## APPENDIX 2

### Spatial Parameters, coordinate information and Transformations

#### Data Base Spatial Extents:

Listed in .\Topo\BR\_2013\_Extents.shp

Zone	Easting	Northing	Projection	Latitude	Longitude	Elevation
17	610579	5380643	UTM_NAD83_Z17	48.569113	-79.501033	142
17	610579	5333907	UTM_NAD83_Z17	48.148796	-79.513316	209
17	697034	5333907	UTM_NAD83_Z17	48.127897	-78.351975	215
17	697034	5380643	UTM_NAD83_Z17	48.547905	-78.330118	192

#### Regional UTM Coordinate parameters:

NAD\_1983\_UTM\_Zone\_17N  
WKID: 26917 Authority: EPSG

Projection: Transverse\_Mercator  
False\_Easting: 500000.0  
False\_Northing: 0.0  
Central\_Meridian: -81.0  
Scale\_Factor: 0.9996  
Latitude\_Of\_Origin: 0.0  
Linear Unit: Meter (1.0)

Geographic Coordinate System: GCS\_North\_American\_1983  
Angular Unit: Degree (0.0174532925199433)  
Prime Meridian: Greenwich (0.0)  
Datum: D\_North\_American\_1983  
Spheroid: GRS\_1980  
Semimajor Axis: 6378137.0  
Semiminor Axis: 6356752.314140356  
Inverse Flattening: 298.257222101

#### Coordinate Transformations:

Horne Mine Grid (HMG) - UTM NAD83 Zone 17 conversion equations

$$\begin{aligned} X_{\text{NAD83UTMZ17}} &= X_{\text{MINE}} * 0.302849 + Y_{\text{MINE}} * -0.010280 + 642665.123540 \\ Y_{\text{NAD83UTMZ17}} &= X_{\text{MINE}} * 0.001673 + Y_{\text{MINE}} * 0.304269 + 5341760.611935 \\ Z_{\text{NAD83}} &= (Z_{\text{MNE}} - 3000) * .3048 \end{aligned}$$

RMS error = 0.410783

$$\begin{aligned} X_{\text{MINE}} &= X_{\text{NAD83UTMZ17}} * 3.301249 + Y_{\text{NAD83UTMZ17}} * 0.111643 + -2717965.988314 \\ Y_{\text{MINE}} &= X_{\text{NAD83UTMZ17}} * -0.018112 + Y_{\text{NAD83UTMZ17}} * 3.285906 + -17540882.914249 \\ Z_{\text{MNE}} &= (Z_{\text{NAD83}} * 3.2808) + 3000 \end{aligned}$$

RMS error = 1.341244

When transforming vertical coordinates from Horne Mine Grid in feet to UTM Zone 17 NAD83 use method 1 below. Alternatively for elevation values from Noranda / Xstrata data between 2005 and 2010 use method 2 below for adjusting by 5000 meters.

Vertical Conversion factors:

Conversion Factors:  
 $Meters(Z_m) = Feet * .3048$   
 $Feet(Z_f) = Meters * 3.2808$

### Method 1

Horne Mine (HMG) Z conversion to meters (Above Mean Sea Level - AMSL)

$$Z_m = (Z_f - 3000) * .3048$$

UTM depth conversion Meters (AMSL) to feet (HMG)

$$Z_f = (Z_m * 3.2808) + 3000$$

Horne\_Mine2UTM.pscript

```
{  
X = (X * 0.302849) + (Y * (-0.010280)) + 642665.123540;  
Y = (X * 0.001673) + (Y * 0.304269) + 5341760.611935;  
Z = ((Z - 3000) * .3048) ;  
}
```

Horne\_UTM2Mine.pscript

```
{  
# Note : Some data sets have added Z offset of + 5000 meters used by Noranda and Xstrata Copper from 2005 - 2010  
X = (X * 3.301249) + (Y * ( 0.111643)) - 2717965.988314;  
Y = (X * -0.018112) + (Y * 3.285906) - 17540882.914249;  
Z = (Z * 3.2808) + 3000 ;  
}
```

### Method 2

Noranda - Xstrata Depth conversion to meters (5000 M custom)

$$Z_m = (Z_f + 3540.5) / 3.2808$$

Noranda - Xstrata Depth conversion Meters to feet

$$Z_f = (Z_m * 3.2808) - 3540.5$$

Noranda\_Depth\_Feet\_to\_Meters.pscript

```
{  
Z = (Z + 3540.5) / 3.2808 ;  
}
```

Noranda\_Depth\_Meters\_to\_Feet.pscript

```
{  
Z = (Z * 3.2808) - 3540.5 ;  
}
```

Horizontal Conversion:

Horne Mine XY conversion Geometric Transformation Method

Based on 4 point reference links using Affine Transformation in ArcMap 9.2

XY reference features established using Infrastructure\_3D feature class.

Gocad transformation equations calculated with Python program (./3d/scripts/

Transform\_Horne2UTM.py) developed by Jarno Elonen <elonen@iki.fi> in 2007 and based on

Paper "Fitting affine and orthogonal transformations between two sets of points, by Helmuth Späth (2004).

Control Points in Horne\_Control\_Mine2UTM\_2011.txt

```
"PointID","Mine_X","Mine_Y","UTM_X","UTM_Y"
1,16845.571141,14554.433654,647617.601212,5346217.102600
2,17164.440502,14427.485791,647714.596195,5346179.345290
3,17598.666779,14755.922777,647843.517151,5346279.702960
4,17200.573659,14953.387626,647720.269157,5346339.369500
```

Table A1 - Horne Mine Shaft locations X,Y in UTM Zone 17 NAD83. With Elevations for start and finish depths in meters and feet. See Horne\_Shfts.prj Gocad file for 3D reference and raw data with calculations in ./topo/ HorneShafts\_2013.xls.

Shaft	X	Y	ElevFt	DepFt	ElevM	DepM
No1	647758.4	5346157.3	13913.05	13588.67	5319.85	5220.98
No2	647518.3	5346391.8	13941.00	13808.00	5328.37	5287.83
No3	647747.6	5346207.7	13913.05	11162.51	5319.85	4481.48
No4	647620.4	5346487.7	13934.96	10840.96	5326.53	4383.47
No5	647519.3	5346447.5	13933.43	9839.37	5326.06	4078.19
No6	648026.5	5346391.4	10919.50	7873.71	4407.41	3479.06
No7	647622.5	5346272.6	12051.17	11156.97	4752.35	4479.79
No8	647912.5	5346406.8	7873.71	5874.00	3479.06	2869.55

