GEOLOGICAL SURVEY OF CANADA
OPEN FILE 7310

Iron oxide compositions in till and bedrock samples from the Sue-Dianne IOCG deposit, Northwest Territories and the Pipe Ni-Cu deposit, Manitoba

C. Dupuis, A.-A. Sappin, M. Pozza, G. Beaudoin, I. McMartin, and M.B. McClenaghan

2012

Natural Resources Canada   Ressources naturelles Canada

Canada

GEOLOGICAL SURVEY OF CANADA
OPEN FILE 7310

Iron oxide compositions in till and bedrock samples from the Sue-Dianne IOCG deposit, Northwest Territories and the Pipe Ni-Cu deposit, Manitoba

C. Dupuis[1], A.-A. Sappin[1], M. Pozza[1], G. Beaudoin[1], I. McMartin[2], and M.B. McClenaghan[2]

[1] Département de géologie et de génie géologique, 1065 av. de la Médecine, Université Laval, Québec, Québec G1V 0A6

[2]Geological Survey of Canada, 601 Booth Street, Ottawa, Ontario K1A 0E8

2012

doi:10.4095/292141

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

Contribution to the Geo-Mapping for Energy and Minerals Program (GEM) 2008-2013

Recommended citation
Dupuis, C., Sappin, A.-A., Pozza, M., Beaudoin, G., McMartin, I., and McClenaghan, M.B., 2012. Iron oxide compositions in till and bedrock samples from the Sue-Dianne IOCG deposit, Northwest Territories and the Pipe Ni-Cu deposit, Manitoba; Geological Survey of Canada, Open File 7310. doi:10.4095/292141

Publications in this series have not been edited; they are released as submitted by the author

Table of Contents

	page
Abstract	4
Introduction	4
Methods	4
Acknowledgements	5
References	7

Appendices (Digital files only)
Appendix A. Electron microprobe data for Fe oxides grains from the ferromagnetic fraction of till and bedrock samples from Sue-Dianne deposit area, Great Bear magmatic zone.

Appendix B. Electron microprobe data for Fe oxides grains from the ferromagnetic fraction of till samples from Pipe Ni-Cu deposit area, Thompson Nickel Belt.

List of Figures

Figure 1. Mineral occurrences and regional bedrock geology of the Sue-Dianne deposit area (from NORMIN database (www.nwtgeoscience.ca/normin) and till/bedrock sample locations. Trend and relative age of striations are from McMartin *et al.* (in prep).

Figure 2. Simplified regional bedrock geology of the northern Thompson Nickel Belt region (Manitoba, Canada), showing the location of till samples (red dots) and the two ice-flow directions. Box outlines area shown in Figure 3 (modified from McClenaghan *et al.* 2011).

Figure 3. Bedrock geology of the Pipe deposit outlined in Figure 2, showing till sample locations (white dots) and the two ice flow directions (from McClenaghan *et al.* 2011).

List of Tables

Table 1. Optimized analytical conditions for electron microprobe analysis of magnetite and hematite grains from till.

ABSTRACT

This open file reports the chemical compositions of Fe oxide mineral grains (mainly magnetite and minor hematite) from the ferromagnetic fraction of bedrock and till from the iron oxide copper-gold (IOCG) Sue-Dianne deposit in the Great Bear magmatic zone, NWT and from till around the Pipe magmatic Ni-Cu deposit in the Thompson Nickel Belt, Manitoba. These data were collected in support of research by the DIVEX research network and the Geological Survey of Canada into the use of magnetite as an indicator mineral for mineral exploration in glaciated terrain.

INTRODUCTION

The composition of Fe-oxides, especially magnetite and hematite, has been shown to be useful to distinguish between different ore deposit types (Carew 2004; Gosselin *et al.* 2006; Singoyi *et al.* 2006; Nadoll *et al.* 2009; Rusk *et al.* 2009, 2010; Dupuis & Beaudoin, 2011). The method can be applied to ferromagnetic fractions of till samples to assist in the detection of mineral deposits up-ice in glaciated terrains. Beaudoin *et al.* (2009) showed that the composition of magnetite (and hematite) in a small aliquot of the total ferromagnetic fraction of till could be representative of the magnetite (and hematite) compositional range of the entire sample.

