A Metal Earth Atlas of Seismic Reflection and Magnetotelluric Transects Across the Superior Province

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Jack M. Simmons[a,b], John A. Ayer[a,b], Mostafa Naghizadeh[a,b], Ademola Q. Adetunji[a,b], David B. Snyder[b], Taus R.C. Jørgensen[a,b], Graham J. Hill[c], Eric A. Roots[a,b], and Saeid Cheraghi[a,b]

[a]Harquail School of Earth Sciences, Laurentian University, 935 Ramsey Lake Road, Sudbury, ON, Canada, P3E 2C6

[b]Metal Earth, Mineral Exploration Research Centre (MERC), Laurentian University, 935 Ramsey Lake Road, Sudbury, ON, Canada, P3E 2C6

[c]Institute of Geophysics, Czech Academy of Sciences, Prague, Czech Republic



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Cover image: Vibroseis trucks collecting seismic reflection data as part of the Metal Earth project.



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Foreword

The seismic reflection and magnetotelluric conductivity sections published in these folios were generated from geophysical data archived by the Metal Earth project, a CAD$104 million applied R&D program that commenced in March 2017. The project comprised a consortium of Canadian and international researchers from academia, government and industry, and was led by the Mineral Exploration Research Centre (MERC) at Laurentian University in Sudbury, Ontario, Canada. Funding consisted of CAD$49.2 million from the Canada First Research Excellence Fund (CFREF), CAD$5 million in funding from the Northern Ontario Heritage Fund Corporation (NOHFC), a CAD$1 million donation from the Harquail family's Midas Touch Foundation, and cash and in-kind contributions from private sector and government survey partners. Metal Earth used state-of-the-art equipment to transform our understanding of the processes responsible for metal endowment and ore localisation during Earth's early evolution, particularly within the Superior Province (or Superior Craton) of Canada. This included the collection of new seismic reflection and magnetotelluric data along 18 transects across the Superior Province, each with differential metal endowment and styles of mineralisation. The processed geophysical data from each transect have been standardised and are published here to facilitate assessments between regions with differential metal endowment. The unprocessed SEG-Y seismic data and magnetotelluric transfer functions for each transect can be downloaded from the 'Metal Earth Hub'. This is Metal Earth contribution number MERC-ME-2024-29.

Introduction

The >2.5 Ga Superior Province (or Superior Craton) of North America is the largest Archean craton on Earth (e.g., Percival et al. 2012). The province consists predominantly of east-west trending metamorphosed volcanic-plutonic terranes or subprovinces that are variably bound by curvilinear metasedimentary belts (Percival et al. 2012; Frieman et al. 2017; Cleven et al. 2020; Rehm et al. 2021). The volcanic-plutonic terranes, in particular the Abitibi and Uchi subprovinces, are host to numerous world-class mineral deposits, including orogenic and intrusion-related gold, volcanogenic massive sulfide (VMS), and magmatic nickel-copper deposits (Dubé et al. 2004; Percival 2007; Monecke et al. 2017). Many of these deposits are spatially associated with crustal-scale fault zones (Harris et al. 2023), which typically define contacts between metavolcanic and metasedimentary assemblages (e.g., Porcupine–Destor–Manneville fault zone, Abitibi subprovince) or boundaries between subprovinces (e.g., Cadillac–Larder Lake fault zone, Abitibi–Pontiac subprovince boundary; Poulsen 2017). Transect research across these structural belts, which formed an integral part of the CAD$104 million Metal Earth R&D project, aimed to identify the processes responsible for differential metal endowment between Archean greenstone belts with otherwise indistinguishable geological characteristics (Eshaghi et al. 2019). To that end, new and existing geological, geochemical, and geophysical data from greenstone belts and subprovinces (Abitibi, Wabigoon, and Uchi subprovinces) of the Superior Province was integrated to produce 18 crustal-scale sections that highlight the crustal architecture and signatures potentially related to metal endowment (**Figure 1**; e.g., Eshaghi et al. 2019; Naghizadeh et al. 2019, 2022; Mathieu et al. 2020; Haugaard et al. 2021; Hill et al. 2021; Zhou et al. 2021; Jørgensen et al. 2022; Roots et al. 2022, 2024; Adetunji et al. 2023; Smith et al. 2023).

Metal Earth commissioned the collection of new seismic reflection and magnetotelluric data in order to improve our understanding of the structure of the upper to lower crust and to identify the pathways along which the constituents of critical minerals migrated. SAExploration Ltd. subsequently collected deep seismic reflection data along transects across the Superior Province in late 2017, using Vibroseis trucks (AHV-IV 364 Commanders), receivers with a 5-Hz response (10 dB down), and a source sweep signal starting at 2 Hz, sweeping up to 150 or 200 Hz (**Table 1**; Naghizadeh et al. 2019). This seismic signal typically provides resolution of tens of meters in the shallow crust to hundreds of meters in the deep crust. Passive seismic data was also collected along select transects to facilitate comparisons between seismic methods (see Naghizadeh et al. (2022) for passive seismic data interpretation of the Larder Lake transect). Broadband magnetotelluric (BBMT) and audio-frequency magnetotelluric (AMT) stations were deployed along each Metal Earth seismic line by Complete MT Solutions. Quantec Geosciences also deployed BBMT stations along existing seismic lines that were commissioned as part of the Lithoprobe (Line WS2B Red Lake) and Discover Abitibi (Line 7 Crawchest and Line 6 South Timmins) projects. Supplemental data from existing MT surveys was also incorporated to provide improved constraints for 3-D modelling (**Table 1**).

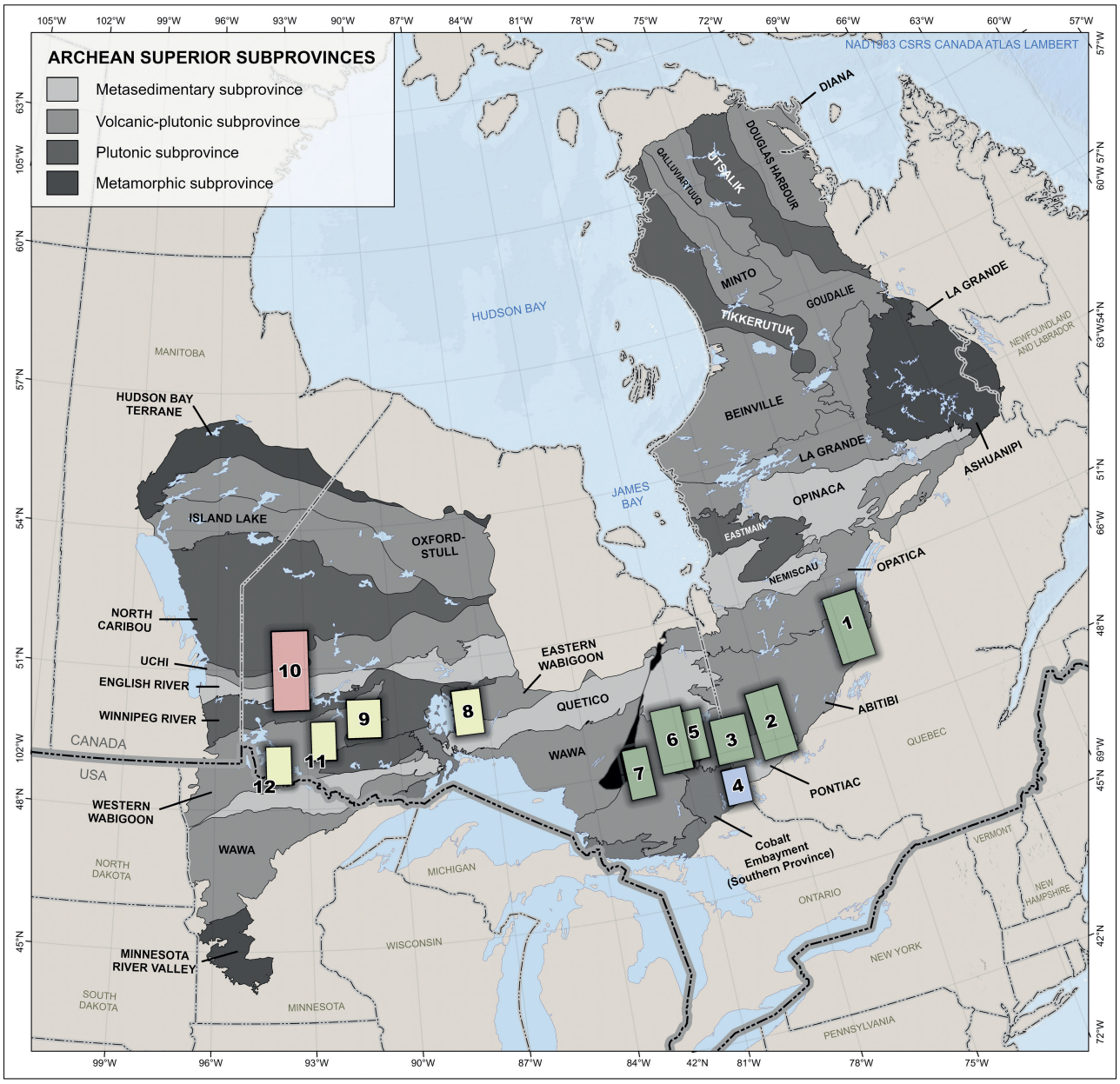
Figure 1. Reference map for the Archean Superior Province in North America (coordinate system: NAD1983 CSRS Canada Atlas Lambert Projection). Map data sourced from Stott et al. (2010), Stott (2011), and Montsion et al. (2018).

Each folio (chapter) within this publication provides an overview of a Metal Earth geological-geophysical transect and presents geologic maps (lithology and assemblage maps) that locate the seismic reflection lines and magnetotelluric measurement sites within each area. Reflection sections were prepared from SEG-Y digital data and (2-D) depth migrated stacked data, and filtered consistently for all the transects. Conductivity sections were similarly prepared as a section from within a 3-D conductivity model and visualised using the same color scale. The reader is referred to articles cited within this publication for further details concerning the processing of seismic reflection and magnetotelluric data. No interpretations of the geophysical sections are included, although supportive geological data is provided for each composite geological-geophysical section.

Data source

The SEG-Y seismic data and magnetotelluric transfer functions for each geophysical transect can be sourced from the 'Metal Earth Hub'.

https://metalearth.geohub.laurentian.ca.



ABITIBI SUBPROVINCE & SOUTHERN PROVINCE

1. Chibougamau transect
a–a' R1 seismic section
A–A' Broadband MT section

2. Chicobi and Malartic transects
b–b' R2 seismic section
B–B' AMT section
c–c' R1 seismic section
C–C' Broadband MT section

3. Rouyn-Noranda and Larder Lake transects
d–d' R1 seismic section
D–D' Broadband MT section
e–e' R1 seismic section
E–E' Broadband MT section

4. Cobalt transect
f–f' R1 seismic section
F–F' Broadband MT section

5. Matheson transect
g–g' R1 seismic section
G–G'Broadband MT section

6. Crawchest and Timmins transects
h–h' R1 seismic section
H–H' Broadband MT section
i–i' R1 seismic section
I–I' Broadband MT section

7. South Swayze and Swayze transects
j–j' R2 seismic section
J–J' AMT section
k–k' R1 seismic section
K–k' Broadband MT section

WABIGOON SUBPROVINCE & UCHI SUBPROVINCE

8. South Geraldton and North Geraldton transects
l–l' R1 seismic section
L–L' Broadband MT section
m–m' R1 seismic section
M–M' Broadband MT section

9. Stugeon Lake transect
n–n' R1 seismic section
N–N' Broadband MT section

10. Red Lake transect
o–o' R1 seismic section
O–O' Broadband MT section

11. Dryden and North Dryden transects
p–p' R1 seismic section
P–P' Broadband MT section
q–q' R2 seismic section
Q–Q' AMT section

12. Rainy River transect
r–r' R1 seismic section
R–R' Broadband MT section

Table 1. Summary of Metal Earth seismic and magnetotelluric transects across the Superior Province.

	Folio	Metal Earth transect	Geological subprovince(s)	Deposits/Mines	Seismic transect information				Magnetotelluric transect information			
					Seismic line no.	Crooked length (km)	Processed length (km)	Reflection data type	Length (km)	Metal Earth # MT sites (BBMT, AMT)	# sites inverted (BBMT, AMT)	3D conduct. mode
QUEBEC, CANADA	1	Chibougamau	Abitibi, Opatica	Chapais Cu–Au, Joe Mann Au–Cu, Corner Bay Cu–Au, Scott VMS	LN111	130	122	R1	170	54, 31	54, 0	ModEM
	2	Chicobi	Abitibi	N/A	LN372	12	12	R2	12	0, 16	0, 16	HEXMT
	2	Malartic	Abitibi, Pontiac	Canadian Malartic Au	LN131	85	83	R1	163	24, 16	24, 16	ModEM
	3	Rouyn-Noranda	Abitibi, Pontiac	Horne and Quemont VMS, Amulet VMS, Millenbach VMS, Granada Au, Duparquet Au	LN141	85	51	R1	95	15, 0	112, 0	HEXMT
ONTARIO, CANADA	4	Larder Lake	Abitibi	Upper Canada Au, Kerr-Addison Au	LN321	49	41	R1	44	26, 15	33, 15	HEXMT
	5	Cobalt	Southern Province, Abitibi	Multiple Ag-Co deposits	LN391	46	35	R1	41	7, 0 7, 32	25, 30 7, 31	ModEM HEXMT (not used)
	6	Matheson	Abitibi	Clavos Au, Taylor Au	LN261	54	45	R1	83	32, 40	32, 40	HEXMT
	7	Crawchest	Abitibi	Hoyle Pond Au, Pamour Au, Nighthawk Au	LN7 Discover Abitibi	153 (4 lines Discover Abitibi)	50	R1	143	80, 0	80, 0	ModEM
	7	Timmins	Abitibi	Hollinger Au, Dome Au, Kidd Creek VMS, Crawford Ni-Cu	LN8 Discover Abitibi		60	R1	143			ModEM
	8	East Swayze	Abitibi	Joburke Au	LN252	12	12	R2	12	15, 15	15, 14	ModEM
	8	Swayze	Abitibi	Jerome Au	LN241	89	80	R1	130	58, 34	49, 0	ModEM
	9	South Geraldton	Quetico, Eastern Wabigoon	Dikdik Au	LN301	>95	42	R1	55	62, 26	48, 0	ModEM
	9	North Geraldton	Eastern Wabigoon	N/A	LN311		53	R1	53			ModEM
	10	Sturgeon Lake	Winnipeg River, Western Wabigoon	F Group VMS, Mattabi VMS, Sturgeon Lake VMS	LN331	73	71	R1	74	16, 0	16, 0	ModEM
	11	Red Lake	Winnipeg River, English River, Uchi, North Caribou Core	Campbell-Red Lake Au, Great Bear Au	WS2B Lithoprobe	228	215	R1	169	45, 0	50, 0	ModEM
	12	Dryden	Western Wabigoon	N/A	LN341	74	61	R1	83	60, 28	34, 0	ModEM
	12	North Dryden	Western Wabigoon	Goliath Au	LN341	7	7	R2	7	0, 23	0, 23	ModEM
	13	Rainy River	Western Wabigoon	Rainy River Cu–Au	LN361	33	33	R1	68	24, 18	24, 18	ModEM

Useful references

Adetunji, A.Q., Launay, G., Ferguson, I.J., Simmons, J.M., Ma, C., Ayer, J., and Lafrance, B. 2023. Crustal conductivity footprint of a world-class orogenic gold district in the Red Lake Greenstone Belt, western Superior Craton. Geology, **51**: 377–382. doi:https://doi.org/10.1130/G50660.1.

Cleven, N.R., Guilmette, C., Davis, D.W., and Côté-Roberge, M. 2020. Geodynamic significance of Neoarchean metasedimentary belts in the Superior Province: Detrital zircon U-Pb LA-ICP-MS geochronology of the Opinaca and La Grande subprovinces. Precambrian Research, **347**: 105819. doi:https://doi.org/10.1016/j.precamres.2020.105819.

Dubé, B., Williamson, K., McNicoll, V., Malo, M., Skulski, T., Twomey, T., and Sanborn-Barrie, M. 2004. Timing of gold mineralization at Red Lake, Northwestern Ontario, Canada: New constraints from U-Pb geochronology at the Goldcorp high-grade zone, Red Lake mine, and the Madsen mine. Economic Geology, **99**: 1611–1641. doi:https://doi.org/10.2113/gsecongeo.99.8.1611.

Eshaghi, E., Smith, R., Naghizadeh, M., Hill, G., Roots, E., Ghahfarokhi, A.M., Cheraghi, S., and Ayer, J. 2019. Metal Earth: Role of multidisciplinary geophysical methods to improve knowledge of mineral deposition across Precambrian rocks. ASEG Extended Abstracts, **2019**: 1–4.

Frieman, B.M., Kuiper, Y.D., Kelly, N.M., Monecke, T., and Kylander-Clark, A. 2017. Constraints on the geodynamic evolution of the southern Superior Province: U-Pb LA-ICP-MS analysis of detrital zircon in successor basins of the Archean Abitibi and Pontiac subprovinces of Ontario and Quebec, Canada. Precambrian Research, **292**: 398–416. doi:https://doi.org/10.1016/j.precamres.2017.01.027.

Harris, J.R., Ayer, J., Naghizadeh, M., Smith, R., Snyder, D., Behnia, P., Parsa, M., Sherlock, R., and Trivedi, M. 2023. A study of faults in the Superior Province of Ontario and Quebec using the random forest machine learning algorithm: Spatial relationship to gold mines. Ore Geology Reviews, **157**: 105403. doi:https://doi.org/10.1016/j.oregeorev.2023.105403.

Haugaard, R., Della Justina, F., Roots, E.A., Cheraghi, S., Vayavur, R., Hill, G., Snyder, D.B., Ayer, J., Naghizadeh, M., and Smith, R. 2021. Crustal-scale geology and fault geometry along the gold-endowed Matheson transect of the Abitibi greenstone belt. Economic Geology, **116**: 1053–1072. doi:https://doi.org/10.5382/econgeo.4813.

Hill, G.J., Roots, E.A., Frieman, B.M., Haugaard, R., Craven, J.A., Smith, R.S., Snyder, D.B., Zhou, X., and Sherlock, R. 2021. On Archean craton growth and stabilisation: Insights from lithospheric resistivity structure of the Superior Province. Earth and Planetary Science Letters, **562**: 116853. doi:https://doi.org/10.1016/j.epsl.2021.116853.

Jørgensen, T.R.C., Gibson, H.L., Roots, E.A., Vayavur, R., Hill, G.J., Snyder, D.B., and Naghizadeh, M. 2022. The implications of crustal architecture and transcrustal upflow zones on the metal endowment of a world-class mineral district. Scientific Reports, **12**: 14710. doi:https://doi.org/10.1038/s41598-022-18836-y.

Mathieu, L., Snyder, D.B., Bedeaux, P., Cheraghi, S., Lafrance, B., Thurston, P., and Sherlock, R. 2020. Deep into the Chibougamau area, Abitibi Subprovince: structure of a Neoarchean crust revealed by seismic reflection profiling. Tectonics, **38**: e2020TC006223. doi:https://doi.org/10.1029/2020TC006223.

Monecke, T., Mercier-Langevin, P., Dubé, B., and Hannington, M.D. 2017. Archean base and precious metal deposits, southern Abitibi greenstone belt, Canada. *In* Archean Base and Precious Metal Deposits, Southern Abitibi Greenstone Belt, Canada. *Edited by* T. Monecke, P. Mercier-Langevin, and B. Dubé. Reviews in Economic Geology. doi:https://doi.org/10.5382/Rev.19.

Montsion, R.M., Thurston, P., and Ayer, J. 2018. 1:2,000,000 Scale Geological Compilation of the Superior Craton - Version 1. Laurentian University Mineral Exploration Research Centre (MERC) **ME-2018-017**.

Naghizadeh, M., Snyder, D., Cheraghi, S., Foster, S., Cilensek, S., Floreani, E., and Mackie, J. 2019. Acquisition and processing of wider bandwidth seismic data in crystalline crust: Progress with the Metal Earth project. Minerals, **9**: 145. doi:https://doi.org/10.3390/min9030145.

Naghizadeh, M., Smith, R., Rubingh, K., Sherlock, R., Ayer, J., Lafrance, B., Cheraghi, S., Snyder, D.B., Vergne, J., Hollis, D., and Mordret, A. 2022. Active and passive seismic imaging of the Central Abitibi greenstone belt, Larder Lake, Ontario. Journal of Geophysical Research: Solid Earth, **127**: e2021JB022334. doi:https://doi.org/10.1029/2021JB022334.

Percival, J.A. 2007. Geology and metallogeny of the Superior Province, Canada. *In* Mineral Deposits of Canada: A Synthesis of Major Deposit-Types, District Metallogeny, the Evolution of Geological Provinces, and Exploration Methods. *Edited by* W.D. Goodfellow. Geological Association of Canada, Mineral Deposits Division, Special Publication. pp. 903–928.

Percival, J.A., Skulski, T., Sanborn-Barrie, M., Stott, G.M., Leclair, A.D., Corkery, M.T., and Boily, M. 2012. Geology and tectonic evolution of the Superior Province, Canada. *In* Tectonic Styles in Canada: The Lithoprobe Perspective. *Edited by* J.A. Percival, F.A. Cook, and R.M. Clowes. Geological Association of Canada. pp. 321–378.

Poulsen, K.H. 2017. The Larder Lake-Cadillac break and its gold districts. *In* Archean Base and Precious Metal Deposits, Southern Abitibi Greenstone Belt, Canada. *Edited by* T. Monecke, P. Mercier-Langevin, and B. Dubé. Reviews in Economic Geology. doi:https://doi.org/10.5382/Rev.19.05.

Rehm, A.G., Jørgensen, T.R.C., Thurston, P.C., Gibson, H.L., and Lafrance, B. 2021. Synsedimentary rifting and basaltic-komatiitic volcanism in the Pontiac subprovince, Superior Craton (Canada): Implications for Neoarchean geodynamics. Precambrian Research, **362**: 106204. doi:https://doi.org/10.1016/j.precamres.2021.106204.

Roots, E.A., Friedman, B.M., Hill, G.J., Smith, R.S., Craven, J.A., Calvert, A.J., and Snyder, D.B. 2024. Constraints on Growth and Stabilization of the Western Superior Craton from Inversion of Magnetotelluric Data. Tectonics, **43**: e2023TC008110. doi:https://doi.org/10.1029/2023TC008110.

Roots, E.A., Hill, G.J., Frieman, B.M., Wannamaker, P.E., Maris, V., Calvert, A.J., Craven, J.A., Smith, R.S., and Snyder, D.B. 2022. Magmatic, hydrothermal and ore element transfer processes of the southeastern Archean Superior Province implied from electrical resistivity structure. Gondwana Research, **105**: 84–95. doi:https://doi.org/10.1016/j.gr.2021.12.004.

Smith, R.S., Naghizadeh, M., Cheraghi, S., Adetunji, A., Vayavur, R., Eshaghi, E., Hill, G.J., Snyder, D., Roots, E.A., and Justina, F.D. 2023. Geophysical transects in the Abitibi greenstone belt of Canada from the mineral-exploration-oriented Metal Earth project. The Leading Edge, **42**: 245—255. doi:https://doi.org/10.1190/tle42040245.1.

Stott, G.M. 2011. A revised terrane subdivision of the Superior Province in Ontario. Ontario Geological Survey (OGS), Miscellaneous Release-Data **MRD278**.

Stott, G.M., Corkery, M.T., Percival, J.A., Simard, M., and Goutier, J. 2010. A Revised Terrane Subdivision of the Superior Province. *In* Summary of Field Work and Other Activities 2010. Ontario Geological Survey (OGS), Open File Report **OFR6260**.

Zhou, X., Lafrance, B., Naghizadeh, M., Snyder, D.B., Adetunji, A.Q., Vayavur, R., Hamilton, M.A., and Ayer, J.A. 2021. Crustal architecture and structural evolution of a Neoarchean sedimentary basin: geological and geophysical evidence from Metal Earth Chicobi transect in the Abitibi subprovince, Superior Province, Quebec, Canada. Precambrian Research, **365**: 106391. doi:https://doi.org/10.1016/j.precamres.2021.106391.

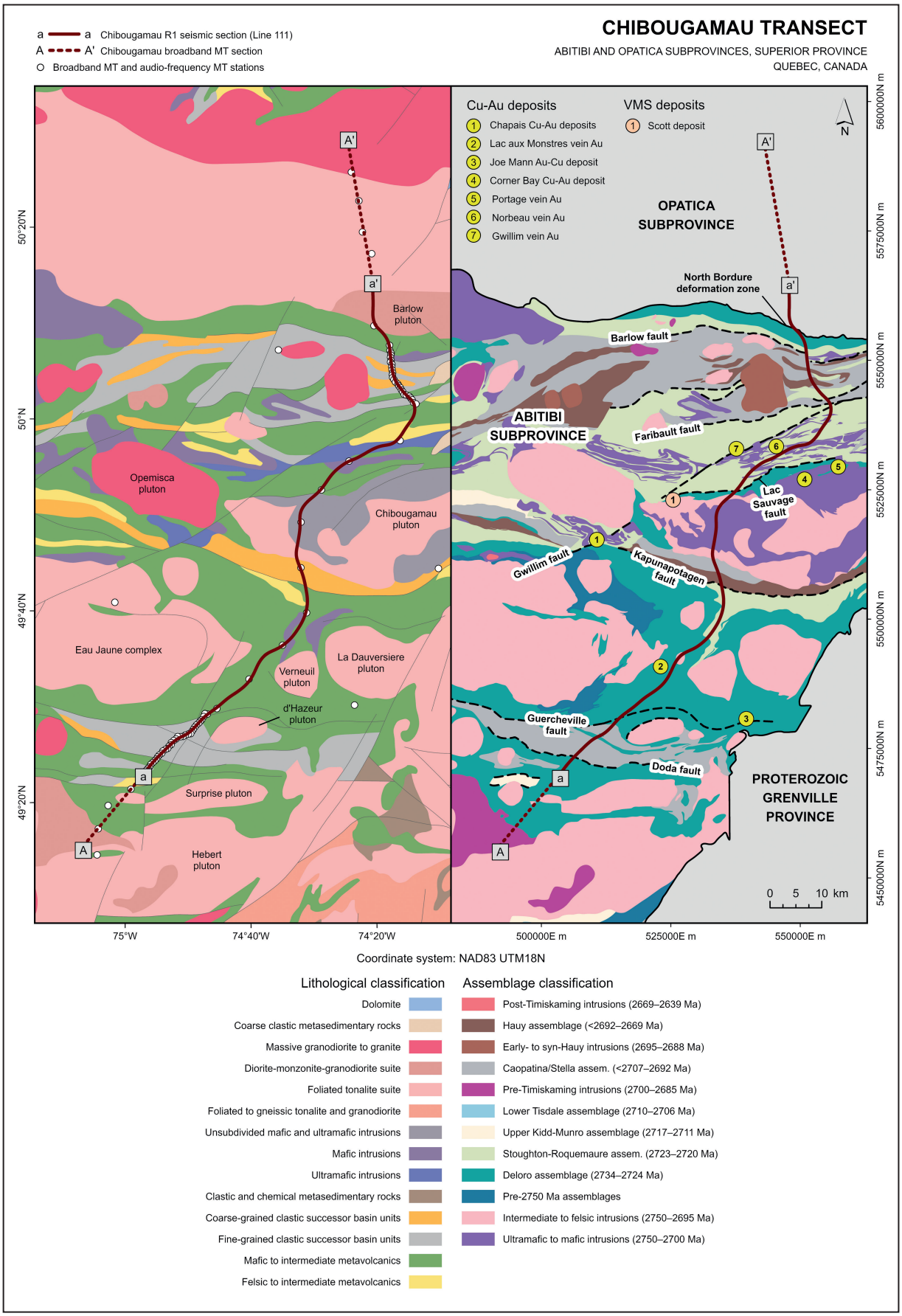
Folio 1
Chibougamau transect

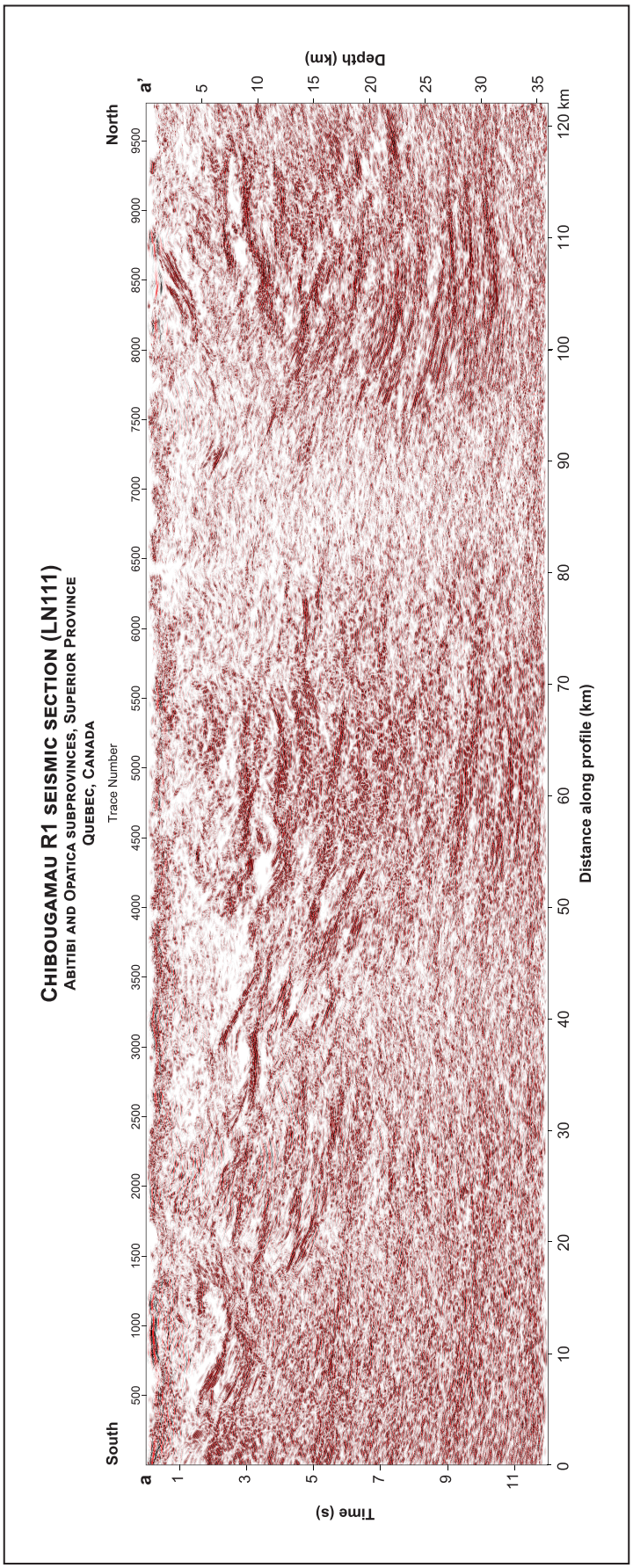
The ~170-km Chibougamau transect [A–A'] is located in central Quebec, extending northward from the Herbert pluton and the northeast Abitibi subprovince [A], across the Barlow fault and the North Bordure deformation zone (an east-west deformation zone that locally bounds the Abitibi subprovince and volcano-plutonic belts of the Opatica subprovince), into plutonic suites of the Opatica subprovince [A'; **Figure 2**]. The transect encompasses ~130 km of new R1 seismic reflection data [a–a'; line 111] that traverses multiple magmatic-hydrothermal systems, metavolcanic assemblages (2734–2724 Ma Deloro and 2723–2720 Ma Stoughton-Roquemaure assemblages), mafic to felsic plutonic suites, and fault-bound metasedimentary belts (2707–2692 Ma Caopatina/Stella, and 2692–2669 Ma Hauy assemblages) of the Chibougamau greenstone belt. BBMT stations were also deployed along the entire transect [A–A'], including the a–a' Chibougamau R1 seismic survey line, resulting in a conductivity section that traverses the Chibougamau-Chapais mining camp and the interpreted boundary between the Abitibi and Opatica subprovinces.