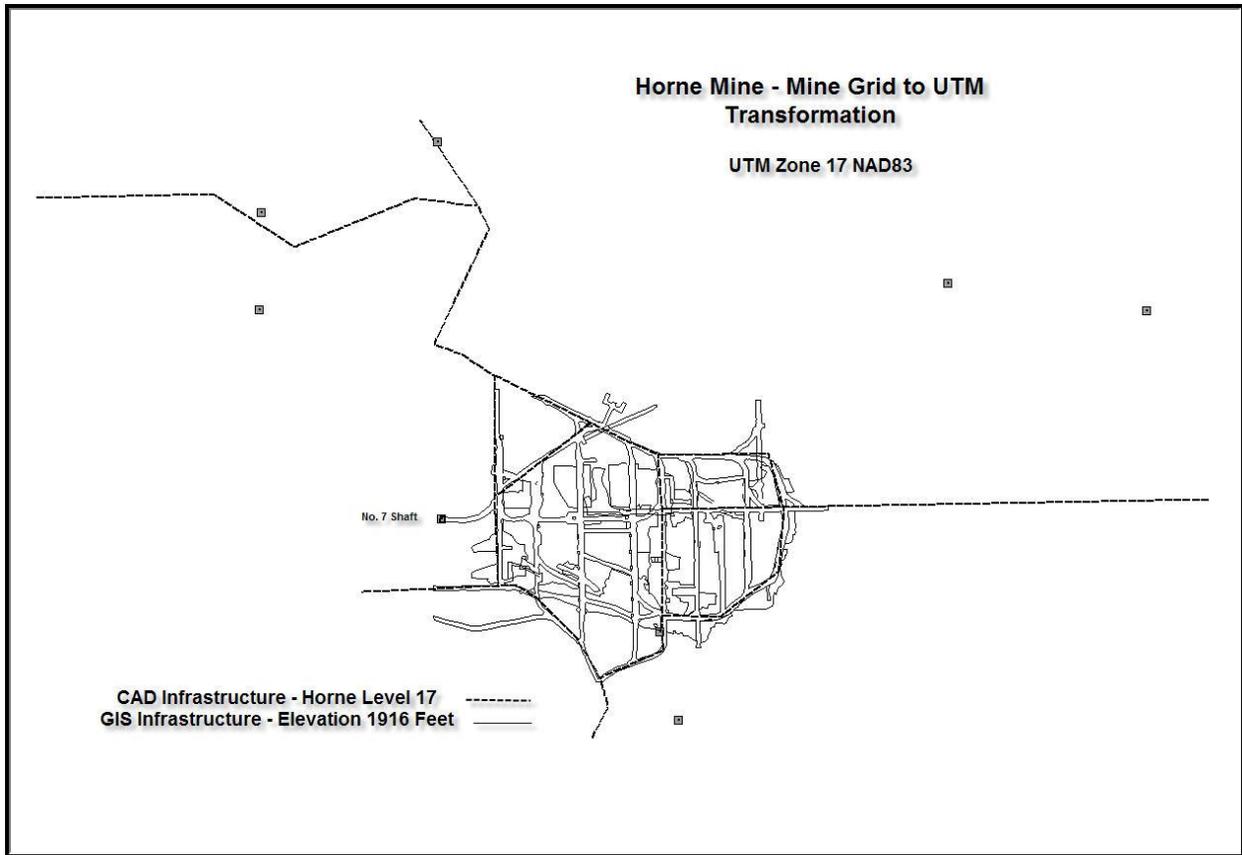


Figure A1 - Location of infrastructure used to co-register historical data in Horne Mine Grid to Noranda / Xstrata CAD files in UTM.

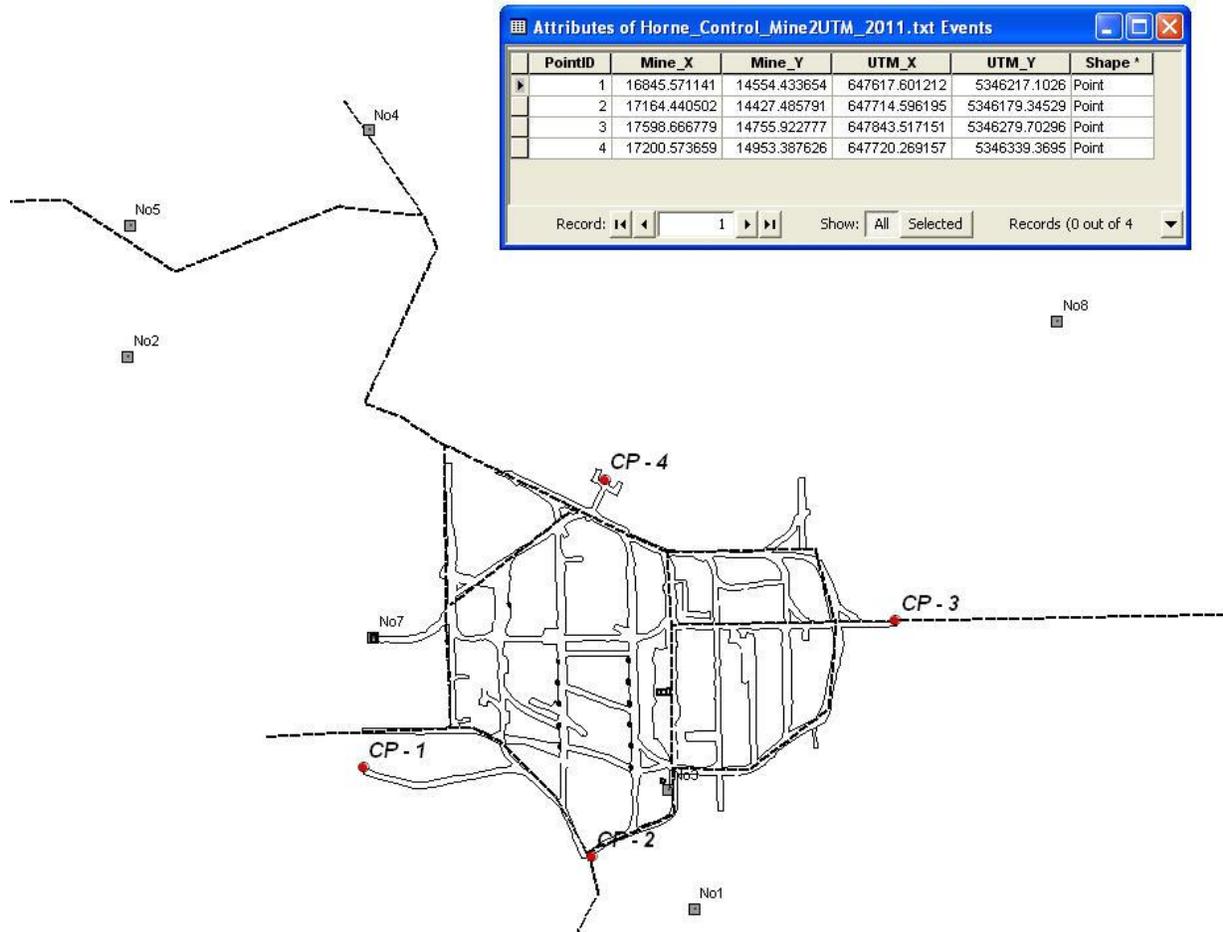


Figure A2 - Location of 4 control points (CP - 1,2,3,4) on Level 17 used to establish affine transformation relative to Horne Mine infrastructure. Transformation from HMG to UTMZ17NAD83, shafts labeled (No1-8).

