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

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1. Introduction

The southeastern Churchill Province (SECP) hosts numerous mafic to ultramafic intrusions, which have been assessed as potential prospective units for orthomagmatic mineralization (e.g., Houlé et al., 2016; Pérez, 2017; Smith et al., 2021). The discovery, by Western Mining Corporation (WMC) in 2000-2001, of economical Ni-Cu-Co showings hosted by gabbroic intrusions located in the northwestern part of the SECP (McKinnon-Matthews et al., 2001), highlighted the need to better characterize this type of intrusions within this part of the Churchill Province. Following the discovery, regional geological mapping at a 1:250 000 scale by the Ministère de l'Énergie et des Ressources naturelles (MERN) of Quebec (Lafrance et al., 2014, 2015; Charette et al., 2016) combined to prospection and geological mapping by the Nunavik Mineral Exploration Fund (Bédard et al., 2020), in partnership with Midland Exploration Inc., led to the recognition of other gabbroic intrusions, in the vicinity and geologically similar to the mineralized mafic intrusions identified by WMC. All these intrusions were assigned to the Soisson Intrusive Suite by Lafrance et al. (2014, 2015), Charette et al. (2016), and Bédard et al. (2020). However, further petrological and geochemical work is needed to confirm their similarity and genetic link, as well as the economic potential of the Soisson Intrusive Suite as a whole.

This study is part of the "Core Zone: Tectonic Framework and Mineral Potential of Northern Quebec and Labrador" activity of the Hudson-Ungava project under the Geo-Mapping for Energy and Minerals Phase II (GEM-2) program; an initiative conducted by the Geological Survey of Canada. It aims to characterize the gabbroic intrusions of the Soisson Intrusive Suite and their mineralization in order to assess their potential to host Ni-Cu-Co mineralization. In complement to a recent petrological, geochemical, and geochronological study conducted by Sappin et al. (Canadian Journal of Earth Sciences, in press), this report presents a summary of petrographic descriptions, whole-rock geochemical results for major and trace element of the Soisson gabbroic rocks, as well as the composition of the main primary minerals (i.e., olivine, clinopyroxene, orthopyroxene, plagioclase, and ilmenite) in these mafic rocks. All data are compiled in the accompanying Excel spreadsheets (*see* Appendices A to G).

2. Regional geology

The Soisson Intrusive Suite is located in the northwestern part of the Core Zone (Fig. 1), within the SECP, which is part of the Paleoproterozoic-age composite Trans-Hudson orogen (e.g., Wardle et al., 2002; Corrigan et al., 2009). It comprises several Mesoproterozoic, kilometer-scale gabbroic intrusions that occur semi-continuously over a ~180 km NW-SE strike length within the George River block and the Kuujjuaq Domain (Lafrance et al., 2014, 2015; Charette et al., 2016; Bédard et al., 2020). These mafic intrusions are hosted by various types of country rocks (Fig. 2), including Meso- to Neoarchean orthogneiss of the Ungava Complex, Meso- to Neoarchean migmatitic tonalite of the Qurlutuq Complex, Neoarchean quartz monzonite of the Saffray Suite, Neoarchean to Paleoproterozoic migmatitic paragneiss of the False Suite, Paleoproterozoic tonalite and granite of the d'Aveneau Suite, Paleoproterozoic diatexite and metatexite of the Winnie Suite, and Paleoproterozoic granite of the Dancelou Suite. The Soisson intrusions are mostly undeformed and unaffected by the regional metamorphism.