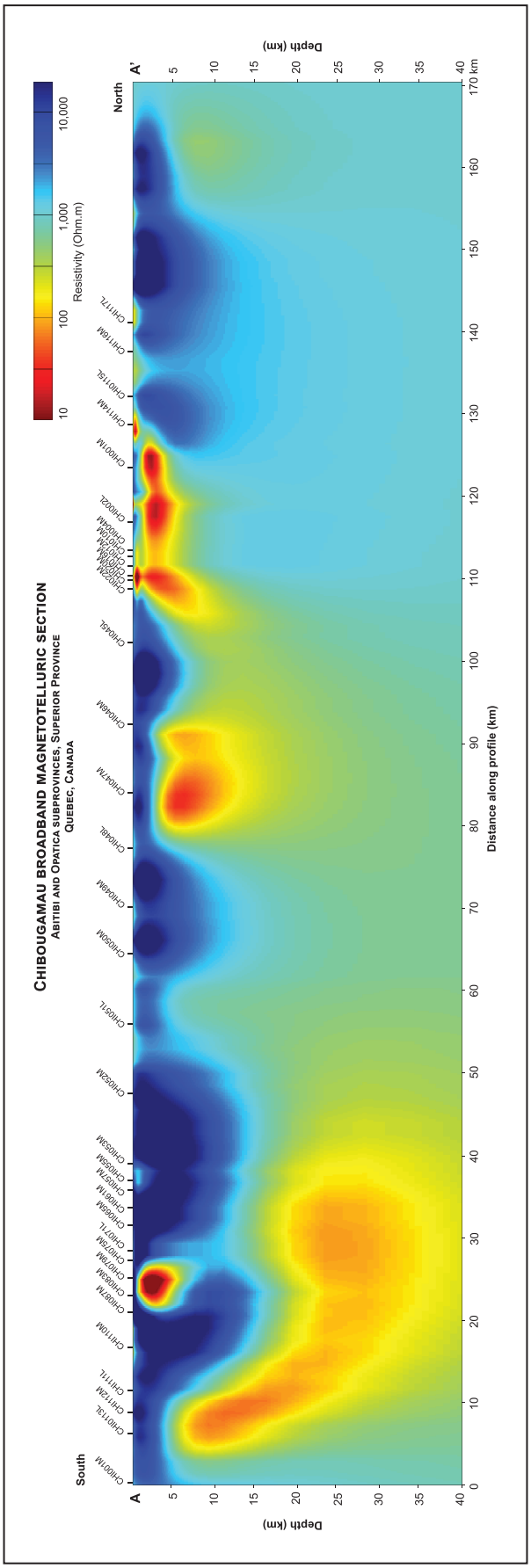
The Chibougamau-Chapais mining camp is host to a variety of mineral deposits and styles of mineralisation, including Fe-Ti-V and Ni-Cu-PGE deposits associated with mafic-ultramafic complexes, VMS deposits (e.g., Lemoine and Scott deposits; Guha et al. 1988; Saunders and Allard 1990), Cu–Au magmatic-hydrothermal deposits (Central Camp and Corner Bay deposit; Mathieu and Racicot 2019), and late shear zone-hosted Au deposits (e.g., Joe Mann and Norbeau deposits; Dube et al. 1989; Leclerc et al. 2012). These deposits produced 85.7 million metric tonnes (Mt) of ore from 1953 to 2008 (1.57 Mt Cu, 176.1 t Au, 108.8 t Ag, and 72,066 t Zn; Guha et al. 1988; Leclerc et al. 2012) and are spatially associated with major faults of the Chibougamau greenstone belt. The Chibougamau R1 seismic reflection and BBMT data provides new insights into the conductivity anomalies of these gold-endowed regional-scale structures and their relationship to Cu–Au endowed plutons (e.g., Chibougamau pluton). These datasets and processed composite sections also help resolve the geometry of crustal-scale features across the Chibougamau greenstone belt (including the dip and depth extent of the Barlow fault) and facilitate comparisons with world-class gold and VMS deposits of the southern Abitibi subprovince (see Folio 2: Chicobi and Malartic, Folio 3: Rouyn-Noranda, Folio 4: Larder Lake, and Folio 7: Crawchest and Timmins transects).

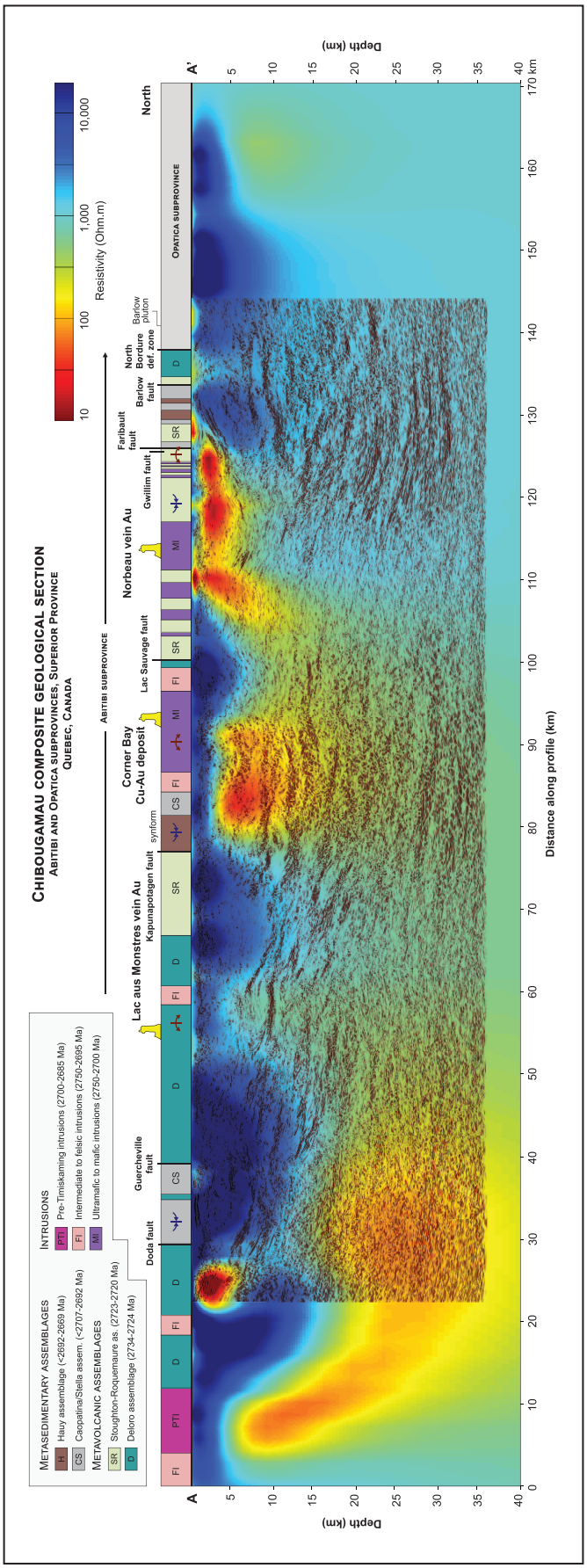
The reader is referred to publications by Mathieu et al. (2020), Bedeaux et al. (2021), and Cheraghi et al. (2021) for interpretations of the Chibougamau R1 seismic data [a–a'] and Maleki et al. (2021) for interpretations of gravity and magnetic data collected along the Chibougamau transect. Refer to Harris et al. (2022) for gold prospectivity maps of the Chibougamau region.

Figure 2. Geological maps of the Chibougamau greenstone belt (northeast Abitibi subprovince) in central Quebec, showing the locations of the Chibougamau R1 seismic [a–a'; line 111] and BBMT [A–A'] sections with respect to major fault systems and mineral deposits. Map data sourced from the Metal Earth compilations of Montsion et al. (2018; lithological data) and Jørgensen and Gibson (2024; assemblage data).


a a Chibougamau R1 seismic section (Line 111)
A A' Chibougamau broadband MT section
Broadband MT and audio-frequency MT stations
CHIBOUGAMAU TRANSECT
ABITIBI AND OPATICA SUBPROVINCES, SUPERIOR PROVINCE
QUEBEC, CANADA
Cu-Au deposits
1 Chapais Cu-Au deposits
2 Lac aux Monstres vein Au
3 Joe Mann Au-Cu deposit
4 Corner Bay Cu-Au deposit
5 Portage vein Au
6 Norbeau vein Au
7 Gwillim vein Au
VMS deposits
1 Scott deposit
N
OPATICA SUBPROVINCE
ABITIBI SUBPROVINCE
PROTEROZOIC GRENVILLE PROVINCE
North Bordure deformation zone
Barlow fault
Faribault fault
Lac Sauvage fault
Gwillim fault
Kapunapotagen fault
Guercheville fault
Doda fault
Barlow pluton
Opemisca pluton
Chibougamau pluton
Eau Jaune complex
Verneuil pluton
La Dauversiere pluton
d'Hazeur pluton
Surprise pluton
Hebert pluton
A
A'
a
a'
50°20'N
50°N
49°40'N
49°20'N
75°W
74°40'W
74°20'W
500000E m
525000E m
550000E m
5600000N m
5575000N m
5550000N m
5525000N m
5500000N m
5475000N m
5450000N m
0 5 10 km
Coordinate system: NAD83 UTM18N
Lithological classification
Dolomite
Coarse clastic metasedimentary rocks
Massive granodiorite to granite
Diorite-monzonite-granodiorite suite
Foliated tonalite suite
Foliated to gneissic tonalite and granodiorite
Unsubdivided mafic and ultramafic intrusions
Mafic intrusions
Ultramafic intrusions
Clastic and chemical metasedimentary rocks
Coarse-grained clastic successor basin units
Fine-grained clastic successor basin units
Mafic to intermediate metavolcanics
Felsic to intermediate metavolcanics
Assemblage classification
Post-Timiskaming intrusions (2669–2639 Ma)
Hauy assemblage (<2692–2669 Ma)
Early- to syn-Hauy intrusions (2695–2688 Ma)
Caopatina/Stella assem. (<2707–2692 Ma)
Pre-Timiskaming intrusions (2700–2685 Ma)
Lower Tisdale assemblage (2710–2706 Ma)
Upper Kidd-Munro assemblage (2717–2711 Ma)
Stoughton-Roquemaure assem. (2723–2720 Ma)
Deloro assemblage (2734–2724 Ma)
Pre-2750 Ma assemblages
Intermediate to felsic intrusions (2750–2695 Ma)
Ultramafic to mafic intrusions (2750–2700 Ma)


CHIBOUGAMAU R1 SEISMIC SECTION (LN111)
ABITIBI AND OPATICA SUBPROVINCES, SUPERIOR PROVINCE
QUEBEC, CANADA
South
North
a
a'
Trace Number
Time (s)
Depth (km)
Distance along profile (km)
120 km


CHIBOUGAMAU BROADBAND MAGNETOTELLURIC SECTION
ABITIBI AND OPATICA SUBPROVINCES, SUPERIOR PROVINCE
QUEBEC, CANADA
Resistivity (Ohm.m)
10
100
1,000
10,000
South
North
A
A'
Depth (km)
Distance along profile (km)
0
5
10
15
20
25
30
35
40
170 km
120
130
140
150
160


CHIBOUGAMAU COMPOSITE GEOLOGICAL SECTION
ABITIBI AND OPATICA SUBPROVINCES, SUPERIOR PROVINCE
QUEBEC, CANADA
METASEDIMENTARY ASSEMBLAGES
H Hauy assemblage (<2692-2669 Ma)
CS Caopatina/Stella assem. (<2707-2692 Ma)
SR Stoughton-Roquemaure as. (2723-2720 Ma)
D Deloro assemblage (2734-2724 Ma)
INTRUSIONS
PTI Pre-Timiskaming intrusions (2700-2685 Ma)
FI Intermediate to felsic intrusions (2750-2695 Ma)
MI Ultramafic to mafic intrusions (2750-2700 Ma)
ABITIBI SUBPROVINCE
OPATICA SUBPROVINCE
Resistivity (Ohm.m)
10
100
1,000
10,000
Doda fault
Guercheville fault
Lac aus Monstres vein Au
Kapunapotagen fault
synform
Corner Bay Cu-Au deposit
Lac Sauvage fault
Norbeau vein Au
Gwillim fault
Faribault fault
Barlow fault
North Bordure def. zone
Barlow pluton
North
A
A'
Depth (km)
Distance along profile (km)
170 km

Useful references

Bedeaux, P., Brochu, A., Mathieu, L., Gaboury, D., and Daigneault, R. 2021. Structural analysis and metamorphism of the Barlow Fault Zone, Chibougamau area, Neoarchean Abitibi Subprovince: implications for gold mineralization. Canadian Journal of Earth Sciences, **58**: 554–571. doi:https://doi.org/10.1139/cjes-2020-0048.

Cheraghi, S., Malehmir, A., Naghizadeh, M., Snyder, D., Mathieu, L., and Bedeaux, P. 2021. Seismic imaging across fault systems in the Abitibi greenstone belt–an analysis of pre-and post-stack migration approaches in the Chibougamau area, Quebec, Canada. Solid Earth Discussions, **12**: 1–36. doi:https://doi.org/10.5194/se-12-1143-2021.

Dube, B., Poulsen, H., and Guha, J. 1989. The effects of layer anisotropy on auriferous shear zones; the Norbeau Mine, Quebec. Economic Geology, **84**: 871–878. doi:https://doi.org/10.2113/gsecongeo.84.4.871.

Guha, J., Dubé, B., Pilote, P., Chown, E.H., Archambault, G., and Bouchard, G. 1988. Gold mineralization patterns in relation to the lithologic and tectonic evolution of the Chibougamau mining district, Quebec, Canada. Mineralium Deposita, **23**: 293–298. doi:https://doi.org/10.1007/BF00206410.

Harris, J.R., Naghizadeh, M., Behnia, P., and Mathieu, L. 2022. Data-driven gold potential maps for the Chibougamau area, Abitibi greenstone belt, Canada. Ore Geology Reviews, **150**: 105176. doi:https://doi.org/10.1016/j.oregeorev.2022.105176.

Jørgensen, T.R.C. and Gibson, H.L. 2024. Assemblage compilation of the Abitibi subprovince, Superior Province, Canada. Metal Earth Project, Mineral Exploration Research Centre. https://metalearth.files.com/f/81ca7963c83475a6

Leclerc, F., Harris, L.B., Bédard, J.H., Van Breemen, O., and Goulet, N. 2012. Structural and stratigraphic controls on magmatic, volcanogenic, and shear zone-hosted mineralization in the Chapais-Chibougamau mining camp, Northeastern Abitibi, Canada. Economic Geology, **107**: 963–989. doi:https://doi.org/10.2113/econgeo.107.5.963.

Maleki, A., Smith, R., Eshaghi, E., Mathieu, L., Snyder, D., and Naghizadeh, M. 2021. Potential-field modelling of the prospective Chibougamau area (northeastern Abitibi subprovince, Quebec, Canada) using geological, geophysical, and petrophysical constraints. Canadian Journal of Earth Sciences, **58**: 297–312. doi:https://doi.org/10.1139/cjes-2019-0221.

Mathieu, L. and Racicot, D. 2019. Petrogenetic study of the multiphase Chibougamau Pluton: Archaean magmas associated with Cu–Au magmato-hydrothermal systems. Minerals, **9**: 174. doi:https://doi.org/10.3390/min9030174.

Mathieu, L., Snyder, D.B., Bedeaux, P., Cheraghi, S., Lafrance, B., Thurston, P., and Sherlock, R. 2020. Deep into the Chibougamau area, Abitibi Subprovince: structure of a Neoarchean crust revealed by seismic reflection profiling. Tectonics, **39**: e2020TC006223. doi:https://doi.org/10.1029/2020TC006223.

Montsion, R.M., Thurston, P., and Ayer, J. 2018. 1:2,000,000 Scale Geological Compilation of the Superior Craton - Version 1. Laurentian University Mineral Exploration Research Centre (MERC) **ME-2018-017**.

Saunders, J.A. and Allard, G.O. 1990. The Scott Lake deposit: a contact-metamorphosed volcanogenic massive sulfide deposit, Chibougamau area, Quebec. Canadian Journal of Earth Sciences, **27**: 180–186. doi:https://doi.org/10.1139/e90-018.

Folio 2

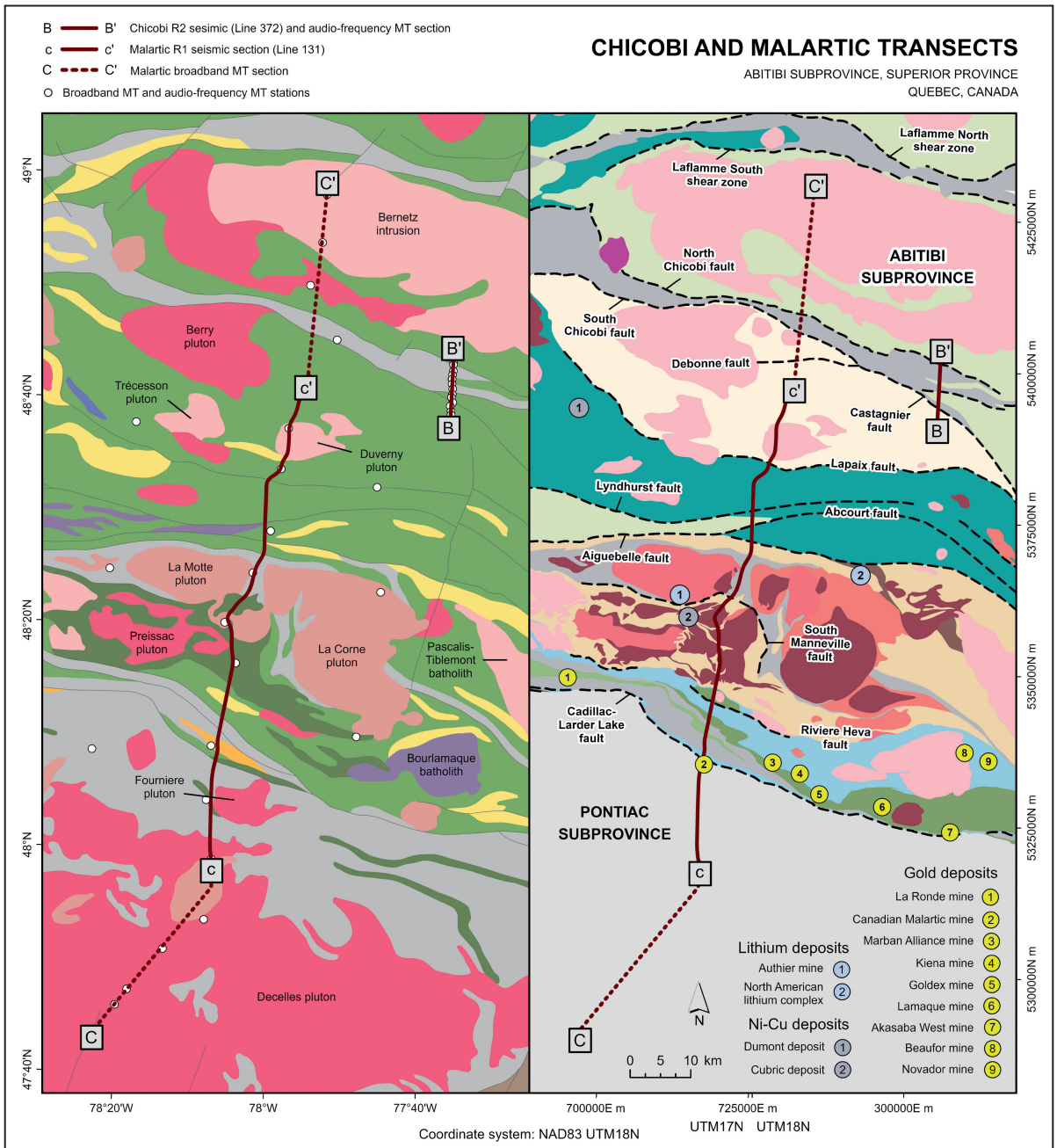
Chicobi and Malartic transects

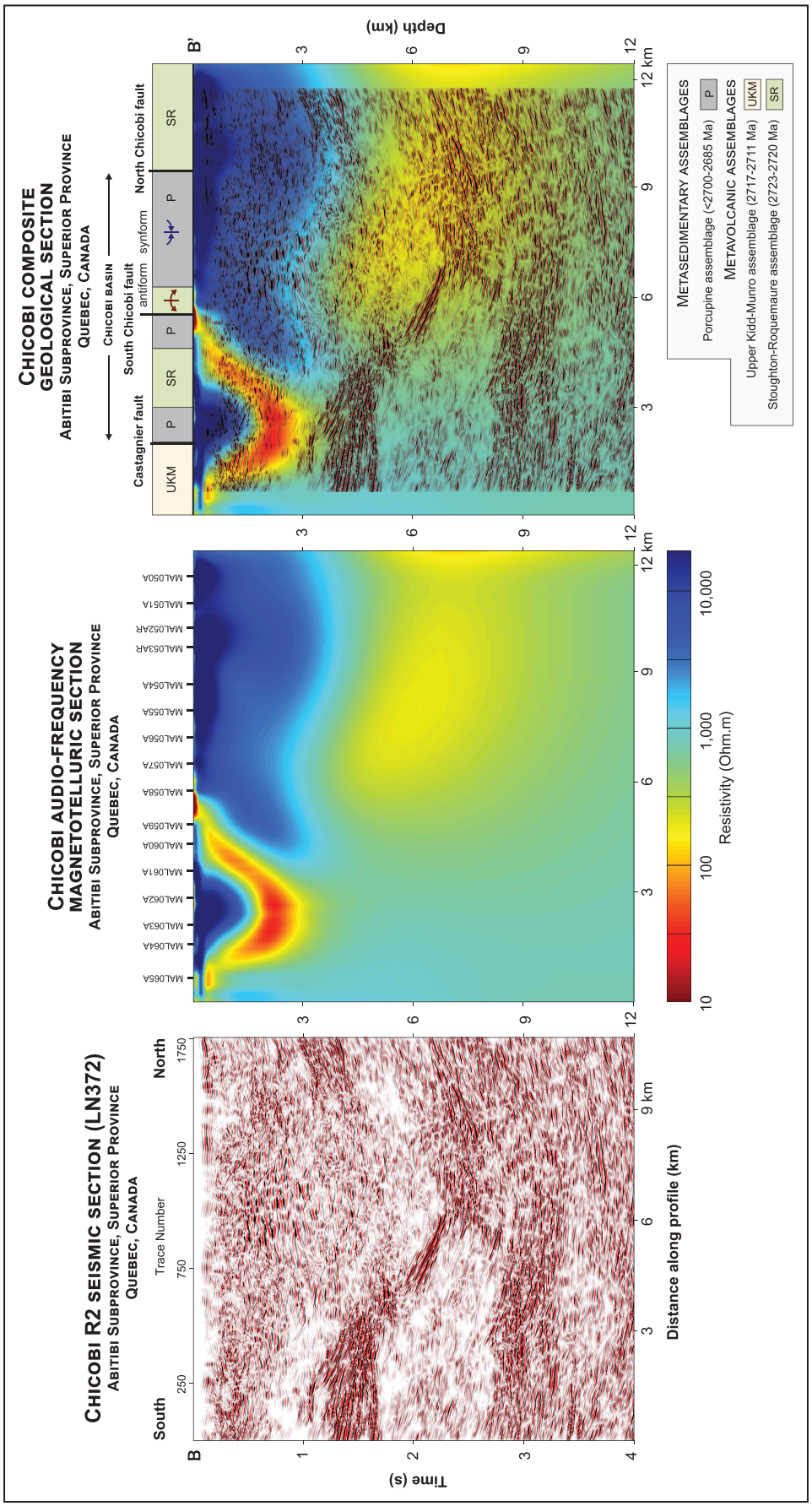
The Chicobi [B–B'] and Malartic [C–C'] transects are located in western Quebec and traverse multiple crustal-scale faults of the Abitibi subprovince. The Chicobi transect [B–B'], located east of Lac-Castagnier, is a comparatively short transect consisting of ~12 km of new R2 seismic reflection [b–b'; line 372] and AMT [B–B'] data that traverse the Chicobi metasedimentary belt, a structural belt bound by the Castagnier fault and the North Chicobi fault (see Zhou et al. 2021; **Figure 3**). These faults also define the interpreted boundary between the northern Abitibi subprovince and the southern Abitibi subprovince (see map of Thurston et al. 2008). The adjacent ~163-km Malartic transect [C–C'; line 131] consists of ~85 km of new R1 seismic reflection data [c–c'; line 131] that intersects the Lyndhurst, Abcourt, and Aiguebelle faults near Amos, the South Manneville fault near La Motte, and the gold-endowed Cadillac-Larder Lake fault (CLLF) at Malartic (**Figure 3**). Intervals of partial or no data result from limited survey road access. BBMT stations were deployed along the entire transect [C–C'], including the c–c' Malartic R1 seismic line, resulting in a conductivity profile that stretches from the Decelles pluton of the Pontiac subprovince, across the CLLF, to the felsic Bernetz intrusion of the northern Abitibi subprovince.

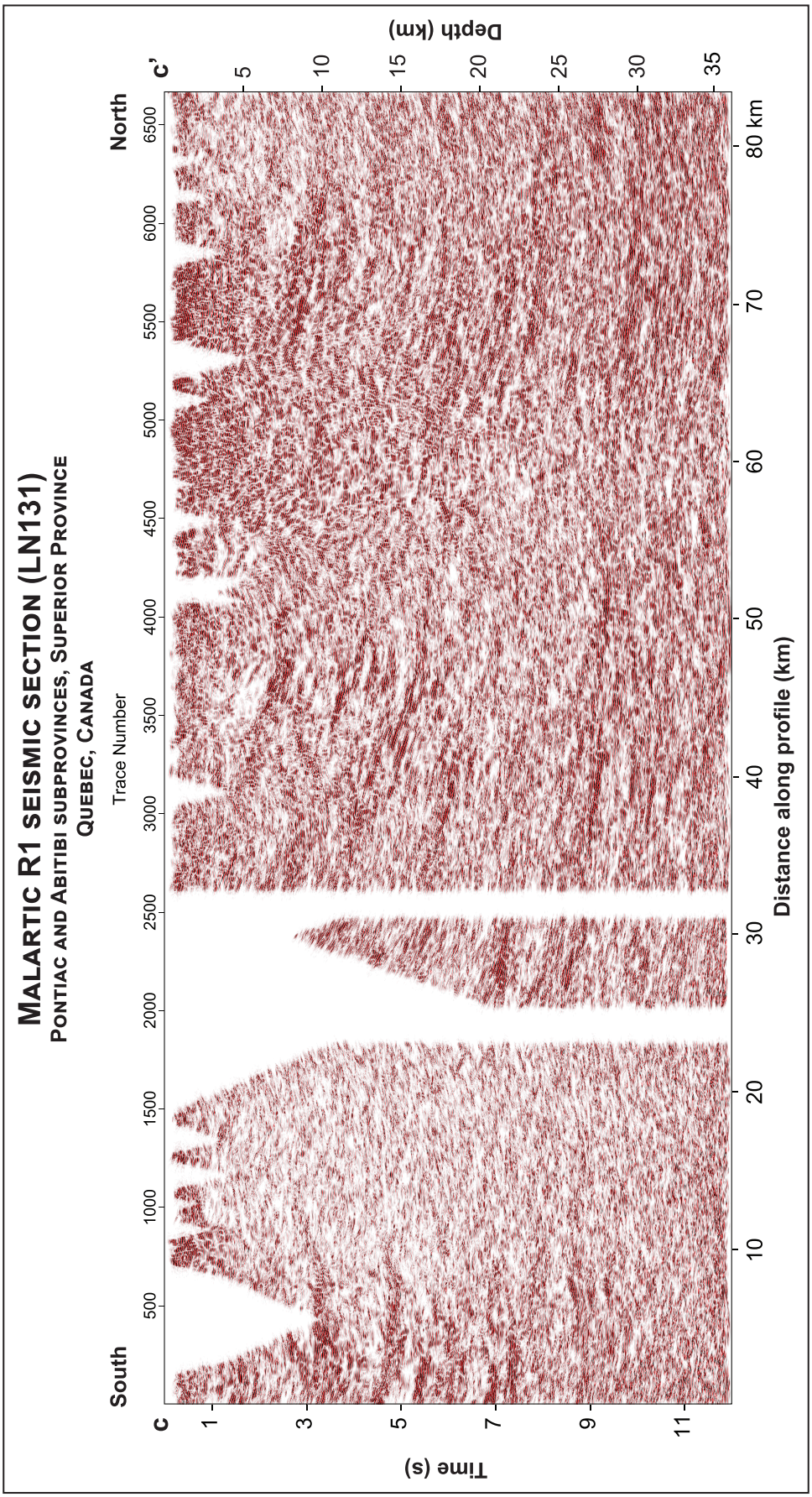
The Cadillac region is most notable for the Canadian Malartic gold mine (332.8 tonnes or 10.7 Moz. at a gold grade of 0.97 ppm; De Souza et al. 2017, 2019), one of several world-class deposits (>100 Moz. gold produced) associated with the regionally extensive CLLF, which stretches ~250 km from Matachewan in Ontario to Val-d'Or in Quebec (Poulsen 2017). The R1 seismic reflection and BBMT data from the Malartic transect provide new insights into the structure of the CLLF and the hydrothermal footprint associated with gold mineralisation at the Canadian Malartic gold mine (cf., Folio 3: Rouyn-Noranda transect and Folio 4: Larder Lake transects). These datasets, including the Chicobi R2 seismic reflection and AMT data, also help resolve the crustal structure of the southern Abitibi subprovince and the major faults (i.e., Castagnier fault, South Chicobi fault, and North Chicobi fault) that define the interpreted boundary between the northern Abitibi subprovince and the southern Abitibi subprovince (see Zhou et al. 2021).