In this report, we present the optimized electron microprobe (EMP) method developed to analyze iron oxide grains, and new geochemical data for Fe oxides in till and bedrock samples collected up-ice, overland down-ice from the Cu-Ag-(Au) IOCG Sue-Dianne deposit in the Great Bear magmatic zone (GBmz), NWT and from the magmatic Ni-Cu deposits in the Thompson Nickel Belt (TNB), Manitoba. Both tests sites are part of joint government-industry-academia research projects. The ongoing objective is to determine the optimum size fraction and number of grains for best representing the range in composition of magnetite and hematite contained in the till ferromagnetic fractions in order to document their compositional variations along ice-flow paths crossing mineral deposits.

METHODS

Eight till samples (7-19 kg of <2 mm material) containing ferromagnetic heavy minerals and five bedrock samples (1 to 3 kg) disaggregated to <2 mm from the Sue-Dianne IOCG deposit area along a 10-km long transect parallel to the predominant ice-flow direction (Fig. 1) were used in this study. Magnetite and hematite in four bedrock thin sections from the Sue-Dianne deposit and nearby Brooke Zone were also studied for comparison. Fourteen till samples (15-20 kg) from the TNB were used in this study, including samples proximal to the Pipe Ni-Cu deposit (Figs. 2 and 3), which collectively refers to the Pipe 1 and 2 underground mines and the Pipe open pit (Fig. 3). The samples are from a 180 km-long transect across the TNB along the general westward direction of the last major ice flow, as well as southwest of the Pipe deposit (Fig. 2) along the older SW direction of ice flow.

Till and bedrock samples were processed using a combination and tabling and heavy liquids (specific gravity 3.2) to produce ferro- and non-ferromagnetic heavy mineral