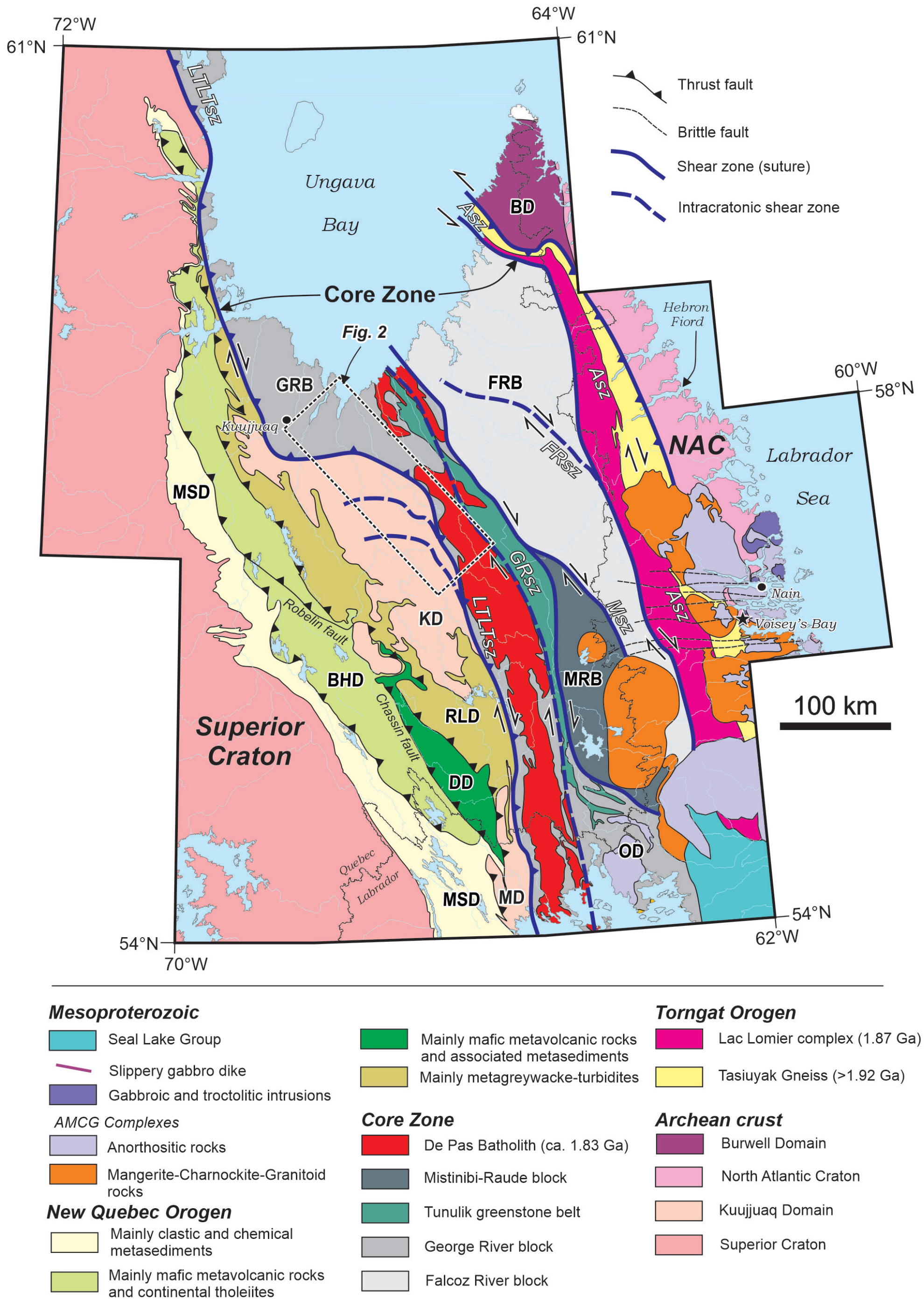

Fig. 1. Geological map showing the main lithotectonic subdivisions of the southeastern Churchill Province (*modified after* Corrigan et al., 2021). Dashed box indicates the location of Figure 2 and the black star indicates the location of the Voisey's Bay Ni-Cu-Co magmatic sulfide deposit. Abbreviations: BD = Burwell Domain, BHD = Baby-Howse Domain, DD = Doublet Domain, FRB = Falcoz River block, GRB = George River block, KD = Kuujjuaq Domain, MD = McKenzie River Domain, MRB = Mistinibi-Raude block, MSD = Melezes–Schefferville Domain, NAC = North Atlantic Craton, OD = Orma Domain, RLD = Rachel-Laporte Domain; Asz = Abloviak shear zone, FRsz = Falcoz River shear zone, GRsz = George River shear zone, LTLTsz = Lac Turcotte - Lac Tudor shear zone, Msz = Moonbase shear zone; AMCG = anorthosite–mangerite–charnockite–granite.

3. Local geology

Overall, the Soisson intrusions show no specific internal structure at outcrop-scale and are mainly composed of massive and subophitic olivine gabbro, gabbro, gabbronorite, and norite (Sappin et al., in press). The two southernmost intrusions of the Soisson Intrusive Suite, the Papavoine and Mantas intrusions (*see* Fig. 2E), were previously studied in more detail by McKinnon-Matthews et al. (2001), Lafrance et al. (2015), and Fleury (2016).

The drilling work carried out by WMC between 2000 and 2001 on the Papavoine intrusion suggests that this intrusion dips to the west and is composed, from base to top of: 1) a semi-continuous basal magmatic breccia (<100 m thick), 2) a semi-continuous serpentinized peridotite unit (<30 m thick), and 3) a gabbroic rock unit (maximum thickness >300 m) with olivine gabbro, gabbro, and troctolite (McKinnon-Matthews et al., 2001). Our work on the Papavoine intrusion focused on surface samples therefore, only the gabbroic rock unit has been characterized in the course of this study.

The mafic-dominated Mantas intrusion is composed, from the core to the border, of subophitic norite and gabbronorite (Fleury, 2016). It also contains a monzodioritic unit (Fleury, 2016), but its relationship with the surrounding gabbroic rocks is uncertain.

The gabbroic intrusions of the Soisson Intrusive Suite contain magmatic Fe-Ni-Cu sulfides. The Papavoine intrusion hosts several Ni-Cu-Co showings (e.g., Papavoine showing with up to 1.2% Ni, 0.5% Cu, 617 ppm Co, and 181 ppb Pt+Pd; McKinnon-Matthews et al., 2001) located near the contact with surrounding paragneiss or within paragneiss. They commonly contain patchy net-textured, disseminated, and millimeter-thick veinlets of sulfides, and locally semi-massive to massive sulfides, including pyrrhotite and minor chalcopyrite, pentlandite, and pyrite (McKinnon-Matthews et al., 2001; Lafrance et al., 2015). The Mantas intrusion also hosts two Ni-Cu-Co showings (e.g., A14-1E showing with up to 0.7% Ni, 0.4% Cu, 494 ppm Co, and 103 ppb Pt+Pd; McKinnon-Matthews et al., 2001) located at the contact with the surrounding paragneiss and diatexite/metatexite. They comprise patchy net-textured, disseminated, and millimeter-thick veinlets of pyrrhotite, chalcopyrite, and pentlandite (locally altered to violarite; Fleury, 2016). The other intrusions of the Soisson Intrusive Suite contain less than 6% pyrrhotite with rare chalcopyrite, pentlandite, and pyrite disseminated within the mafic rocks.