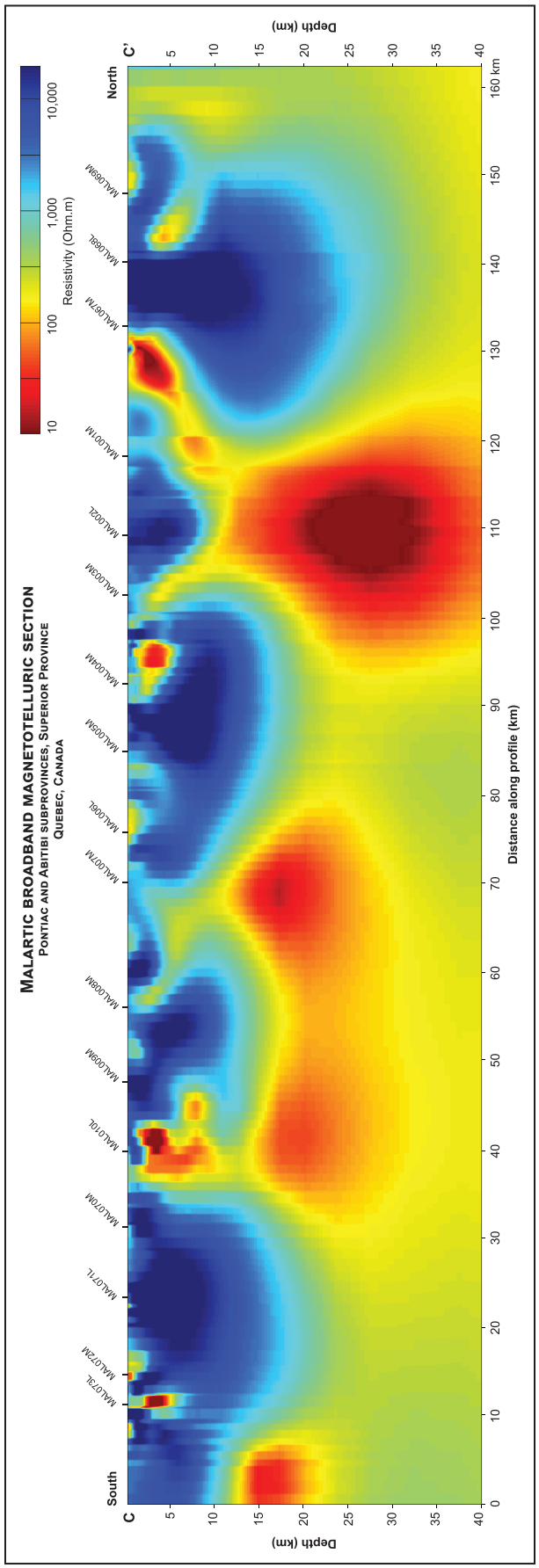
The reader is referred to a publication by Zhou et al. (2021) for interpretations of the Chicobi R2 seismic reflection [b–b'] and AMT [B–B'] data. Refer to Samson et al. (2022) for a discussion on the structural geology of the CLLF in the Malartic transect area.

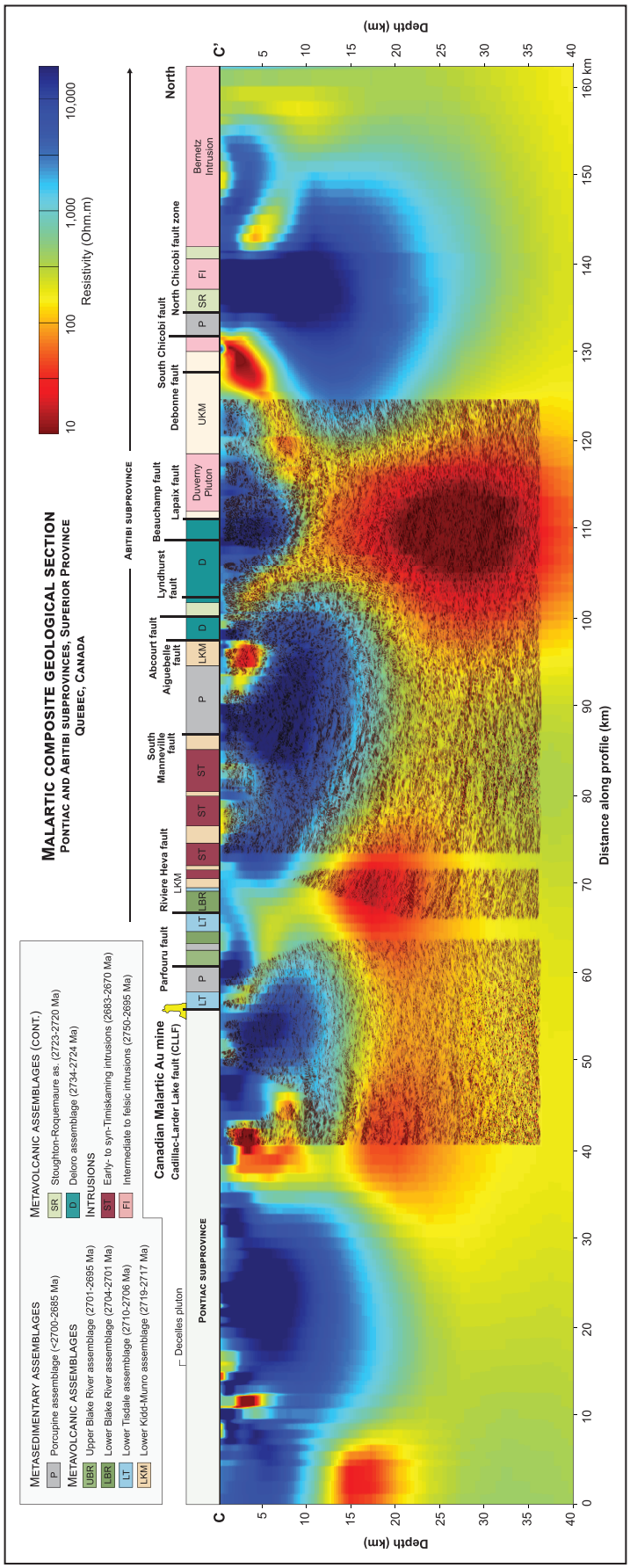
Figure 3. Geological maps of the Abitibi greenstone belt (southern Abitibi subprovince) in western Quebec, showing the locations of the Chicobi R2 seismic [b–b'; line 372] and audio-frequency MT [B–B'] sections and the Malartic R1 seismic [c–c'; line 131] and BBMT [C–C'] sections. Map data sourced from the Metal Earth compilations of Montsion et al. (2018; lithological data) and Jørgensen and Gibson (2024; assemblage data).


B B' Chicobi R2 sesimic (Line 372) and audio-frequency MT section
c c' Malartic R1 seismic section (Line 131)
C C' Malartic broadband MT section
Broadband MT and audio-frequency MT stations
CHICOBI AND MALARTIC TRANSECTS
ABITIBI SUBPROVINCE, SUPERIOR PROVINCE
QUEBEC, CANADA
Bernetz intrusion
Berry pluton
Trécesson pluton
Duverny pluton
La Motte pluton
Preissac pluton
La Corne pluton
Pascalis-Tiblemont batholith
Bourlamaque batholith
Fourniere pluton
Decelles pluton
Laflamme North shear zone
Laflamme South shear zone
North Chicobi fault
South Chicobi fault
ABITIBI SUBPROVINCE
Debonne fault
Castagnier fault
Lapaix fault
Lyndhurst fault
Abcourt fault
Aiguebelle fault
South Manneville fault
Cadillac-Larder Lake fault
Riviere Heva fault
PONTIAC SUBPROVINCE
Gold deposits
La Ronde mine 1
Canadian Malartic mine 2
Marban Alliance mine 3
Kiena mine 4
Goldex mine 5
Lamaque mine 6
Akasaba West mine 7
Beaufor mine 8
Novador mine 9
Lithium deposits
Authier mine 1
North American lithium complex 2
Ni-Cu deposits
Dumont deposit 1
Cubric deposit 2
N
0 5 10 km
49°N
48°40'N
48°20'N
48°N
47°40'N
78°20'W
78°W
77°40'W
700000E m
725000E m
300000E m
5425000N m
5400000N m
5375000N m
5350000N m
5325000N m
5300000N m
UTM17N UTM18N
Coordinate system: NAD83 UTM18N
Lithological classification
Massive granodiorite to granite
Diorite-monzonite-granodiorite suite
Foliated tonalite suite
Mafic intrusions
Ultramafic intrusions
Clastic and chemical metasedimentary rocks
Coarse-grained clastic successor basin units
Fine-grained clastic successor basin units
Mafic to ultramafic metavolcanics
Mafic to intermediate metavolcanics
Felsic to intermediate metavolcanics
Assemblage classification
Post-Timiskaming intrusions (2669–2639 Ma)
Timiskaming assemblage (2679–2669 Ma)
Early- to syn-Timiskaming intrusions (2683–2670 Ma)
Pre-Timiskaming intrusions (2695–2682 Ma)
Porcupine assemblage (2700–2685 Ma)
Pre-Timiskaming intrusions (2700–2685 Ma)
Upper Blake River assemblage (2701–2695 Ma)
Lower Blake River assemblage (2704–2701 Ma)
Lower Tisdale assemblage (2710–2706 Ma)
Upper Kidd-Munro assemblage (2717–2711 Ma)
Lower Kidd-Munro assemblage (2719–2717 Ma)
Stoughton-Roquemaure assem. (2723–2720 Ma)
Deloro assemblage (2734–2724 Ma)
Intermediate to felsic intrusions (2750–2695 Ma)
Ultramafic to mafic intrusions (2750–2700 Ma)


CHICOBI R2 SEISMIC SECTION (LN372)
ABITIBI SUBPROVINCE, SUPERIOR PROVINCE
QUEBEC, CANADA
South
North
Trace Number
250
750
1250
1750
B
Time (s)
Distance along profile (km)
CHICOBI AUDIO-FREQUENCY MAGNETOTELLURIC SECTION
ABITIBI SUBPROVINCE, SUPERIOR PROVINCE
QUEBEC, CANADA
MAL065A
MAL064A
MAL063A
MAL062A
MAL061A
MAL060A
MAL059A
MAL058A
MAL057A
MAL056A
MAL055A
MAL054A
MAL053AR
MAL052AR
MAL051A
MAL050A
12 km
10
100
1,000
10,000
Resistivity (Ohm.m)
CHICOBI COMPOSITE GEOLOGICAL SECTION
ABITIBI SUBPROVINCE, SUPERIOR PROVINCE
QUEBEC, CANADA
CHICOBI BASIN
Castagnier fault
South Chicobi fault
antiform
synform
North Chicobi fault
UKM
P
SR
P
P
SR
B'
Depth (km)
12 km
METASEDIMENTARY ASSEMBLAGES
Porcupine assemblage (<2700-2685 Ma)
P
METAVOLCANIC ASSEMBLAGES
Upper Kidd-Munro assemblage (2717-2711 Ma)
UKM
Stoughton-Roquemaure assemblage (2723-2720 Ma)
SR


MALARTIC R1 SEISMIC SECTION (LN131)
PONTIAC AND ABITIBI SUBPROVINCES, SUPERIOR PROVINCE
QUEBEC, CANADA
South
North
c
c'
Trace Number
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
6000
6500
Time (s)
1
3
5
7
9
11
Depth (km)
5
10
15
20
25
30
35
10
20
30
40
50
60
70
80 km
Distance along profile (km)


MALARTIC BROADBAND MAGNETOTELLURIC SECTION
PONTIAC AND ABITIBI SUBPROVINCES, SUPERIOR PROVINCE
QUEBEC, CANADA
Resistivity (Ohm.m)
10
100
1,000
10,000
C
C'
South
North
Depth (km)
Distance along profile (km)
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160 km
MAL0073L
MAL0073M
MAL0071L
MAL0070M
MAL0070L
MAL0099M
MAL0098M
MAL0070M
MAL0068L
MAL0068M
MAL0004M
MAL0003M
MAL0002L
MAL0001M
MAL0067M
MAL0068L
MAL0069M


MALARTIC COMPOSITE GEOLOGICAL SECTION
PONTIAC AND ABITIBI SUBPROVINCES, SUPERIOR PROVINCE
QUEBEC, CANADA
Resistivity (Ohm.m)
10
100
1,000
10,000
METASEDIMENTARY ASSEMBLAGES
P Porcupine assemblage (<2700-2685 Ma)
METAVOLCANIC ASSEMBLAGES
UBR Upper Blake River assemblage (2701-2695 Ma)
LBR Lower Blake River assemblage (2704-2701 Ma)
LT Lower Tisdale assemblage (2710-2706 Ma)
LKM Lower Kidd-Munro assemblage (2719-2717 Ma)
METAVOLCANIC ASSEMBLAGES (CONT.)
SR Stoughton-Roquemaure as. (2723-2720 Ma)
D Deloro assemblage (2734-2724 Ma)
INTRUSIONS
ST Early- to syn-Timiskaming intrusions (2683-2670 Ma)
FI Intermediate to felsic intrusions (2750-2695 Ma)
Canadian Malartic Au mine
Cadillac-Larder Lake fault (CLLF)
Parfouru fault
Riviere Heva fault
South Mannevill fault
Abcourt fault
Aiguebelle fault
Lyndhurst fault
Beauchamp fault
Lapaix fault
Debonne fault
South Chicobi fault
North Chicobi fault zone
Decelles pluton
Duverny Pluton
Bernetz Intrusion
PONTIAC SUBPROVINCE
ABITIBI SUBPROVINCE
C
C'
North
Depth (km)
Distance along profile (km)
160 km

Useful references

De Souza, S., Dubé, B., Mercier-Langevin, P., McNicoll, V., Dupuis, C., and Kjarsgaard, I. 2019. Hydrothermal alteration mineralogy and geochemistry of the Archean world-class Canadian Malartic disseminated-stockwork gold deposit, southern Abitibi greenstone belt, Quebec, Canada. Economic Geology, **114**: 1057–1094. doi:https://doi.org/10.5382/econgeo.4674.

De Souza, S., Dubé, B., McNicoll, V., Dupuis, C., Mercier-Langevin, P., Creaser, R.A., and Kjarsgaard, I. 2017. Chapter 9: Geology and hydrothermal alteration of the world-class Canadian Malartic gold deposit: genesis of an Archean stockwork-disseminated gold deposit in the Abitibi greenstone belt. *In* Archean Base and Precious Metal Deposits, Southern Abitibi Greenstone Belt, Canada. *Edited by* T. Monecke, P. Mercier-Langevin, and B. Dubé. Reviews in Economic Geology. doi:https://doi.org/10.5382/Rev.19.09.

Jørgensen, T.R.C. and Gibson, H.L. 2024. Assemblage compilation of the Abitibi subprovince, Superior Province, Canada. Metal Earth Project, Mineral Exploration Research Centre. https://metalearth.files.com/f/81ca7963c83475a6

Montsion, R.M., Thurston, P., and Ayer, J. 2018. 1:2,000,000 Scale Geological Compilation of the Superior Craton - Version 1. Laurentian University Mineral Exploration Research Centre (MERC) **ME-2018-017**.

Poulsen, K.H. 2017. The Larder Lake-Cadillac break and its gold districts. *In* Archean Base and Precious Metal Deposits, Southern Abitibi Greenstone Belt, Canada. *Edited by* T. Monecke, P. Mercier-Langevin, and B. Dubé. Reviews in Economic Geology. doi:https://doi.org/10.5382/Rev.19.05.

Samson, B., Lafrance, B., Zhou, X., Hamilton, M., Quesnel, B., Scheffer, C., Beaudoin, G., and Perrouty, S. 2022. Structural geology of the Cadillac Group along the Malartic segment of the Larder Lake Cadillac deformation zone, Quebec, and implications for gold mineralization. Canadian Journal of Earth Sciences, **59**: 540–565. doi:https://doi.org/10.1139/cjes-2022-0009.

Thurston, P.C., Ayer, J.A., Goutier, J., and Hamilton, M.A. 2008. Depositional gaps in Abitibi greenstone belt stratigraphy: A key to exploration for syngenetic mineralization. Economic Geology, **103**: 1097–1134. doi:https://doi.org/10.2113/gsecongeo.103.6.1097.

Zhou, X., Lafrance, B., Naghizadeh, M., Snyder, D.B., Adetunji, A.Q., Vayavur, R., Hamilton, M.A., and Ayer, J.A. 2021. Crustal architecture and structural evolution of a Neoarchean sedimentary basin: geological and geophysical evidence from Metal Earth Chicobi transect in the Abitibi Subprovince, Superior Province, Quebec, Canada. Precambrian Research, **365**: e106391. doi:https://doi.org/10.1016/j.precamres.2021.106391.

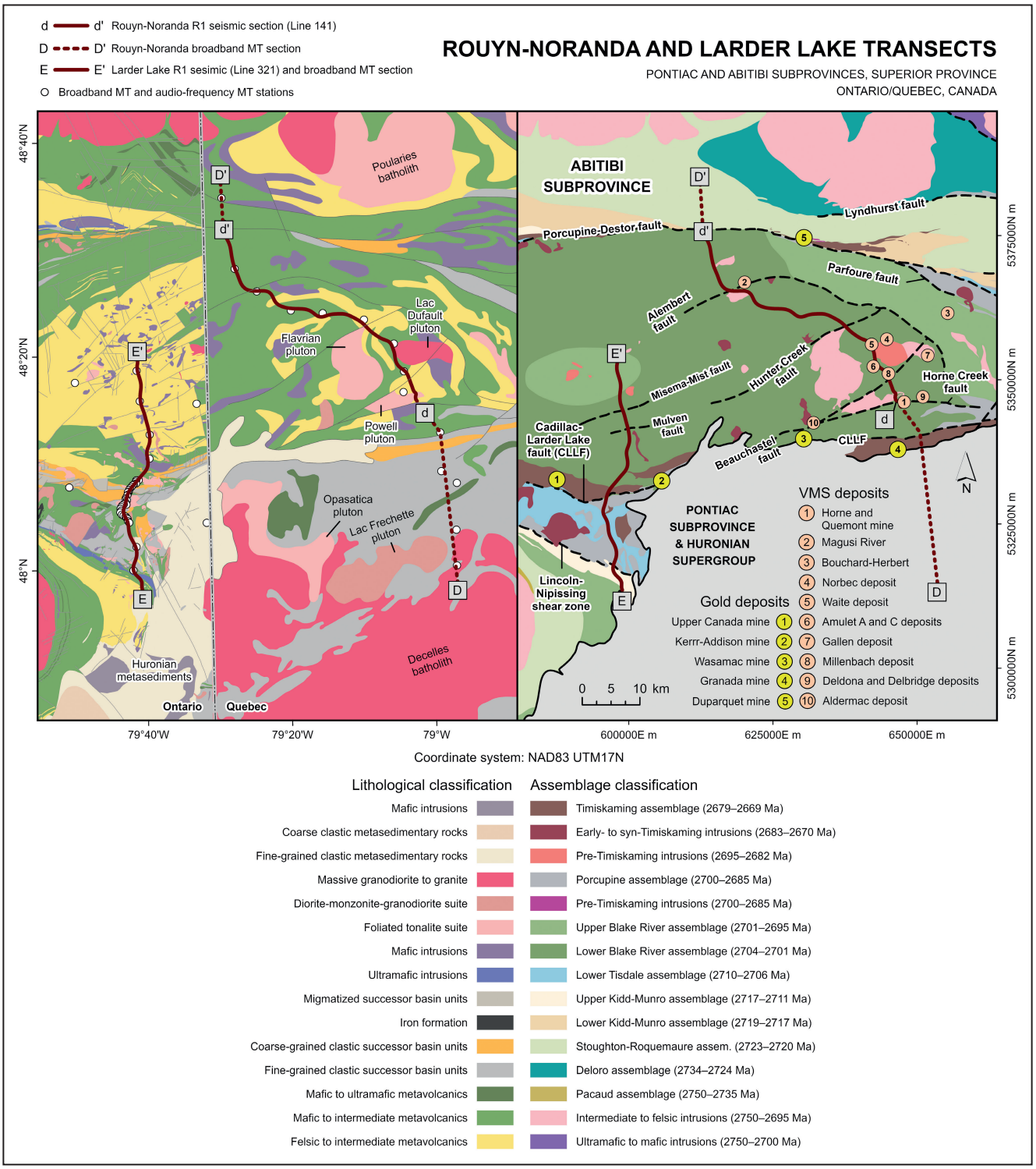
Folio 3
Rouyn-Noranda transect

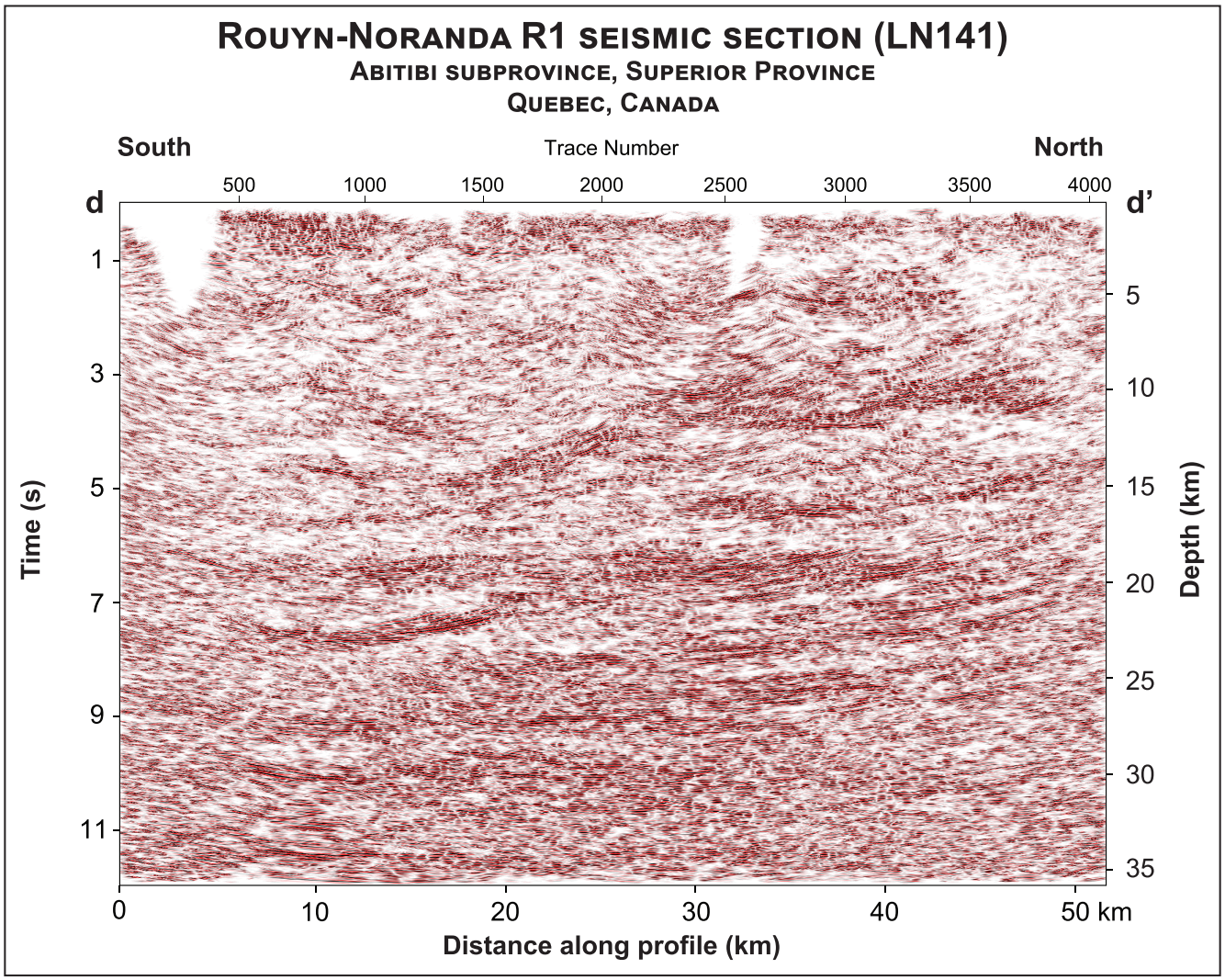
The ~95-km Rouyn-Noranda transect [D–D'] is located in northwest Quebec, extending northward from the Decelles batholith [D] of the Pontiac subprovince, across the gold-endowed Cadillac-Larder Lake fault (CLLF) and Porcupine-Destor fault (PDF), into metavolcanic rocks of the 2723-2720 Ma Stoughton-Roquemaure assemblage [D'] within the Abitibi subprovince (**Figure 4**). The transect encompasses ~85 km of new R1 seismic reflection data [d–d'; line 141] that was collected from the Horne Creek fault in Rouyn-Noranda [d] to the Porcupine-Destor fault near Duparquet [d'] within the Abitibi subprovince. The resulting R1 seismic section intersects the Alembert, Hunter Creek, and Beauchastel faults. BBMT stations were also deployed along the entire transect [D–D'], including the d–d' Rouyn-Noranda R1 seismic line, resulting in a conductivity section that traverses the gold-endowed CLLF and PDF, and multiple VMS deposits of the Rouyn-Noranda mining camp (Gibson and Galley 2007; Jørgensen et al. 2022).

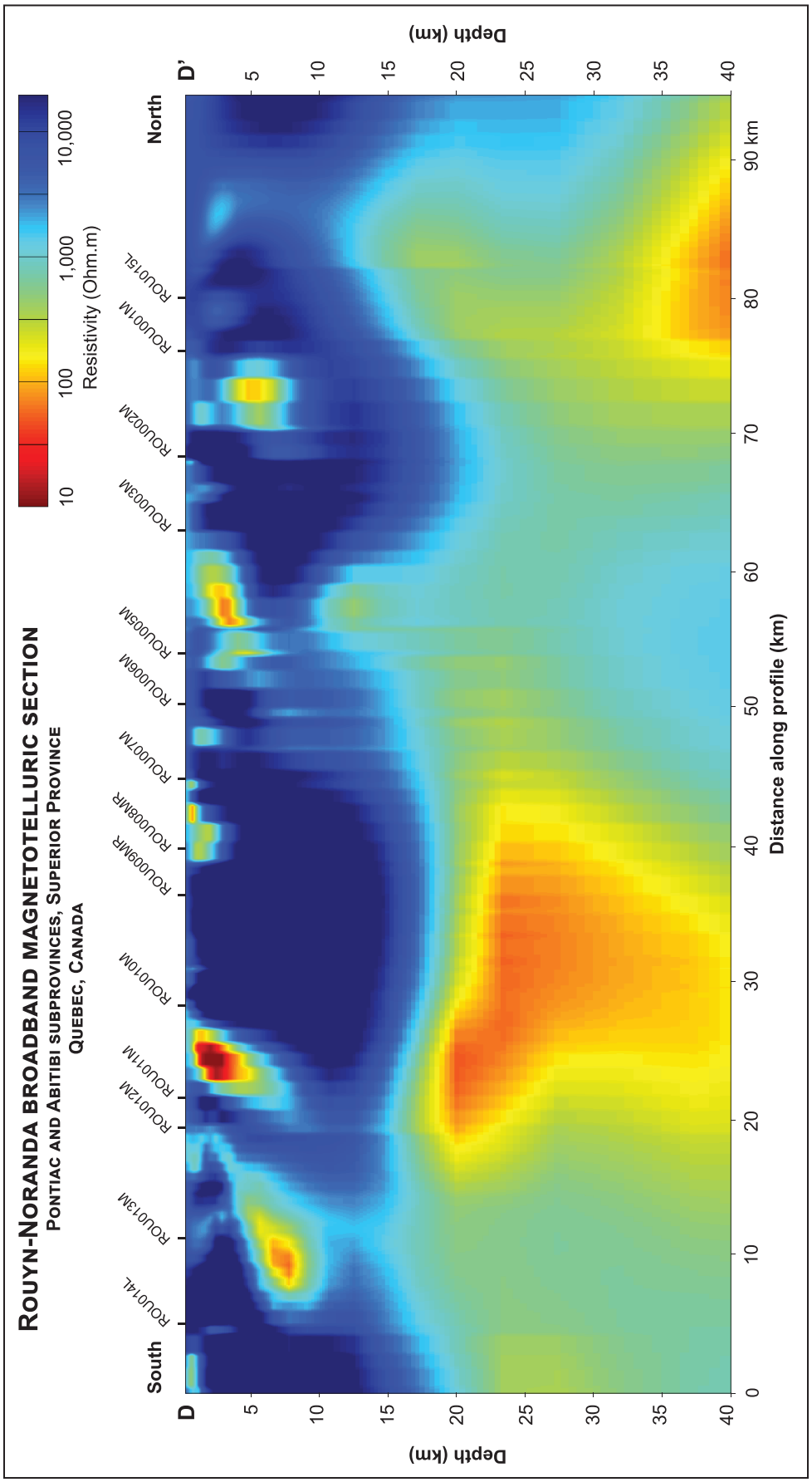
The Rouyn-Noranda mining camp is an unusual polymetallic camp, characterised by minor synvolcanic intrusion-hosted Cu-Mo-Au-Ag mineralisation, 19 orogenic gold deposits, and 20 VMS deposits that are hosted predominantly by the 2704–2701 Ma Lower Blake River assemblage (~130 Mt ore; Gibson and Galley 2007; Monecke et al. 2017; Jørgensen et al. 2022). The camp is also host to the Horne deposit, an unusual VMS deposit with a large gold endowment of ~325 t (10.5 Moz; Kerr and Gibson 1993; Krushnisky et al. 2023). The BBMT profile, which traverses the CLLF (cf., Folio 2: Chicobi and Malartic transects and Folio 4: Larder Lake transect) and the PDF (cf., Folio 6: Matheson transect and Folio 7: Crawchest and Timmins transects), provides an opportunity to evaluate the footprint of mineralisation (i.e., Duparquet and Granada gold mines) associated with these regionally extensive gold-endowed fault systems. The composite seismic-MT sections also enable the assessment of trans-crustal hydrothermal upflow zones and their role in the formation Au-rich VMS deposits across the Rouyn-Noranda mining camp (see Jørgensen et al. 2022), which is widely acknowledged as the world's largest Archean VMS camp.