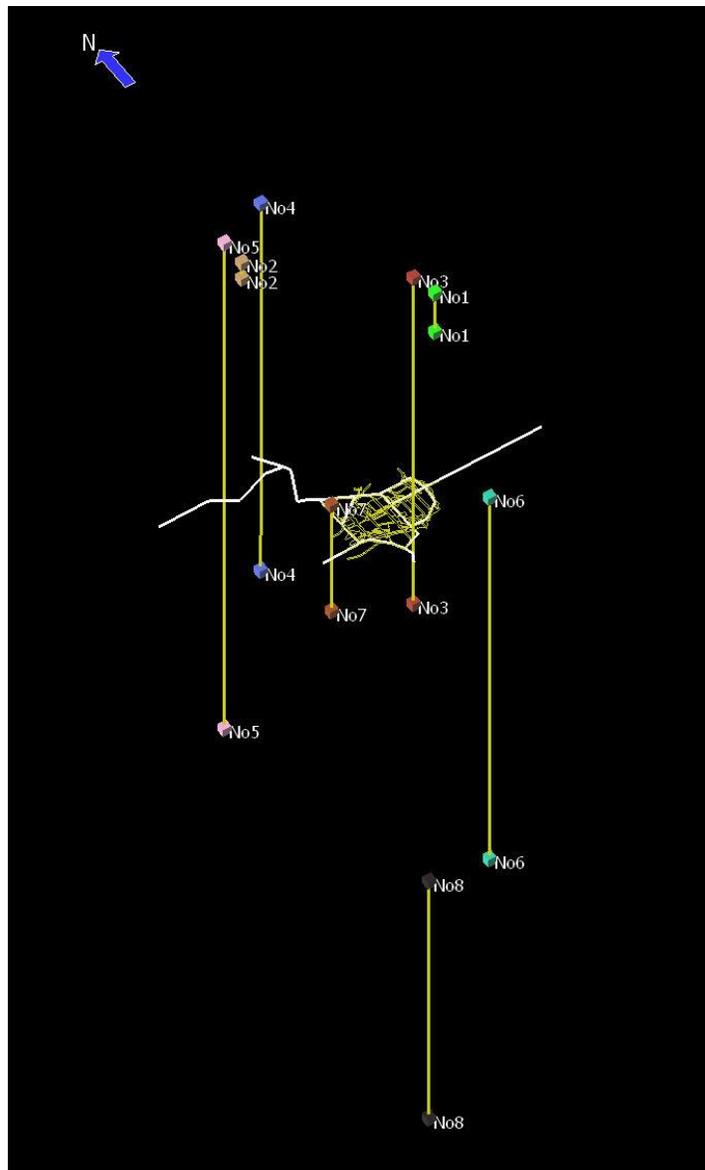
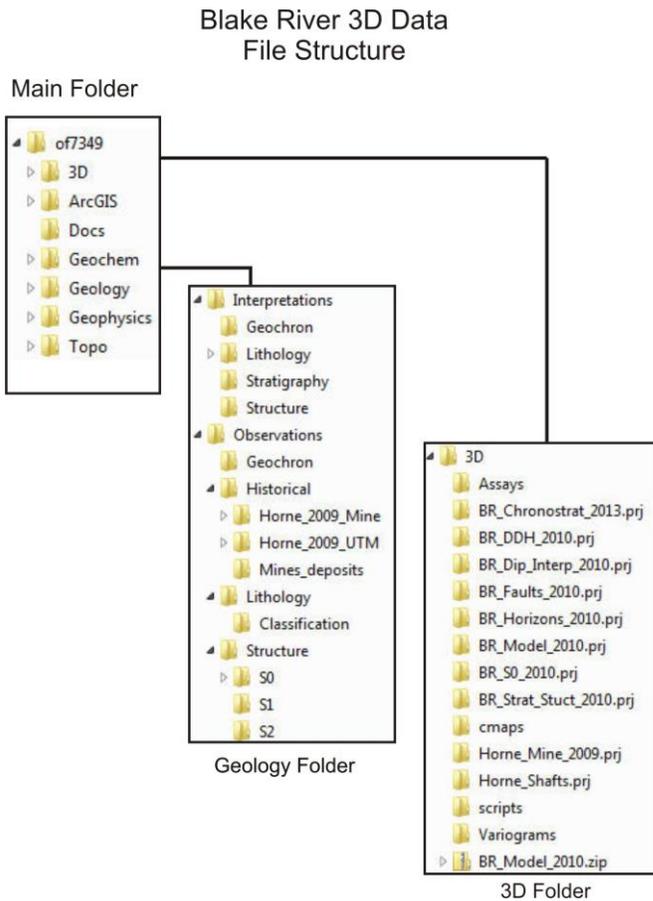


Figure A3 - 3D representation of Horne Mine shafts from gocad file Horne\_Shafts.prj (UTM Z17 NAD83) showing reference infrastructure layers from Noranda / Xstrata data. See Gocad property scripts for conversions.

## APPENDIX 3 Detailed Database Descriptions



### Microsoft Access Databases

<u>Database</u>	<u>File Location</u>
BR_2013.mdb	.\of7349\Geology\Observations\Lithology
XSTRATA_DD_H.mdb	.\of7349\Geology\Observations\Lithology
BR_2010_S0.mdb	.\of7349\Geology\Observations\Structure\S0\
Horne_Geochem_2013.mdb	.\of7349\Geochem\Observations

#### **BR\_2013.mdb**

Regional Blake River Group, Québec drill hole data base from public sources primarily E-Sigeom

#### **BR\_DD\_H\_COL**

Blake River Group table containing 3D (X,Y,Z) location for each drill hole in UTM coordinates

**HOLEID** - Unique ID for each drill hole (primary key)

**X** - UTM, Zone 17 NAD83 Easting location of drill hole collar (meters)

**Y** - UTM, Zone 17 NAD83 Northing location of drill hole collar (meters)

**Z** - Z elevation location of drill hole collar from DEM or converted Horne Mine Coordinates (meters)

**LENGTH** - Down hole distance (meters) from start of hole to end.

### **BR\_DDH\_DEV**

Blake River Group table containing drill deviation information measured at increments along the hole

**HOLEID** - Unique ID for each drill hole (primary key)

**DISTANCE** - Logged down hole distance (meters) for hole orientation measurement

**AZIMUTH** - Logged angle (degrees) in the horizontal plane, clock wise from north = 0

**DIP** - Logged angle (degrees) between horizontal and hole trajectory, measured in vertical plane

### **BR\_DDH\_LITH**

Blake River Group table containing lithologic descriptive information

**OBJECTID** - DBASE auto number counter for indexing

**GeoObservID** - Object identifier used in ArcGIS to link spatial features and descriptive tables.

**HOLEID** - Unique ID for each drill hole (primary key)

**FROM** - Start of interval (meters)

**TO** - End of interval (meters)

**LENGTH** - Length of segment (TO minus FROM)

**LITHOLOGY** - Raw Sigeom descriptive codes

**Domain** - Structure domain or sub-region

**LithCode4** - Working highest level descriptive lithology code

**L1** - Principal lithology descriptive code

**L2** - Secondary lithology descriptive code

**L3** - Tertiary lithology descriptive code

**T1** - Principal textural descriptive code

**T2** - Secondary textural descriptive code

**T3** - Tertiary textural descriptive code

**Mineralize** - Presence (1) or absence (0) of mineralization

**LithclassBR** - Blake River Group regional compilation lithology class

Lithology Classification code for field **LithClassBR** :