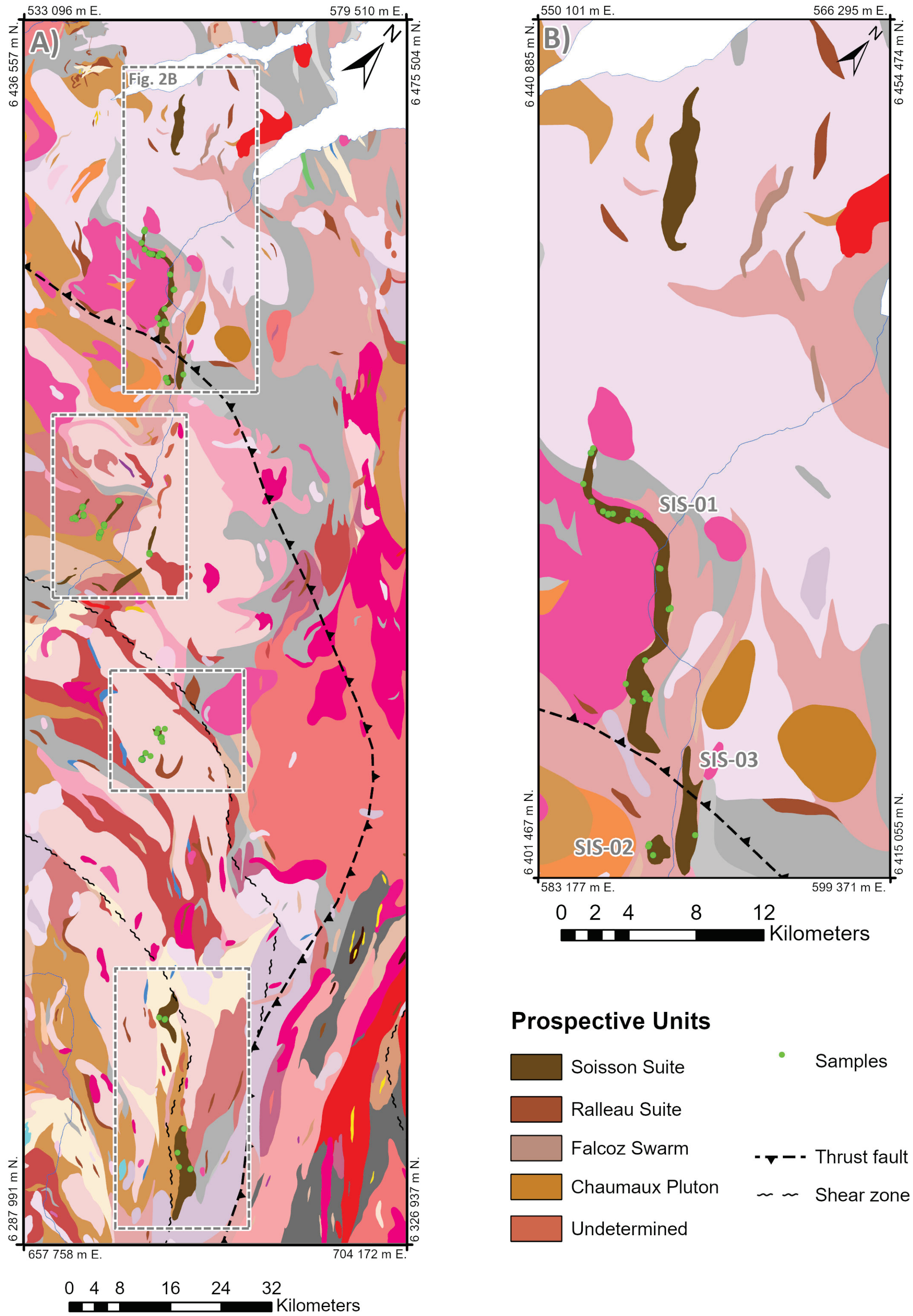

Fig. 2. A) Geological map showing the distribution of the mafic-dominated prospective units including those from the Soisson and Ralleau Intrusive Suites, the Chaumaux Pluton, the Falcoz Swarm, and the samples used in the course of this study (Map on the left). **B)** to **E)** Close-up of the regions shown in (A) (Maps on the right). Legend of the geological units is based from SIGÉOM (2021) and shown after the maps, while legend of the prospective units is from Houlé et al. in preparation compiled from various sources such as McKinnon-Matthews et al. (2001), SIGÉOM (2021), and unpublished data of Nunavik Mineral Exploration Fund and shown underneath close-ups. Structural lineaments are from Corrigan et al. (2021). Coordinates in UTM NAD83, Zone 19.