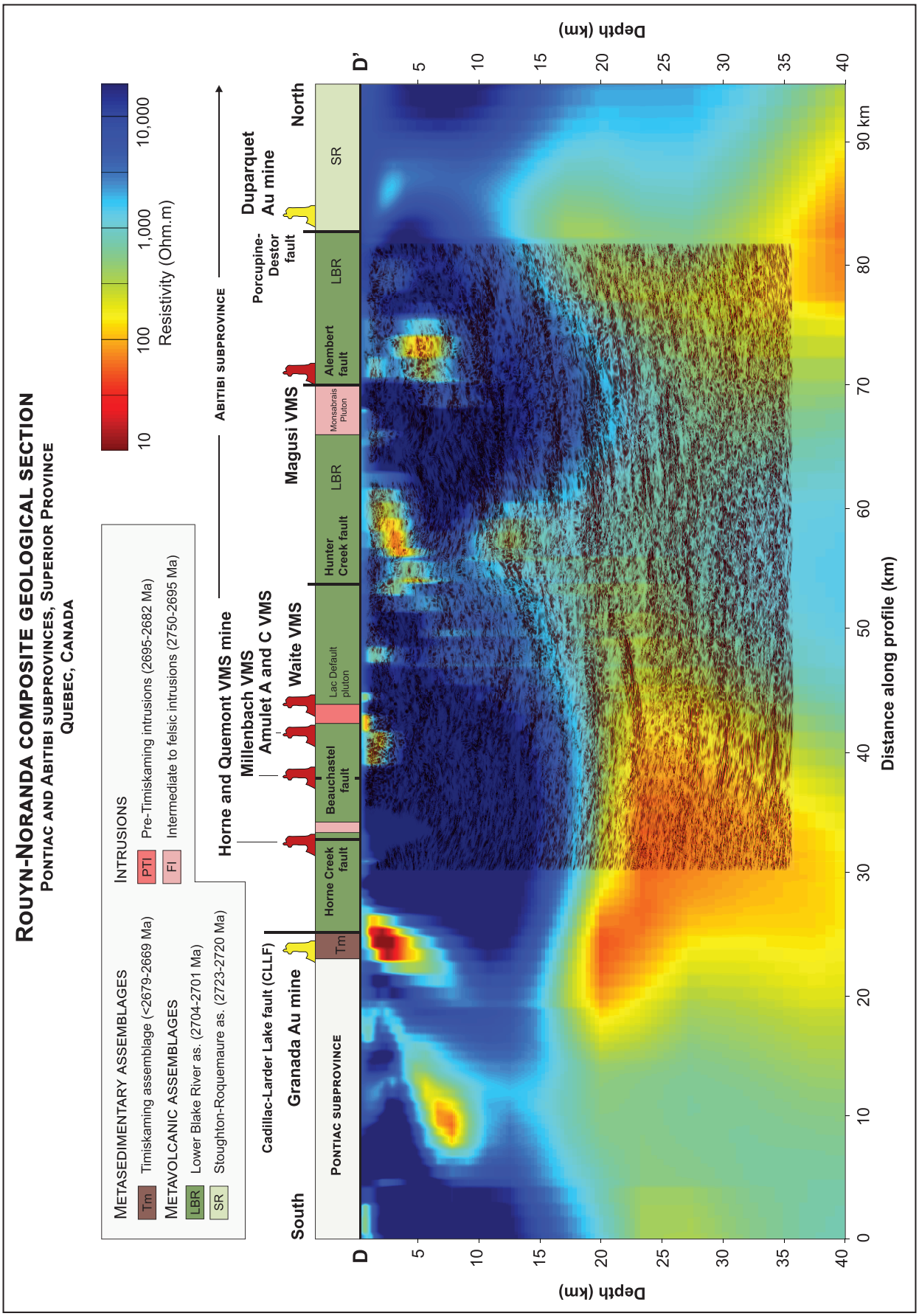
The reader is referred to a publication by Jørgensen et al. (2022) for interpretations of the Rouyn-Noranda R1 seismic reflection [d–d'; line 141] and BBMT [D–D'] data. Refer to Behnia et al. (2023) for prospectivity maps for VMS mineralisation in the Rouyn-Noranda region.

Figure 4. Geological maps of the of the Abitibi greenstone belt (southern Abitibi subprovince) in western Quebec and eastern Ontario, showing the locations of the Rouyn-Noranda R1 seismic MT [d–d'; line 141] and BBMT [D–D'] sections and the Larder Lake R1 seismic [e–e'; line 321] and BBMT [E–E'] sections. Map data sourced from the Metal Earth compilations of Montsion et al. (2018; lithological data) and Jørgensen and Gibson (2024; assemblage data).


d d' Rouyn-Noranda R1 seismic section (Line 141)
D D' Rouyn-Noranda broadband MT section
E E' Larder Lake R1 sesimic (Line 321) and broadband MT section
Broadband MT and audio-frequency MT stations
ROUYN-NORANDA AND LARDER LAKE TRANSECTS
PONTIAC AND ABITIBI SUBPROVINCES, SUPERIOR PROVINCE
ONTARIO/QUEBEC, CANADA
ABITIBI SUBPROVINCE
PONTIAC SUBPROVINCE & HURONIAN SUPERGROUP
Poularies batholith
Flavrian pluton
Lac Dufault pluton
Powell pluton
Opasatica pluton
Lac Frechette pluton
Decelles batholith
Huronian metasediments
Ontario
Quebec
Porcupine-Destor fault
Lyndhurst fault
Parfoure fault
Alembert fault
Misema-Mist fault
Hunter Creek fault
Horne Creek fault
Mulven fault
Beauchastel fault
CLLF
Cadillac-Larder Lake fault (CLLF)
Lincoln-Nipissing shear zone
VMS deposits
1 Horne and Quemont mine
2 Magusi River
3 Bouchard-Herbert
4 Norbec deposit
5 Waite deposit
6 Amulet A and C deposits
7 Gallen deposit
8 Millenbach deposit
9 Deldona and Delbridge deposits
10 Aldermac deposit
Gold deposits
Upper Canada mine 1
Kerrr-Addison mine 2
Wasamac mine 3
Granada mine 4
Duparquet mine 5
0 5 10 km
N
48°40'N
48°20'N
48°N
79°40'W
79°20'W
79°W
600000E m
625000E m
650000E m
5375000N m
5350000N m
5325000N m
5300000N m
Coordinate system: NAD83 UTM17N
Lithological classification
Mafic intrusions
Coarse clastic metasedimentary rocks
Fine-grained clastic metasedimentary rocks
Massive granodiorite to granite
Diorite-monzonite-granodiorite suite
Foliated tonalite suite
Mafic intrusions
Ultramafic intrusions
Migmatized successor basin units
Iron formation
Coarse-grained clastic successor basin units
Fine-grained clastic successor basin units
Mafic to ultramafic metavolcanics
Mafic to intermediate metavolcanics
Felsic to intermediate metavolcanics
Assemblage classification
Timiskaming assemblage (2679–2669 Ma)
Early- to syn-Timiskaming intrusions (2683–2670 Ma)
Pre-Timiskaming intrusions (2695–2682 Ma)
Porcupine assemblage (2700–2685 Ma)
Pre-Timiskaming intrusions (2700–2685 Ma)
Upper Blake River assemblage (2701–2695 Ma)
Lower Blake River assemblage (2704–2701 Ma)
Lower Tisdale assemblage (2710–2706 Ma)
Upper Kidd-Munro assemblage (2717–2711 Ma)
Lower Kidd-Munro assemblage (2719–2717 Ma)
Stoughton-Roquemaure assem. (2723–2720 Ma)
Deloro assemblage (2734–2724 Ma)
Pacaud assemblage (2750–2735 Ma)
Intermediate to felsic intrusions (2750–2695 Ma)
Ultramafic to mafic intrusions (2750–2700 Ma)


ROUYN-NORANDA R1 SEISMIC SECTION (LN141)
ABITIBI SUBPROVINCE, SUPERIOR PROVINCE
QUEBEC, CANADA
South
Trace Number
North
500
1000
1500
2000
2500
3000
3500
4000
d
d'
1
3
5
7
9
11
Time (s)
5
10
15
20
25
30
35
Depth (km)
0
10
20
30
40
50 km
Distance along profile (km)


ROUYN-NORANDA BROADBAND MAGNETOTELLURIC SECTION
PONTIAC AND ABITIBI SUBPROVINCES, SUPERIOR PROVINCE
QUEBEC, CANADA
10
100
1,000
10,000
Resistivity (Ohm.m)
South
North
D
D'
ROU014L
ROU013M
ROU012M
ROU011M
ROU010M
ROU009MR
ROU008MR
ROU007M
ROU006M
ROU005M
ROU003M
ROU002M
ROU001M
ROU015L
Depth (km)
0
5
10
15
20
25
30
35
40
Distance along profile (km)
0
10
20
30
40
50
60
70
80
90 km


ROUYN-NORANDA COMPOSITE GEOLOGICAL SECTION
PONTIAC AND ABITIBI SUBPROVINCES, SUPERIOR PROVINCE
QUEBEC, CANADA
METASEDIMENTARY ASSEMBLAGES
Tm Timiskaming assemblage (<2679-2669 Ma)
METAVOLCANIC ASSEMBLAGES
LBR Lower Blake River as. (2704-2701 Ma)
SR Stoughton-Roquemaure as. (2723-2720 Ma)
INTRUSIONS
PTI Pre-Timiskaming intrusions (2695-2682 Ma)
FI Intermediate to felsic intrusions (2750-2695 Ma)
10
100
1,000
10,000
Resistivity (Ohm.m)
South
D
PONTIAC SUBPROVINCE
Tm
Granada Au mine
Cadillac-Larder Lake fault (CLLF)
Horne Creek fault
Beauchastel fault
Lac Default pluton
Horne and Quemont VMS mine
Millenbach VMS
Amulet A and C VMS
Waite VMS
Hunter Creek fault
LBR
Monsabrais Pluton
Magusi VMS
Alembert fault
ABITIBI SUBPROVINCE
Porcupine-Destor fault
Duparquet Au mine
North
D'
SR
Depth (km)
0
5
10
15
20
25
30
35
40
Distance along profile (km)
10
20
30
40
50
60
70
80
90 km

Useful references

Behnia, P., Harris, J., Liu, H., Jørgensen, T.R.C., Naghizadeh, M., and Roots, E.A. 2023. Random forest classification for volcanogenic massive sulfide mineralization in the Rouyn-Noranda Area, Quebec. Ore Geology Reviews, **161**: 105612. doi:https://doi.org/10.1016/j.oregeorev.2023.105612.

Gibson, H. and Galley, A. 2007. Volcanogenic massive sulphide deposits of the Archean, Noranda District, Quebec. *In* Mineral deposits of Canada: a synthesis of major deposit-types, district metallogeny, the evolution of geological provinces, and exploration methods: St. John, Newfoundland and Labrador, Canada, Special Publication 5 Geological Association of Canada. pp. 533–552.

Jørgensen, T.R.C. and Gibson, H.L. 2024. Assemblage compilation of the Abitibi subprovince, Superior Province, Canada. Metal Earth Project, Mineral Exploration Research Centre. https://metalearth.files.com/f/81ca7963c83475a6.

Jørgensen, T.R.C., Gibson, H.L., Roots, E.A., Vayavur, R., Hill, G.J., Snyder, D.B., and Naghizadeh, M. 2022. The implications of crustal architecture and transcrustal upflow zones on the metal endowment of a world-class mineral district. Scientific Reports, **12**: 14710. doi:https://doi.org/10.1038/s41598-022-18836-y.

Kerr, D.J. and Gibson, H.L. 1993. A comparison of the Horne volcanogenic massive sulfide deposit and intracauldron deposits of the Mine Sequence, Noranda, Quebec. Economic Geology, **88**: 1419–1442. doi:https://doi.org/10.2113/gsecongeo.88.6.1419.

Krushnisky, A., Mercier-Langevin, P., Ross, P.-S., Goutier, J., McNicoll, V., Moore, L., Monecke, T., Jackson, S.E., Yang, Z., Petts, D.C., and Pilote, C. 2023. Geology and controls on gold enrichment at the Horne 5 deposit and implications for the architecture of the gold-rich Horne volcanogenic massive sulfide complex, Abitibi greenstone belt, Canada. Economic Geology, **118**: 285–318. doi:https://doi.org/10.5382/econgeo.4978.

Monecke, T., Gibson, H.L., and Goutier, J. 2017. Volcanogenic massive sulfide deposits of the Noranda camp. *In* Archean Base and Precious Metal Deposits, Southern Abitibi Greenstone Belt, Canada. *Edited by* T. Monecke, P. Mercier-Langevin, and B. Dubé. Reviews in Economic Geology. doi:https://doi.org/10.5382/Rev.19.06.

Montsion, R.M., Thurston, P., and Ayer, J. 2018. 1:2,000,000 Scale Geological Compilation of the Superior Craton - Version 1. Laurentian University Mineral Exploration Research Centre (MERC) **ME-2018-017**.

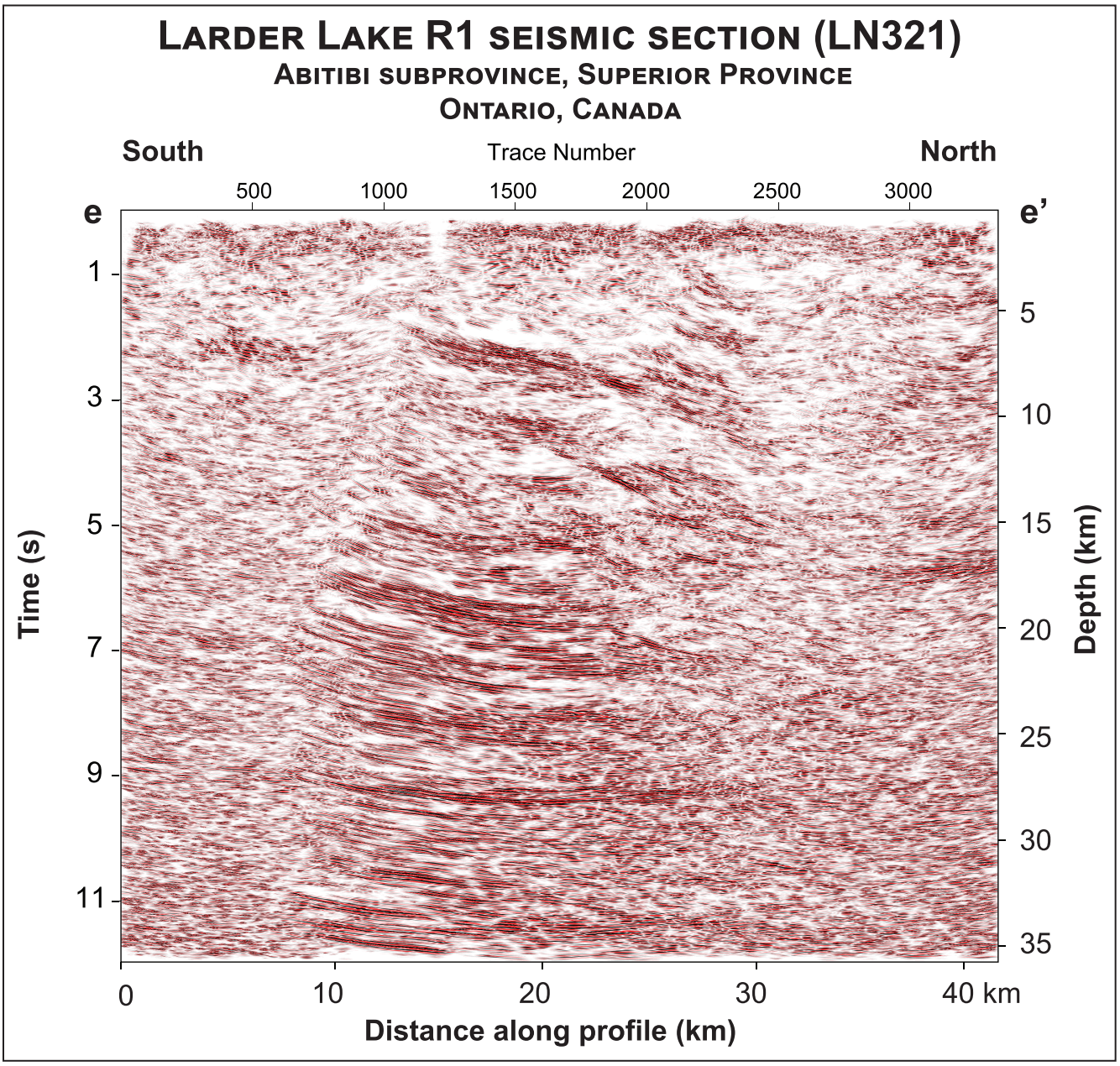
Folio 4

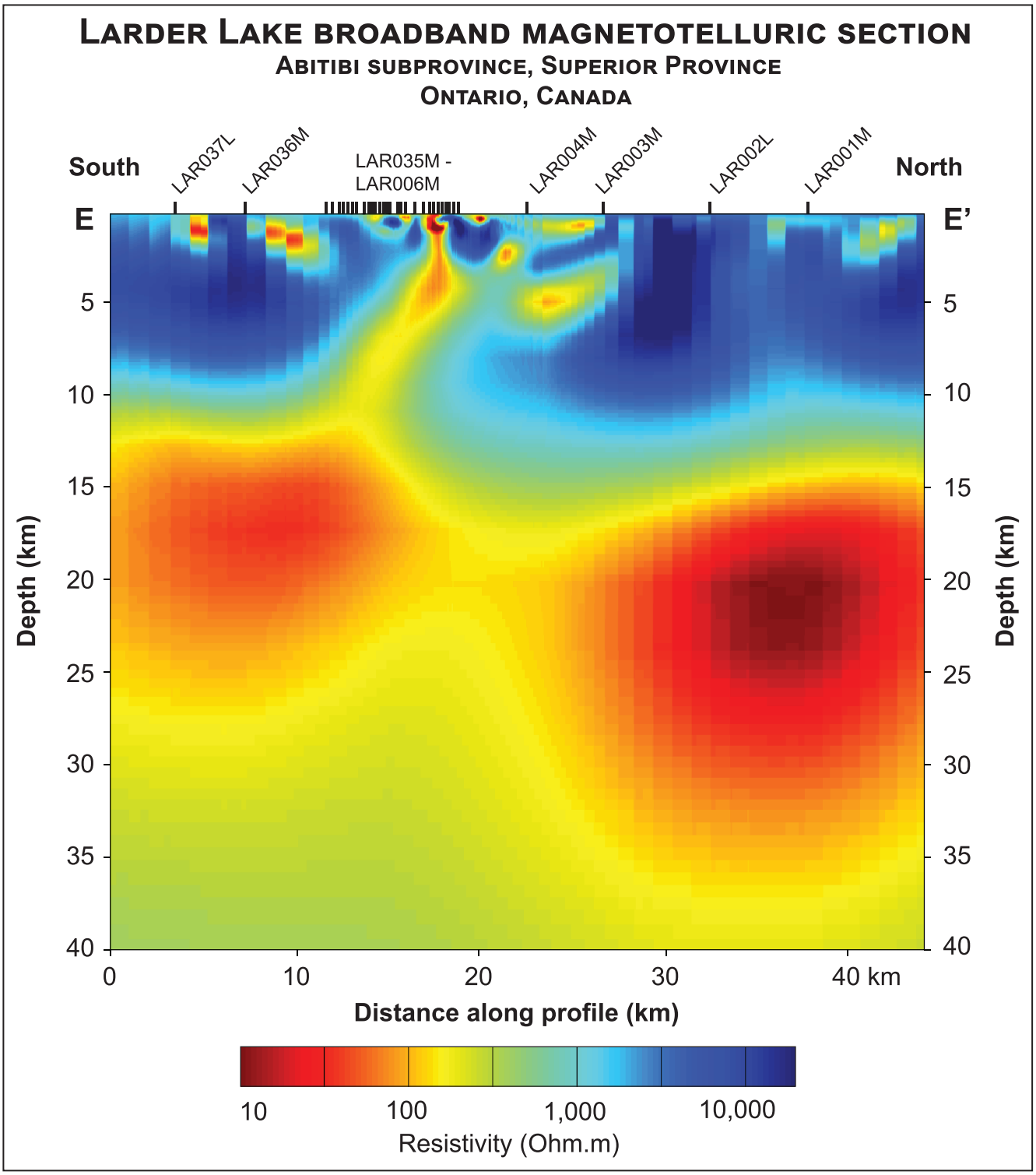
Larder Lake transect

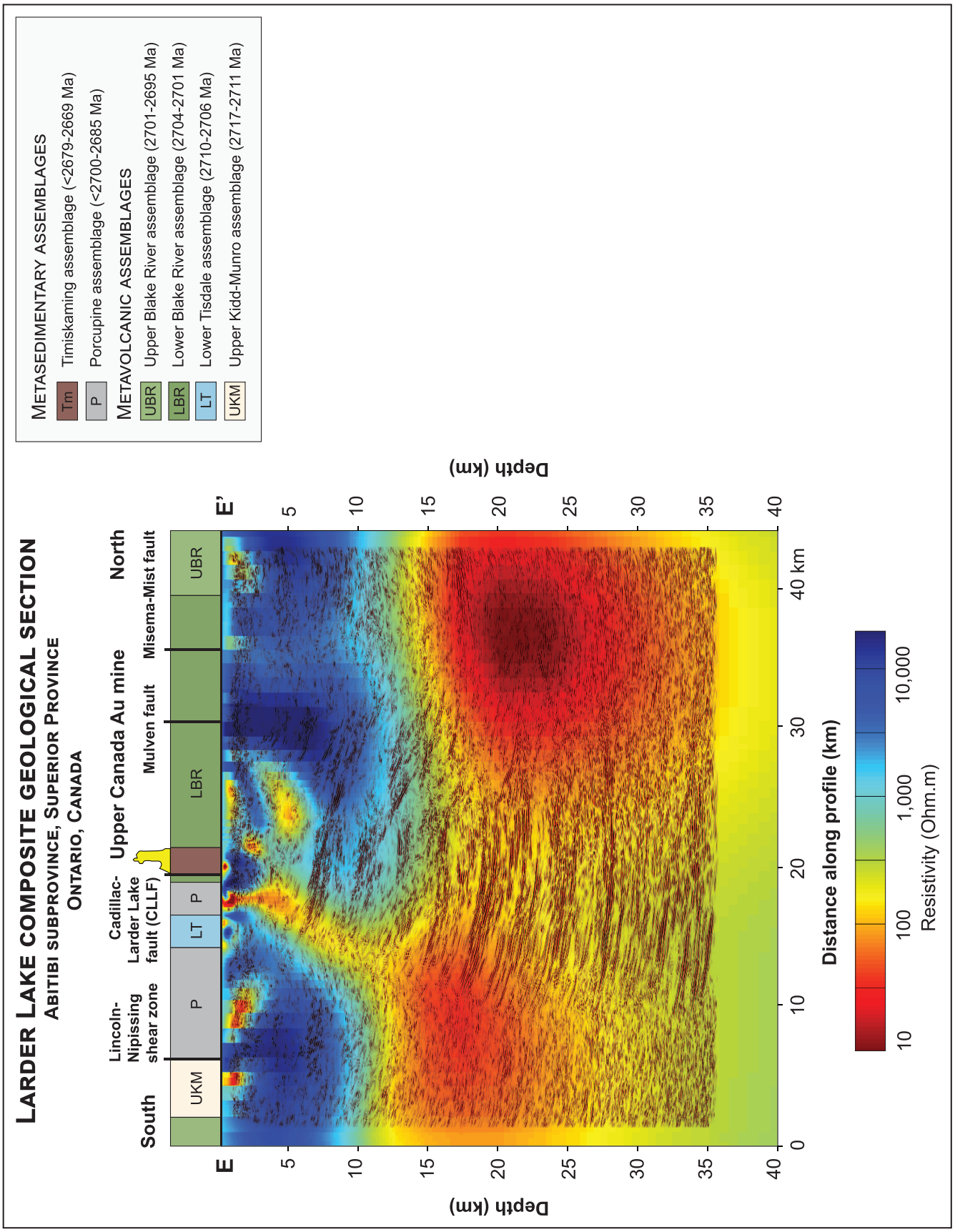
The ~44-km Larder Lake transect [E–E'] is located in northeast Ontario, adjacent to the border with Quebec, within the southern Abitibi subprovince (see **Figure 4** in Folio 3). The transect encompasses ~49 km of new R1 seismic reflection data [e–e'; line 321] that was collected along forestry roads, highways 624 and 66, and Larder Lake Station Road between St Anthony Lake [e] and Parysek Lake [e']. The R1 seismic reflection survey was complimented by the collection of passive seismic data, enabling comparisons between datasets (cf., Naghizadeh et al. 2022). These seismic transects intersect the Lincoln-Nipissing shear zone (LNSZ) and the gold-endowed Cadillac-Larder Lake fault (CLLF), which locally define boundaries between metavolcanic (i.e., 2717–2711 Ma Upper Kidd-Munro, 2710–2706 Ma Lower Tisdale, and 2704–2695 Ma Blake River assemblages) and metasedimentary (2700–2685 Ma Porcupine and the 2679-2669 Ma Timiskaming assemblages) deposits of the Abitibi greenstone belt. BBMT stations were also deployed along the entire transect, including the e–e' R1 seismic reflection line, resulting in a conductivity section [E–E'] across the Larder Lake gold camp.

The Larder Lake region is most notable for the world-class Upper Canada and Kerr-Addison-Chesterville gold mines (Kishida and Kerrich 1987; Robert and Poulsen 1997), which are spatially associated with the CLLF and metasediments of the Timiskaming assemblage. The occurrence of world-class gold deposits along the CLLF (Ispolatov et al. 2008; Poulsen 2017) contrasts with the LNSZ, which does not host significant mineralisation and is bound by older metavolcanic and metasedimentary deposits (i.e., Upper Kidd-Munro and Porcupine assemblages). The processed R1 seismic reflection and BBMT data from the Larder Lake transect consequently provides an opportunity to directly compare two differentially endowed fault systems.

The reader is referred to publications by Naghizadeh et al. (2022) and Fam et al. (2023) for interpretations of the Larder Lake seismic reflection data [e–e'; line 321] and Roots et al. (2022) for a discussion of the BBMT results [E–E']. Refer to Liu et al. (2023) for mineral prospectivity maps of the Larder Lake region.


Larder Lake R1 seismic section (LN321)
Abitibi subprovince, Superior Province
Ontario, Canada
South
Trace Number
North
500
1000
1500
2000
2500
3000
e
e’
1
3
5
7
9
11
Time (s)
5
10
15
20
25
30
35
Depth (km)
0
10
20
30
40 km
Distance along profile (km)


LARDER LAKE BROADBAND MAGNETOTELLURIC SECTION
ABITIBI SUBPROVINCE, SUPERIOR PROVINCE
ONTARIO, CANADA
South
North
LAR037L
LAR036M
LAR035M - LAR006M
LAR004M
LAR003M
LAR002L
LAR001M
E
E'
Depth (km)
5
10
15
20
25
30
35
40
0
10
20
30
40 km
Distance along profile (km)
10
100
1,000
10,000
Resistivity (Ohm.m)


LARDER LAKE COMPOSITE GEOLOGICAL SECTION
ABITIBI SUBPROVINCE, SUPERIOR PROVINCE
ONTARIO, CANADA
METASEDIMENTARY ASSEMBLAGES
Tm Timiskaming assemblage (<2679-2669 Ma)
P Porcupine assemblage (<2700-2685 Ma)
METAVOLCANIC ASSEMBLAGES
UBR Upper Blake River assemblage (2701-2695 Ma)
LBR Lower Blake River assemblage (2704-2701 Ma)
LT Lower Tisdale assemblage (2710-2706 Ma)
UKM Upper Kidd-Munro assemblage (2717-2711 Ma)
South
North
Lincoln-Nipissing shear zone
Cadillac-Larder Lake fault (CLLF)
Upper Canada Au mine
Mulven fault
Misema-Mist fault
UKM
P
LT
P
LBR
UBR
E
E'
Depth (km)
0
5
10
15
20
25
30
35
40
40 km
Distance along profile (km)
10
100
1,000
10,000
Resistivity (Ohm.m)

Useful references

Fam, H.J.A., Naghizadeh, M., Smith, R., Yilmaz, O., Cheraghi, S., and Rubingh, K. 2023. High-resolution 2.5 D multifocusing imaging of a crooked seismic profile in a crystalline rock environment: Results from the Larder Lake area, Ontario, Canada. Geophysical Prospecting, **71**: 1152–1180. doi:https://doi.org/10.1111/1365-2478.13285.

Ispolatov, V., Lafrance, B., Dubé, B., Creaser, R.A., and Hamilton, M. 2008. Geologic and structural setting of gold mineralization in the Kirkland Lake-Larder Lake gold belt, Ontario. Economic Geology, **103**: 1309–1340. doi:https://doi.org/10.2113/gsecongeo.103.6.1309.

