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Abstract: The geology of Clergue and Walker townships consists of folded mafic to felsic volcanic rocks of the 2718 to 2710 Ma Kidd-Munro assemblage-. A newly recognized marker horizon helps to outline the stratigraphy and internal folding in the Kidd-Munro synclinorium.

Volcanic stratigraphy is generally steeply dipping, east-west trending, and (sub)parallel to a regional S_2 cleavage that is axial planar to interpreted upright, isoclinal, doubly plunging F_2 folds that expose the Kidd-Munro assemblage in a regional synclinorium. Along the southern and northern flanks of this synclinorium, the Porcupine assemblage siltstone units young toward the Kidd-Munro volcanic rocks suggesting thrust contacts. The simplest interpretation of the structure, satisfying all observed younging directions, is that the southern and northern bounding faults of the Kidd-Munro assemblage are the same thrust surface that, together with the assemblage, was folded into a regional synclinorium. The identification of this folded thrust suggests that gold mineralization along the southern thrust may resurface along the northern exposure.

Résumé : La géologie des cantons de Clergue et de Walker est caractérisée par la présence de roches volcaniques mafiques à felsiques plissées de l'assemblage de Kidd-Munro datant de 2718 à 2710 Ma. La reconnaissance d'un nouvel horizon repère a aidé à mettre en évidence la stratigraphie et le plissement interne dans le synclinorium de Kidd-Munro.

Les strates volcaniques ont généralement un fort pendage, une direction est-ouest et sont (sub)parallèles à une schistosité régionale S_2, laquelle se situerait dans le plan axial de présumés plis P_2 droits isoclinaux à double plongement, qui exposent l'assemblage de Kidd-Munro dans un synclinorium régional. Le long des versants sud et nord de ce synclinorium, les unités de siltstone de l'assemblage de Porcupine vont des plus anciennes aux plus récentes vers les roches volcaniques de Kidd-Munro, laissant croire à l'existence de contacts de chevauchement. Selon la plus simple interprétation de la structure, qui concorde avec tous les indices de polarité observés, les failles bordières sud et nord de l'assemblage de Kidd-Munro font partie de la même surface de chevauchement qui a été plissée avec l'assemblage en un synclinorium régional. L'identification de ce chevauchement plissé permet de croire que la minéralisation aurifère présente le long du chevauchement sud pourrait rejoindre la surface à nouveau le long de la zone d'affleurement du chevauchement au nord.

INTRODUCTION

The study area is underexplored for base-metal mineralization, largely due to the fact that patented lands cover much of the area. However, the Pipestone Thrust host the Clavos Gold Mine owned by St. Andrew's Goldfields and the Montclerg gold property owned by Matamec Explorations Inc. Gold was first discovered at Clavos in 1946 and exploration has been ongoing ever since. The Clavos Gold Mine was in production from mid-2005 to August 2006, producing 98 125 tonnes with an average grade of 6.2 g/t Au. Gold was discovered on the Montclerg property in 1938, on the shores of Driftwood River. Following this discovery, exploration was carried out intermittently. Presently, Matamec Exploration is carrying out a drilling program to test lateral extension of mineralized structures.

Herein we report on the structural geometry and bounding relationships of the ca. 2718 to 2710 Ma Kidd-Munro assemblage of the Abitibi greenstone belt in Ontario. The 2007 field season consisted of mapping, sampling, and data collection in Clergue and Walker townships (Fig. 1). In Clergue and Walker townships field investigations focused on construction of a structural-stratigraphic section across the east-west-trending belt of the Kidd-Munro assemblage. Clergue and Walker townships are easily accessed from Timmins via Highway 101, east for approximately 40 km, and then north for 20 km via Highway 11. The area is intersected by multiple concession roads.

REGIONAL GEOLOGY

On the regional scale, the Kidd-Munro (2718–2710 Ma; Bleeker, 1999; Ayer et al., 2002) volcanic rocks in this area are bounded to the north by the sedimentary rocks interpreted to belong to the Porcupine assemblage (<2688 Ma; Bleeker and Parrish, 1996; Bleeker et al., 2008). These rocks, consisting of turbiditic greywacke and mudstone units, are exposed on the northeastern shore of Frederick House Lake (Fig. 1). To the south, Kidd-Munro volcanic rocks are in fault contact with the main belt of Porcupine assemblage greywacke (Fig. 1). Porcupine greywacke unitss and the structurally overlying Kidd-Munro volcanic rocks both young northwards, suggesting that this fault is an early thrust (Pipestone Thrust described by Bleeker et al., 2006).

In the study area, the Kidd-Munro assemblage consists predominantly of mafic volcanic rocks, locally interbedded with minor felsic volcanic rocks (Fig. 2). The volcanic rocks are intruded by subvolcanic mafic to ultramafic sills and late quartz-feldspar porphyry. North-south-trending mafic dykes of the Proterozoic Matachewan swarm cut across the entire area. All volcanic and intrusive rocks of the study area underwent low-grade regional metamorphism. For simplicity, we omit the prefix meta- in the remainder of this report.

STRATIGRAPHY OF CLERGUE AND WALKER TOWNSHIPS

Previous work in the area consists of field mapping, geophysics, and industry-based exploration projects. Carlson and Ginn (1965) and Berger (1997) published the latest most detailed maps of the area. In 2004, the Ontario Geological Survey (OGS) conducted an airborne geophysical survey (Fig. 3; OGS, 2004) that was used to help interpret the regional structure.