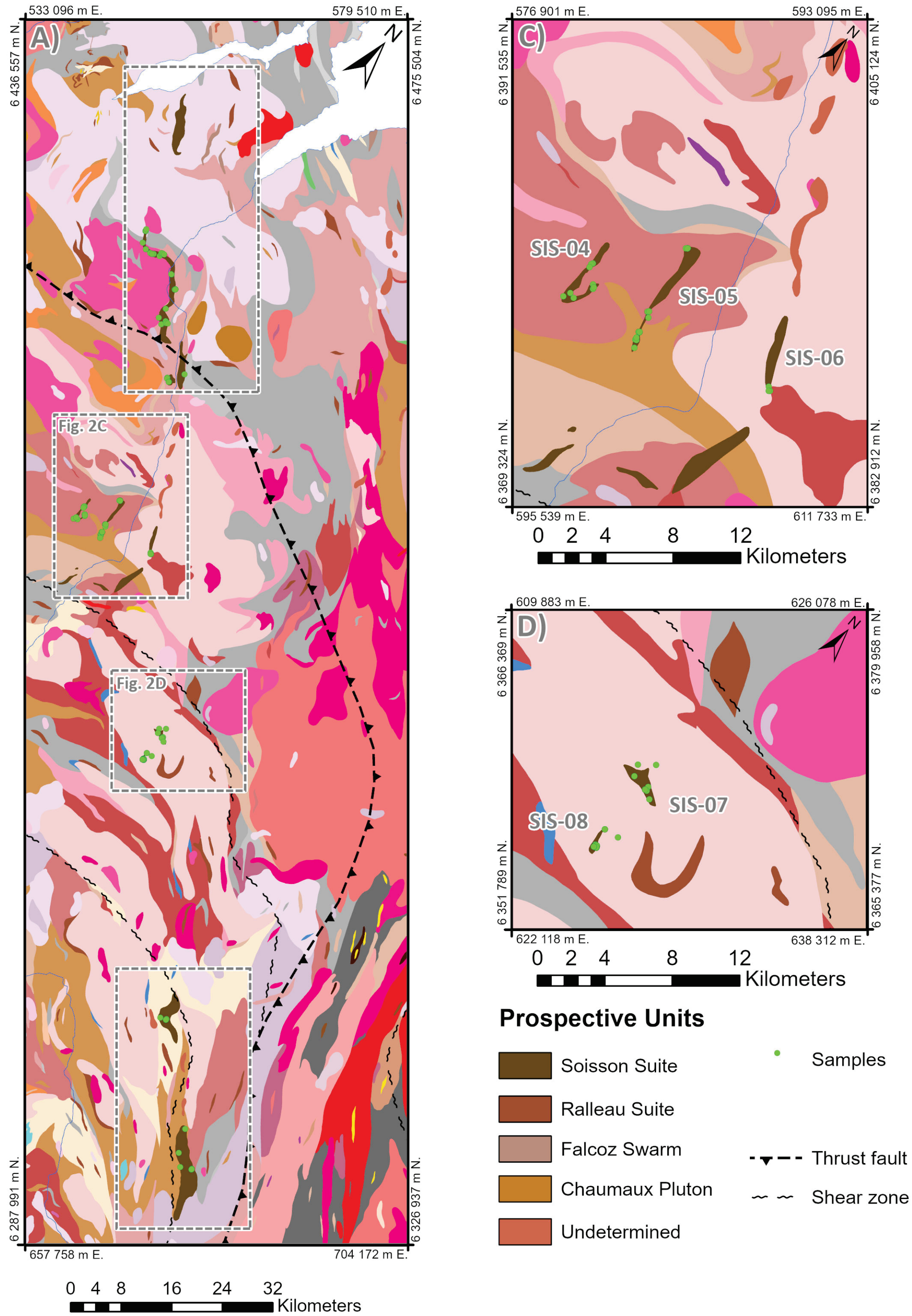

Fig. 2. Continued.