Jørgensen, T.R.C. and Gibson, H.L. 2024. Assemblage compilation of the Abitibi subprovince, Superior Province, Canada. Metal Earth Project, Mineral Exploration Research Centre. https://metalearth.files.com/f/81ca7963c83475a6

Kishida, A. and Kerrich, R. 1987. Hydrothermal alteration zoning and gold concentration at the Kerr-Addison Archean lode gold deposit, Kirkland Lake, Ontario. Economic Geology, **82**: 649–690. doi:https://doi.org/10.2113/gsecongeo.82.3.649.

Liu, H., Harris, J., Sherlock, R., Behnia, P., Grunsky, E., Naghizadeh, M., Rubingh, K., Tuba, G., Roots, E., and Hill, G. 2023. Mineral prospectivity mapping using machine learning techniques for gold exploration in the Larder Lake area, Ontario, Canada. Journal of Geochemical Exploration, **253**. doi:https://doi.org/10.1016/j.gexplo.2023.107279.

Montsion, R.M., Thurston, P., and Ayer, J. 2018. 1:2,000,000 Scale Geological Compilation of the Superior Craton - Version 1. Laurentian University Mineral Exploration Research Centre (MERC) **ME-2018-017**.

Naghizadeh, M., Smith, R., Rubingh, K., Sherlock, R., Ayer, J., Lafrance, B., Cheraghi, S., Snyder, D.B., Vergne, J., Hollis, D., and Mordret, A. 2022. Active and passive seismic imaging of the central Abitibi greenstone belt, Larder Lake, Ontario. Journal of Geophysical Research: Solid Earth, **127**: e2021JB022334. doi:https://doi.org/10.1029/2021JB022334.

Poulsen, K.H. 2017. The Larder Lake-Cadillac break and its gold districts. *In* Archean Base and Precious Metal Deposits, Southern Abitibi Greenstone Belt, Canada. *Edited by* T. Monecke, P. Mercier-Langevin, and B. Dubé. Reviews in Economic Geology. doi:https://doi.org/10.5382/Rev.19.05.

Robert, F. and Poulsen, K.H. 1997. World-class Archaean gold deposits in Canada: An overview. Australian Journal of Earth Sciences, **44**: 329–351. doi:https://doi.org/10.1080/08120099708728316.

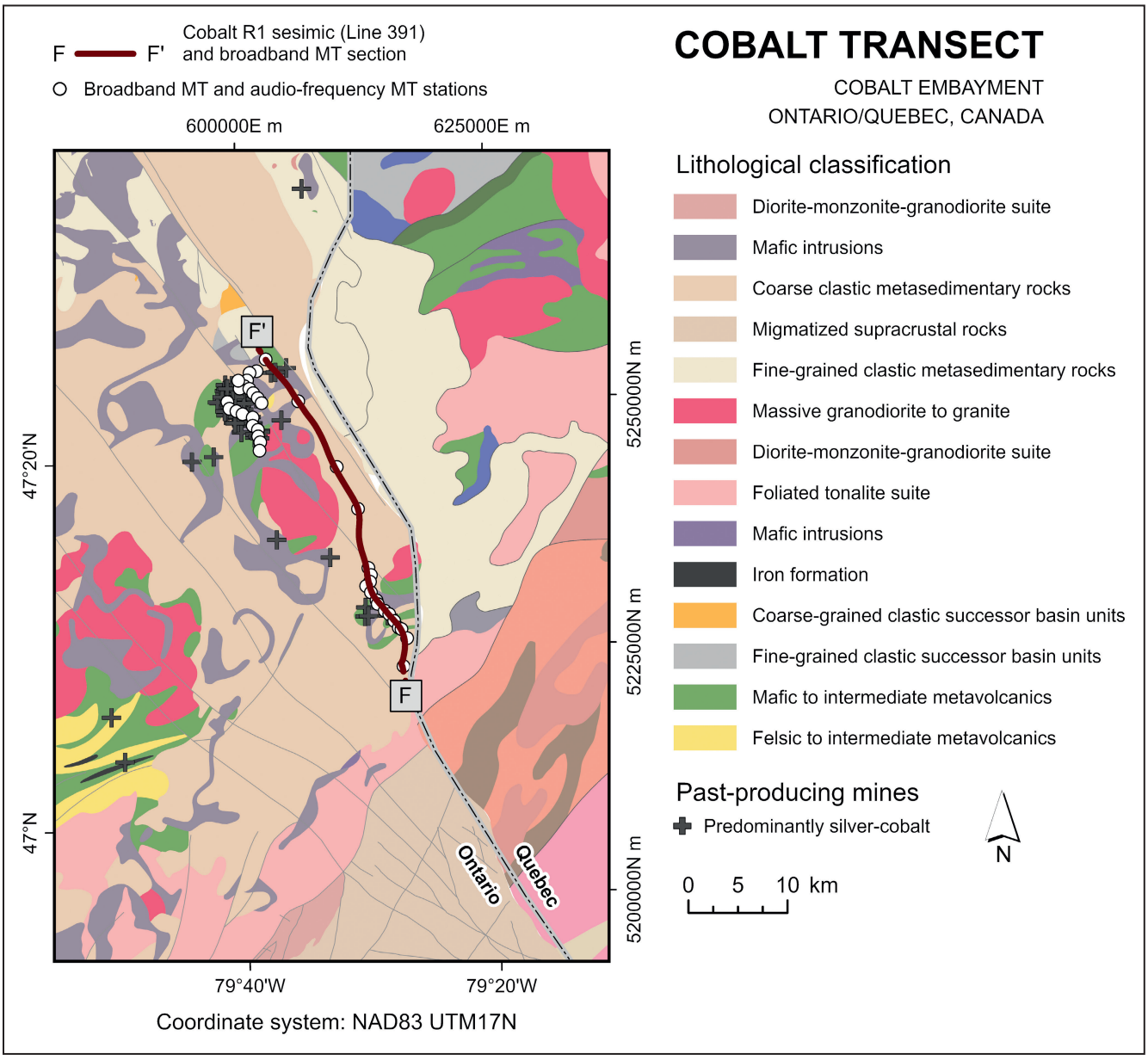
Roots, E.A., Hill, G.J., Frieman, B.M., Wannamaker, P.E., Maris, V., Calvert, A.J., Craven, J.A., Smith, R.S., and Snyder, D.B. 2022. Magmatic, hydrothermal and ore element transfer processes of the southeastern Archean Superior Province implied from electrical resistivity structure. Gondwana Research, **105**: 84–95. doi:https://doi.org/10.1016/j.gr.2021.12.004.

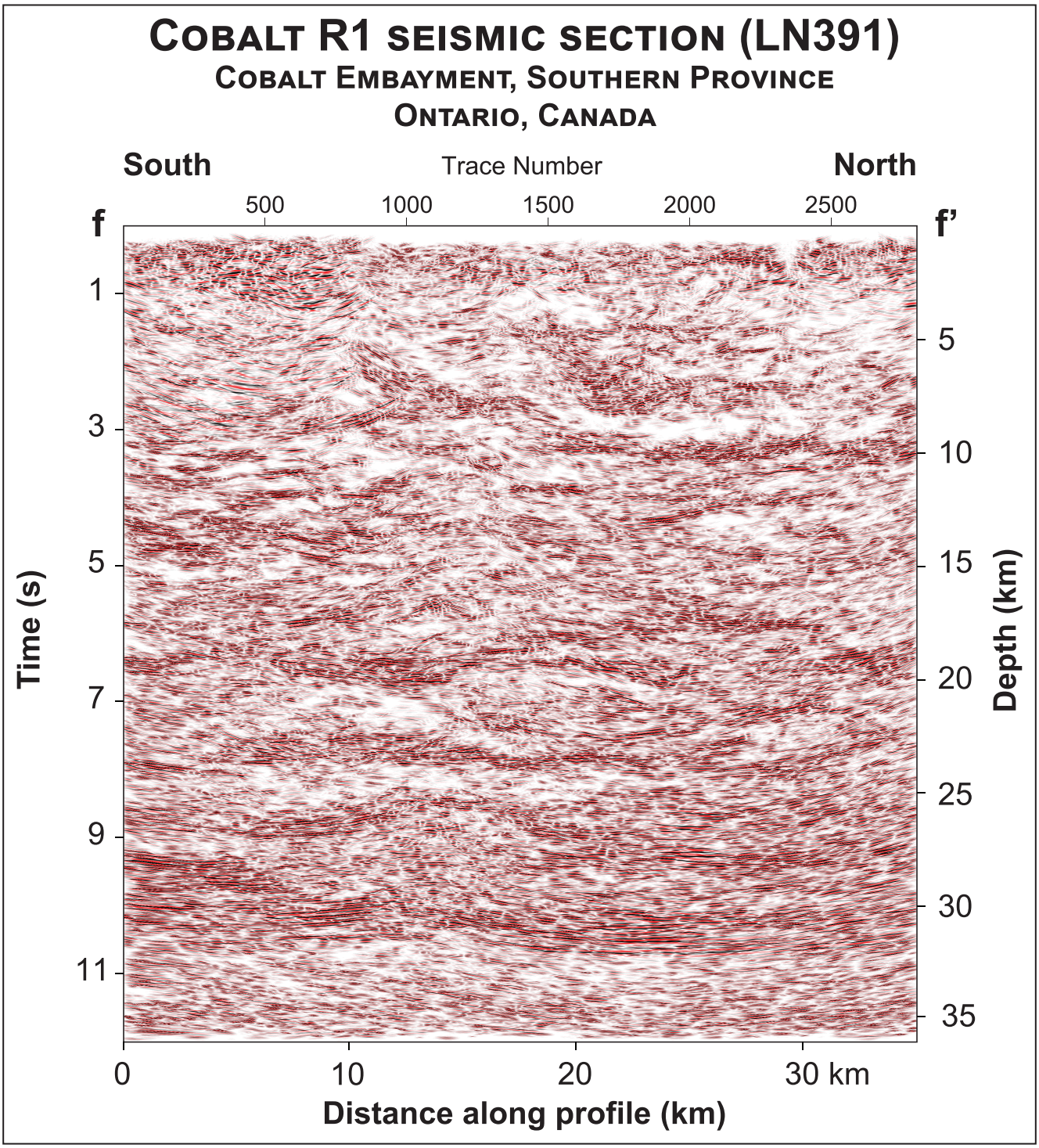
Folio 5
Cobalt transect

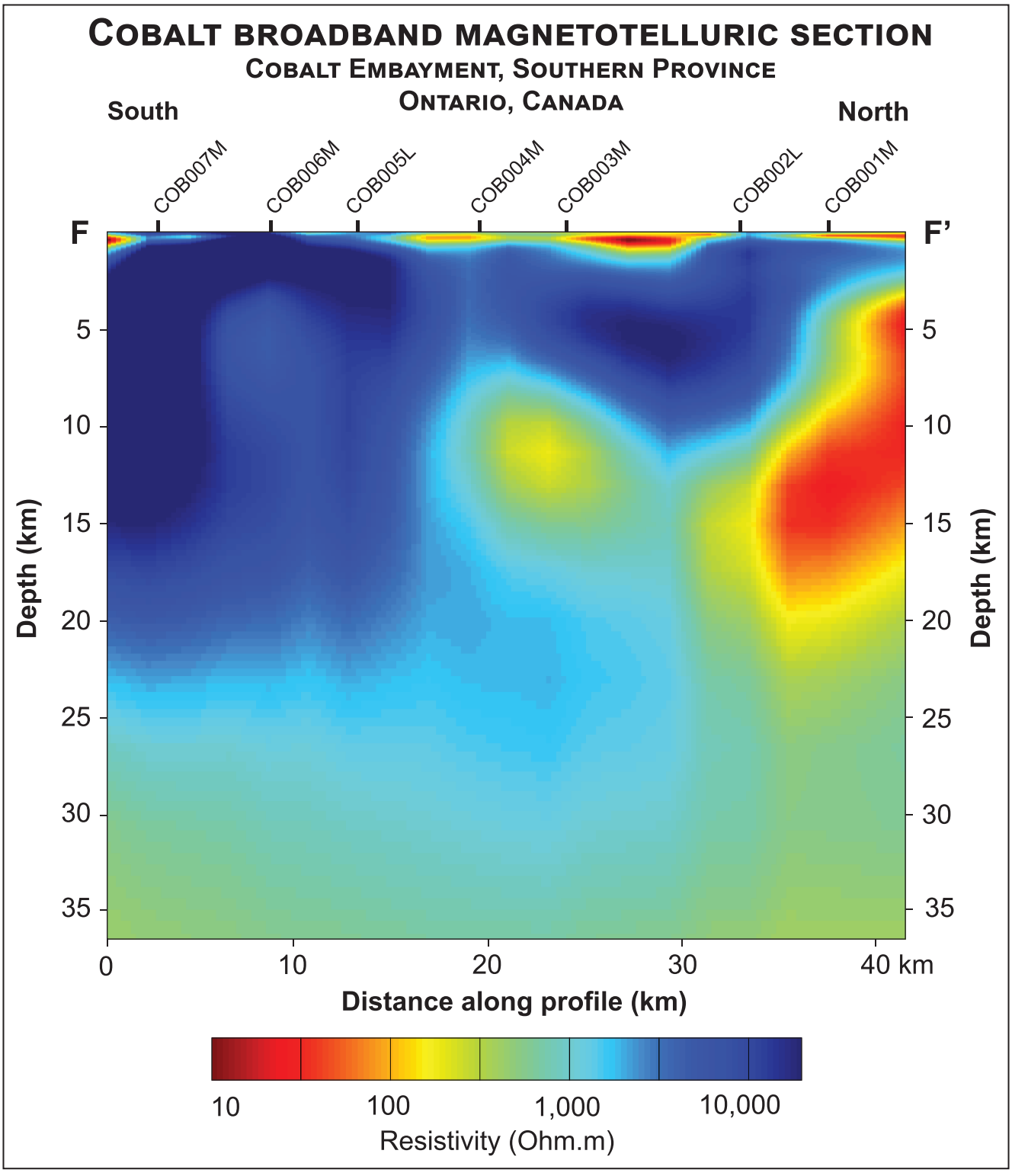
The ~41-km Cobalt transect [F–F'] is located in northeast Ontario, adjacent to the border with Quebec, within the so-called Cobalt Embayment of the Southern Province (Figure 5). In contrast to other Metal Earth transects, which traverse Archean greenstone belts of the Superior Province, the Cobalt transect extends across predominantly Paleoproterozoic siliciclastic rocks of the 2480–2219 Ma Huronian supergroup that host minor silver, cobalt, placer gold, and unconformity-related uranium deposits (Mossman and Harron 1984; Marshall and Watkinson 2000; Potter and Taylor 2009, 2010; Long and Rainbird 2022). These Paleoproterozoic sediments are interpreted to overlie Archean basement rocks of the Abitibi subprovince, which is supported by local inliers of metavolcanics and interflow metasediments associated with the 2700-2685 Ma Porcupine assemblage. The transect encompasses ~46 km of R1 seismic reflection data [f–f'; line 391] that was collected between the Lower Notch Generating Station [f] and North Cobalt [f']. BBMT stations were also deployed along entire transect [F–F'], including the f–f' R1 seismic survey line, resulting in a conductivity section across the mineralised Cobalt mining camp.

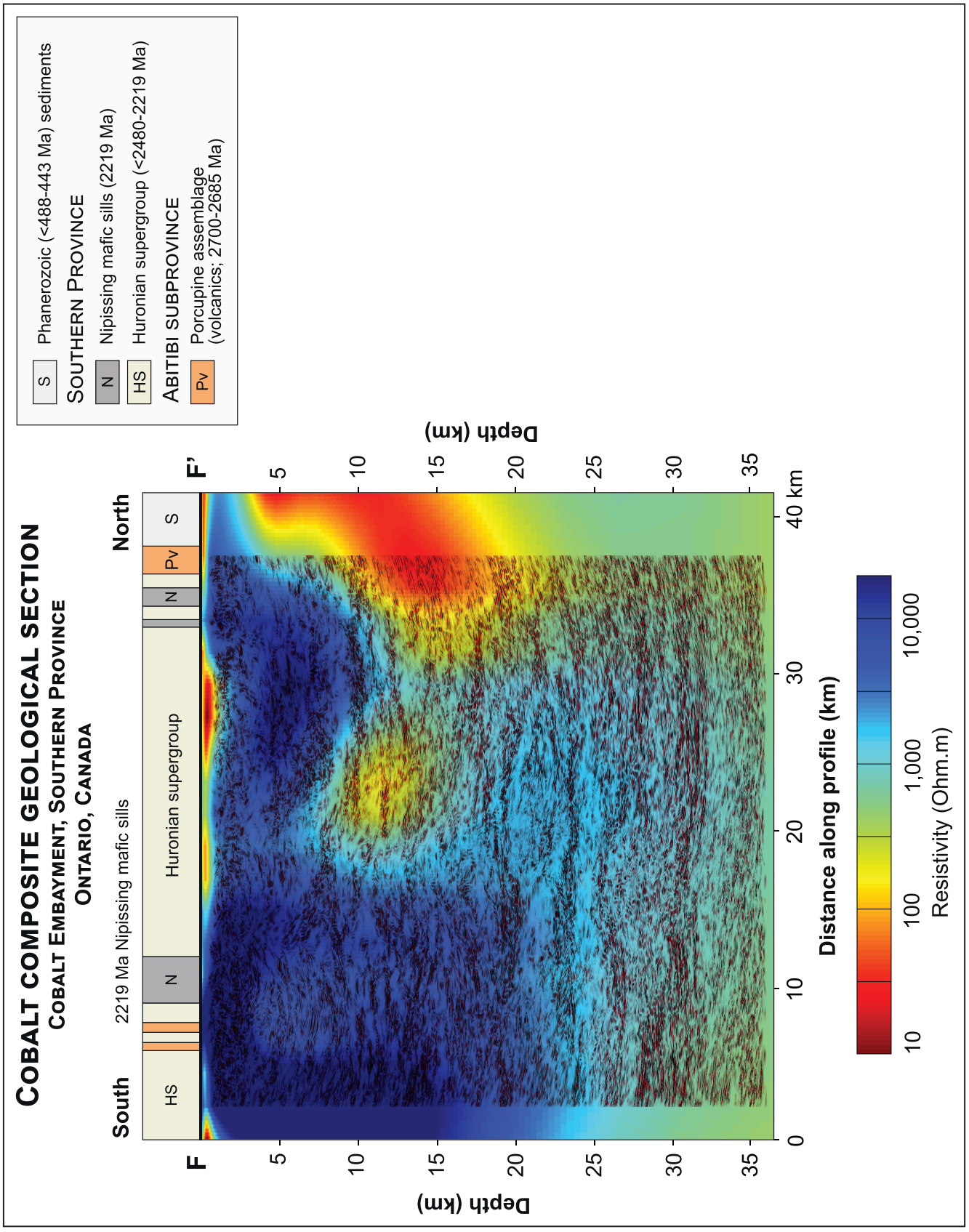
The Cobalt mining camp has historically produced ~445 Moz. of silver from silver-sulfarsenide veins, many of which occur within ca 2219 Ma Nipissing diabase sills and dikes adjacent to the Huronian-Archean unconformity (Marshall and Watkinson 2000). The R1 seismic reflection and BBMT sections, which traverse many historic silver-sulfarsenide deposits, provide an opportunity to evaluate the apparent relationship between Proterozoic silver arsenide vein mineralisation and the underlying basement of the Abitibi subprovince, a potential source of silver-sulfarsenide metals (Potter and Taylor 2009).

Figure 5. Geological map of the Cobalt Embayment within the Southern Province in northeast Ontario, showing the location of the Cobalt R1 seismic [f–f'; line 391] and BBMT [F–F'] sections with respect to past producing silver-cobalt mines. Map data sourced from the Metal Earth compilation of Montsion et al. (2018; lithological data).


F F' Cobalt R1 sesimic (Line 391) and broadband MT section
Broadband MT and audio-frequency MT stations
600000E m
625000E m
5250000N m
5225000N m
5200000N m
47°20'N
47°N
79°40'W
79°20'W
F'
F
Ontario
Quebec
COBALT TRANSECT
COBALT EMBAYMENT
ONTARIO/QUEBEC, CANADA
Lithological classification
Diorite-monzonite-granodiorite suite
Mafic intrusions
Coarse clastic metasedimentary rocks
Migmatized supracrustal rocks
Fine-grained clastic metasedimentary rocks
Massive granodiorite to granite
Diorite-monzonite-granodiorite suite
Foliated tonalite suite
Mafic intrusions
Iron formation
Coarse-grained clastic successor basin units
Fine-grained clastic successor basin units
Mafic to intermediate metavolcanics
Felsic to intermediate metavolcanics
Past-producing mines
Predominantly silver-cobalt
N
0 5 10 km
Coordinate system: NAD83 UTM17N


COBALT R1 SEISMIC SECTION (LN391)
COBALT EMBAYMENT, SOUTHERN PROVINCE
ONTARIO, CANADA
South
Trace Number
North
500
1000
1500
2000
2500
f
f'
1
3
5
7
9
11
Time (s)
5
10
15
20
25
30
35
Depth (km)
0
10
20
30 km
Distance along profile (km)


COBALT BROADBAND MAGNETOTELLURIC SECTION
COBALT EMBAYMENT, SOUTHERN PROVINCE
ONTARIO, CANADA
South
North
COB007M
COB006M
COB005L
COB004M
COB003M
COB002L
COB001M
F
F'
5
10
15
20
25
30
35
Depth (km)
0
10
20
30
40 km
Distance along profile (km)
10
100
1,000
10,000
Resistivity (Ohm.m)


COBALT COMPOSITE GEOLOGICAL SECTION
COBALT EMBAYMENT, SOUTHERN PROVINCE
ONTARIO, CANADA
South
North
F
F'
HS
N
Pv
S
2219 Ma Nipissing mafic sills
Huronian supergroup
Depth (km)
0
5
10
15
20
25
30
35
40 km
Distance along profile (km)
10
100
1,000
10,000
Resistivity (Ohm.m)
S Phanerozoic (<488-443 Ma) sediments
SOUTHERN PROVINCE
N Nipissing mafic sills (2219 Ma)
HS Huronian supergroup (<2480-2219 Ma)
ABITIBI SUBPROVINCE
Pv Porcupine assemblage (volcanics; 2700-2685 Ma)

Useful references

Long, D.G.F., and Rainbird, R.H. 2022. Trapped in a graben: deposition of Huronian gold-bearing conglomerates in a fault-influenced, valley-confined, fluvial system in the southern Cobalt Basin, Ontario, Canada. Canadian Journal of Earth Sciences, **60**: 778–801. doi:https://doi.org/10.1139/cjes-2022-0025.

Marshall, D., and Watkinson, D.H. 2000. The Cobalt mining district: Silver sources, transport and deposition. Exploration and Mining Geology, **9**: 81–90. doi:https://doi.org/10.2113/0090081.

Montsion, R.M., Thurston, P., and Ayer, J. 2018. 1:2,000,000 Scale Geological Compilation of the Superior Craton - Version 1. Laurentian University Mineral Exploration Research Centre (MERC) **ME-2018-017**.

Mossman, D.J., and Harron, G.A. 1984. Witwatersrand-type paleoplacer gold in the Huronian Supergroup of Ontario, Canada. Geoscience Canada, **11**.

Potter, E.G., and Taylor, R.P. 2009. The lead isotope composition of ore minerals from precious metal-bearing, polymetallic vein systems in the Cobalt Embayment, northern Ontario: metallogenetic implications. Economic Geology, **104**: 869–879. doi:https://doi.org/10.2113/gsecongeo.104.6.869.

Potter, E.G., and Taylor, R.P. 2010. The stable and radiogenic isotopic attributes of precious-metal-bearing polymetallic veins from the cobalt embayment, northern Ontario, Canada: genetic and exploration implications. The Canadian Mineralogist, **48**: 391–414. doi:https://doi.org/10.3749/canmin.48.2.391.

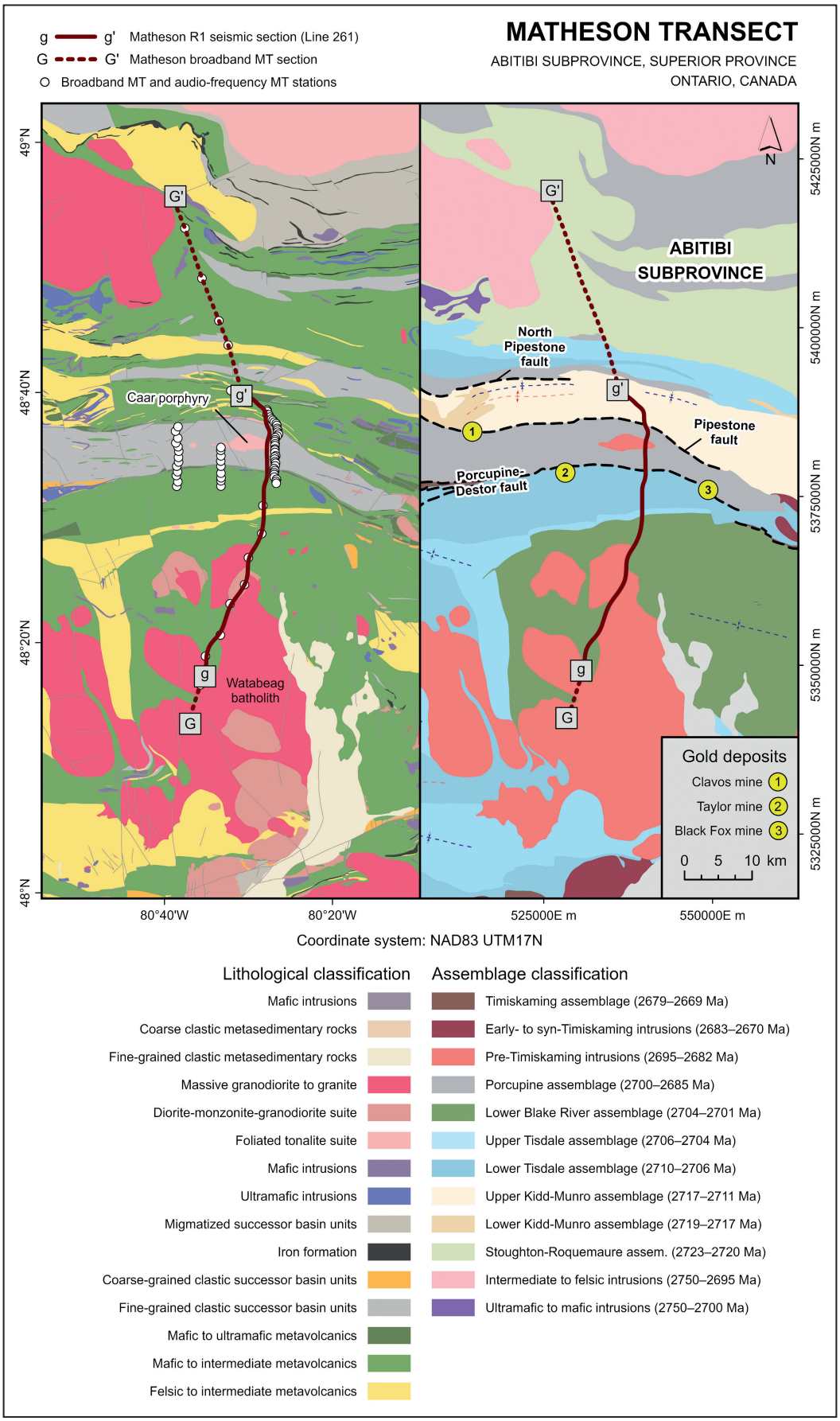
Folio 6
Matheson transect

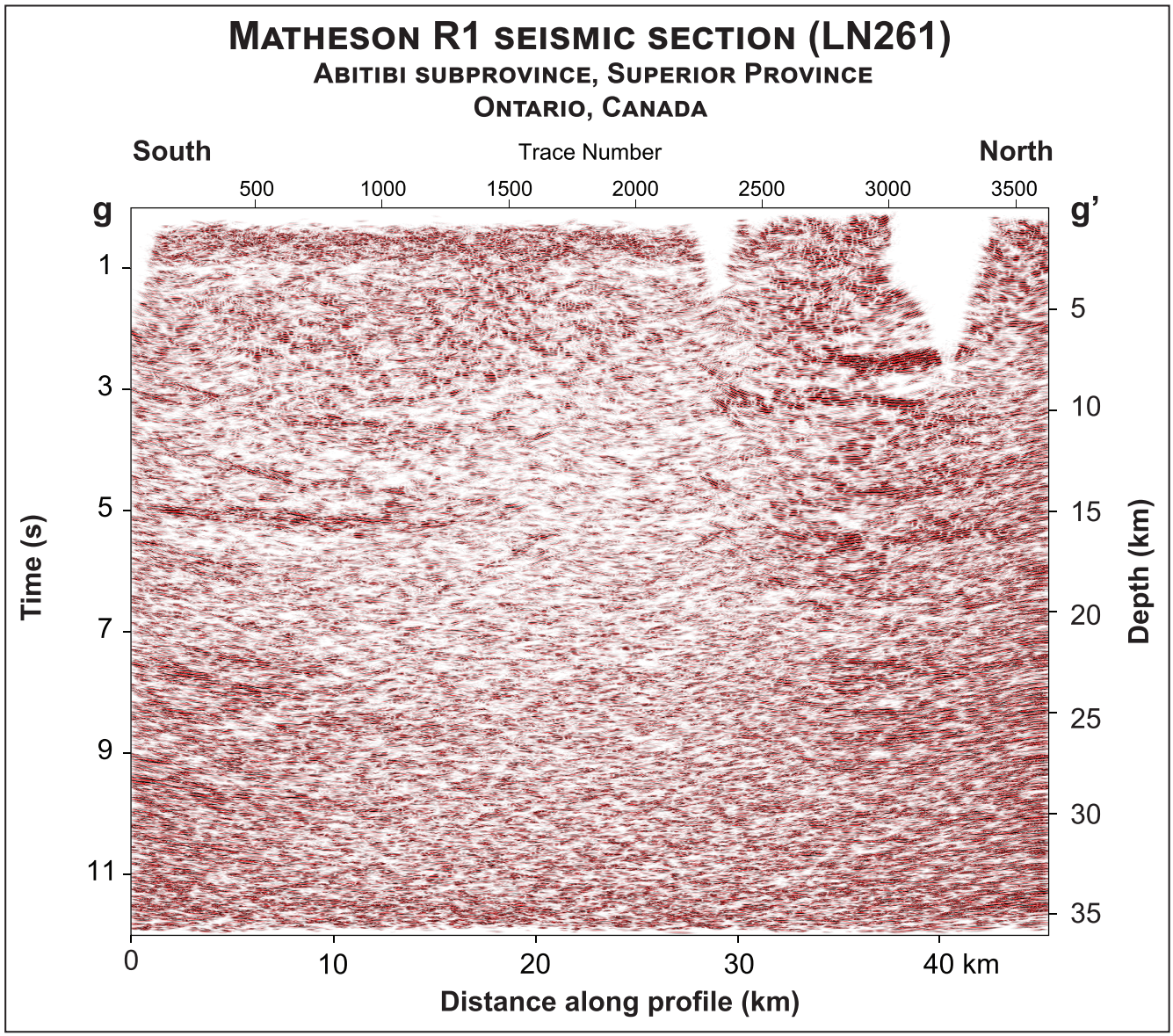
The ~83-km Matheson transect [G–G'] is located in northeast Ontario, east of the Timmins-Porcupine gold camp, extending from the Watabeag pluton (west of Watabeag Lake), across the gold-endowed Porcupine-Destor fault (PDF) and Pipestone fault, into metavolcanics of the 2723–2720 Ma Stoughton-Roquemaure assemblage (south of Withington Lake; **Figure 6**). The transect encompasses ~54 km of new R1 seismic reflection data [g–g'; line 261] that traverses multiple metavolcanic assemblages (i.e., 2723–2720 Ma Stoughton-Roquemaure, 2710–2706 Lower Tisdale, 2706–2704 Ma Upper Tisdale, and 2704–2701 Ma Lower Blake River assemblages) and metasedimentary deposits (i.e., 2700–2685 Ma Porcupine assemblage) of the southern Abitibi subprovince. A comparatively short ~13-km R2 seismic reflection survey across the PDF and the Pipestone fault, which was conducted parallel to the g–g' Matheson R1 seismic survey, aimed to resolve the shallow structure of these crustal-scale faults and the geometry of the Porcupine sedimentary basin (see Haugaard et al. 2021). BBMT stations were also deployed along the entire transect [G–G'], including the g–g' Matheson R1 seismic survey line, resulting in a conductivity section across the Porcupine basin and the regionally extensive PDF.