Mafic volcanic rocks

The geology of the area is dominated by mafic volcanic rocks with facies varying from pillowed to massive flows. The flows are generally aphyric, with colour varying from dark to medium green. Locally, mafic pillowed flows possess quartz-calcite amygdules. In the south of the study area, in the vicinity of the Pipestone Thrust, the amygdules are filled by quartz and chlorite (Fig. 4a), which imparts a black colour to the amygdules. Under the microscope, the mafic volcanic rocks are characterized by a fine-grained groundmass of chlorite, plagioclase, quartz, carbonate, and opaque minerals. In addition, slightly coarser, tabular plagioclase crystals (0.5 mm by 1 mm) also occur.

Within the mafic volcanic rocks, a marker horizon has been identified. It consists of a plagioclase-rich, glomeroporphyritic, mafic unit (Fig. 4b) with a lithofacies varying from massive to pillowed flows. Locally tuff-like flows with large phenocrysts were also observed. On weathered and fresh surfaces the unit is pale green and can be easily distinguished by clusters of plagioclase phenocrysts. The plagioclase phenocrysts vary in size from 0.5 to 1.5 cm and appear to be altered to light green epidote (saussuritized). Petrographic analysis shows large plagioclase phenocrysts are replaced by a fibrous growth of fine plagioclase with a sweeping extinction (Fig. 4c). This particular unit was traced in the field in three distinct east-west-trending segments, each with a strike extent of about 2 to 4 km (Fig. 2). We did not observe fold closures between these individual segments, but interpret the existence of such closures based on geophysical data.

Felsic volcanic rocks

Felsic volcanic rocks were observed interbedded within the dominant mafic volcanic rocks. They consist of thin flows, 5 to10 m in thickness, with lithofacies varying from massive flows to flow breccia (Fig. 4d, e). On the weathered surface, these rocks are pale grey to white; on a fresh surface, they appear dark greenish-grey to black. The felsic flows are characterized by an aphyric texture. The breccias are angular with clasts size varying from 1 to 15 cm. Petrographic analysis shows a fine-grained groundmass composed of quartz,

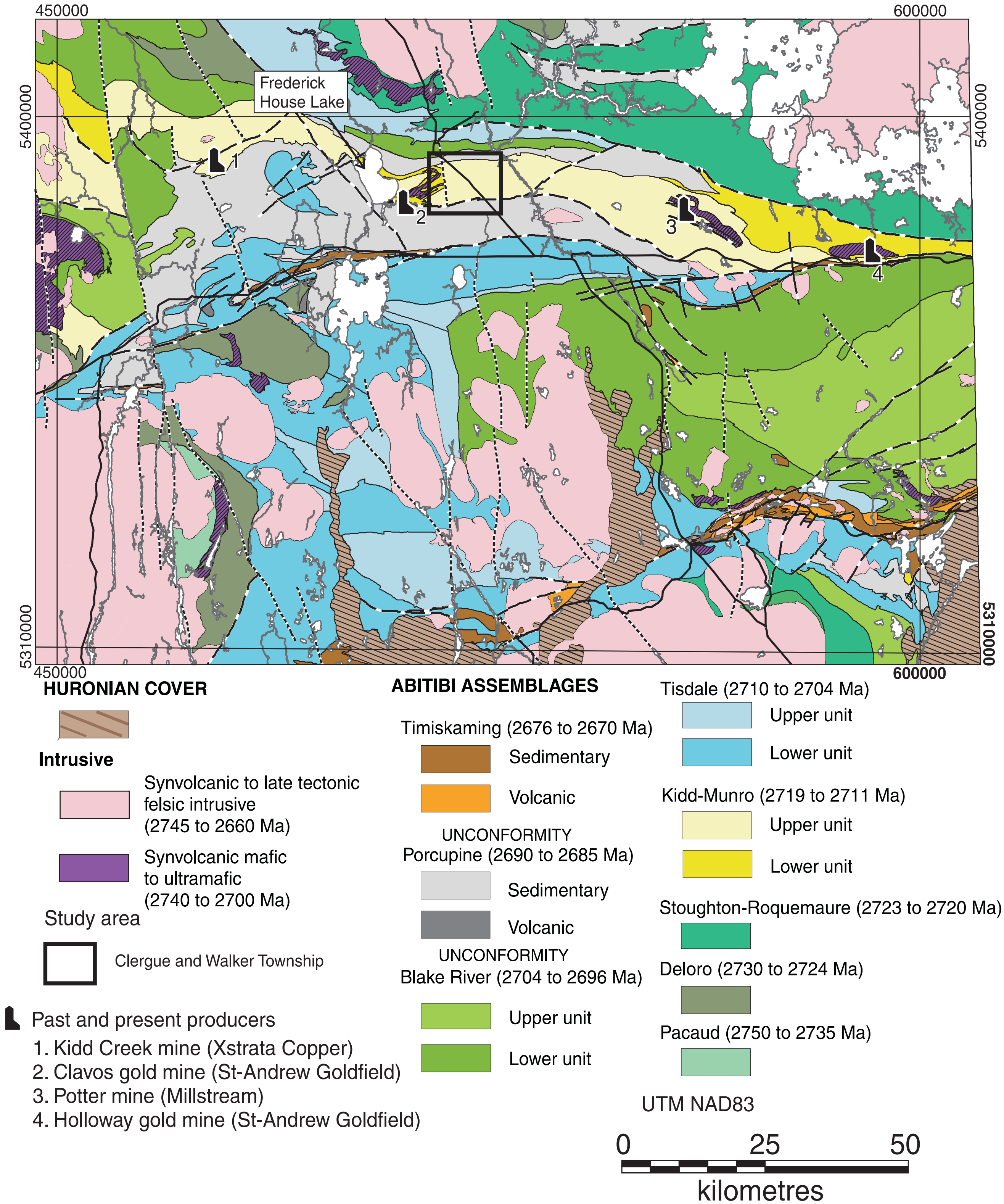

Figure 1. Tectono-stratigraphic map of the of the south-central Abitibi greenstone belt in Ontario, illustrating major assemblages and structures (from Ayer et al., 2005). The Clergue and Walker Township area is indicated by the black rectangle. Some past and present producers in the Kidd-Munro assemblage are also indicated.