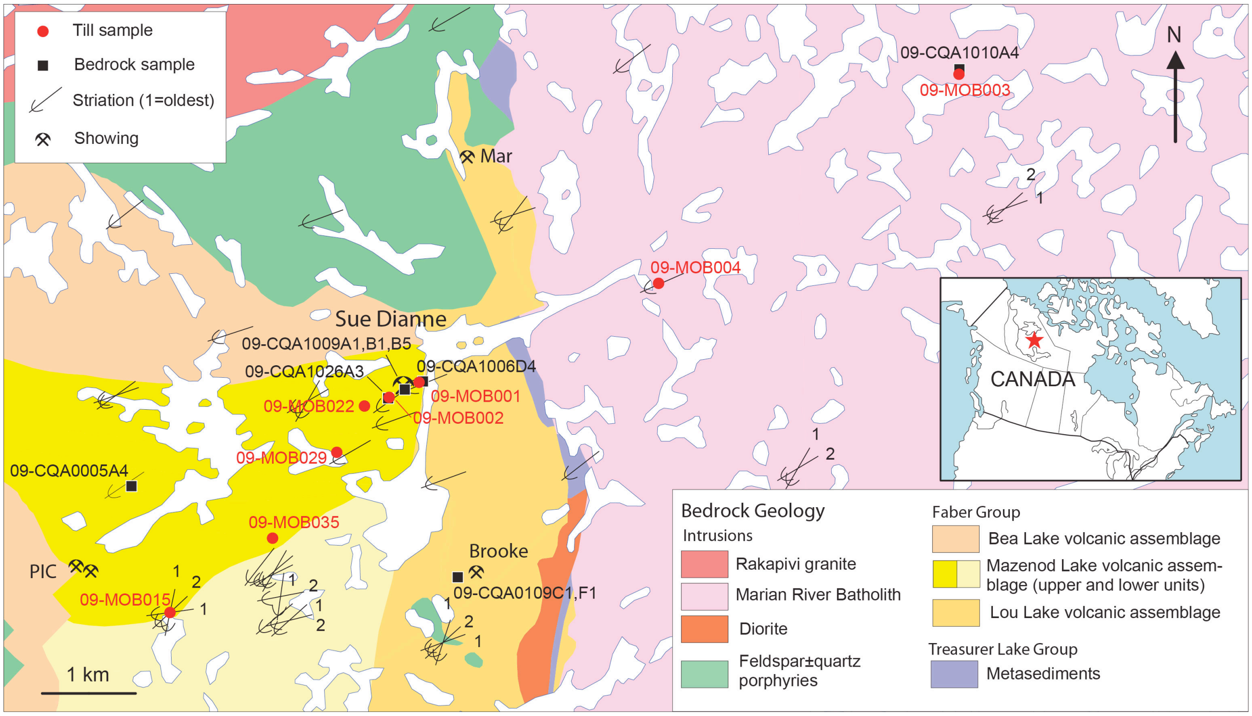

Figure 1. Mineral occurrences and regional bedrock geology of the Sue-Dianne deposit area (from NORMIN database: www.nwtgeoscience.ca/normin) and till/bedrock sample locations. Trend and relative age of striations are from McMartin et al. (in prep).

concentrates for picking of indicator minerals. Sample processing procedures and sample weights of the various fractions produced are reported for the Sue-Dianne samples by McMartin *et al.* (in prep.) and for the TNB samples by McClenaghan *et al.* (in press).

Individual grains from the ferromagnetic fraction of the samples were mounted in 25 mm epoxy grain mounts and the minor and trace element contents were determined for magnetite and hematite grains using a CAMECA SX-100 five-spectrometer electron microprobe (EMP) at the Université Laval, Québec. Analytical conditions are modified from those reported by Dupuis and Beaudoin (2011). The optimized EMP analytical conditions for magnetite and hematite are summarized in Table 1. EMP data for grains from the Sue-Dianne and Thompson are presented in Appendix A and B, respectively.

ACKNOWLEDGEMENTS

This research was funded by the DIVEX research network, and the Geological Survey of Canada (GSC). Samples were collected by P. Normandeau and I. McMartin as part of the IOCG-Great Bear Multiple Metals Project lead by Louise Corriveau (GSC-Québec) under the GSC's Geo-mapping for Energy and Minerals Program (GEM). Samples from the TNB were collected by B. McClenaghan as part of the GSC's Targeted Geoscience 3 (TGI3) Program in collaboration with the Manitoba Geological Survey and Vale, and with financial support from the Canadian Mining Industry Research Organization (CAMIRO). We would like to thank M. Choquette (Université Laval) for providing essential technical support during EMP analyses, the IOCG-Great Bear Project and the Thompson Nickel Belt Project for providing the samples. Dan Kerr (GSC) is thanked for reviewing the manuscript.