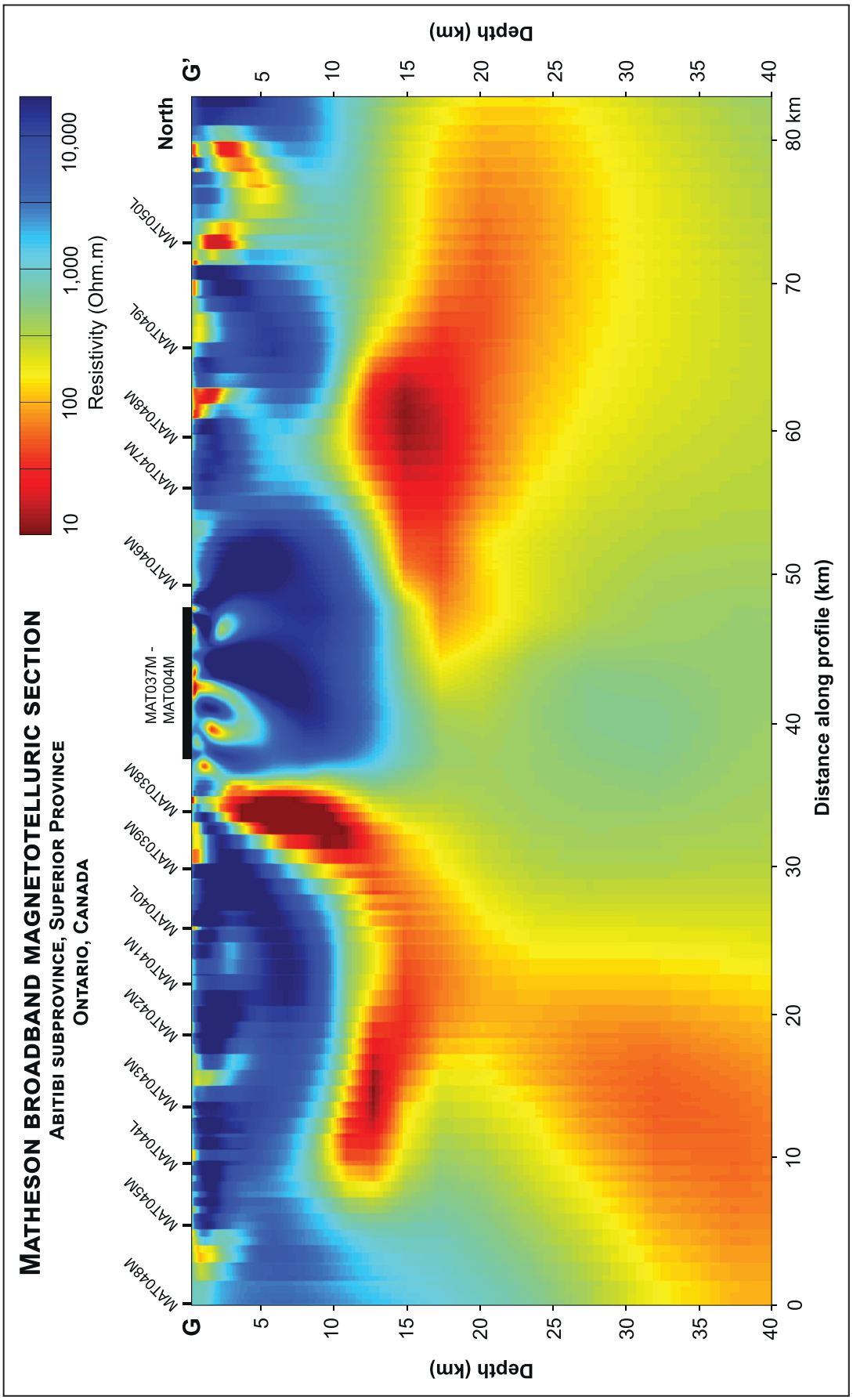
The Matheson area is host to a series of gold deposits that are spatially related to the PDF and the Pipestone fault, most notably the Black Fox deposit (0.95 Moz. Au), Taylor deposit (0.31 Moz. Au), and the Clavos deposit (Haugaard et al., 2021). These fault segments (and more broadly the Matheson area) are considered to be moderately endowed, especially in comparison to equivalent faults segments in the Timmins-Porcupine gold camp (see Folio 7: Crawchest and Timmins transects), which host some of the largest Archean gold deposits on Earth (Bateman et al. 2005, 2008; Dubé et al. 2017, 2020). The R1 seismic reflection and BBMT data from the Matheson transect therefore enable comparisons between differentially endowed segments of the PDF (cf., Folio 7: Crawchest and Timmins transects and Folio 8: Swayze transect).

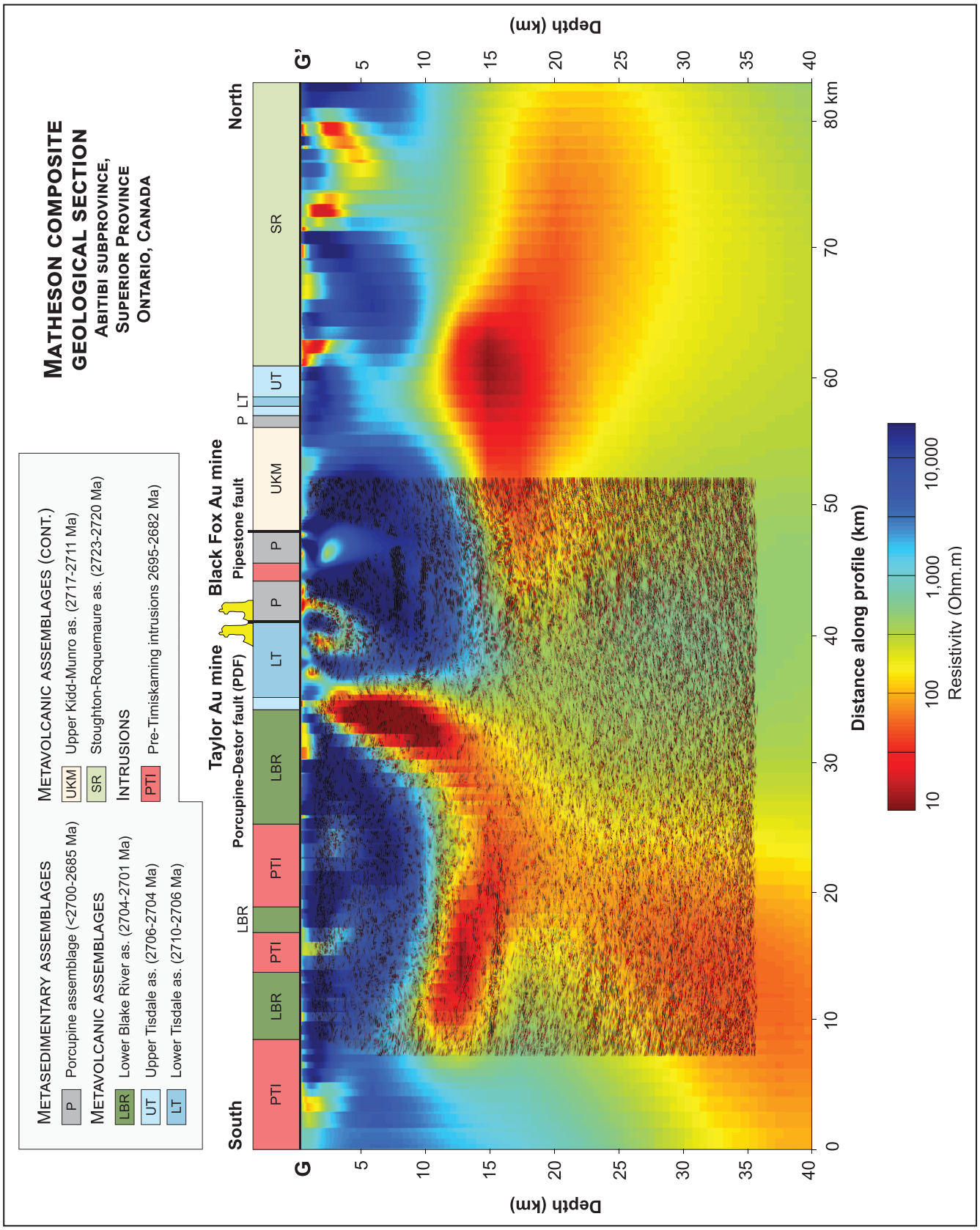
The reader is referred to a publication by Haugaard et al. (2021) for interpretations of the R1 [g–g'; line 261] and R2 seismic reflection data, and the BBMT data [G–G']. Refer to Maepa (2021) and Della Justina et al. (2024) for discussions on prospectivity mapping and the significance of gravity data in the Matheson transect area. See Roots et al. (2022) for a discussion of the regional MT data.

Figure 6. Geological maps of the Abitibi greenstone belt (southern Abitibi Subprovince) in northeast Ontario, showing the location of the Matheson R1 seismic [g–g'; line 261] and BBMT [G–G'] sections with respect to major crustal-scale faults (e.g., Porcupine-Destor and Pipestone faults) and gold deposits (i.e., Taylor and Black Fox mines). Map data sourced from the Metal Earth compilations of Montsion et al. (2018; lithological data) and Jørgensen and Gibson (2024; assemblage data).


g g' Matheson R1 seismic section (Line 261)
G G' Matheson broadband MT section
Broadband MT and audio-frequency MT stations
MATHESON TRANSECT
ABITIBI SUBPROVINCE, SUPERIOR PROVINCE
ONTARIO, CANADA
ABITIBI SUBPROVINCE
North Pipestone fault
Pipestone fault
Porcupine-Destor fault
Caar porphyry
Watabeag batholith
N
Gold deposits
Clavos mine 1
Taylor mine 2
Black Fox mine 3
0 5 10 km
49°N
48°40'N
48°20'N
48°N
80°40'W
80°20'W
525000E m
550000E m
5425000N m
5400000N m
5375000N m
5350000N m
5325000N m
Coordinate system: NAD83 UTM17N
Lithological classification
Mafic intrusions
Coarse clastic metasedimentary rocks
Fine-grained clastic metasedimentary rocks
Massive granodiorite to granite
Diorite-monzonite-granodiorite suite
Foliated tonalite suite
Mafic intrusions
Ultramafic intrusions
Migmatized successor basin units
Iron formation
Coarse-grained clastic successor basin units
Fine-grained clastic successor basin units
Mafic to ultramafic metavolcanics
Mafic to intermediate metavolcanics
Felsic to intermediate metavolcanics
Assemblage classification
Timiskaming assemblage (2679–2669 Ma)
Early- to syn-Timiskaming intrusions (2683–2670 Ma)
Pre-Timiskaming intrusions (2695–2682 Ma)
Porcupine assemblage (2700–2685 Ma)
Lower Blake River assemblage (2704–2701 Ma)
Upper Tisdale assemblage (2706–2704 Ma)
Lower Tisdale assemblage (2710–2706 Ma)
Upper Kidd-Munro assemblage (2717–2711 Ma)
Lower Kidd-Munro assemblage (2719–2717 Ma)
Stoughton-Roquemaure assem. (2723–2720 Ma)
Intermediate to felsic intrusions (2750–2695 Ma)
Ultramafic to mafic intrusions (2750–2700 Ma)


MATHESON R1 SEISMIC SECTION (LN261)
ABITIBI SUBPROVINCE, SUPERIOR PROVINCE
ONTARIO, CANADA
South
Trace Number
North
500
1000
1500
2000
2500
3000
3500
g
g'
1
3
5
7
9
11
Time (s)
5
10
15
20
25
30
35
Depth (km)
0
10
20
30
40 km
Distance along profile (km)


MATHESON BROADBAND MAGNETOTELLURIC SECTION
ABITIBI SUBPROVINCE, SUPERIOR PROVINCE
ONTARIO, CANADA
10
100
1,000
10,000
Resistivity (Ohm.m)
North
G
G'
MAT048M
MAT045M
MAT044L
MAT043M
MAT042M
MAT041M
MAT040L
MAT039M
MAT038M
MAT037M - MAT004M
MAT046M
MAT047M
MAT048M
MAT049L
MAT050L
Depth (km)
Distance along profile (km)
0
10
20
30
40
50
60
70
80 km
5
15
25
35


MATHESON COMPOSITE
GEOLOGICAL SECTION
ABITIBI SUBPROVINCE,
SUPERIOR PROVINCE
ONTARIO, CANADA
METASEDIMENTARY ASSEMBLAGES
P Porcupine assemblage (<2700-2685 Ma)
METAVOLCANIC ASSEMBLAGES
LBR Lower Blake River as. (2704-2701 Ma)
UT Upper Tisdale as. (2706-2704 Ma)
LT Lower Tisdale as. (2710-2706 Ma)
METAVOLCANIC ASSEMBLAGES (CONT.)
UKM Upper Kidd-Munro as. (2717-2711 Ma)
SR Stoughton-Roquemaure as. (2723-2720 Ma)
INTRUSIONS
PTI Pre-Timiskaming intrusions 2695-2682 Ma)
South
North
G
G'
Taylor Au mine
Porcupine-Destor fault (PDF)
Black Fox Au mine
Pipestone fault
PTI
LBR
P
LT
UKM
SR
UT
Depth (km)
Distance along profile (km)
0
10
20
30
40
50
60
70
80 km
5
15
25
35
10
100
1,000
10,000
Resistivity (Ohm.m)

Useful references

Bateman, R., Ayer, J.A., and Dubé, B. 2008. The Timmins-Porcupine gold camp, Ontario: Anatomy of an Archean greenstone belt and ontogeny of gold mineralization. Economic Geology, **103**: 1285–1308. doi:https://doi.org/10.2113/gsecongeo.103.6.1285.

Bateman, R., Ayer, J.A., Dubé, B., and Hamilton, M.A. 2005. The Timmins–Porcupine Gold Camp, Northern Ontario: The Anatomy of an Archaean Greenstone Belt and its Gold Mineralization: Discover Abitibi Initiative. Ontario Geological Survey (OGS), Open File Report **OFR6158**.

Dubé, B., Mercier-Langevin, P., Ayer, J., Atkinson, B.T., and Monecke, T. 2017. Chapter 2: Orogenic greenstone-hosted quartz-carbonate gold deposits of the Timmins-Porcupine camp. *In* Archean Base and Precious Metal Deposits, Southern Abitibi Greenstone Belt, Canada. *Edited by* T. Monecke, P. Mercier-Langevin, and B. Dubé. Reviews in Economic Geology. pp. 51–79. doi:https://doi.org/10.5382/Rev.19.02.

Dubé, B., Mercier-Langevin, P., Ayer, J., Pilote, J.-L., and Monecke, T. 2020. Chapter 3: Gold deposits of the world-class Timmins-Porcupine camp, Abitibi greenstone belt, Canada. *In* Geology of the World's Major Gold Deposits and Provinces. *Edited by* R.H. Sillitoe, R.J. Goldfarb, F. Robert, and S.F. Simmons. Society of Economic Geologists. pp. 53–80. doi:https://doi.org/10.5382/SP.23.03.

Della Justina, F., Smith, R.S., Haugaard, R., 2024. A case-history using gravity data to validate alternate interpretations of the material below a deep seismic reflector in the Matheson area of Ontario, Canada. Geophysics. https://doi.org/10.1190/geo2023-0523.1.

Haugaard, R., Della Justina, F., Roots, E., Cheraghi, S., Vayavur, R., Hill, G., Snyder, D.B., Ayer, J., Naghizadeh, M., and Smith, R. 2021. Crustal-Scale Geology and Fault Geometry Along the Gold-Endowed Matheson Transect of the Abitibi Greenstone Belt. Economic Geology, **116**: 1053–1072. doi:https://doi.org/10.5382/econgeo.4813.

Jørgensen, T.R.C., and Gibson, H.L. 2024. Assemblage compilation of the Abitibi subprovince, Superior Province, Canada. Metal Earth Project, Mineral Exploration Research Centre. https://metalearth.files.com/f/81ca7963c83475a6

Maepa, F. 2021. Exploration targeting for gold deposits using spatial data analytics, machine learning and deep transfer learning in the Swayze and Matheson greenstone belts, Ontario, Canada. Laurentian University.

Montsion, R.M., Thurston, P., and Ayer, J. 2018. 1:2,000,000 Scale Geological Compilation of the Superior Craton - Version 1. Laurentian University Mineral Exploration Research Centre (MERC) **ME-2018-017**.

Roots, E.A., Hill, G.J., Frieman, B.M., Wannamaker, P.E., Maris, V., Calvert, A.J., Craven, J.A., Smith, R.S., and Snyder, D.B. 2022. Magmatic, hydrothermal and ore element transfer processes of the southeastern Archean Superior Province implied from electrical resistivity structure. Gondwana Research, **105**: 84–95. doi:https://doi.org/10.1016/j.gr.2021.12.004.

Folio 7

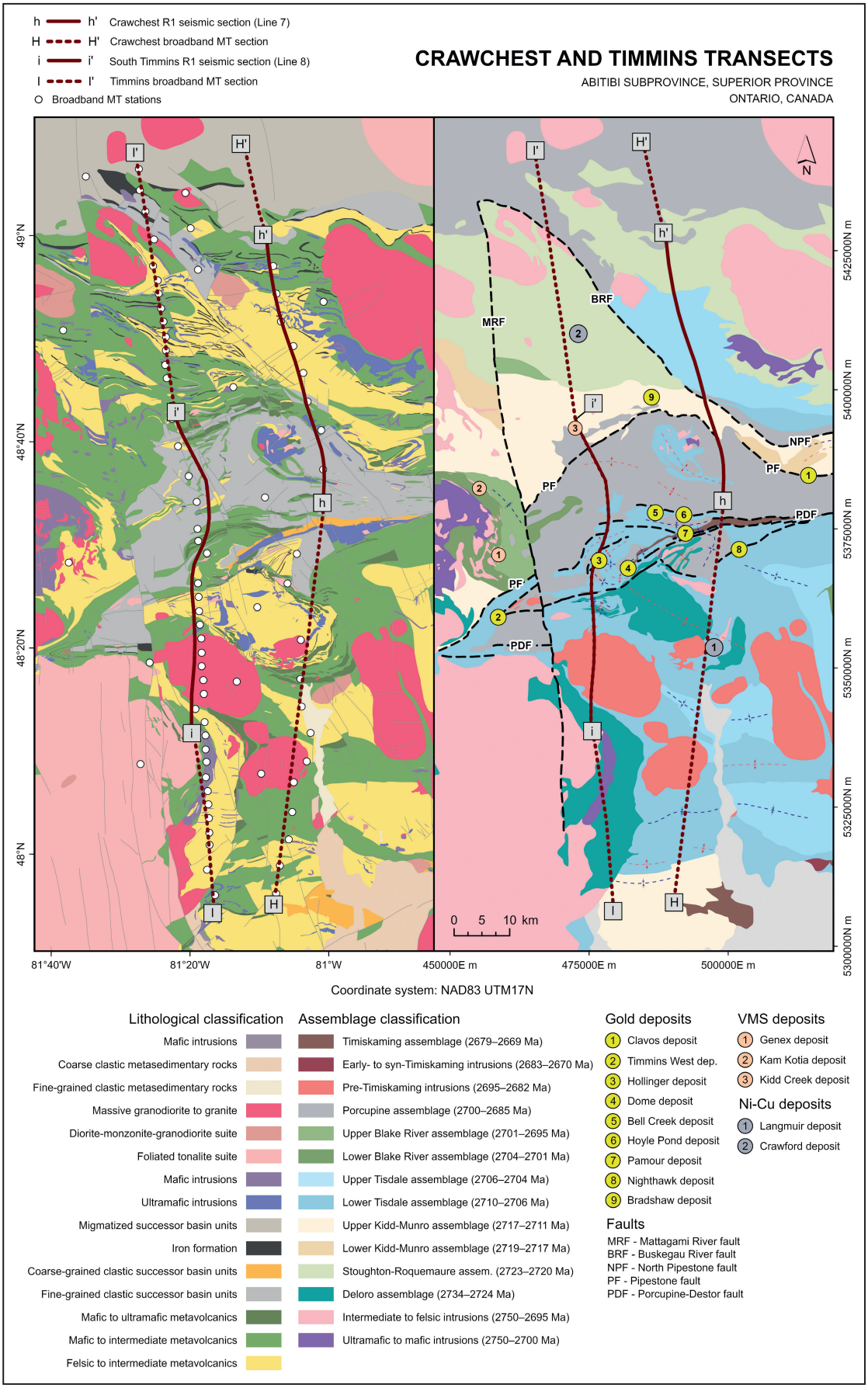
Crawchest and Timmins transects

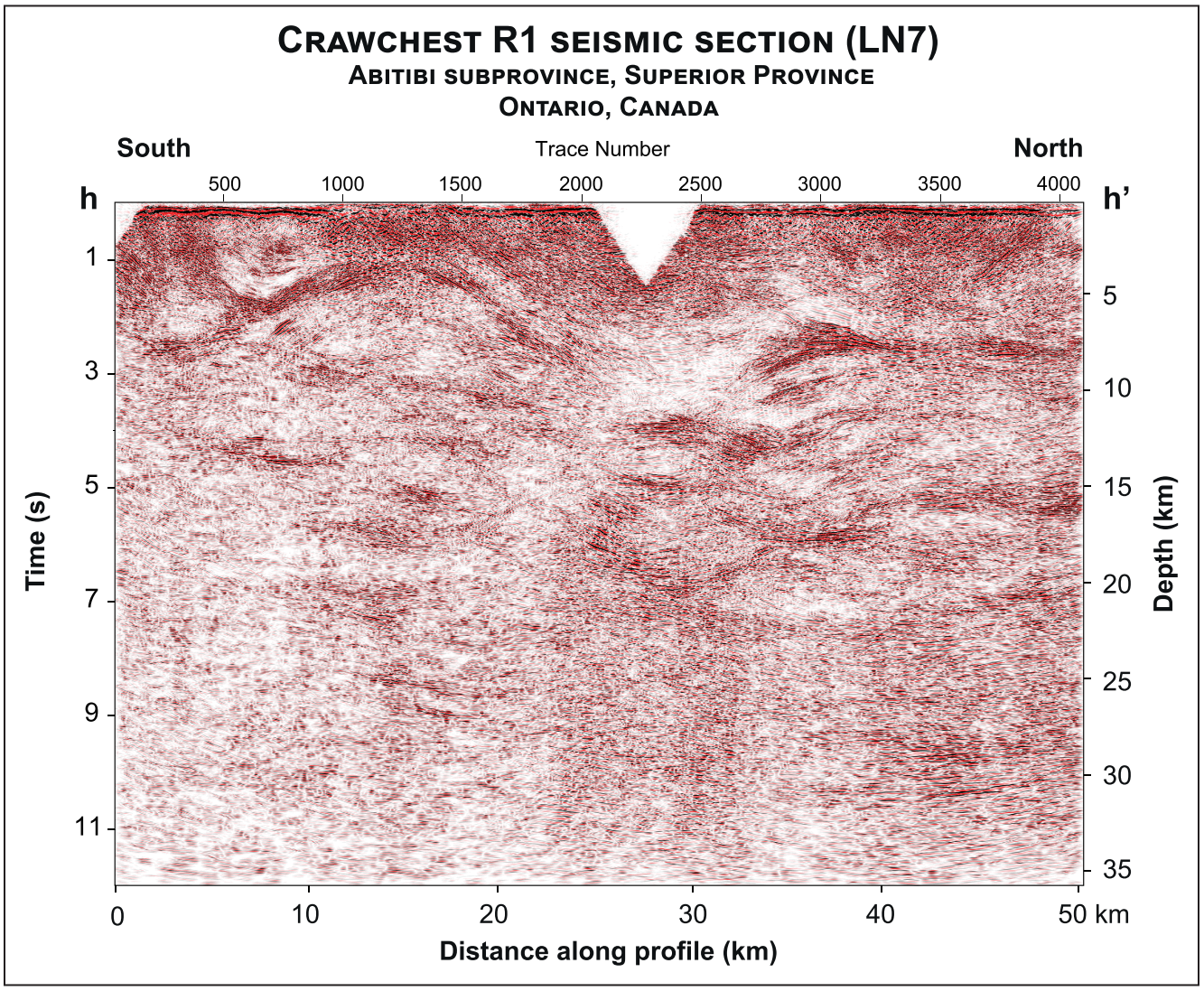
The ~143 km Crawchest [H–H'] and ~143 km Timmins [I–I'] transects are located in northeast Ontario and traverse the giant Timmins-Porcupine gold camp of the southern Abitibi subprovince (Bateman et al. 2005, 2008; Dubé et al. 2017, 2020; **Figure 7**). Each transect trends parallel to the existing R1 seismic reflection surveys (the ~50 km Crawchest and the ~60 km South Timmins seismic lines) that were conducted in July 2004 by Kinetex Inc., Calgary, as part of the Discover Abitibi Initiative (see Snyder et al. 2008 for survey details) and intersect the gold-endowed Porcupine-Destor fault (PDF) and the Pipestone fault. The >50 km Crawchest R1 seismic reflection line [h–h'; line 7] stretches from Highway 610 (west of Kettle Lakes Provincial Park) to Belisle Lake (southwest of Cochrane), traversing metavolcanics of the 2723–2720 Ma Stoughton-Roquemaure, 2717–2711 Ma Upper Kidd-Munro, and 2706–2704 Ma Upper Tisdale assemblages, and metasediments of the 2700–2685 Ma Porcupine assemblage. The adjacent ~60 km South Timmins R1 seismic line [i–i'; line 8] stretches northward from Bartlett Lake (along Naybob Road) to the Kidd Creek mine off Highway 655, traversing the giant Hollinger gold deposit and fault-bound metavolcanic and metasedimentary deposits of the Upper Kidd-Munro (which hosts the Kidd Creek volcanogenic massive sulfide (VMS) deposit), Upper Tisdale, Porcupine, and the 2679–2669 Ma Timiskaming assemblage. The seismic data from both seismic lines were reprocessed to a depth of ~36 km (cf., ~15 km depths sections of Snyder et al. 2008). Broadband MT stations were deployed along the entirety of each transect, including the h–h' Crawchest and i–i' South Timmins seismic lines, resulting in conductivity sections across the giant Timmins-Porcupine gold camp.