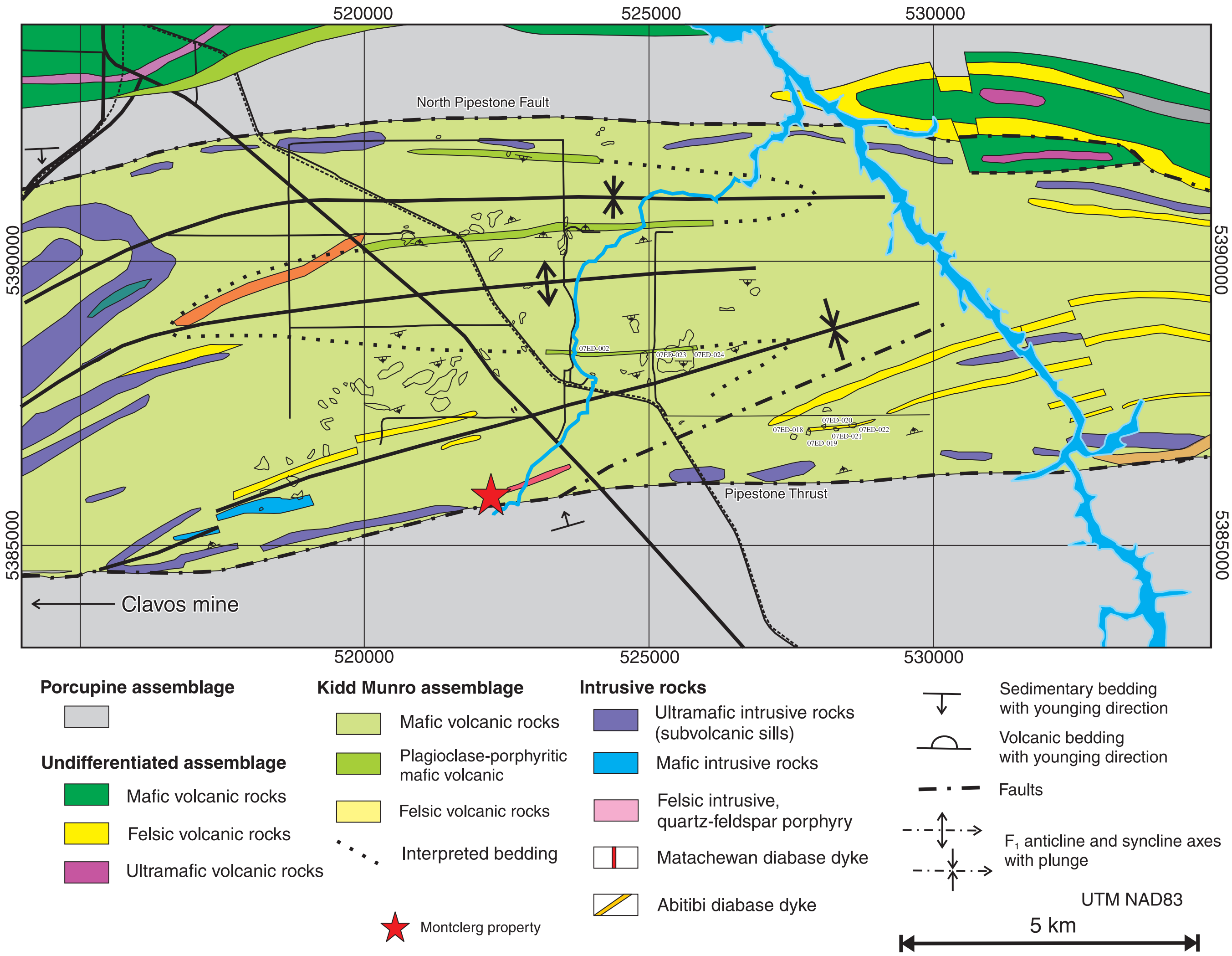

Figure 2. Second magnetic derivative map of Clergue and Walker townships area.

plagioclase, and muscovite, and larger quartz phenocryst (~2 mm) preserving primary crystal faces and embayment textures.

Intrusions

The stratigraphy is intruded by mafic sills, dykes, and metre- to kilometre-scale felsic intrusions. The mafic subvolcanic sills and dykes consist of a medium-grained equigranular groundmass of amphibole, chlorite, and plagioclase. The mafic sills could not be easily followed in the field. However, geophysical data suggest that they extend for 1 to 2 km along strike. The felsic intrusions consist of quartz-feldspar porphyry and appear localized near or in the Pipestone Thrust (Fig. 2).

STRUCTURAL GEOLOGY

Stratigraphic layering (S_0) in Clergue and Walker townships generally dips near-vertically while striking east-west (Fig. 5a). In the south, near the Pipestone Thrust, S_0 dips and youngs toward the north, as revealed by our field observations and by recent drilling at the Montclerg property (Fig. 2). The study area was affected by at least three deformation events (D_1 to D_3). The first event (D_1) consists of a thrusting displacement along the Pipestone Thrust, superposing the Kidd-Munro volcanic rocks on the sedimentary rock of the Porcupine assemblage, during a north-south compression regime. However, no fabric, kinematic indicator, or thrust sense were observed.