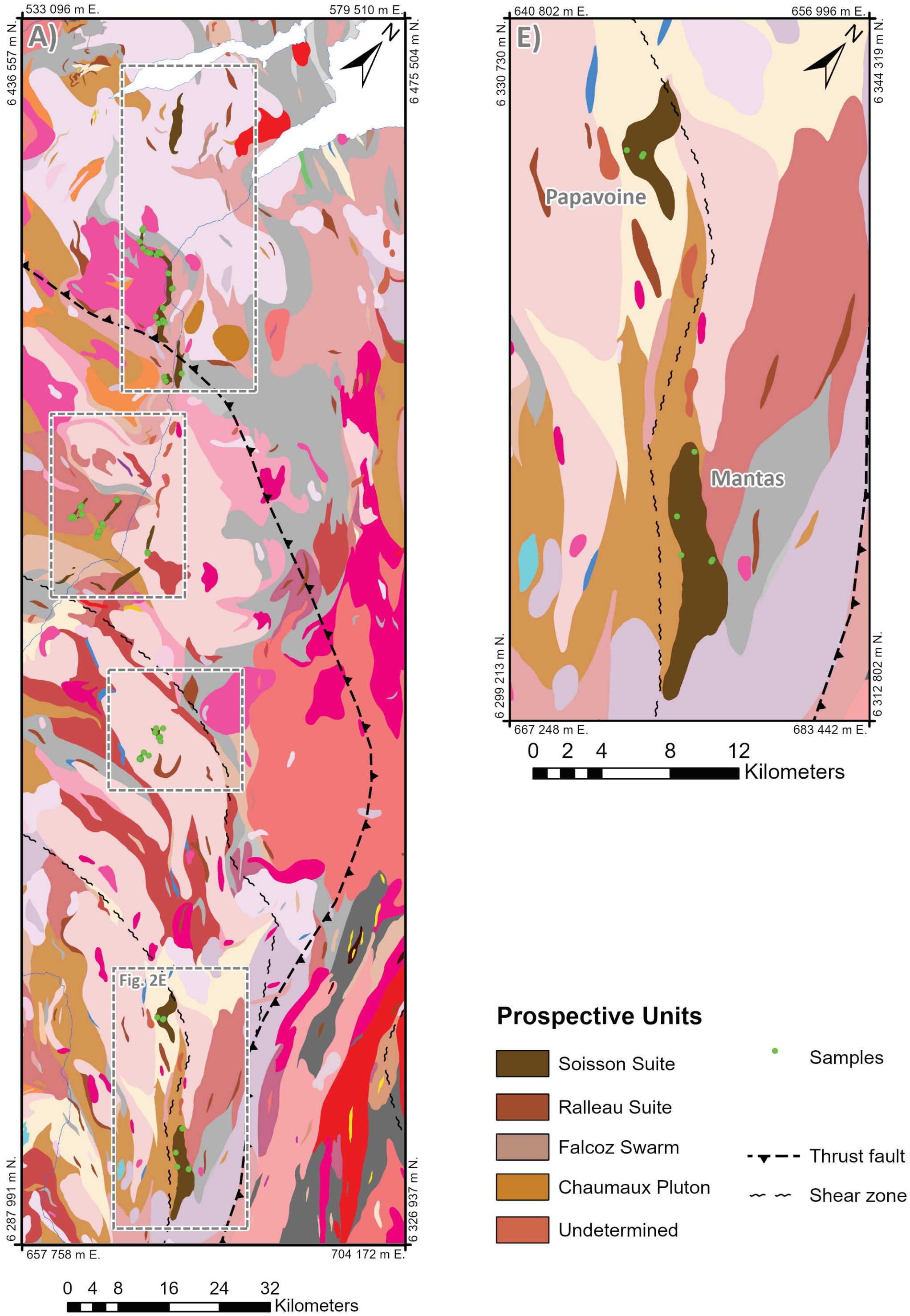

Fig. 2. Continued.

Paleoproterozoic

- Massive to foliated tonalite and white granite with biotite
- Heterogeneous tonalite and white granite with biotite schlierens and various enclaves
- Opdalite and jotunite with porphyritic texture
- Leucocratic gabbro and gabbronorite, anorthosite and quartz anorthosite
- Massive or slightly foliated, homogeneous, fine-grained gray granite with biotite-muscovite
- Massive pink granite with biotite-muscovite
- Massive pegmatitic granite with biotite-muscovite
- Homogeneous quartz diorite, tonalite and diorite with biotite-hornblende
- Granodiorite and quartz monzodiorite with biotite±hornblende porphyritic texture
- Granodiorite and quartz monzodiorite with biotite±hornblende
- Highly magnetic, spotted, granite and quartz monzonite with biotite porphyritic texture
- Granodiorite and quartz monzodiorite with bluish quartz porphyritic texture
- Heterogeneous granite with numerous enclaves of gneiss, migmatite, and diorite
- Monzogranite with biotite±hornblende; granite with biotite; massive, medium- to coarse-grained leucogranite
- Granoblastic, gneissic, banded, mylonitic or homogeneous diorite and quartz diorite with amphibole; minor tonalite
- Foliated gabbro, gabbronorite, and clinopyroxenite with clinopyroxene-amphibole
- Massive, medium-grained pyroxenite and melanocratic gabbronorite
- Homogeneous diatexite with biotite±hornblende porphyritic texture
- Homogeneous, heterogranular diatexite with biotite±hornblende
- Stromatic diatexite and metatexite with biotite±hornblende
- Stromatic diatexite and metatexite with biotite-garnet±sillimanite±kyanite

Neoarchean to Paleoproterozoic

- Banded amphibolite with hornblende-clinopyroxene-carbonate±garnet; banded, felsic to intermediate meta-pyroclastic rocks with epidote-biotite-hornblende
- Banded, heterogeneous migmatite with stromatic or raft structure
- Tonalite and anatexic granite rich in biotite schlierens

Neoarchean

- Banded, granoblastic, fine-grained paragneiss and paraschist with biotite-muscovite-sillimanite
- Banded, granoblastic, migmatitized paragneiss with biotite±hornblende
- Banded, granoblastic, migmatitized paragneiss with biotite-garnet
- Banded, granoblastic calc-silicate rocks
- Banded, oxide-facies iron formation; minor banded, silicate-facies iron formation
- Massive, granoblastic, fine-grained quartzite
- Tonalitic gneiss
- Homogeneous meta-arkose, laminated meta-arenite, and banded, conglomeratic meta-arkose with muscovite-biotite-hematite-specularite
- Foliated, granoblastic quartz monzonite; minor granodiorite, quartz monzodiorite, and monzogranite
- Massive to slightly foliated, homogeneous pink granite with biotite-magnetite
- Heterogeneous granite with numerous enclaves of gneiss and biotite-magnetite
- Banded to mylonitic, granoblastic paragneiss with biotite±garnet±sillimanite±hornblende
- Massive to foliated, homogeneous, medium- to coarse-grained amphibolitized gabbro
- Homogeneous metamorphosed pyroxenite and peridotite
- Tonalitic migmatite with stromatic, raft, or biotite schlieren structure
- Banded tonalitic to dioritic gneiss with hornblende-biotite
- Foliated tonalitic gneiss with whitish bands and biotite±amphibole
- Dioritic gneiss with hornblende-biotite±clinopyroxene; dioritic to quartz dioritic gneiss
- Granitic gneiss with biotite±hornblende

Fig. 2. Continued.

4. Methodology

4.1. Sampling

Ten representative gabbroic intrusions were selected across the Soisson Intrusive Suite for this study, including from north to south, the SIS-01 to SIS-08 intrusions, the Papavoine intrusion, and the Mantas intrusion (Fig. 2). The present investigation focus on eighty-six bedrock samples collected from these intrusions by the Geological Survey of Canada (GSC) and the Nunavik Mineral Exploration Fund (e.g., Bédard et al., 2020) between 2014 and 2020. All of them were analyzed for whole-rock major and trace elements and a suite of fifteen samples were selected for detailed petrographic description and mineral chemical analysis. Lithogeochemical data extracted from the Système d'information géominière (SIGÉOM) database of the MERN (SIGÉOM, 2021) for seven gabbroic rock samples from the Soisson Intrusive Suite collected by the MERN during regional bedrock mapping surveys between 2012 and 2015 were also included in the study. Furthermore, the whole-rock major and trace element contents of four gabbroic rock samples from the Mantas intrusion determined by Fleury (2016) are presented in this report for comparative purposes. The location of all the samples used in the course of this study is shown on Figure 2.