<b>FF</b>	=	Felsic Flow
<b>FLT</b>	=	Felsic Lapilli Tuff
<b>FTB</b>	=	Felsic Tuff Breccia
<b>MILT</b>	=	Mafic to Intermediate Lapilli Tuff
<b>MITB</b>	=	Mafic to intermediate Tuff Breccia
<b>MIV</b>	=	Mafic to Intermediate metavolcanics
<b>Other</b>	=	non-volcanic and volcanic clastic rocks
<b>XORE</b>	=	Exhalite or local sulphide mineralized rocks

See full lithology reclassification matrix in: .\of7349\Geology\Observations\Lithology\Classification\LithologyClassification.xls  
As well as Microsoft Access database: .\of7349\Geology\Observations\Lithology\Classification\Classification\_DDH.mdb In table  
LithologyClassification.

**LithcodeBR** - Blake River Group regional compilation lithology class code

**OCCCount** - Outcrop lithology code occurrence count for unique lithologies

**DDHCount** - Drill hole lithology code occurrence count for unique lithologies

**SigeomCode** - Code from E-Sigeom describing lithology (See table Sigeom in BR\_Stratigraphy)

### **XSTRATA DDH.mdb**

Regional Blake River Group, Québec drill hole data base from private sources primarily Xstrata Copper Canada.

#### LithologyClassification

Hierarchical classification applied to Blake River VMS camp in 2009 for re-classification

**ID** - DBASE auto number

**LithClassBR** - General Blake River compilation class

**LithCodeBR** - General Blake River compilation code

**LithoClass1** - Most general lithology class

**LithoCode1** - Most general lithology code

**LithoClass2** - second most general lithology class

**LithoCode2** - second most general lithology code

**LithoClass3** - second most detailed lithology class

**LithoCode3** - second most detailed lithology code

**LithoClass4** - finest lithology class

**LithoCode4** - finest lithology code

**OCCCount** - Outcrop lithology code occurrence count for unique lithologies

**DDHCount** - Drill hole lithology code occurrence count for unique lithologies

**SigeomCode** - Code from E-Sigeom describing lithology (See table Sigeom in BR\_Stratigraphy)

**Xstrata** - raw code passed from Xstrata

#### **SigCodes**

Lithology look-up table provided by E-Sigeom

**Code** - Lithology abbreviation code

**Lithology** - description of lithology in English

#### **Sigeom Texture**

Textural look-up table provided by E-Sigeom

**Code** - Lithology abbreviation code

**Texture** - description of textural feature in English

### **Xstrata\_COL**

Blake River Group table containing 3D (X,Y,Z) location for hole in UTM coordinates Xstrata Data

**HOLEID** - Unique ID for each drill hole (primary key)

**X** - UTM, Zone 17 NAD83 Easting location of drill hole collar (meters)

**Y** - UTM, Zone 17 NAD83 Northing location of drill hole collar (meters)

**Z** - Z elevation location of drill hole collar from DEM or converted Horne Mine Coordinates (meters)

**LENGTH** - Down hole distance (meters) from start of hole to end

**Type** - Geology information availability

### **Xstrata\_DEV**

Blake River Group table containing drill deviation information at increments along the hole from Xstrata

**HOLEID** - Unique ID for each drill hole (primary key)

**AZIMUTH** - Logged angle (degrees) in the horizontal plane, clock wise from north = 0

**DIP** - Logged angle (degrees) between horizontal and hole trajectory, measured in vertical plane

**DISTANCE** - Logged down hole distance (meters) for hole orientation measurement

### **Xstrata\_LITH**

Blake River Group table containing lithologic descriptive information from Xstrata

**HOLEID** - Unique ID for each drill hole (primary key)

**FROM** - Start of interval (meters)

**TO** - End of interval (meters)

**LITHOLOGY** - Raw Sigeom descriptive codes

**LITHOCODE4** - Working highest level descriptive lithology code **LITHOCLASS**

**LITHOCLASSBR** - Blake River Group regional compilation lithology class

**LITHOCODEBR** - Blake River Group regional compilation lithology class code

### **BR 2010\_S0.mdb**

Planar bedding and flow contact orientation observations. See spatial geodata files for more complete compilation of other structural elements.

**ID** - Database auto number for indexing

**PROJECTION** - Coordinate system

**TYPE** - geometric element, planar, linear site

**AZIMUTH** - Strike angle (Degrees Right Hand Rule), as measured from north = 0 clockwise (0-360)

**DIPLUNGE** - dip angle (Degrees), perpendicular to strike measured in vertical plane to horizontal

**FEAT\_FR** - description of structural element in French

**FEAT\_EN** - description of structural element in English

**SOURCE** - company or institute that provided data

**OVERTURNED** - stratigraphic top information (0 = upright, 1 = overturned, -1 = unknown)

**DOMAIN** - Structural domain or fault block region

**X** - UTM, Zone 17 NAD83 Easting location observation (meters)

**Y** - UTM, Zone 17 NAD83 Northing location of observation (meters)

**Z** - Z elevation location of observation from DEM (meters)

### **Horne Geochem 2013.mdb**

3D Geochem data from Horne Mine and Central Camp region.

Reference (Grunsky 2008, Taylor et al. in press, Hillary and Grunsky 2010)

### **CC Collar 2011**

Table containing 3D (X,Y,Z) location information for each drill hole in UTM coordinates\_Central Camp region.

**HOLEID** - Unique ID for each drill hole (primary key)

**X** - UTM, Zone 17 NAD83 Easting location of drill hole collar (meters)

**Y** - UTM, Zone 17 NAD83 Northing location of drill hole collar (meters)

**Z** - Z elevation location of drill hole collar from DEM or converted Horne Mine Coordinates (meters)

**LENGTH** - Down hole distance (meters) from start of hole to end.

### **CC Survey 2011**

Table containing drill deviation information measured at increments along the hole.

**HOLEID** - Unique ID for each drill hole (primary key)

**DISTANCE** - Logged down hole distance (meters) for hole orientation measurement

**AZIMUTH** - Logged angle (degrees) in the horizontal plane, clock wise from north = 0

**DIP** - Logged angle (degrees) between horizontal and hole trajectory, measured in vertical plane

### **Horne Collar 2011**

Table containing 3D (X,Y,Z) location information for each drill hole in UTM coordinates Near Horne Mine.