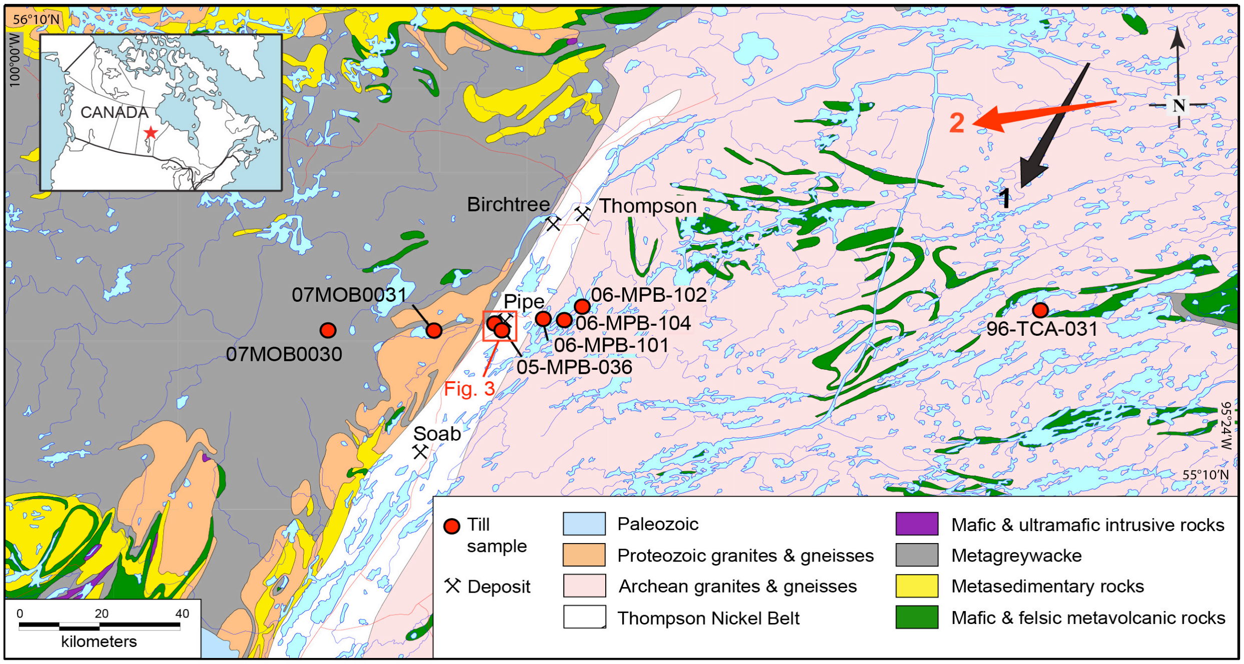

Figure 2. Simplified regional bedrock geology of the northern Thompson Nickel Belt region (Manitoba, Canada), showing the location of till samples (red dots) and the two ice-flow directions (1= older flow). Box outlines area shown in Figure 3 (modified from McClenaghan et al. 2011).

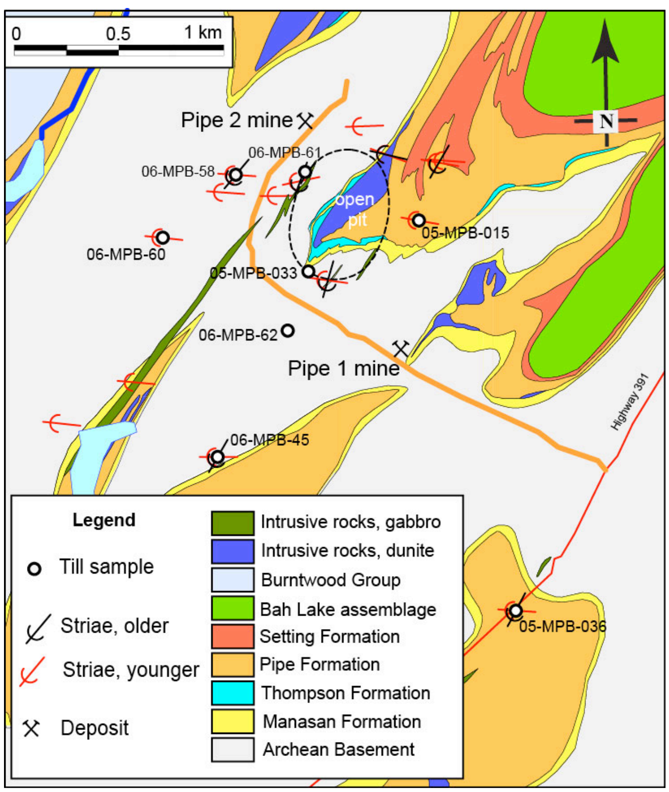

Figure 3. Bedrock geology of the Pipe deposit outlined in Figure 2, showing till sample locations (white dots) and the two ice flow directions (1=older flow) (from McClenaghan et al. 2011).

Table 1. Optimized analytical conditions for electron microprobe analysis of magnetite and hematite grains from till.

Element	Crystal	Line	Sinq* Peak	Sinq* Background	Counting time (s) Peak	Counting time (s) Background	Range of Detection Limits (ppm)
Zn	LIF	Ka	0.35635	0.35135	40	15	44-144
Cu	LIF	Ka	0.38256	0.37756	40	20	37-90
Ni	LIF	Ka	0.41173	0.40673	40	20	27-67
Mn	LLIF	Ka	0.52207	0.51607	40	20	17-45
Cr	LLIF	Ka	0.52207	0.51607	80	20	47-62
V	LLIF	Ka	0.62197	0.62797	80	20	45-65
K	LPET	Ka	0.42742	0.42142	40	20	14-16
Ca	LPET	Ka	0.38387	0.37787	40	20	15-17
Ti	LPET	Ka	0.31423	0.30823	40	20	19-25
Al	TAP	Ka	0.32462	0.33062	40	20	18-20
Si	TAP	Ka	0.27737	0.28337	60	20	14-16
Mg	TAP	Ka	0.38502	0.39102	40	20	20-23

* l=2d Sinq, where l is the wavelength and d is the interplanar distance of the analysing crystal.