D_2 is manifested in the area by forming three major, upright folds (F_2); two major synclines and a central anticline (Fig. 2). The dominant D_2 event is defined by a near-vertical foliation (S_2) (*see* Fig. 5b) that is (sub)parallel to bedding (S_0). It trends west-southwest in southern Clergue Township and rotates to an east-west trend in northern Clergue and

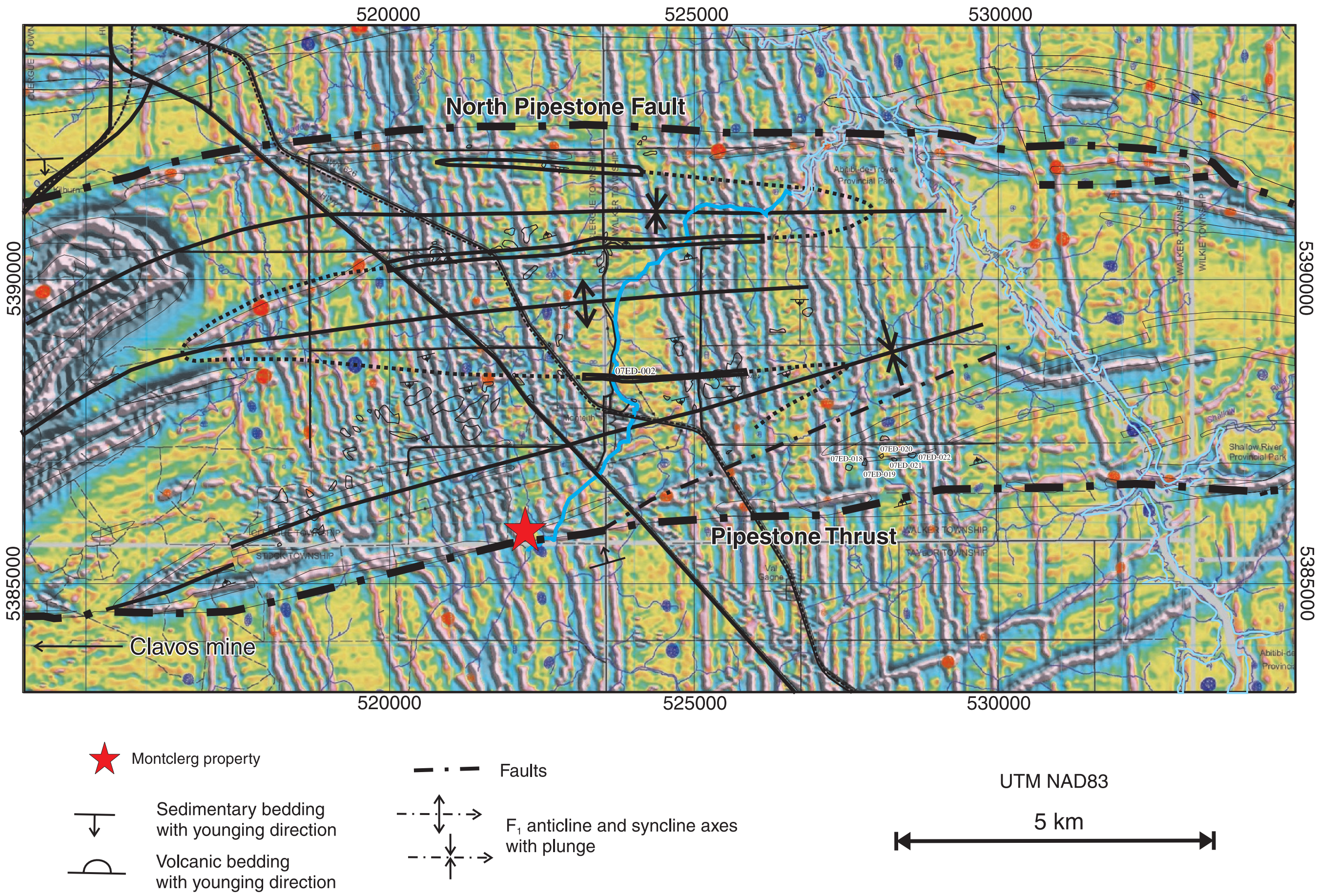

Figure 3. Geological map of Clergue and Walker townships area. In the poorly exposed northern parts of the area, generalized polygons are draped over a gradient magnetic map. Note the location of the Montclerg property (indicated by a red star).

Walker Townships. The intensity of S_2 varies and appears most intense near interpreted fold hinges (which we base on reversals in younging direction). Consequently, the S_2 foliation appears axial planar to the upright isoclinal F_2 folds. The axes of these macroscopic F_2 folds appear doubly plunging, varying from a steep west-southwesterly plunge in Clergue Township to a moderate easterly plunge in Walker Township (Fig. 2).

The third deformation (D_3) event is characterized by a weak S_3 vertical cleavage that trends north-northwest (Fig. 5c) and does not appear to be associated with folding in the study area. However, in the Porcupine gold mining camp and surrounding area, a similar cleavage forms a well known structural element, where it is commonly associated with asymmetric Z-shaped folds.

REGIONAL INTERPRETATIONS/ CONSIDERATIONS

In Clergue and Walker Townships, Kidd-Munro volcanic rocks overlie much younger turbidites of the Porcupine assemblage both along the North Pipestone Thrust and Pipestone Thrust. In southern Munro Township (40 km to the east) the same relationship has been observed in drill core and outcrops. Bleeker et al. (2006) interpreted this relationship as a major thrust, placing older Kidd-Munro volcanic rocks on top of younger Porcupine assemblage greywackes. This major fault structure has been named the Pipestone Thrust. This thrust likely extends all the way to the Kidd-Creek mine, where volcanic rocks hosting the giant Kidd-Creek massive sulphide deposit also structurally overlie younger Porcupine greywackes (Bleeker and Parrish, 1996). A similar relationship has now been observed on the northern shore of Frederick House Lake, in Dundonald Township (W. Bleeker, unpub. data) where south-facing volcanic rocks of the Kidd-Munro assemblage again overlie younger turbidites of the Porcupine assemblage.