**HOLEID** - Unique ID for each drill hole (primary key)

**X** - UTM, Zone 17 NAD83 Easting location of drill hole collar (meters)

**Y** - UTM, Zone 17 NAD83 Northing location of drill hole collar (meters)

**Z** - Z elevation location of drill hole collar from DEM or converted Horne Mine Coordinates (meters)

**LENGTH** - Down hole distance (meters) from start of hole to end

### **Horne Survey 2011**

Table containing drill deviation information measured at increments along the hole.

**HOLEID** - Unique ID for each drill hole (primary key)

**DISTANCE** - Logged down hole distance (meters) for hole orientation measurement

**AZIMUTH** - Logged angle (degrees) in the horizontal plane, clock wise from north = 0

**DIP** - Logged angle (degrees) between horizontal and hole trajectory, measured in vertical plane

### **Horne WR**

3D Whole rock data for Noranda Central Camp region. Data courtesy of Xstrata 2010.

**STUDY** - informal study name of data region.

**CLASS** - General felsic and mafic categories used in O18 study by Taylor et al. in press with classification field of Jensen 1976. Compositional fields 8 and 11 (dacitic rocks), and 9 and 12 (rhyolitic rocks), represent the 'felsic'. Fields 7 and 10 the 'mafic' group designation.

(See source data from Hillary, E M and Grunsky, E. C., 2010 and classification of Jensen 1976)

**ACMT ... WOLL** - Lab Analysis and Normative mineral calculation fields provided by Grunsky 2009.  
Values in Wt%.

**JENTYP** - Jensen (1976) field class number

**CNDM** - Normative Corundum value

**RSIAL** - Ratio of SiO<sub>2</sub> and Al<sub>2</sub>O<sub>3</sub>

**COORD** - Coordinate system and projection

**X** - UTM, Zone 17 NAD83 Easting location of sample (meters)

**Y** - UTM, Zone 17 NAD83 Northing location of sample (meters)

**Z** - Z elevation location of sample from DEM or drill hole (meters)

### **O18 Data 2012**

Oxygen Isotope analysis compiled from study done by Taylor et al. (in press)

**LABNO** - Internal lab number

**Sample\_No** - Specific sample ID

**ADDATE** - Date included in the study

**HOLEID** - Unique hole identifier for sample

**INTERVAL\_F** - Interval collected in feet

**Type** - Physical sample type; surface traverse, subsurface sample from drill core

**O18** - Oxygen isotope values

**Depth** - along drill path distance from start of collar to sample in meters

**DepthFT** - along drill path distance from start of collar to sample in feet

**Source** - Sample origin

**Quality** - general quality of analysis, not updated

**X** - UTM, Zone 17 NAD83 Easting location of sample (meters)

**Y** - UTM, Zone 17 NAD83 Northing location of sample (meters)

**Z** - Z elevation location of sample from DEM or drill hole (meters)

**Notes** - general information on location, descriptions of material, rock type, alteration

**REFERENCE** - Publication reference for data used from previous studies

## Appendix 4 Geospatial Data Bases

All geospatial files are viewable in ArcScene and ArcGIS - ESRI®

**File location -**  
**Spatial feature sets - description**  
**Field Listings - select data sets only**

### Regional Blake River Group - (Québec)

#### Location of 2D and 3D Maps:

.\of7349\ArcGIS

**BR\_Data\_2013.mxd** - Regional overview of observational data

**BR\_Data\_2013.sxd** - Regional 3D view of select data sets

**Horne\_Data\_2013.sxd** - Geology and assays, Horne Mine Upper and Lower UTM NAD83 Z17

**Horne\_Vertical\_Conversion.sxd** - Horne mine to UTM grid conversion control points

.\of7349\ArcGIS\Layers location of layer files for map symbolization control

#### Mineralization & Geochemistry:

.\of7349\Geochem\Observations

**BR Metals CUPbZnAu** - Summary of metal showings

**Export Cugt2p** - Example exported locations of high (> 2 percent) Copper values

**Major 2009** - Major whole rock oxide analysis 3D locations and values

**O18 2011** - Oxygen isotope analysis 3D locations

.\of7349\Geology\Observations\Historical\Mines\_deposits

**BR VMS** - Summary of VMS deposits with production information

**FID** - Spatial Feature ID

**Shape** - GIS feature class type

**ID** - Internal ID

**Easting** - UTM Zone 17 NAD83 meters

**Northing** - UTM Zone 17 NAD83 meters

**Elevation** - Above Mean Sea Level (meters) from DEM at surface

**OF6869ID** - ID to link with GSC Open File 6869 locations

**NAME** - Deposit historical name

**COUNTRY** - National boundary

**State\_Prov** - Name of Province

**CAMP** - Local mining region

**Orogen** - Metamorphic, structural event

**Latitude** - In decimal degrees

**Longitude** - In decimal degrees

**Class** - Logical classifier switch 1 and 0 for query purposes

**Type** - Volcanic type

**ORE\_mt** - Ore produced in millions of tons

**CU\_pct** - Copper weight percent

**PB\_pct** - Lead weight percent

**ZN\_pct** - Zinc weight percent

**AU\_gpt** - Gold grams per ton  
**AG\_gpt** - Silver grams per ton  
**AU\_tons** - Tonnage gold produced  
**ORE\_Age** - Age estimate in millions of years  
**SOURCE** - Reference for data source

## **Lithostratigraphy:**

.\of7349\Geology\Observations\Lithology

**BR\_OC\_2010\_3d** - Regional classified outcrop lithology data from all sources

**FID** - Spatial Feature ID  
**Shape** - GIS feature class type  
**ID** - Internal ID  
**X** - UTM Zone 17 NAD83 Easting meters  
**Y** - UTM Zone 17 NAD83 Northing meters  
**Z** - Elevation above mean sea Level (meters) from DEM at surface  
**Projection** - Coordinate system and projection  
**OC\_OCID** - Internal ID field from Sigeom  
**OC\_Status** - Internal tracking field  
**OC\_Domain** - Structural Domain or region  
**OC\_PC1** - First component abundance estimate percentage  
**OC\_L1** - First component lithology  
**OC\_T1** - First component texture  
**OC\_PC2** - Second component abundance estimate percentage  
**OC\_L2** - Second component lithology  
**OC\_T2** - Second component texture  
**OC\_PC3** - Third component abundance estimate percentage  
**OC\_L3** - Third component lithology  
**OC\_T3** - Third component texture  
**OC\_PC4** - Fourth component abundance estimate percentage  
**OC\_L4** - Fourth component lithology  
**OC\_T4** - Fourth component texture  
**OC\_Mineral** - Mineralization  
**OC\_Note** - Extra information  
**LD1** - Lithology description class 1  
**L1** - Lithology class 1 code  
**LD2** - Lithology description class 2  
**L2** - Lithology class 2 code  
**LD3** - Lithology description class 3  
**L3** - Lithology class 3 code  
**LD4** - Lithology description class 4  
**L4** - Lithology class 4 code  
**LD5** - Lithology description class 5  
**L5** - Lithology class 5 code  
**OCCount** - Outcrop lithology code occurrence count for unique lithologies  
**DDHCount** - Drill hole lithology code occurrence count for unique lithologies  
**SigeomCode** - Code from E-Sigeom describing lithology (See table Sigeom in BR\_Stratigraphy)  
**LithClassBR** - Blake River Group regional compilation lithology class  
**LithCodeBR** - Blake River Group regional compilation lithology class code