4.2. Whole-rock chemistry

Rock samples collected by Nunavik Mineral Exploration Fund in the SIS-01 to SIS-08 intrusions were prepared and analyzed for major and trace elements at ALS Minerals (Vancouver, British-Columbia). They were initially crushed in a low-Cr jaw crusher to 70% <2 mm, split using a riffle splitter, and pulverized by a flying disk or ring and puck mill to 85% <75 microns. Samples were analyzed for major and minor elements by inductively-coupled plasma atomic emission spectroscopy (ICP-AES) following a fusion with lithium metaborate. Total S was determined by Leco® combustion and infrared spectroscopy. Trace elements, including incompatible lithophile elements and rare earth elements (REE), were analyzed by inductively-coupled plasma mass spectrometry (ICP-MS) following a lithium borate fusion and nitric acid digestion. Base metals (Co, Cu, Ni, Pb, Sc, and Zn) were analyzed by ICP-AES following a four acid digestion. Se was analyzed by ICP-MS after an aqua regia digestion.

Rock samples collected by the GSC in the Papavoine intrusion were prepared and analyzed for whole-rock chemistry at Bureau Veritas Commodities (Vancouver, British-Columbia) and Activation Laboratories Ltd. (Actlabs–Ancaster, Ontario). At Bureau Veritas Commodities, the rock samples were initially crushed in a jaw crusher with low-Cr steel plates to 80% <2 mm, split using a riffle splitter, and pulverized using a ring and puck mill to 85% <75 microns. Samples were analyzed for major, minor, and a few trace elements (Ni, Sc) by ICP-AES following a lithium borate fusion. Total S was determined by Leco® combustion and infrared spectroscopy. Trace elements, comprising incompatible lithophile elements and REE, were analyzed by ICP-MS following a lithium borate fusion and nitric acid dissolution. Cu, Pb, Se, and Zn were analyzed by ICP-AES/ICP-MS after a modified aqua regia digestion (1:1:1 HNO_3:HCl:H_2O). At Actlabs, the rock samples were crushed in a low-Cr jaw crusher to 90% <2 mm, split using a riffle splitter, then pulverized using an agate ball mill to 85% <75 microns. Major and minor elements were analyzed on fused glass discs by wavelength dispersive X-ray fluorescence spectrometry (WD-XRFS). Sulfur was determined by Leco® combustion and infrared absorption. Trace elements (e.g., incompatible lithophile elements, REE) were analyzed by ICP-MS following a lithium borate fusion and nitric acid dissolution. Sc and Se were analyzed by instrumental neutron activation analysis (INAA).

Standard, blank, and duplicate samples were used to check the precision and accuracy of the analyses. Routine analytical accuracies (1 sigma, relative) are ±5% or better for most major elements and ±10% or better for most minor and trace elements. Routine analytical precisions (1 sigma, relative) are ±2% or better for most major elements and ±10% or better for most minor and trace elements.

4.3. Mineral chemistry

Olivine, clinopyroxene, orthopyroxene, plagioclase, and ilmenite were analyzed in polished thin sections by wavelength-dispersive X-ray emission spectrometry using a five-spectrometer CAMECA SX-100 electron probe microanalyzer at Université Laval (Québec, Canada). The analytical conditions were 15 kV accelerating voltage, 20 nA beam current, 20–15 s counting times on peaks and 10–7.5 s on backgrounds for olivine, pyroxene and plagioclase, and 30–15 s on peaks and 15–7.5 s on backgrounds for ilmenite. The accuracy of analyses was verified using simple oxides (GEO Standard Block, from P&H Developments) and minerals (Mineral Standard Mount MINM25-53, from Astimex Scientific Limited; reference samples from Jarosewich et al., 1980) as calibration standards. Magnetite composition was not determined as these grains host numerous ilmenite microexsolution and have extremely variable contents in major and minor elements.

5. Results

5.1. Petrographic description

The rock samples collected from the Soisson Intrusive Suite include olivine gabbro, gabbro, and gabbronorite. The texture and the primary and secondary mineralogy of these different lithofacies are described below and a summary of the main petrographic observations for individual samples is provided in Appendix A.

Olivine gabbro is composed mostly of plagioclase, olivine, and clinopyroxene, and minor magnetite, ilmenite, biotite, apatite, and locally orthopyroxene. These rocks have cumulate textures with cumulus plagioclase-olivine±clinopyroxene±orthopyroxene, enclosed by clinopyroxene±orthopyroxene ±olivine oikocrysts. Magnetite, ilmenite, and biotite (closely associated with Fe-oxides) are interstitial to cumulus minerals. Olivine gabbro also contains metamorphic minerals like amphibole, serpentine, talc, chlorite, and sericite.

Gabbro is composed primarily of plagioclase and clinopyroxene, with accessory magnetite, ilmenite, biotite, apatite, and rare olivine (totally replaced by iddingsite). Gabbro shows cumulate textures with (1) cumulus plagioclase-olivine and clinopyroxene oikocrysts or (2) cumulus plagioclase-clinopyroxene with plagioclase oikocrysts. In both cumulate rocks, magnetite/ilmenite is interstitial to clinopyroxene and plagioclase, and biotite is interstitial to Fe-oxides, plagioclase, and apatite. Secondary chlorite is present in both types of gabbro.