Collectively these observations suggest that the entire Kidd-Munro assemblage overlies a folded thrust surface — the Pipestone Thrust — and sits structurally on top of younger Porcupine greywackes. After thrust emplacement, the Pipestone Thrust and structurally overlying Kidd-Munro volcanic rocks were folded into a regional synclinorium during ongoing deformation (Fig. 6). The Porcupine assemblage, and possibly the Tisdale-Deloro

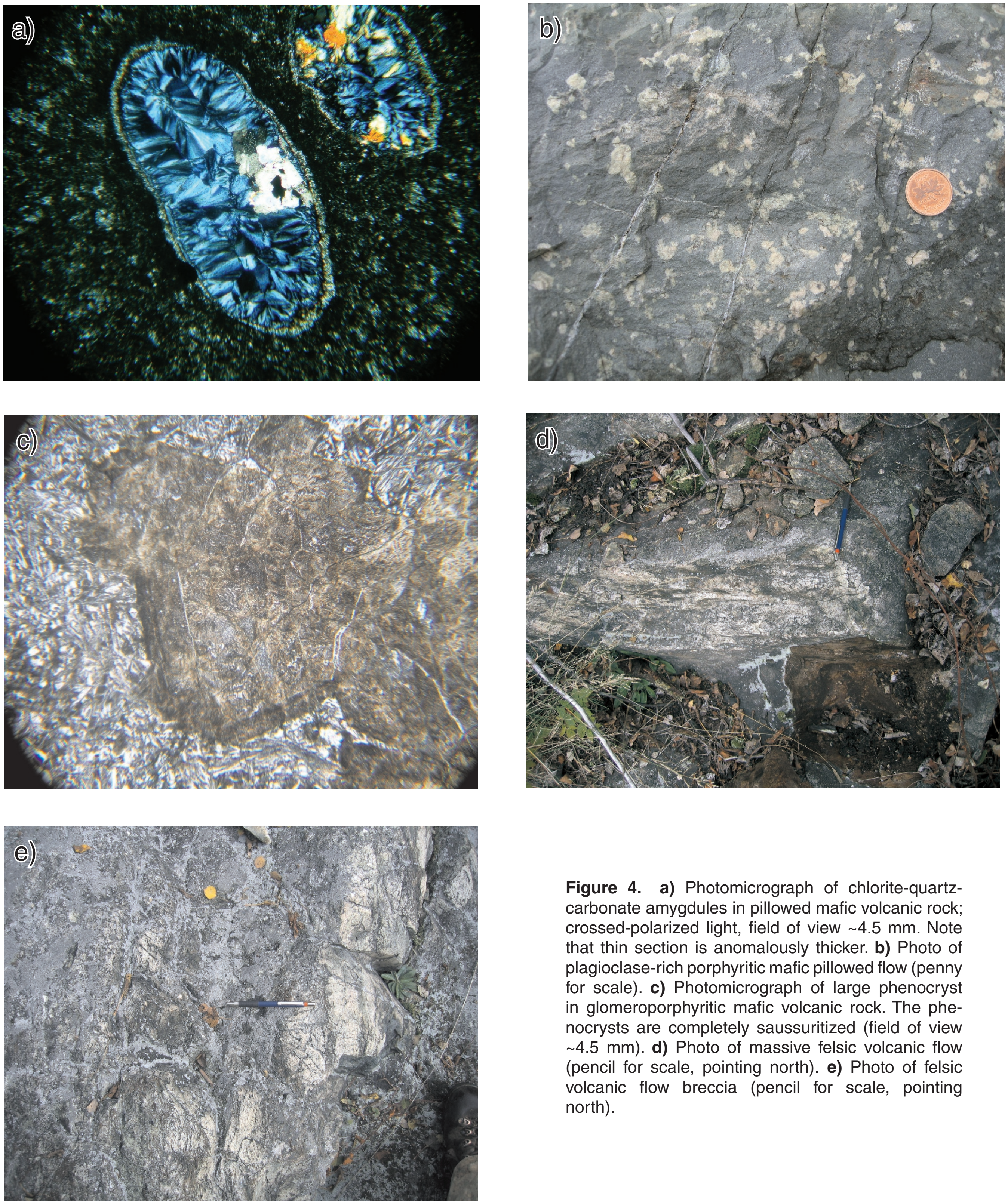

Figure 4. **a)** Photomicrograph of chlorite-quartz-carbonate amygdules in pillowed mafic volcanic rock; crossed-polarized light, field of view ~4.5 mm. Note that thin section is anomalously thicker. **b)** Photo of plagioclase-rich porphyritic mafic pillowed flow (penny for scale). **c)** Photomicrograph of large phenocryst in glomeroporphyritic mafic volcanic rock. The phenocrysts are completely saussuritized (field of view ~4.5 mm). **d)** Photo of massive felsic volcanic flow (pencil for scale, pointing north). **e)** Photo of felsic volcanic flow breccia (pencil for scale, pointing north).