**BR\_DDH\_2010** - Drill path and attributes for Regional Blake River Group, Québec drill holes from public sources primarily E-Sigeom

**FID** - Spatial Feature ID

**Shape** - GIS feature class type

**OBJECTID** - DBASE auto number counter for indexing

**GeoObservID** - Object identifier used in ArcGIS to link spatial features and descriptive tables.

**HOLEID** - Unique ID for each drill hole (primary key)

**FROM** - Start of interval (meters)

**TO** - End of interval (meters)

**LENGTH** - Length of segment (TO minus FROM)

**LITHOLOGY** - Raw Sigeom descriptive codes

**Domain** - Structure domain or sub-region

**LithCode4** - Working highest level descriptive lithology code

**L1** - Principal lithology descriptive code

**L2** - Secondary lithology descriptive code

**L3** - Tertiary lithology descriptive code

**T1** - Principal textural descriptive code

**T2** - Secondary textural descriptive code

**T3** - Tertiary textural descriptive code

**Mineralize** - Presence (1) or absence (0) of mineralization

**LithclassBR** - Blake River Group regional compilation lithology class

Lithology Classification code for field **LithClassBR** :

<b>FF</b>	=	Felsic Flow
<b>FLT</b>	=	Felsic Lapilli Tuff
<b>FTB</b>	=	Felsic Tuff Breccia
<b>MILT</b>	=	Mafic to Intermediate Lapilli Tuff
<b>MITB</b>	=	Mafic to intermediate Tuff Breccia
<b>MIV</b>	=	Mafic to Intermediate metavolcanics
<b>Other</b>	=	non-volcanic and volcanic clastic rocks
<b>XORE</b>	=	Exhalite or local sulphide mineralized rocks

See full lithology reclassification matrix in: .\of7349\Geology\Observations\Lithology\Classification\LithologyClassification.xls

As well as Microsoft Access database:

.\of7349\Geology\Observations\Lithology\Classification\Classification\_DDH.mdb

In table LithologyClassification

**LithcodeBR** - Blake River Group regional compilation lithology class code

**OCCount** - Outcrop lithology code occurrence count for unique lithologies

**DDHCount** - Drill hole lithology code occurrence count for unique lithologies

**SigeomCode** - Code from E-Sigeom describing lithology (See table Sigeom in BR\_Stratigraphy)

**BR\_Collars\_2008** - Drill hole collar locations in UTM Zone 17 NAD83 Sigeom derived data

**XSTRAT\_Collars\_2010** - Drill hole collar locations in UTM Zone 17 NAD83 XSTRATA derived data

**XSTRATA\_Path\_2010** - Calculated geometry of drill path from XSTRATA

**XSTRATA\_DDH\_2010** - XSTRATA lithologic descriptive information and classification

**BR\_3D\_V1** - Selection of felsic volcanic regional lithologies (Sigeom code equivalent V1)

**BR\_Interp\_V1** - Generalization of felsic volcanic centres from BR\_3D\_V1

## Geochronology:

.\of7349\Geology\Observations\Geochron

**BR\_Geochron\_2013** - location and table of U/Pb geochronology data

.\of7349\Geology\Interpretations\Geochron

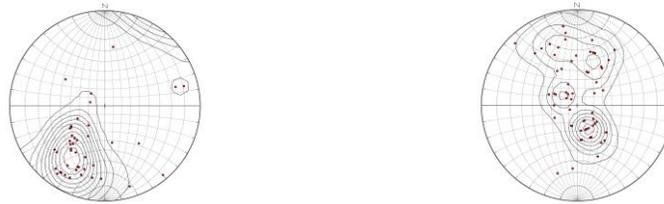
**Chronostratigraphic Marker** - Estimations of age equivalent stratigraphic horizon traces

**BR\_ICM\_2010.mx** - Estimations of age equivalent stratigraphic horizon traces Gocad file

## Structural Data: (Compiled from E-Sigeom)

**BR\_Domains** - Structural domains or regions representing regional scale fault blocks with common internal structural - stratigraphic characteristics. See Structural stereographic plots in .\of7349\Geology\Observations\Structure\S0\plots

(See figure 5 in main text for Domain Map).



**Figure A3** - Example of contrasting structural domains: lower hemisphere plots of poles to S0 for Central Domain (left) and Ouest Domain (right).

**3d Regional Faults** - Compiled regional faults from E-Sigeom

**BR\_S0\_3D** - Planar structural elements for primary deposition; bedding, flow contacts

**FID** - Spatial Feature ID

**Shape** - GIS feature class type

**PROJECTION** - Coordinate system

**X** - UTM, Zone 17 NAD83 Easting location observation (meters)

**Y** - UTM, Zone 17 NAD83 Northing location of observation (meters)

**Z** - Z elevation location of observation from DEM (meters)

**TYPE** - geometric element, planar, linear site

**AZIMUTH** - Strike angle (Degrees Right Hand Rule), as measured from north = 0 clockwise (0-360)

**DIPLUNGE** - dip angle (Degrees), perpendicular to strike measured in vertical plane to horizontal

**FEAT\_FR** - description of structural element in French

**FEAT\_EN** - description of structural element in English

**SOURCE** - company or institute that provided data

**OVERTURNED** - stratigraphic top information (0 = upright, 1 = overturned, -1 = unknown)

**DOMAIN** - Structural domain or fault block region

**BR S1 3D** - Planar structural elements for first generation overprinting cleavage

**BR S2 3D** - Planar structural elements for second generation overprinting fabric (can be fracture sets, locally distributed)

**S0 Trace** - Interpretive map trace and the trajectory of S0.

**S1 Trace** - Interpretive map trace and the trajectory of S1.

**S2 Trace** - Interpretive map trace and the trajectory of S2.

**Tops** - Trajectory of depositional tops, perpendicular to S0.

**Fold Trace** - Map trace of significant fold structure axial surface and topography intersection.

**Fault Dip Interpretation** - Estimates of local planar dip of regional faults from 3d\_Regional\_Faults. Based on consultation of geoscience experts from the region.

## **Geophysics:**

.\of7349\Geophysics\Seismic (see Gocad project files for actual seismic profiles in BR\_Seismic\_2013.gprj)

**Seis\_L21plus** - Deep seismic profile from Lithoprobe, Line 21. (Processed by Perron and Calvert 1998)

**Seis\_Ribigo** - High Resolution 2D seismic profile processed by GSC TGI3 - Abitibi project. See Belfeur for details.

**Seis\_Amul** - High Resolution 2D seismic profile processed by GSC TGI3 - Abitibi project. (See Bellefleur et al. 2013, 2007 for details)

.\of7349\Geophysics\Magnetics

Total field magnetic and derived products already published from GSC Open files or posted on public sites.