REFERENCES

Beaudoin, G., Dupuis, C. and McClenaghan, B. 2009. Fingerprinting mineral deposit types using iron-oxide chemistry: Application to till from Thompson, Manitoba, Canada. *In:* Lentz, D.R., Thorne, K.G. and Beal, K.-L. (eds). Proceedings of the 24th International Applied Geochemistry Symposium, Fredericton, v. **1**, p. 7–10.

Carew, M. J. 2004. *Controls on Cu-Au mineralisation and Fe oxide metasomatism in the Eastern Fold Belt, N.W. Queensland, Australia*. PhD thesis, James Cook University.

Dupuis, C. and Beaudoin, G. 2011. Discriminant diagrams for iron oxide trace element fingerprinting of mineral deposit types. *Mineralium Deposita*, v . 46, p.319–335, doi: 10.1007/s00126-011-0334-y.

Gosselin, P., Beaudoin, G. and Jébrak, M. 2006. Application of the geochemical signature of iron oxides to mineral exploration. *Geological Association of Canada - Mineralogical Association of Canada Annual Meeting, Program with Abstracts*, v. **31**, CD-ROM.

McClenaghan, M.B., Layton-Matthews, D. and Matile, G.L.D. 2011. Till geochemical signatures of magmatic Ni-Cu deposits, Thompson nickel belt, Manitoba, Canada. *Geochemistry, Exploration, Environment, Analysis*, v. 11, p.145-159.

McClenaghan, M.B. Kjarsgaard, I.M., Averill, S.A., Layton-Matthews, D., Crabtree, D., Matile, G., McMartin, I. and Pyne, M. in press. Indicator mineral signatures of magmatic Ni-Cu deposits, Thompson Nickel Belt, Manitoba: Part 2- till data. Geological Survey of Canada, Open File 7200.

McMartin, I., Normandeau, P.-X., Beaudoin, G. and Corriveau, L. in prep. Composition of till and bedrock across the Great Bear magmatic zone: field database and analytical results from the GEM IOCG-Great Bear Project. Geological Survey of Canada, Open File 7307.

Nadoll, P., Mauk, J.L., Hayes, T.S., Koenig, A.E., Hofstra, A.H. and Box, S. E. 2009. Geochemistry of magnetite from hydrothermal ore deposits and their host rocks in the Proterozoic Belt Supergroup, USA. *In:* Williams *et al.* (eds) Smart science for exploration and mining. Proceedings of the 10th Biennial SGA Meeting, Townsville, p.129–131.

Rusk, B., Oliver, N., Brown, A., Lilly, R. and Jungmann, D. 2009. Barren magnetite breccias in the Cloncurry region, Australia; comparisons to IOCG deposits. *In:* Williams *et al.* (eds) Smart science for exploration and mining. Proceedings of the 10th Biennial SGA Meeting, Townsville, p. 656–658.

Rusk, B., Oliver, N., Cleverley, J., Blenkinsop, T., Zhang, D., Williams, P., and Habermann, P. 2010. Physical and chemical characteristics of the Ernest Henrt iron oxide copper gold deposit, Australia; implications for IOCG genesis. *In:* Porter, T.M. (ed) Hydrothermal Iron Oxide Copper-Gold and Related Deposits: A Global Perspective. PGC Publishing, v. **3**, p. 1-18.

Singoyi, B., Danyushevsky, L., Davidson, G.J., Large, R. and Zaw, K. 2006. Determination of trace elements in magnetites from hydrothermal deposits using thebLA ICP-MS technique. SEG Keystone Conference, Denver, Colorado, CD-ROM.