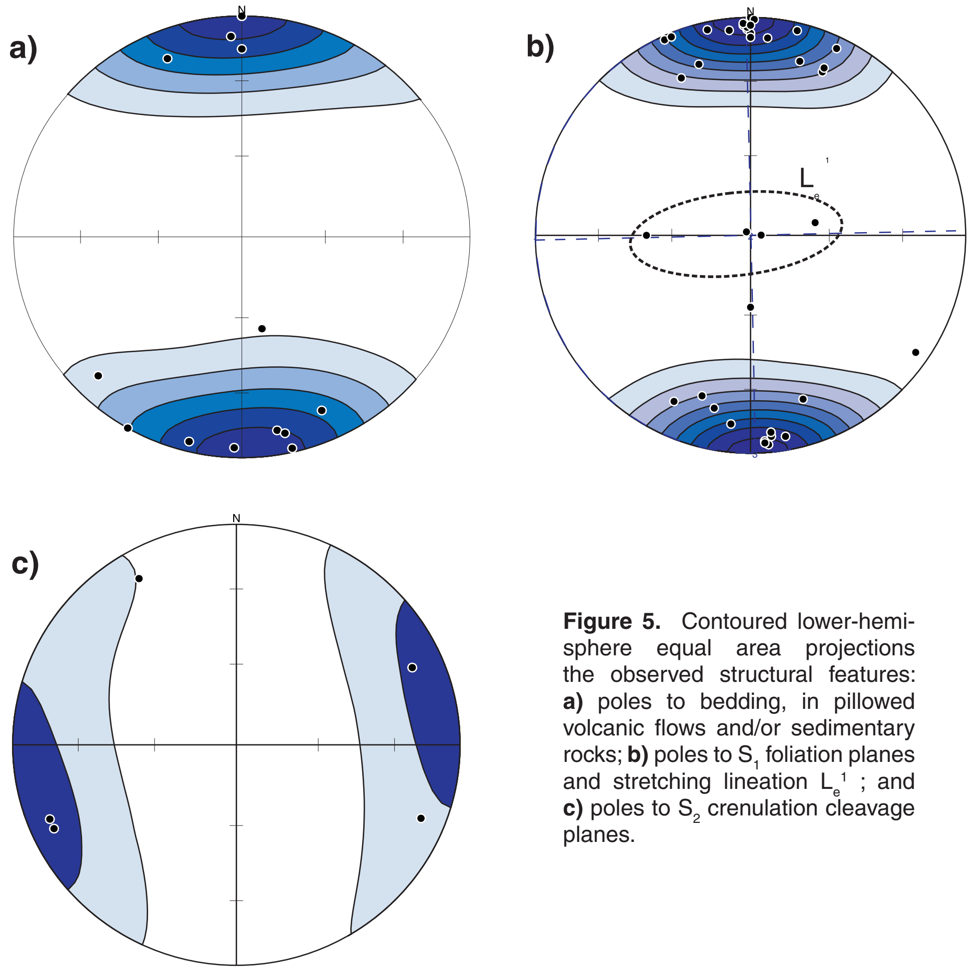

Figure 5. Contoured lower-hemisphere equal area projections the observed structural features: **a)** poles to bedding, in pillowed volcanic flows and/or sedimentary rocks; **b)** poles to S_1 foliation planes and stretching lineation L_e^1; and **c)** poles to S_2 crenulation cleavage planes.

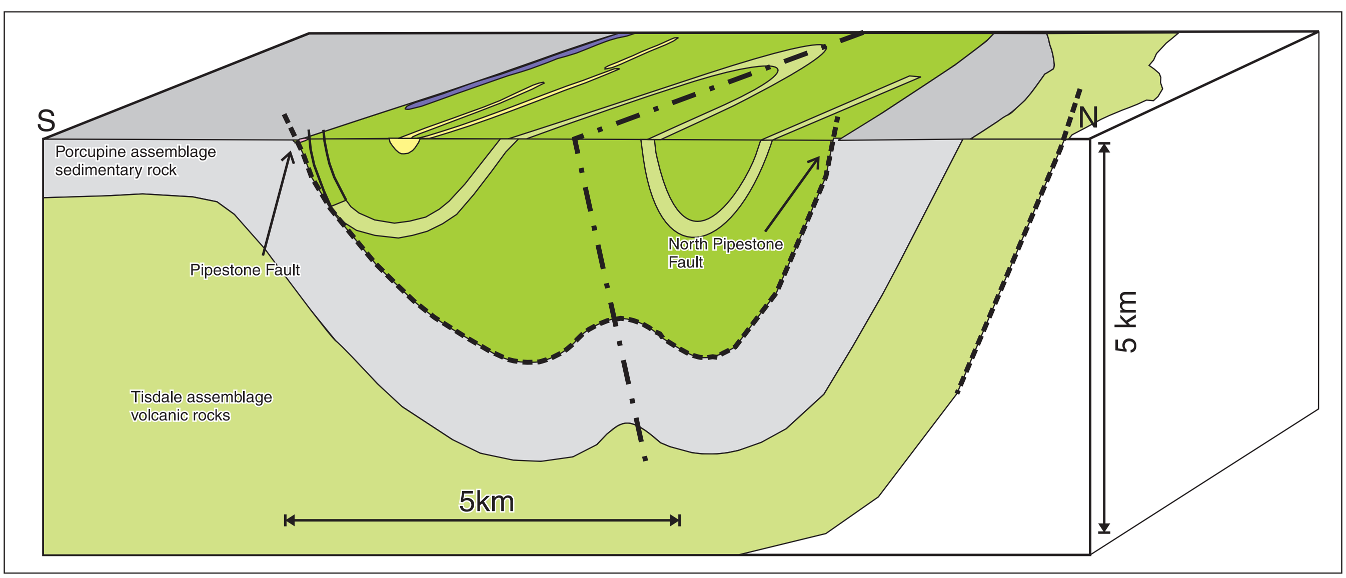

Figure 6. Block diagram of the folded thrust sheet of the Kidd-Munro assemblage on top of the Porcupine assemblage, forming a klippe-like structure. View is toward the west.

assemblages, with their type areas south of the Kidd-Munro belt, likely extend beneath the folded Kidd-Munro assemblage and resurface to the north of the synclinorium (Fig. 1). In essence, the Kidd-Munro volcanic rocks define a regional erosional remnant of a folded thrust klippe.