**Ab\_MT\_mag** - Abitibi gridded Mega Tem derived magnetics by Pierre Keating GSC 2008, 50 m cell size

**BR\_mt\_mag** - Local BR region total field magnetic data aquired during Mega TEM survey. 50 m cell size

**BR\_mt\_mags** - BR region shaded relief image of total field magnetics from MT survey, 50 m cell size

**Blake\_mag** - Local BR region regional gridded total field magnetic data courtesy of GSC Geophysical data centre, 100 m cell size.

**Blake\_shad** -BR region shaded relief image of regional total field magnetics, 100 m cell size.

**Abitibi\_mag** - Abitibi sub-province regional total field magnetics data courtesy of GSC Geophysical data centre, 100 m cell size.

**Abitibi\_mags** - Abitibi sub-province shaded relief of total field magnetics data courtesy of GSC Geophysical data centre, 100 m cell size.

.\of7349\Geophysics\Gravity

Gravity and derivative produces (see Jobin, Dion, and Keating 2008 for detailed information)

**BR\_Regional\_grav.tif** - Georeferenced gridded Regional Bouguer Anomaly image, GSC Geophysical Data Centre 250 m cell size

**BR\_worms.dat** - collections of upward continued point maxima of the potential field gradient

**Gravity\_Stations** - location of observation sites for gravity survey to produce of5981

**of5981\_2v** - Second vertical derivative of the bouguer anomaly map.

**of5981\_grav** - Blake River Group, bouguer anomaly map 100 m cell size.

**of5981\_shad** - Shaded relief image of gravity , bouguer anomaly map

### **Reference Data:**

**Study Area** - Blake River Group, Québec study region footprint.

**BR 2013 Extents** - Corner points for the Blake River Group, Québec study region

**Towns** - Cultural information, location and population of towns in the study area.

**BR Lakes** - Hydrographic reference for the study area

**BR Roads** - Road network through the region, urban and rural roads.

### **Topographic:**

**Blake\_dem** - CDED derived topographic data used to level observation data sets.

### **Local Horne (Upper & Lower ) Mine (Noranda, Québec)**

.\of7349\Geology\Observations\Historical

Horne\_Control\_Mine2UTM\_2011.txt - Control points used for transformation

Horne\_Shifts\_UTM\_NAD83\_2009 - Location of shafts Horne Mine

Level4\_Adjusted2UTM\_Xstrata\_2009 - Test plan for transformation

Level17\_Adjusted2UTM\_Xstrata\_2009 - Test plan for transformation

.\of7349\Geology\Observations\Historical\Mines\_deposits

Various sets of deposit sites from E-Sigeom and from P. Mercier-Langevin

.\of7349\Geology\Observations\Historical\Horne\_2009\_Mine

Upper and Lower Horne Mine data in Mine Grid Coordinates

geoseries.gdb - Geodatabase for data sets

Shape files of other test level sets

.\of7349\Geology\Observations\Historical\Horne\_2009\_UTM

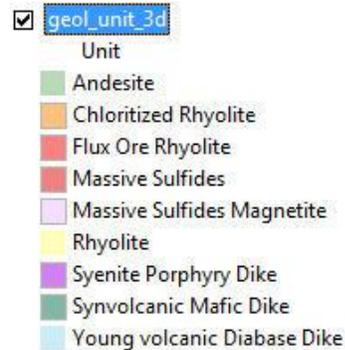
Upper and Lower Horne Mine data in UTM Zone 17 NAD83 Grid Coordinates

geoseries.gdb - Geodatabase for data sets

Shape files of other test level sets

.\of7349\ArcGIS  
Horne\_Data\_2013.sxd - 3D Arcscene

Geol\_unit\_3d - Geology plan map (see below for legend)



Shape *	Shape_Length	Shape_Are	Shape_Leng	Z	Unit	Date_end	Date_start	Certainty	scan_name	ID	ZMeters	ZFeet
Polygon Z	2.11876	0.221329	7.025028	-482.8032	Md	1974	1954	yes	1416_21_Levelplan_a	4026	-482.8032	1416
Polygon Z	3.308583	0.534604	10.980952	-482.8032	Md	1974	1954	yes	1416_21_Levelplan_a	4025	-482.8032	1416
Polygon Z	4.792071	1.508326	15.861867	-482.8032	Md	1974	1954	yes	1416_21_Levelplan_a	4020	-482.8032	1416
Polygon Z	6.887174	0.916298	22.841537	-482.8032	Md	1974	1954	yes	1416_21_Levelplan_a	4024	-482.8032	1416
Polygon Z	6.999164	1.724144	23.195432	-482.8032	Md	1974	1954	yes	1416_21_Levelplan_a	4045	-482.8032	1416
Polygon Z	7.442696	2.439223	24.608917	-482.8032	Md	1974	1954	yes	1416_21_Levelplan_a	4044	-482.8032	1416
Polygon Z	8.813497	3.043552	29.26661	-482.8032	Md	1974	1954	yes	1416_21_Levelplan_a	4040	-482.8032	1416
Polygon Z	9.216389	2.902322	30.549755	-482.8032	Md	1974	1954	yes	1416_21_Levelplan_a	4028	-482.8032	1416
Polygon Z	11.08363	1.793148	36.547639	-482.8032	Md	1974	1954	yes	1416_21_Levelplan_a	4081	-482.8032	1416
Polygon Z	11.108422	2.52956	36.677935	-482.8032	Md	1974	1954	yes	1416_21_Levelplan_a	4030	-482.8032	1416

Figure A4: Geology classification for local historic mine plan maps and table of information for each polygon digitized.

MineOutline\_3d - Limit of model on local plan

Model\_outline\_3d - maximum plan extents of data and geology objects

Drill\_Hole\_3d - Drill paths with drilling dates

Fault\_3d - Fault traces

Geological\_contact\_3d - line work of geology contacts

Infrastructure\_3d - mine workings, drifts shafts, pillars

Sampled\_point\_3d - Assay locations for Cu and Au

Structure\_3d - Planar features; contacts, fault, bedding, flow orientations

Export\_Cugt2p - Example of high copper value 3D distribution greater than 2 percent