Gabbronorite contains plagioclase, orthopyroxene, clinopyroxene, and minor quartz, magnetite, ilmenite, biotite, and apatite. It displays cumulate textures with cumulus plagioclase-orthopyroxene-clinopyroxene, orthopyroxene±clinopyroxene oikocrysts, and interstitial quartz, magnetite/ilmenite, and biotite (generally associated with Fe-oxides). Metamorphic minerals include chlorite, talc, and sericite.

5.2. Geochemistry

The whole-rock major and trace element results for the studied gabbroic rocks from the Soisson Intrusive Suite are provided in Appendix B.

Gabbroic rocks are characterized by low to intermediate SiO_2 contents (59–40 wt.%), high TiO_2 (4.3–0.4 wt.%), Fe_2O_3t (21–8 wt.%), and CaO (14–4 wt.%) contents, low to intermediate MgO contents (14–3 wt.%), and low Mg numbers (Mg# = 100 x MgO/(MgO + Fe_2O_{3t}) in moles, 69–31). They also have low Cr (636–14 ppm) and Ni (1625–9 ppm) contents and are enriched in light rare earth elements (REE) relative to heavy REE (La/Yb_{pm} = 15–2.2; primitive mantle normalization from Sun and McDonough, 1989).

5.3. Mineral chemistry

The major element contents of olivine, clinopyroxene, orthopyroxene, plagioclase, and ilmenite in selected samples of olivine gabbro, gabbro and gabbronorite from the Soisson Intrusive Suite are provided in Appendices C to G.

Olivine gabbro contains olivine with Mg numbers (Mg#, where Mg# = 100 × Mg/(Mg + Fe^{2+})) ranging from 71 to 45. It hosts clinopyroxene with Mg# ranging from 82 to 67, Cr_2O_3 contents ranging from 0.63 to 0.005 wt.%, and Al_2O_3 contents ranging from 6.06 to 1.48 wt.% and orthopyroxene with Mg# ranging from 74 to 62, Cr_2O_3 contents ranging from 0.10 to 0.004 wt.%, and Al_2O_3 contents ranging from 1.13 to 0.01 wt.%. Plagioclase in these rocks ranges $An_{72–38}$ (where An = 100 × Ca/(Na + K + Ca)) and has K_2O contents included between 2.96 and 0.11 wt.%. Ilmenite has MgO contents ranging from 3.39 to 0.24 wt.%, V_2O_3 contents ranging from 0.59 to 0.02 wt.%, and MnO contents ranging from 1.40 to 0.28 wt.%.

Gabbro contains clinopyroxene with Mg# ranging from 78 to 68, Cr_2O_3 contents ranging from 0.33 to 0.01 wt.%, and Al_2O_3 contents ranging from 4.54 to 2.45 wt.%. Plagioclase ranges $An_{82–43}$ and has K_2O contents ranging from 0.56 to 0.12 wt.%. Furthermore, ilmenite has MgO contents ranging from 0.73 to 0.06 wt.%, V_2O_3 contents ranging from 0.25 to 0.02 wt.%, and MnO contents ranging from 1.00 to 0.69 wt.%.

Gabbronorite contains clinopyroxene with Mg# ranging from 69 to 54, Cr_2O_3 contents ranging from 0.10 to 0.004 wt.%, and Al_2O_3 contents ranging from 2.52 to 0.93 wt.% and orthopyroxene with Mg# ranging from 77 to 68, Cr_2O_3 contents ranging from 0.29 to 0.04 wt.%, and Al_2O_3 contents ranging from 3.77 to 1.41 wt.%. Plagioclase in these rocks ranges $An_{66–42}$ and has K_2O contents included between 0.75 and 0.25 wt.%. Ilmenite has MgO contents ranging from 0.40 to 0.01 wt.%, V_2O_3 contents ranging from 0.32 to 0.04 wt.%, and MnO contents ranging from 1.28 to 0.55 wt.%.

6. Conclusions

The Mesoproterozoic Soisson Intrusive Suite is composed of a series of kilometer-scale gabbroic intrusions trending NW-SE over ~180 km in the northwestern part of the Core Zone, within the southeastern Churchill Province. These gabbroic intrusions mostly comprise olivine gabbro, gabbro, gabbronorite, and norite with well-preserved cumulate textures. Olivine gabbro contains cumulus plagioclase-olivine±clinopyroxene±orthopyroxene, clinopyroxene±orthopyroxene±olivine oikocrysts, and interstitial magnetite, ilmenite, and biotite. It hosts olivine with $Mg\#_{71–45}$, clinopyroxene with $Mg\#_{82–67}$, orthopyroxene with $Mg\#_{74–62}$, plagioclase with $An_{72–38}$, and ilmenite with V_2O_3 contents included between 0.59 and 0.02 wt.%. Gabbro contains cumulus plagioclase-olivine and clinopyroxene oikocrysts or cumulus plagioclase-clinopyroxene with plagioclase oikocrysts. These rocks also contain interstitial magnetite, ilmenite, and biotite. Gabbro has clinopyroxene with $Mg\#_{78–68}$, plagioclase with $An_{82–43}$, and ilmenite with V_2O_3 contents ranging from 0.25 to 0.02 wt.%. Gabbronorite hosts cumulus plagioclase-orthopyroxene-clinopyroxene, orthopyroxene±clinopyroxene oikocrysts, and interstitial quartz, magnetite, ilmenite, and biotite. It contains clinopyroxene with $Mg\#_{69–54}$, orthopyroxene with $Mg\#_{77–68}$, plagioclase with $An_{66–42}$, and ilmenite with V_2O_3 contents ranging from 0.32 to 0.04 wt.%. All the gabbroic rocks of the Soisson Intrusive Suite have a mafic composition with low to intermediate SiO_2 and MgO contents and are characterized by an enrichment in light REE versus heavy REE.