ECONOMIC POTENTIAL OF CLERGUE AND WALKER TOWNSHIP

The southern portion of Clergue and Walker townships has been periodically explored for gold and hosts numerous showings, particularly the Clavos Gold Mine, and the Montclerg property. In this area, the mafic volcanic rocks of the Kidd-Munro assemblage are characterized by a corridor of penetrative cleavage associated with a distinct iron-carbonate, muscovite, and arsenopyrite alteration typical of some deposits in the Porcupine gold camp. This alteration was observed by Van Hees (unpub. company report, 2007) at the Montclerg property, where he describes narrow zones of muscovite-arsenopyrite mineralization parallel to the intense foliation. Gold mineralization was observed on shallow-dipping extensional and fault-filling quartz-carbonate veins (*see* Fig. 7).

The exact mode of emplacement of the mineralisation at Montclerg is not clear at this point. Old reports suggest that the mineralization occupies narrow zones that are steeply dipping, associated with fault-filling veins and strong sericite-arsenopyrite alteration (Matamec Expl., pers. comm., 2007). However, more recent work suggests that the mineralization is instead located in flat extensional veins (Van Hees, unpub. company report, 2007). Coincidently, the gold mineralization at the Montclerg property occupies a similar spatial and stratigraphic relationship to the Pipestone Thrust as the Croesus Mine in southern Munro Township. In addition, the folding of the thrust fault opens up new targets for gold exploration along the northern contact of the Kidd-Munro assemblage . Volcanic rocks in the hanging wall of this part of the thrust could be an ideal host for additional gold mineralization.

Clergue and Walker townships have received little interest for base-metal exploration due to the patented lands that cover most of the area. However, the observed stratigraphy of interbedded mafic and felsic volcanic rocks that was locally affected by carbonate, sulphide, and dark chlorite alteration is prospective for volcanogenic massive-sulphide mineralization (VMS). The potential of the area is highlighted by observation of disseminated chalcopyrite and sphalerite in the mafic volcanic rocks of Clergue Township

CONCLUSION

The main belt of the Kidd-Munro assemblage structurally overlies younger sediments of the Porcupine assemblage and forms an east-west band of volcanic rocks that extends

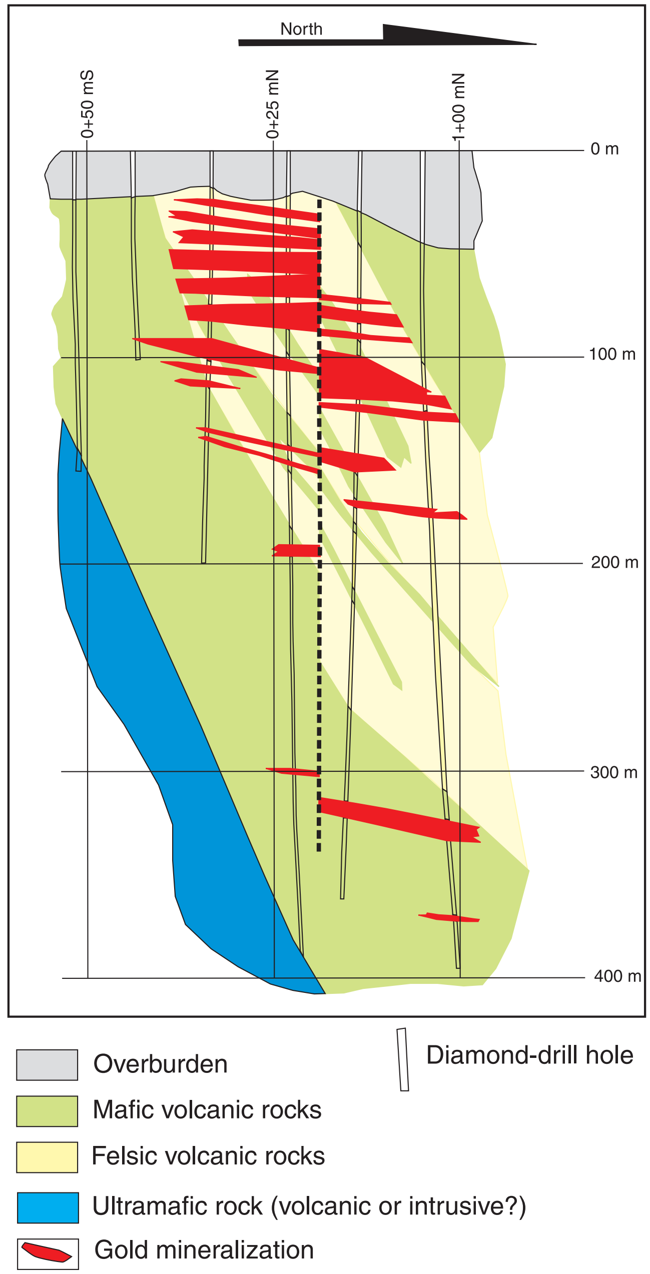

Figure 7. Geological section of the Montclerg property, along grid line 49+00 mE and viewed toward the west-southwest (azimuth of 250°). From Van Hees (unpub. company report, 2007).

from Kidd Creek mine to the border with Quebec. Our preferred interpretation is that the Kidd-Munro assemblage was emplaced along a shallow dipping thrust fault — the Pipestone Thrust, during a north-south shortening event. This thrust fault and the overlying volcanic rocks were subsequently folded into a regional synclinorium, and are presently preserved as a structural klippe. The proposed model (Fig. 6) respects overall younging directions of the Kidd-Munro volcanic rocks, converging inward toward the axial zone of a synclinorium. In addition, the overall observations are not easily reconciled with just local imbrication of a regionally extensive layer-cake stratigraphy (cf. Ayer et al., 2002). Future work in the area will consist of defining the stratigraphy by constructing stratigraphic columns using marker horizons.