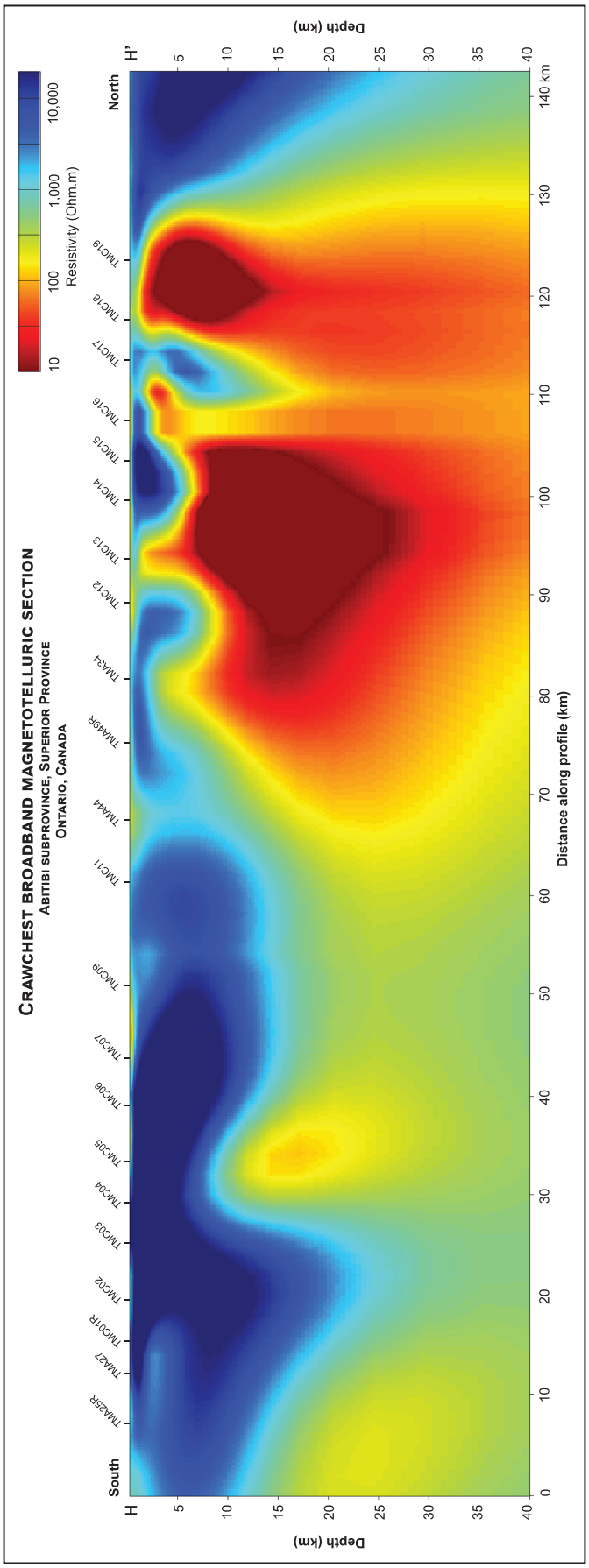
The Timmins-Porcupine gold camp is the largest Archean orogenic gold camp on earth (>75 Moz gold), characterised by multiple world-class intrusion and orogenic gold deposits, including the Hollinger, Dome, Bell Creek, Hoyle Pond, and Pamour deposits, which are distributed along strike of the PDF (Bateman et al. 2005, 2008; Dubé et al. 2020). The camp is also host to the giant Kidd Creek deposit, an anomalous high-grade Cu–Zn VMS deposit with total past production, reserves, and resources to the 9,800-ft level (2,990 m) of 170.9 million tonnes (Dubé et al. 2020). Minor Cu–Ni–PGE magmatic sulfide deposits have also been recognised, most notably the Langmuir and Crawford deposits. The reprocessed R1 seismic reflection data and new broadband MT sections provide an opportunity to reevaluate the structural evolution of the Timmins-Porcupine gold camp, a region characterised by structural and rheological discontinuities, competency contrasts, and early-stage folds with associated fracture and fault networks. Each transect also traverses the gold-endowed PDF, enabling comparisons with moderately endowed segments of the PDF (cf., Folio 6: Matheson transect) and the Cadillac–Larder Lake fault (cf., Folio 2: Chicobi and Malartic transects; Folio 3: Rouyn–Noranda transect and Folio 4: Larder Lake transect).

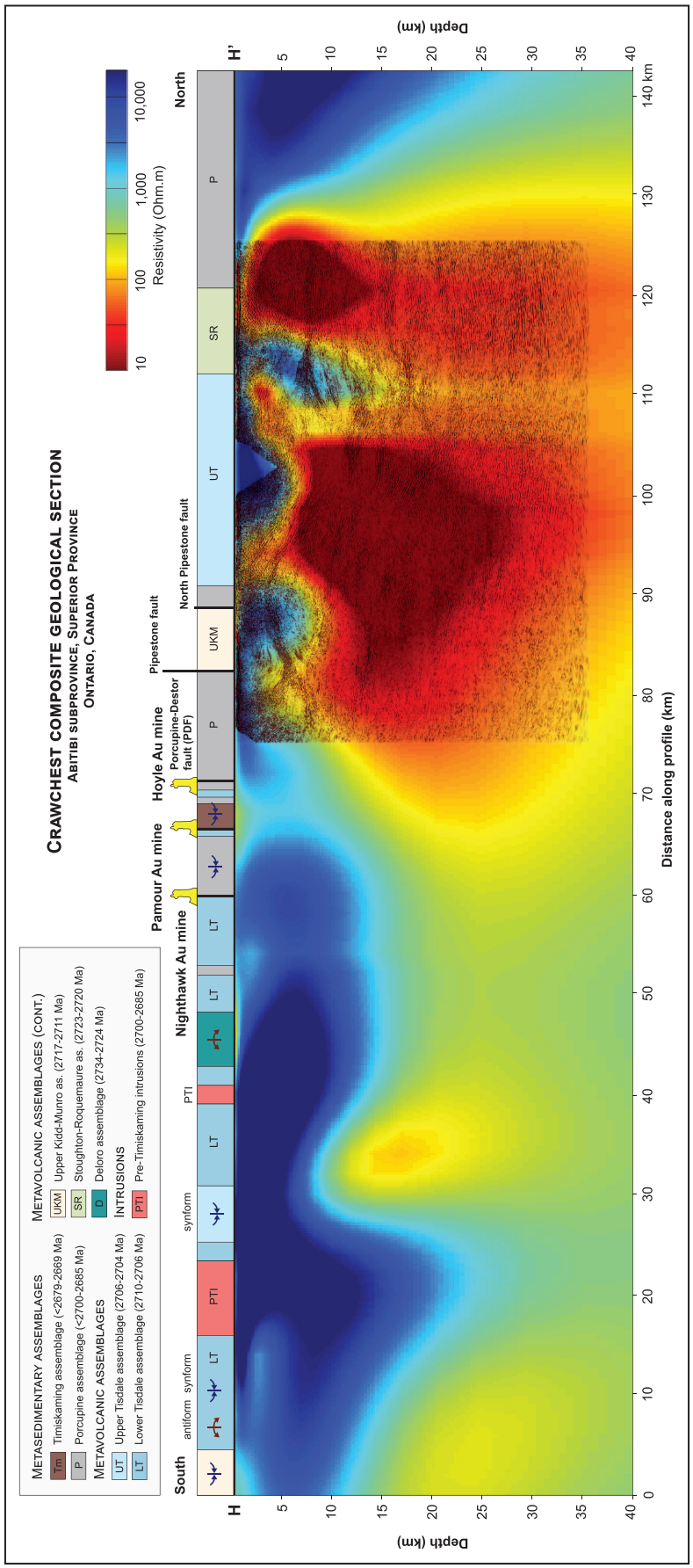
The reader is referred to publications by Snyder et al. (2008, 2009) for interpretations of the Discover Abitibi Initiative R1 Crawchest [h–h'; line 7] and South Timmins [i–i'; line 8] seismic sections. Refer to Adetunji et al. (2024) for an interpretation of the reprocessed seismic data [h–h' and i–i'] and the new BBMT data [H–H' and I–I'].

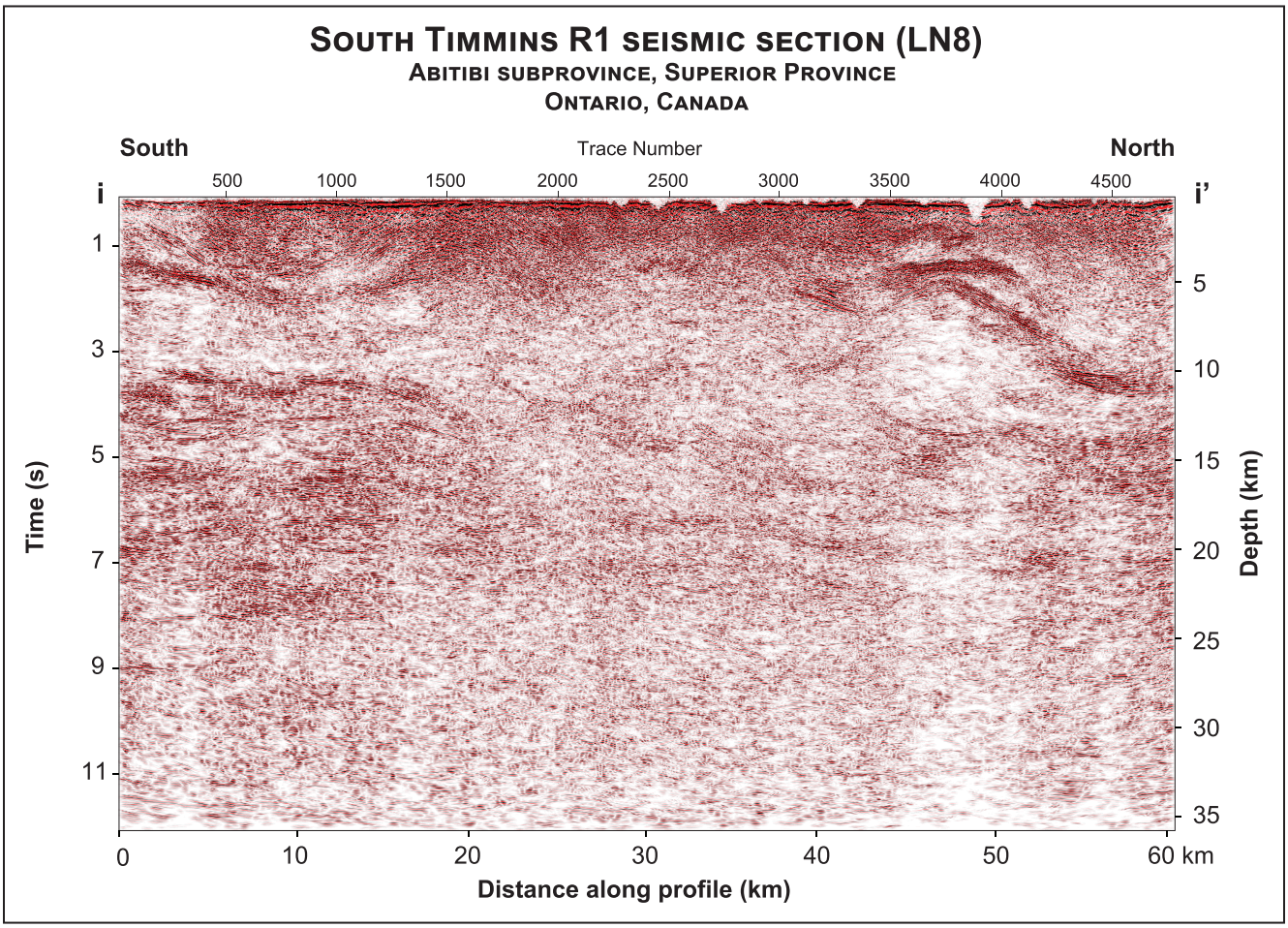
Figure 7. Geological maps of the world-class Timmins-Porcupine gold camp within the Abitibi greenstone belt (southern Abitibi subprovince) in eastern Ontario, showing the locations of the Crawchest [H–H'] and Timmins [I–I'] R1 seismic and BBMT surveys that were conducted as part of the Discover Abitibi Initiative and the Metal Earth program, respectively. Map data sourced from the Metal Earth compilations of Montsion et al. (2018; lithological data) and Jørgensen and Gibson (2024; assemblage data).

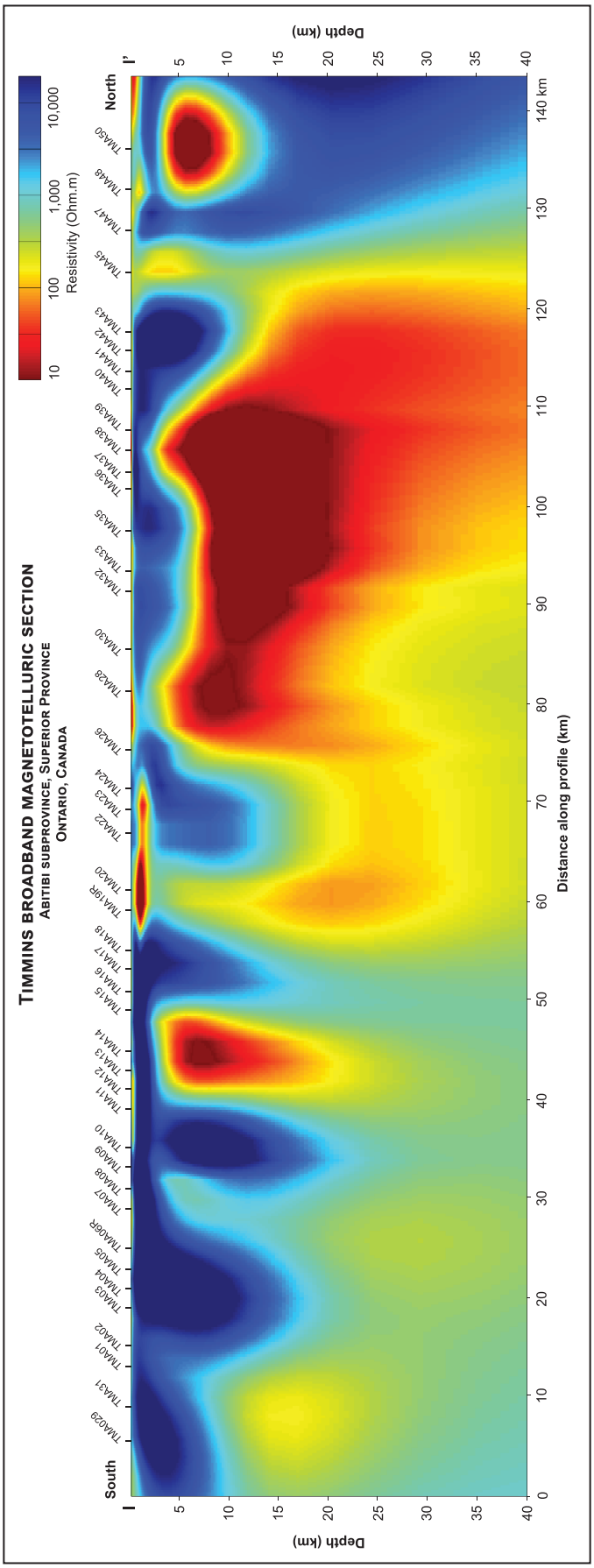

h h' Crawchest R1 seismic section (Line 7)
H H' Crawchest broadband MT section
i i' South Timmins R1 seismic section (Line 8)
I I' Timmins broadband MT section
Broadband MT stations
CRAWCHEST AND TIMMINS TRANSECTS
ABITIBI SUBPROVINCE, SUPERIOR PROVINCE
ONTARIO, CANADA
N
BRF
MRF
NPF
PF
PDF
0 5 10 km
49°N
48°40'N
48°20'N
48°N
81°40'W
81°20'W
81°W
450000E m
475000E m
500000E m
5425000N m
5400000N m
5375000N m
5350000N m
5325000N m
5300000N m
Coordinate system: NAD83 UTM17N
Lithological classification
Mafic intrusions
Coarse clastic metasedimentary rocks
Fine-grained clastic metasedimentary rocks
Massive granodiorite to granite
Diorite-monzonite-granodiorite suite
Foliated tonalite suite
Mafic intrusions
Ultramafic intrusions
Migmatized successor basin units
Iron formation
Coarse-grained clastic successor basin units
Fine-grained clastic successor basin units
Mafic to ultramafic metavolcanics
Mafic to intermediate metavolcanics
Felsic to intermediate metavolcanics
Assemblage classification
Timiskaming assemblage (2679–2669 Ma)
Early- to syn-Timiskaming intrusions (2683–2670 Ma)
Pre-Timiskaming intrusions (2695–2682 Ma)
Porcupine assemblage (2700–2685 Ma)
Upper Blake River assemblage (2701–2695 Ma)
Lower Blake River assemblage (2704–2701 Ma)
Upper Tisdale assemblage (2706–2704 Ma)
Lower Tisdale assemblage (2710–2706 Ma)
Upper Kidd-Munro assemblage (2717–2711 Ma)
Lower Kidd-Munro assemblage (2719–2717 Ma)
Stoughton-Roquemaure assem. (2723–2720 Ma)
Deloro assemblage (2734–2724 Ma)
Intermediate to felsic intrusions (2750–2695 Ma)
Ultramafic to mafic intrusions (2750–2700 Ma)
Gold deposits
1 Clavos deposit
2 Timmins West dep.
3 Hollinger deposit
4 Dome deposit
5 Bell Creek deposit
6 Hoyle Pond deposit
7 Pamour deposit
8 Nighthawk deposit
9 Bradshaw deposit
Faults
MRF - Mattagami River fault
BRF - Buskegau River fault
NPF - North Pipestone fault
PF - Pipestone fault
PDF - Porcupine-Destor fault
VMS deposits
1 Genex deposit
2 Kam Kotia deposit
3 Kidd Creek deposit
Ni-Cu deposits
1 Langmuir deposit
2 Crawford deposit

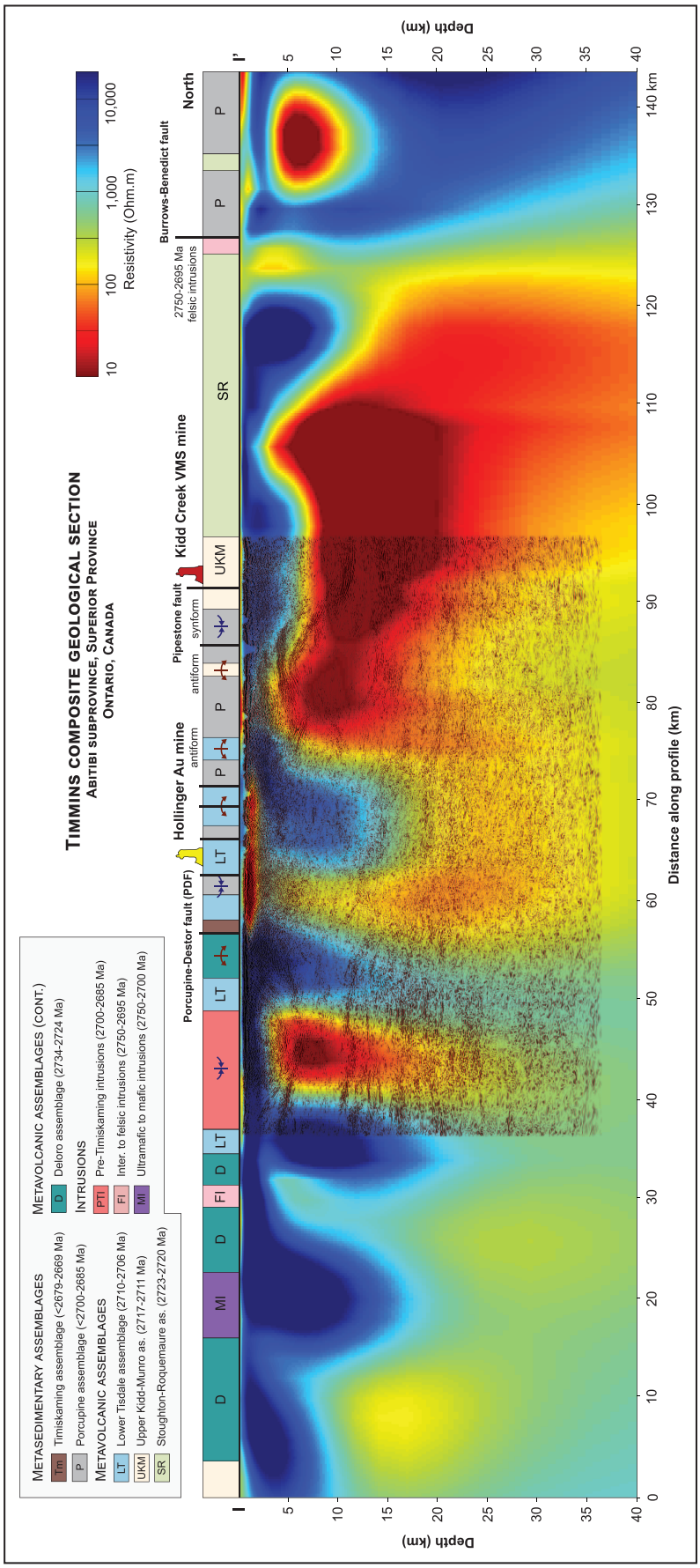

CRAWCHEST R1 SEISMIC SECTION (LN7)
ABITIBI SUBPROVINCE, SUPERIOR PROVINCE
ONTARIO, CANADA
South
Trace Number
North
500
1000
1500
2000
2500
3000
3500
4000
h
h'
1
3
5
7
9
11
Time (s)
5
10
15
20
25
30
35
Depth (km)
0
10
20
30
40
50 km
Distance along profile (km)


CRAWCHEST BROADBAND MAGNETOTELLURIC SECTION
ABITIBI SUBPROVINCE, SUPERIOR PROVINCE
ONTARIO, CANADA
Resistivity (Ohm.m)
10
100
1,000
10,000
South
North
H
H'
Depth (km)
Distance along profile (km)
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140 km
TMAC25R
TMAC27
TMAC01R
TMAC02
TMAC03
TMAC04
TMAC05
TMAC06
TMAC07
TMAC09
TMAC11
TMA44
TMA49R
TMA34
TMAC12
TMAC13
TMAC14
TMAC15
TMAC16
TMAC17
TMAC18
TMAC19


CRAWCHEST COMPOSITE GEOLOGICAL SECTION
ABITIBI SUBPROVINCE, SUPERIOR PROVINCE
ONTARIO, CANADA
METASEDIMENTARY ASSEMBLAGES
Tm Timiskaming assemblage (<2679-2669 Ma)
P Porcupine assemblage (<2700-2685 Ma)
METAVOLCANIC ASSEMBLAGES
UT Upper Tisdale assemblage (2706-2704 Ma)
LT Lower Tisdale assemblage (2710-2706 Ma)
METAVOLCANIC ASSEMBLAGES (CONT.)
UKM Upper Kidd-Munro as. (2717-2711 Ma)
SR Stoughton-Roquemaure as. (2723-2720 Ma)
D Deloro assemblage (2734-2724 Ma)
INTRUSIONS
PTI Pre-Timiskaming intrusions (2700-2685 Ma)
Resistivity (Ohm.m)
10
100
1,000
10,000
South
antiform synform
synform
PTI
Nighthawk Au mine
Pamour Au mine
Hoyle Au mine
Porcupine-Destor fault (PDF)
Pipestone fault
North Pipestone fault
North
H
H'
Depth (km)
Distance along profile (km)
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140 km
5
15
25
35


South Timmins R1 seismic section (LN8)
Abitibi subprovince, Superior Province
Ontario, Canada
South
Trace Number
North
500
1000
1500
2000
2500
3000
3500
4000
4500
i
i'
1
3
5
7
9
11
Time (s)
5
10
15
20
25
30
35
Depth (km)
0
10
20
30
40
50
60 km
Distance along profile (km)


TIMMINS BROADBAND MAGNETOTELLURIC SECTION
ABITIBI SUBPROVINCE, SUPERIOR PROVINCE
ONTARIO, CANADA
Resistivity (Ohm.m)
10
100
1,000
10,000
South
North
I
I'
Depth (km)
Distance along profile (km)
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140 km
TMA029
TMA031
TMA001
TMA002
TMA003
TMA004
TMA005
TMA006R
TMA007
TMA008
TMA009
TMA010
TMA011
TMA012
TMA013
TMA014
TMA015
TMA016
TMA017
TMA018
TMA019R
TMA020
TMA022
TMA023
TMA024
TMA026
TMA028
TMA030
TMA032
TMA033
TMA035
TMA036
TMA037
TMA038
TMA039
TMA040
TMA041
TMA042
TMA043
TMA045
TMA047
TMA048
TMA050


TIMMINS COMPOSITE GEOLOGICAL SECTION
ABITIBI SUBPROVINCE, SUPERIOR PROVINCE
ONTARIO, CANADA
METASEDIMENTARY ASSEMBLAGES
Tm Timiskaming assemblage (<2679-2669 Ma)
P Porcupine assemblage (<2700-2685 Ma)
METAVOLCANIC ASSEMBLAGES
LT Lower Tisdale assemblage (2710-2706 Ma)
UKM Upper Kidd-Munro as. (2717-2711 Ma)
SR Stoughton-Roquemaure as. (2723-2720 Ma)
METAVOLCANIC ASSEMBLAGES (CONT.)
D Deloro assemblage (2734-2724 Ma)
INTRUSIONS
PTI Pre-Timiskaming intrusions (2700-2685 Ma)
FI Inter. to felsic intrusions (2750-2695 Ma)
MI Ultramafic to mafic intrusions (2750-2700 Ma)
Porcupine-Destor fault (PDF)
Hollinger Au mine
antiform
Pipestone fault
antiform
synform
Kidd Creek VMS mine
2750-2695 Ma felsic intrusions
Burrows-Benedict fault
North
10
100
1,000
10,000
Resistivity (Ohm.m)
Depth (km)
Distance along profile (km)
140 km

Useful references

Adetunji, A.Q., Ferguson, I.J., Simmons, J.M., Ma, C., Cheraghi, S., Ayer, J., and Snyder, D.B. (in press). Trans-crustal geophysical responses beneath the supergiant Timmins-Porcupine orogenic gold camp, Canada. Solid Earth.

Bateman, R., Ayer, J.A., and Dubé, B. 2008. The Timmins-Porcupine gold camp, Ontario: Anatomy of an Archean greenstone belt and ontogeny of gold mineralization. Economic Geology, **103**: 1285–1308. https://doi.org/10.2113/gsecongeo.103.6.1285

Bateman, R., Ayer, J.A., Dubé, B., and Hamilton, M.A. 2005. The Timmins–Porcupine gold camp, northern Ontario: The anatomy of an Archaean greenstone belt and its gold mineralization: Discover Abitibi initiative. Ontario Geological Survey (OGS), Open File Report **OFR6158**.

Dubé, B., Mercier-Langevin, P., Ayer, J., Atkinson, B.T., and Monecke, T. 2017. Chapter 2: Orogenic greenstone-hosted quartz-carbonate gold deposits of the Timmins-Porcupine camp. *In* Archean Base and Precious Metal Deposits, Southern Abitibi Greenstone Belt, Canada. *Edited by* T. Monecke, P. Mercier-Langevin, and B. Dubé. Reviews in Economic Geology, Vol. 19. Society of Economic Geologists. pp. 51–79 https://doi.org/10.5382/Rev.19.02

Dubé, B., Mercier-Langevin, P., Ayer, J., Pilote, J.-L., and Monecke, T. 2020. Chapter 3: Gold deposits of the world-class Timmins-Porcupine camp, Abitibi greenstone belt, Canada. *In* Geology of the World's Major Gold Deposits and Provinces. *Edited by* R.H. Sillitoe, R.J. Goldfarb, F. Robert, and S.F. Simmons. Society of Economic Geologists. pp. 53–80 https://doi.org/10.5382/SP.23.03

Jørgensen, T.R.C., and Gibson, H.L. 2024. Assemblage compilation of the Abitibi subprovince, Superior Province, Canada. Metal Earth Project, Mineral Exploration Research Centre. https://metalearth.files.com/f/81ca7963c83475a6

Montsion, R.M., Thurston, P., and Ayer, J. 2018. 1:2,000,000 Scale Geological Compilation of the Superior Craton - Version 1. Laurentian University Mineral Exploration Research Centre (MERC) **ME-2018-017**.