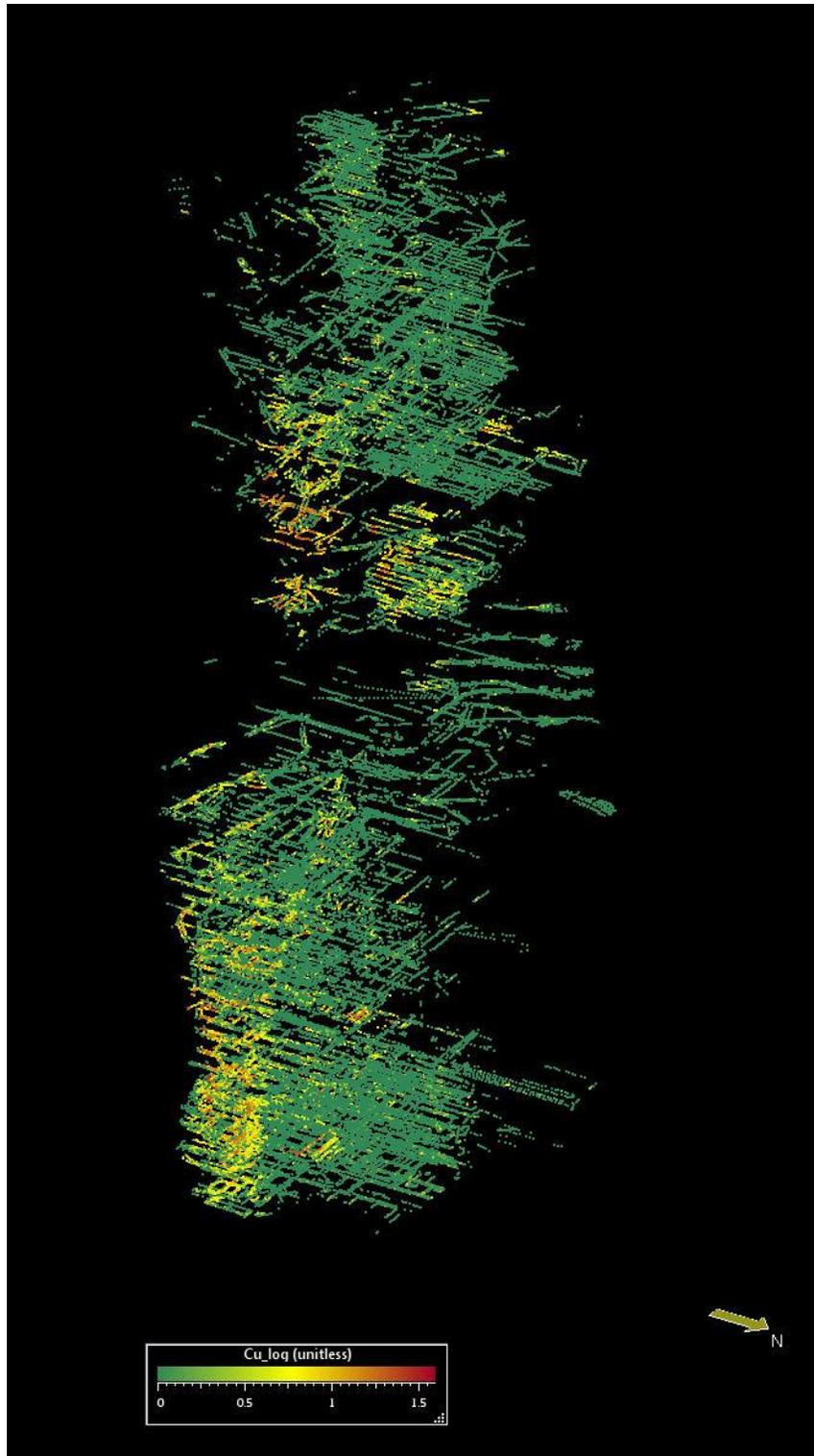


Figure A5 – Gocad / SKUA 3D snap shot of copper distribution in Upper and Lower Horne mine. Highest values are red and lower values are green.

## **Appendix 5**

### **Paradigm GOCAD/SKUA Projects and data files**

.\of7349\3D - Location of GOCAD and SKUA project files

#### **Gocad Projects:**

(ver. 2009.3.p with SPARSE, GIS3D in Mira Geoscience Mining Suite)

BR\_DDH\_2010 - Drill hole paths and with regional classifications

BR\_Dip\_Interp\_2010 - planar estimates from drill triangulation and modelled surfaces

BR\_Faults\_2010 - significant faults

BR\_Grav\_Mag\_2013 - Regional gravity and magnetics with modelled WORMS by Pierre Keating 2009.

BR\_Horizons\_2010 - 3D horizons including exhalites

BR\_S0\_2010 - Planar deposition observations, dip tablets

BR\_Seismic\_2013 - 2D profiles from lithoprobe and mine surveys

Horne\_Mine\_2009 - Horne Mine GRID 3D data and model

#### **SKUA Projects :**

(ver. 2009.3.p with SPARSE, GIS3D in Mira Geoscience Mining Suite)

BR\_Model\_2010 - General structural and stratigraphic elements (takes several minutes to load)

BR\_Strat\_Struct\_2010 - Calculated geologic grids model (example only)

BR\_Chronostrat\_2013 - 3D geochronology data

Horne\_Shafts - Reference locations for shafts used in coordinate transformations

## Lithology:

.\of7349\Geology\Observations\Lithology

ASCII Data files - \*.vs \*.pl for BRLithoClass of compilation

Lithology Classification used for suffix ie. \_FF :

<b>FF</b>	=	Felsic Flow
<b>FLT</b>	=	Felsic Lapilli Tuff
<b>FTB</b>	=	Felsic Tuff Breccia
<b>MILT</b>	=	Mafic to Intermediate Lapilli Tuff
<b>MITB</b>	=	Mafic to intermediate Tuff Breccia
<b>MIV</b>	=	Mafic to Intermediate metavolcanics
<b>Other</b>	=	non-volcanic and volcanic clastic rocks
<b>XORE</b>	=	Exhalite or local sulphide mineralized rocks

.\of7349\Geology\Observations\Lithology

3D Lithology points from Drill core-

BR\_2010\_FF.vs

BR\_2010\_FLT.vs

BR\_2010\_FTB.vs

BR\_2010\_Lithology.vs

BR\_2010\_MILT.vs

BR\_2010\_MITB.vs

BR\_2010\_MIV.vs

BR\_2010\_XAORE.vs

3D Lithology points from outcrop -

BR\_OC\_2010.vs

BR\_OC\_2010\_FF.vs

BR\_OC\_2010\_FLT.vs

BR\_OC\_2010\_FTB.vs

BR\_OC\_2010\_MILT.vs

BR\_OC\_2010\_MITB.vs

BR\_OC\_2010\_MIV.vs

BR\_OC\_2010\_XAORE.vs

3D Lithology Intervals from drill core -

Reclassified from E-Sigeom

BR\_DDH\_2010\_FF.pl

BR\_DDH\_2010\_FLT.pl

BR\_DDH\_2010\_FTB.pl

BR\_DDH\_2010\_MILT.pl

BR\_DDH\_2010\_MITB.pl

BR\_DDH\_2010\_MIV.pl

BR\_DDH\_2010\_XAORE.pl

Reclassified from Xstrata:

Xstrata\_FF\_2010.pl

Xstrata\_FLT\_2010.pl

Xstrata\_MILT\_2010.pl

Xstrata\_MITB\_2010.pl  
Xstrata\_MIV\_2010.pl  
Xstrata\_XAORE\_2010.pl

**Extra Support Files:**

.\of7349\3D\cmaps - colour maps for symbolizing objects

.\of7349\3D\scripts - projection and property processing scripts

.\of7349\3D\Variograms - various variograms used in modelling metal and lithology distributions

**Mineralization:**

.\of7349\Geochem\Observations\Assays

Assays.vs - Cu and Au point set Horne Mine Upper and Lower Mine

Assays.cmap - symbolization colour map