Economic potential of the Clergue-Walker Township area is limited at the moment to gold exploration along the Pipestone Thrust. Gold mineralization has been intersected by drill core at the Montclerg Property, associated with strong muscovite-arsenopyrite alteration. This alteration is typical of some major deposits in the Porcupine gold camp (Colvine et al., 1988; Brisbin, 1997; Dinel, 2007). In addition, the structural continuity of the Pipestone Thrust to the northern boundary of the Kidd-Munro volcanic rocks could provide similar targets for gold exploration. In terms of base-metal exploration, the Clergue-Walker Township area has received limited interest from industry. The volcanic stratigraphy of interbedded mafic and felsic volcanic rocks, and the locally observed alteration, indicate potential for Cu-Zn mineralisation.

Future work will be focused on the stratigraphy of the Potterdoal Cu-Zn deposit in north Munro Township. An uncommon base-metal deposit hosted in mafic to ultramafic volcanic rocks of the Kidd-Munro assemblage. The study will be focused toward defining the stratigraphy, description of the lithologies and their geochemistry, and investigation of the alteration associate with the mineralization. In addition, future works will consistof investigating the relationship between the Kidd-Munro assemblage stratigraphy with the Porcupine-Destor deformation zone in the Harker, Holloway, Frècheville, Stoughton, and Marriott townships in northeastern Ontario. In those areas we will investigate the nature of the deformation corridor to better characterize the deformation events and style of deformation.

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REFERENCE

Ayer, J.A., Amelin, Y., Corfu, F., Kamo, S., Ketchum, J., Kwok, K., and Trowell, N., 2002. Evolution of the southern Abitibi greenstone belt based on U-Pb geochronology; autochthonous volcanic construction followed by plutonism, regional deformation and sedimentation; Precambrian Research, v. 115, no. 1–4, p. 63–95. doi:10.1016/S0301-9268(02)00006-2

Ayer, J.A., Thurston, P.C., Bateman, R., Dubé, B., Gibson, H.L., Hamilton, M.A., Hathway, B., Hocker, S.M., Hudak, G., Ispolatov, V.O., Lafrance, B., Lesher, C.M., Macdonal, P.J., Péloquin, A.S., Piercey, S.J., Reed, L.E., and Thompson, P.H., 2005. Overview of results from the Greenstone Architecture Project: Discover Abitibi Initiative; Ontario Geological Survey, Open File Report 6154, 146 p.

Berger, B.R., 1997. Project Unit 97–01; geological investigations along Highway 101, east of Matheson; *in* Summary of Field Work and Other Activities 1997, Ontario Geological Survey, Miscellaneous Paper 168, p. 20–22.

Bleeker, W., 1999. Structure, stratigraphy and primary setting of the Kidd Creek volcanogenic massive sulphide deposit: a semi quantitative reconstruction., *in* The giant Kidd Creek volcanogenic massive sulfide deposit, western Abitibi Subprovince, Canada, Editors, M.D. Hannington and C. Tucker BarrieEconomic Geology Monograph, v. 10, p. 71–122.

Bleeker, W. and Parrish, R.R., 1996. Stratigraphy and U-Pb zircon geochronology of Kidd Creek: implications for the formation of giant volcanogenic massive sulphide deposits and tectonic history of the Abitibi greenstone belt; Canadian Journal of Earth Sciences, v. 33, p. 1213–1231.

Bleeker, W., Berger, B., Houlé, M.G., Ayer, J.A., and van Breemen, O., 2006. Kidd-Munro assemblage and structural-stratigraphic architecture; *in* Summary of Field Work and Other Activities 2006, Ontario Geological Survey, Open File Report 6192, p. 4–6 to 4–8.

Bleeker, W., van Breemen, O., and Berger, B., 2008. The Pipestone thrust and the fundamental terrane architecture of the south-central Abitibi greenstone belt, Superior craton, Canada; *in* Abstracts, Geological Association of Canada Annual Meeting, Quebec City, May 2008, p. 24.

Brisbin, D.I., 1997. The Geological Setting of gold deposits in the Porcupine Gold Camp, Timmins, Ontario, Ph.D. thesis, Queen's University, Kingston, Ontario, 523 p.

Carlson, H.D. and Ginn, R.M., 1965. Clergue township, District of Cochrane, Ontario Department of Mines, Preliminary Geological Map P.308, scale 1:15 840.

Colvine, A.C., Fyon, J.A., Heather, K.B., Marmont, S., Smith, P.M., and Troop, D.G., 1988. Archean Lode Gold Deposits in Ontario, Ontario Geological Survey, Miscellaneous Paper 139, 136 p.

Dinel, E., 2007. Structural, geochemical and host rock control on gold mineralization in tholeiitic volcanic rock of the Tisdale assemblage, Timmins, Ontario; the Hoyle Pond mine and the Vipond V10b unit; Ph.D. thesis, University of Ottawa, Ottawa, Ontario, 248 p.

Ontario Geological Survey, 2004. Colour-filled contours of the residual magnetic field and Keating coefficients, central Abitibi Destor-Porcupine-Pipestone faults area; Ontario Geological Survey, Map 81 905, scale 1:50 000.

Geological Survey of Canada Project X92