The petrographic, geochemical, and mineral chemistry data of the samples from the Soisson intrusions presented in this report are used as geological framework complementing a more detailed study on the petrogenesis and emplacement of these intrusions in the Core Zone. The complete results of this study will be published in Sappin et al. (Canadian Journal of Earth Sciences, in press).

7. Acknowledgments

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8. References

Bédard, M.-P., Brind'Amour-Côté, C., Trépanier, S., and Bédard, F., 2020. Report of 2018-2019 exploration activities on the Soisson-NMEF project, southeastern Churchill Province, Nunavik, Quebec. Nunavik Mineral Exploration Fund; Ministère de l'Énergie et des Ressources naturelles, Québec, GM 71566, 78 p.

Charette, B., Lafrance, I., and Mathieu, G., 2016. Géologie de la région du lac Jeannin (SNRC 24B); Ministère de l'Énergie et des Ressources naturelles, Québec, BG 2015-01.

Corrigan, D., Pehrsson, S., Wodicka, N., and De Kemp, E., 2009. The Palaeoproterozoic Trans-Hudson Orogen: a prototype of modern accretionary processes; *in* Ancient Orogens and Modern Analogues, (ed.) J.B. Murphy, J.D. Keppie, and A.J. Hynes; Geological Society of London, Special Publications 327, p. 457–479. doi.org/10.1144/SP327.19.

Corrigan, D., van Rooyen, D., and Wodicka, N., 2021. Indenter tectonics in the Canadian Shield: A case study for Paleoproterozoic lower crust exhumation, orocline development, and lateral extrusion; Precambrian Research, v. 355. doi.org/10.1016/j.precamres.2020.106083.

Fleury, J.-P., 2016. Caractérisation des minéralisations en Ni-Cu±EGP associées à la Suite de Soisson, sud-est de la Province de Churchill, Québec; B.Sc. thesis, Université du Québec à Montréal, Montréal, Quebec, 32 p.

Houlé, M.G., Bédard, M.-P., McNicoll, V.J., Corrigan, D., and Huot, F., 2016. Report of activities for the Core Zone: Investigations of the mafic and ultramafic intrusive rocks of the Montagnais sills, northern Labrador Trough, Nunavik, Quebec; Geological Survey of Canada, Open File 7979, 12 p. doi:10.4095/297548.

Jarosewich, E., Nelen, J.A., and Norberg, J.A., 1980. Reference samples for electron microprobe analysis; Geostandards Newsletter, v. 4, p. 43–47. doi.org/10.1111/j.1751-908X.1980.tb00273.x.

Lafrance, I., Simard, M., and Bandyayera, D., 2014. Géologie de la région du lac Saffray (SNRC 24G-24F); Ministère des Ressources naturelles, Québec, RG 2014-02, 49 p.

Lafrance, I., Bandyayera, D., and Bilodeau, C., 2015. Géologie de la région du lac Henrietta (SNRC 24H); Ministère de l'Énergie et des Ressources naturelles, Québec, RG 2015-01, 62 p.

McKinnon-Matthews, J., Harris, B., Stollenwerk, M., Doherty, M., and McCall, L., 2001. The 2000-2001 exploration program on the Quebec 7 property; Ministère de l'Énergie et des Ressources naturelles, Québec, GM 59375, 1326 p.

Pérez, R.P., 2017. La Suite mafique-ultramafique de Nuvulialuk: une nouvelle séquence ophiolitique dans l'arrière-pays de la Zone Noyau du sud-est de la Province de Churchill (Québec); M.Sc. thesis, Université du Québec à Chicoutimi, Saguenay, Quebec, 169 p.

Sappin, A.-A., Houlé, M.G., Corrigan, D., Bédard, M.-P., Rayner, N., Wodicka, N., and Brind'Amour-Côté, C., in press. Petrography, chemical composition, and age constraints of the Mesoproterozoic Soisson mafic Intrusive Suite in the southeastern Churchill Province (Canada); Canadian Journal of Earth Sciences.

SIGÉOM, 2021. Système d'information géominière du Québec. Ministère de l'Énergie et des Ressources Naturelles. <http://sigeom.mines.gouv.qc.ca> [accessed June 15, 2021].

Smith, W.D., Maier, W.D., and Bliss, I., 2021. The geology, geochemistry, and petrogenesis of the Huckleberry Cu-Ni-PGE prospect in the Labrador Trough, Canada: Perspectives for regional prospectivity; Ore Geology Reviews, v. 128. doi.org/10.1016/j.oregeorev.2020.103905.

Sun, S.-S., and McDonough, W.F., 1989. Chemical and isotopic systematics of oceanic basalts: implications for mantle composition and processes; *in* Magmatism in the Ocean Basins, (ed.) A.D. Saunders and M.J. Norry; Geological Society of London, Special Publications 42, p. 313–345. doi.org/10.1144/GSL.SP.1989.042.01.19.

Wardle, R.J., James, D.T., Scott, D.J., and Hall, J., 2002. The southeastern Churchill Province: synthesis of a Paleoproterozoic transpressional orogen; Canadian Journal of Earth Sciences, v. 39, p. 639–663. doi.org/10.1139/e02-004.