Snyder, D.B., Bleeker, W., Reed, L.E., Ayer, J.A., Houlé, M.G., and Bateman, R. 2008. Tectonic and metallogenic implications of regional seismic profiles in the Timmins mining camp. Economic Geology, **103**: 1135–1150. https://doi.org/10.2113/gsecongeo.103.6.1135

Snyder, D.B., Cary, P., and Salisbury, M. 2009. 2D-3C high-resolution seismic data from the Abitibi Greenstone Belt, Canada. Tectonophysics, **472**: 226–237. https://doi.org/10.1016/j.tecto.2008.05.038

Folio 8

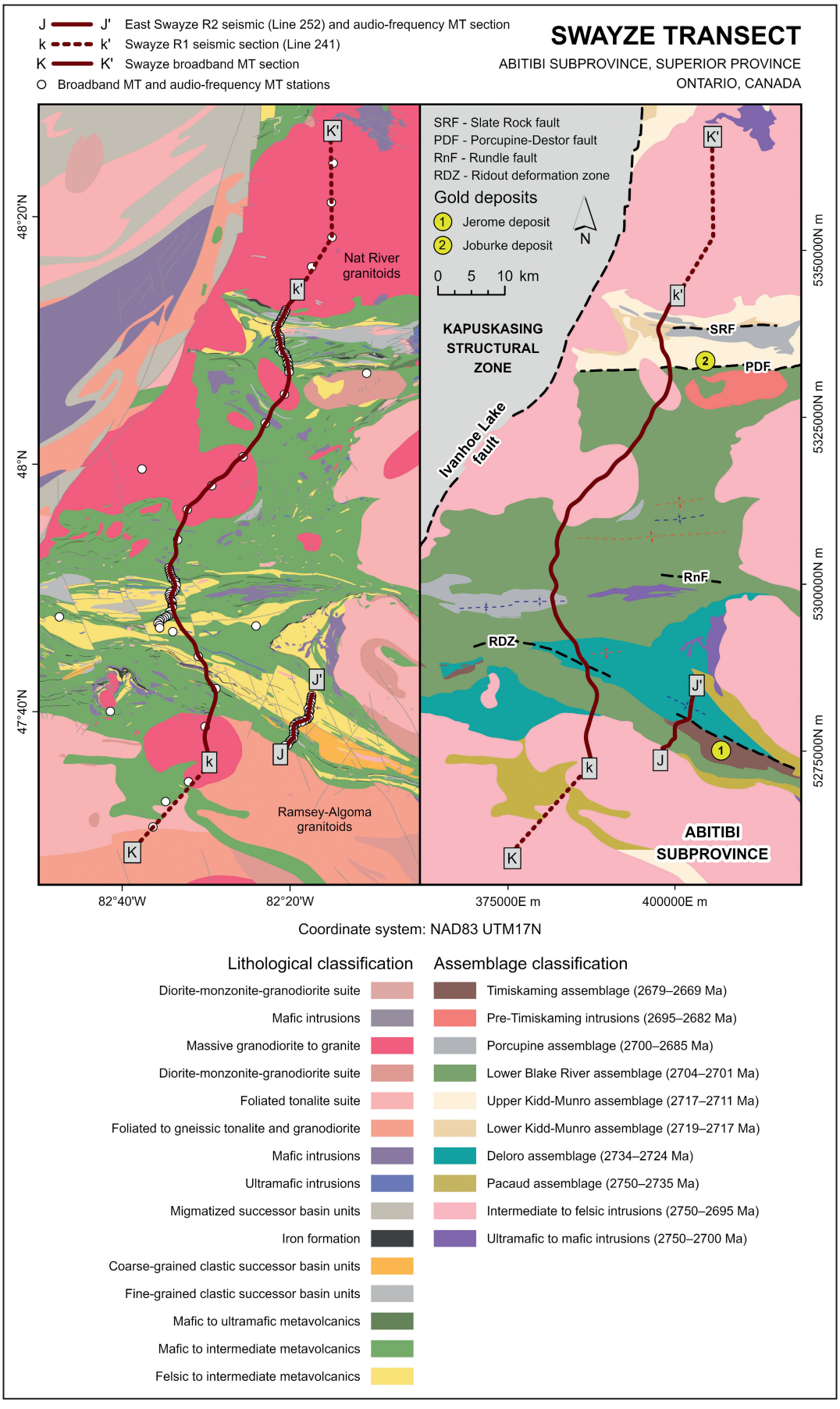
East Swayze and Swayze transects

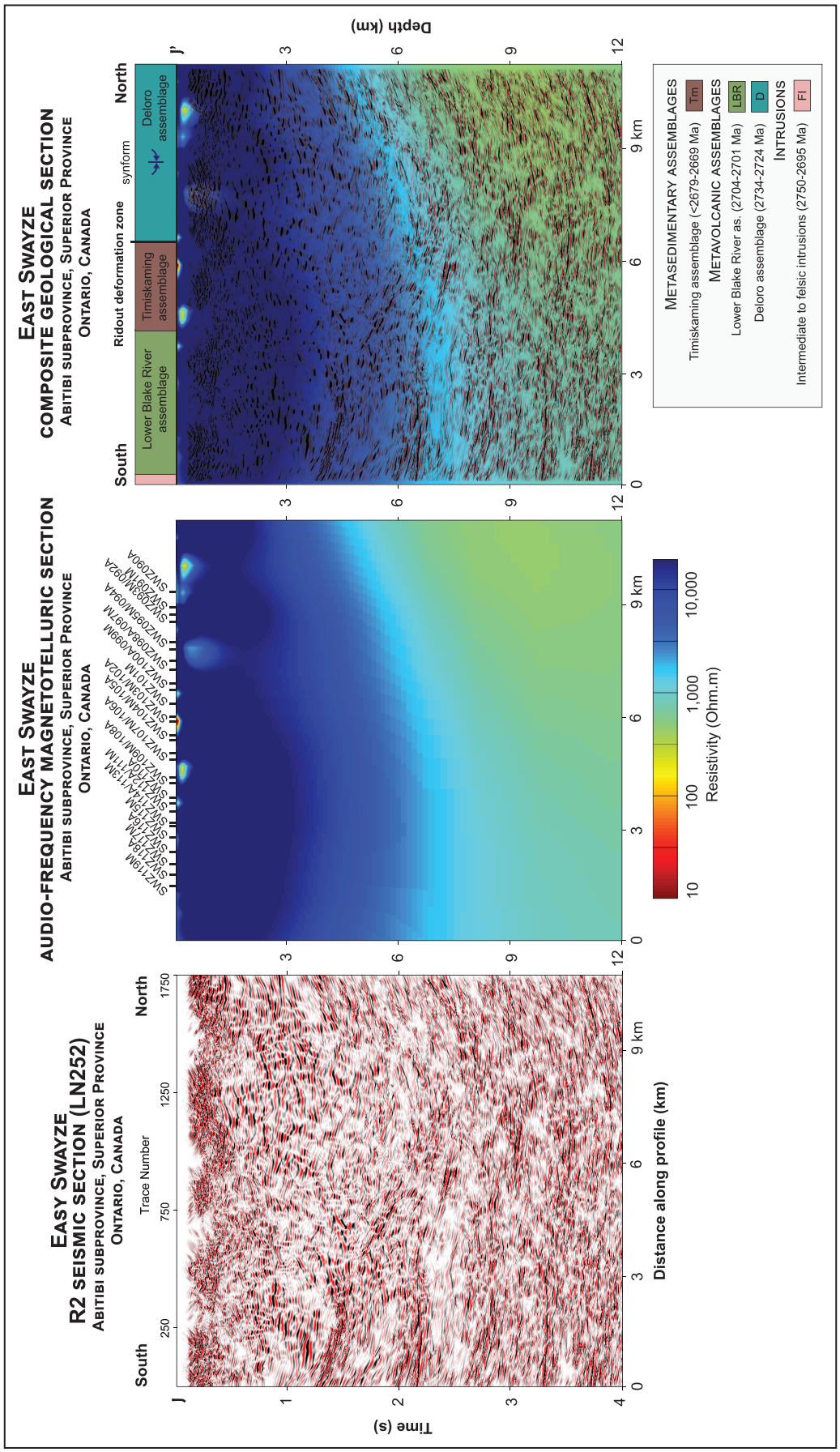
The East Swayze [J–J'] and Swayze [K–K'] transects are located in northeast Ontario and traverse metavolcanic and plutonic suites of the Swayze greenstone belt, a poorly endowed belt adjacent to the Kapuskasing structural zone (Heather 1993; Haugaard et al. 2017; **Figure 8**). The ~12-km East Swayze transect extends northward along Mallard Road (west of Opeepeesway Lake) and consists of R2 seismic reflection [j–j'; line 252] and AMT [J–J'] data that traverse metavolcanics and metasediments of the 2734–2724 Ma Deloro, 2717–2711 Ma Lower Blake River, and the 2679–2669 Ma Timiskaming assemblage. Metasediments of the Timiskaming assemblage, which host the nearby Jerome gold deposit (Hastie et al. 2020), are locally bound by the so-called Ridout deformation zone, an east-west domain that is postulated to represent an extension of the gold-endowed Cadillac-Larder Lake fault (CLLF). The adjacent ~130-km Swayze transect [K–K'] stretches from Woman River Forest Provincial Park [K] to Moore Lake [K'] and encompasses ~89 km of R1 seismic reflection data [k–k'; line 241] collected along Foleyet Timber Road. The R1 seismic line intersects the Ridout deformation zone, Porcupine-Destor fault (PDF), and the Slate Rock fault, and traverses folded metavolcanics and siliciclastic metasediments of the 2734–2724 Deloro, 2717–2711 Ma Upper Kidd-Munro, 2717–2711 Lower Blake River, and the 2700–2685 Ma Porcupine assemblage. Metavolcanics of the Upper Kidd-Munro assemblage, which are locally bound by the PDF, host the nearby Joburke gold deposit. BBMT stations were deployed along the entire transect [K–K'], including the k–k' Swayze R1 seismic survey line, resulting in a conductivity section that terminates within the Ramsey-Algoma granitoids [K] and the Nat River granitoids [K'].

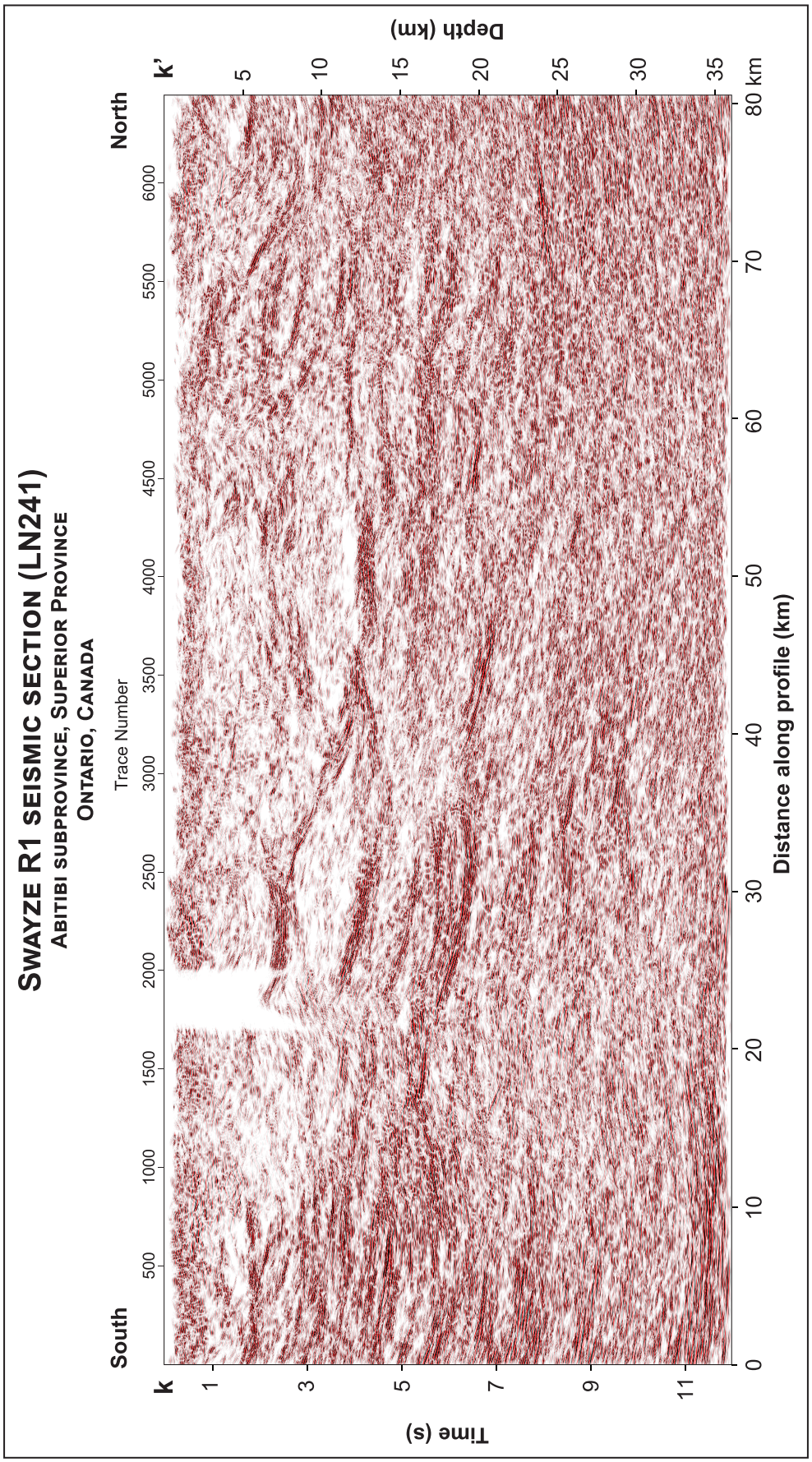
The Swayze greenstone belt is host to a relatively a small number of base metal occurrences and gold deposits (total past production <0.1 M oz. Au) and is considered poorly endowed relative to the world-class Timmins-Porcupine and Rouyn-Noranda mining camps. The East Swayze and Swayze geophysical transects consequently provide an opportunity to compare the crustal architecture of a poorly endowed greenstone belt with adjacent moderately and strongly endowed segments of the PDF and CLLF (cf., Folio 3: Rouyn Noranda transect, Folio 6: Matheson transect, and Folio 7: Crawchest and Timmins transects).

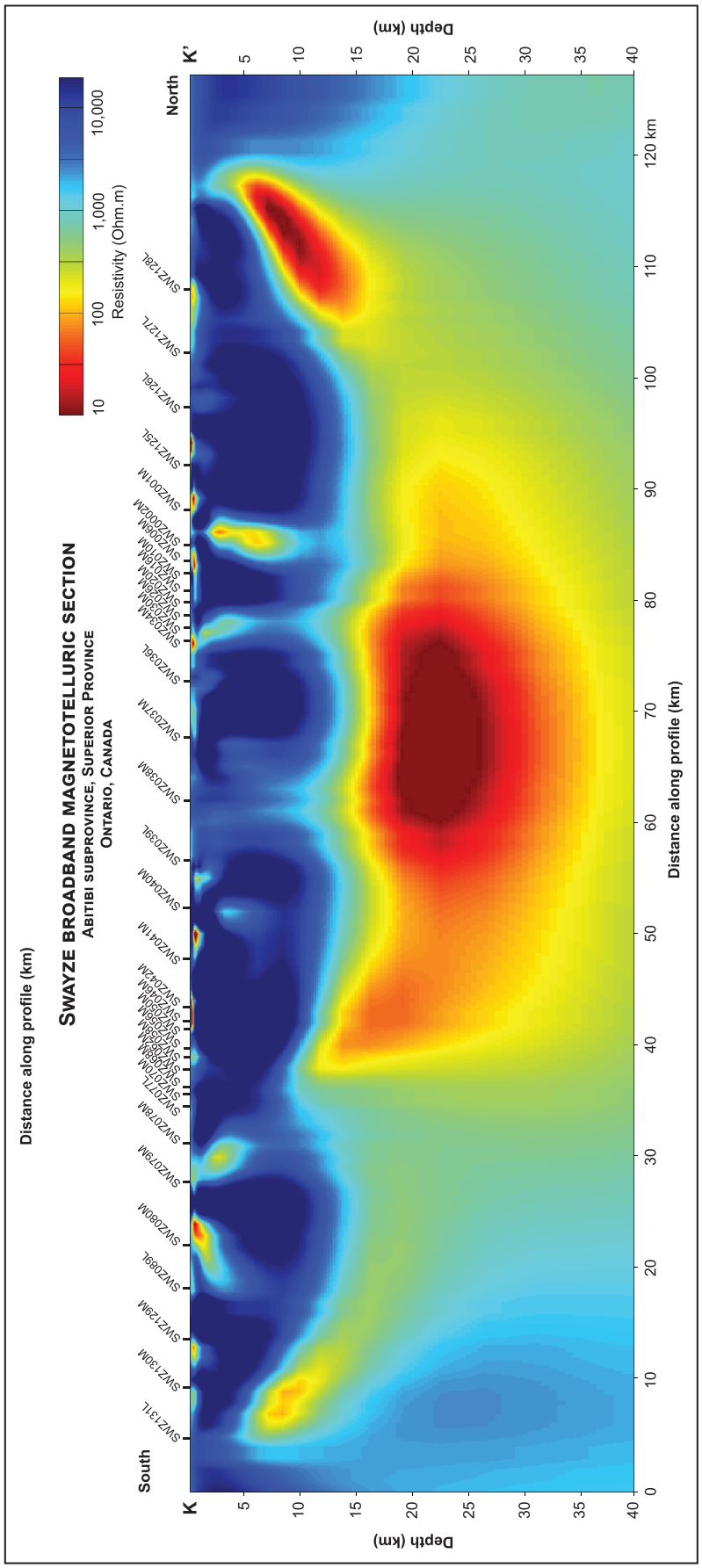
The reader is referred to publications by Cheraghi et al. (2020) and Cheraghi et al. (2023) for interpretations of the East Swayze R2 seismic [j–j'; line 252] and AMT data [J–J'], and Hill et al. (2021) for interpretations of the Swayze BBMT transect data [K–K']. See Harris et al. (2001), Maepa and Smith (2020), and Maepa et al. (2021) for a discussion on the controls on gold mineralisation and mineral prospectivity mapping in the Swayze greenstone belt.

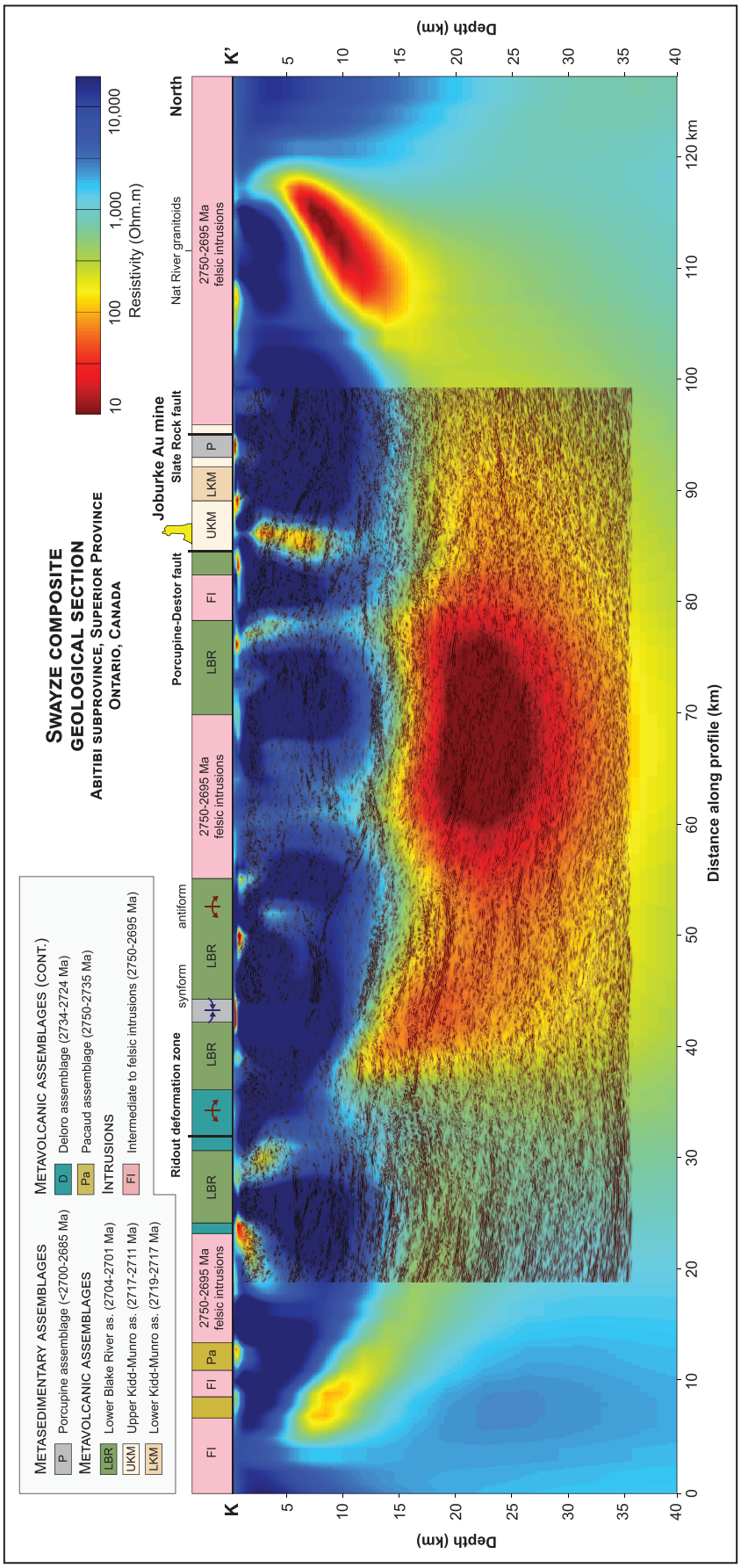
Figure 8. Geological maps of the Swayze greenstone belt (southern Abitibi Subprovince) in northeast Ontario, showing the locations of the East Swayze R2 seismic [j–j'; line 252] and AMT [J–J'] sections and the Swayze R1 seismic MT [k–k'; line 241] and BBMT [K–K'] sections. Map data sourced from the Metal Earth compilations of Montsion et al. (2018; lithological data) and Jørgensen and Gibson (2024; assemblage data).


J J' East Swayze R2 seismic (Line 252) and audio-frequency MT section
k k' Swayze R1 seismic section (Line 241)
K K' Swayze broadband MT section
Broadband MT and audio-frequency MT stations
SWAYZE TRANSECT
ABITIBI SUBPROVINCE, SUPERIOR PROVINCE
ONTARIO, CANADA
SRF - Slate Rock fault
PDF - Porcupine-Destor fault
RnF - Rundle fault
RDZ - Ridout deformation zone
Gold deposits
1 Jerome deposit
2 Joburke deposit
N
0 5 10 km
Nat River granitoids
Ramsey-Algoma granitoids
KAPUSKASING STRUCTURAL ZONE
Ivanhoe Lake fault
ABITIBI SUBPROVINCE
48°20'N
48°N
47°40'N
82°40'W
82°20'W
375000E m
400000E m
5350000N m
5325000N m
5300000N m
5275000N m
Coordinate system: NAD83 UTM17N
Lithological classification
Diorite-monzonite-granodiorite suite
Mafic intrusions
Massive granodiorite to granite
Diorite-monzonite-granodiorite suite
Foliated tonalite suite
Foliated to gneissic tonalite and granodiorite
Mafic intrusions
Ultramafic intrusions
Migmatized successor basin units
Iron formation
Coarse-grained clastic successor basin units
Fine-grained clastic successor basin units
Mafic to ultramafic metavolcanics
Mafic to intermediate metavolcanics
Felsic to intermediate metavolcanics
Assemblage classification
Timiskaming assemblage (2679–2669 Ma)
Pre-Timiskaming intrusions (2695–2682 Ma)
Porcupine assemblage (2700–2685 Ma)
Lower Blake River assemblage (2704–2701 Ma)
Upper Kidd-Munro assemblage (2717–2711 Ma)
Lower Kidd-Munro assemblage (2719–2717 Ma)
Deloro assemblage (2734–2724 Ma)
Pacaud assemblage (2750–2735 Ma)
Intermediate to felsic intrusions (2750–2695 Ma)
Ultramafic to mafic intrusions (2750–2700 Ma)


EAST SWAYZE
COMPOSITE GEOLOGICAL SECTION
ABITIBI SUBPROVINCE, SUPERIOR PROVINCE
ONTARIO, CANADA
South
North
Lower Blake River assemblage
Ridout deformation zone
Timiskaming assemblage
synform
Deloro assemblage
J
J'
Depth (km)
0
3
6
9
12
9 km
METASEDIMENTARY ASSEMBLAGES
Timiskaming assemblage (<2679-2669 Ma) Tm
METAVOLCANIC ASSEMBLAGES
Lower Blake River as. (2704-2701 Ma) LBR
Deloro assemblage (2734-2724 Ma) D
INTRUSIONS
Intermediate to felsic intrusions (2750-2695 Ma) FI
EAST SWAYZE
AUDIO-FREQUENCY MAGNETOTELLURIC SECTION
ABITIBI SUBPROVINCE, SUPERIOR PROVINCE
ONTARIO, CANADA
SWZ119A
SWZ117A
SWZ115A
SWZ113A
SWZ111A
SWZ109A
SWZ107A
SWZ105A
SWZ103A
SWZ101A
SWZ099A
SWZ097A
SWZ095A
SWZ093A
SWZ091A
10
100
1,000
10,000
Resistivity (Ohm.m)
EASY SWAYZE
R2 SEISMIC SECTION (LN252)
ABITIBI SUBPROVINCE, SUPERIOR PROVINCE
ONTARIO, CANADA
South
North
Trace Number
250
750
1250
1750
J
Time (s)
0
1
2
3
4
Distance along profile (km)
3
6
9 km


SWAYZE R1 SEISMIC SECTION (LN241)
ABITIBI SUBPROVINCE, SUPERIOR PROVINCE
ONTARIO, CANADA
South
North
k
k'
Trace Number
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
6000
Time (s)
1
3
5
7
9
11
Depth (km)
5
10
15
20
25
30
35
0
10
20
30
40
50
60
70
80 km
Distance along profile (km)


SWAYZE BROADBAND MAGNETOTELLURIC SECTION
ABITIBI SUBPROVINCE, SUPERIOR PROVINCE
ONTARIO, CANADA
Resistivity (Ohm.m)
10
100
1,000
10,000
K
K'
South
North
Depth (km)
Distance along profile (km)
0
10
20
30
40
50
60
70
80
90
100
110
120 km
5
15
25
35


SWAYZE COMPOSITE
GEOLOGICAL SECTION
ABITIBI SUBPROVINCE, SUPERIOR PROVINCE
ONTARIO, CANADA
METASEDIMENTARY ASSEMBLAGES
P Porcupine assemblage (<2700-2685 Ma)
METAVOLCANIC ASSEMBLAGES
LBR Lower Blake River as. (2704-2701 Ma)
UKM Upper Kidd-Munro as. (2717-2711 Ma)
LKM Lower Kidd-Munro as. (2719-2717 Ma)
METAVOLCANIC ASSEMBLAGES (CONT.)
D Deloro assemblage (2734-2724 Ma)
Pa Pacaud assemblage (2750-2735 Ma)
INTRUSIONS
FI Intermediate to felsic intrusions (2750-2695 Ma)
Resistivity (Ohm.m)
10
100
1,000
10,000
Joburke Au mine
Slate Rock fault
Nat River granitoids
North
Porcupine-Destor fault
Ridout deformation zone
synform
antiform
2750-2695 Ma felsic intrusions
LBR
FI
Pa
UKM
LKM
P
K
K'
Depth (km)
Distance along profile (km)
120 km

Useful references

Cheraghi, S., Naghizadeh, M., Snyder, D., Haugaard, R., and Gemmell, T. 2020. High-resolution seismic imaging of crooked two-dimensional profiles in greenstone belts of the Canadian shield: results from the Swayze area, Ontario, Canada. Geophysical Prospecting, **68**: 62–81. doi:https://doi.org/10.1111/1365-2478.12854.

Cheraghi, S., Hloušek, F., Buske, S., Malehmir, A., Adetunji, A., Haugaard, R., Snyder, D., and Vayavur, R. 2023. Reflection seismic imaging across a greenstone belt, Abitibi (Ontario), Canada. Geophysical Prospecting, **71**: 1096–1115. doi:https://doi.org/10.1111/1365-2478.13284.

Harris, J.R., Wilkinson, L., Heather, K., Fumerton, S., Bernier, M., Ayer, J., and Dahn, R. 2001. Application of GIS processing techniques for producing mineral prospectivity maps—a case study: mesothermal Au in the Swayze Greenstone Belt, Ontario, Canada. Natural Resources Research, **10**: 91–124. doi:https://doi.org/10.1023/A:1011548709573.

Hastie, E.C.G., Kontak, D.J., and Lafrance, B. 2020. Gold remobilization: Insights from gold deposits in the Archean Swayze greenstone belt, Abitibi Subprovince, Canada. Economic Geology, **115**: 241–277. doi:https://doi.org/10.5382/econgeo.4709.

Haugaard, R., Gemmell, T.P., Ayer, J.A., and Thurston, P.C. 2017. Lithological and Stratigraphic Relationships of the Swayze Area, Abitibi Greenstone Belt. Ontario Geological Survey (OGS), Open File Report **OFR6333**.

Heather, K.B. 1993. Regional geology, structure, and mineral deposits of the Archean Swayze greenstone belt, southern Superior Province, Ontario. Geological Survey of Canada, Paper 0068-7650 **93-1C**. doi:https://doi.org/10.4095/134257.

Hill, G.J., Roots, E.A., Frieman, B.M., Haugaard, R., Craven, J.A., Smith, R.S., Snyder, D.B., Zhou, X., and Sherlock, R. 2021. On Archean craton growth and stabilisation: Insights from lithospheric resistivity structure of the Superior Province. Earth and Planetary Science Letters, **562**: e116853. doi:https://doi.org/10.1016/j.epsl.2021.116853.

Jørgensen, T.R.C., and Gibson, H.L. 2024. Assemblage compilation of the Abitibi subprovince, Superior Province, Canada. Metal Earth Project, Mineral Exploration Research Centre. https://metalearth.files.com/f/81ca7963c83475a6

Maepa, F., Smith, R.S., and Tessema, A. 2021. Support vector machine and artificial neural network modelling of orogenic gold prospectivity mapping in the Swayze greenstone belt, Ontario, Canada. Ore Geology Reviews, **130**: e103968. doi:https://doi.org/10.1016/j.oregeorev.2020.103968.

Maepa, F.M., and Smith, R.S. 2020. Examining the controls on gold deposit distribution in the Swayze greenstone belt, Ontario, Canada, using multi-scale methods of spatial data analysis. Ore Geology Reviews, **125**: e103671. doi:https://doi.org/10.1016/j.oregeorev.2020.103671.

Montsion, R.M., Thurston, P., and Ayer, J. 2018. 1:2,000,000 Scale Geological Compilation of the Superior Craton - Version 1. Laurentian University Mineral Exploration Research Centre (MERC) **ME-2018-017**.

Folio 9

South Geraldton and North Geraldton transects

The Geraldton transect is located in central Ontario and consists of the South Geraldton [L–L'] and North Geraldton [M–M'] transects (**Figure 9**). The ~55-km South Geraldton transect [L–L'] extends from Triangle Lake to Atigogama Lake and encompasses new R1 seismic reflection data collected along Leopard Lake and Kinghorn roads [l–l'; line 301]. BBMT stations were deployed along the entire transect [L–L'], including the l–l' South Geraldton seismic survey line, resulting in a conductivity section that traverses the metasedimentary and metavolcanic assemblages of the Beardmore-Geraldton belt and the boundary between the Quetico and eastern Wabigoon subprovinces (Tóth et al. 2022). The transect also intersects the Paint Lake deformation zone, which defines the interpreted boundary between the Beardmore-Geraldton belt and older metavolcanic assemblages of the Onaman-Tashota belt, namely the 2749–2735 Ma Elmhirst-Rickaby assemblage (Lemkow et al. 2005). The adjacent ~53-km North Geraldton transect [M–M'] consists of R1 seismic reflection data [m–m'] that was collected from Wilkinson Lake [m; located 13 km southwest of L'] to Devanney Lake [m'] along Kinghorn Road. This transect traverses metavolcanic assemblages of the Onaman-Tashota belt, including the 2789–2750 Ma Onaman, 2749–2740 Ma Willet, 2749–2735 Ma Elmhirst-Rickaby, and 2724–2720 Ma Metcalfe-Venus assemblages, and intersects the Humbolt Bay deformation zone (Lemkow et al. 2005). BBMT stations were also deployed along the entire transect [M–M'], although the resulting conductivity profile is not entirely representative of the complex 3D conductivity anomaly in the transect area.

The Geraldton transect area, in particular the Beardmore-Geraldton belt, is host to a number of small gold deposits (total past production <4–5 Moz. Au; Northern Empire, Leitch, Sand River, MacLeod–Cockshut, and Hardrock mines) and multiple base and precious metal showings (Mason and White 1986; DeWolfe et al. 2007). The region is also dominated by older metavolcanic assemblages (generally >2720 Ma; Lemkow et al. 2005; Tóth et al. 2022) that are comparable in age to the 2750–2735 Ma Pacaud, 2734–2724 Ma Deloro and the 2723–2720 Ma Stoughton-Roquemaure assemblages of Abitibi subprovince. These transects ultimately provide an opportunity to evaluate the boundary between the Quetico and eastern Wabigoon subprovinces and facilitate comparisons with more strongly endowed regions of the Abitibi subprovince.

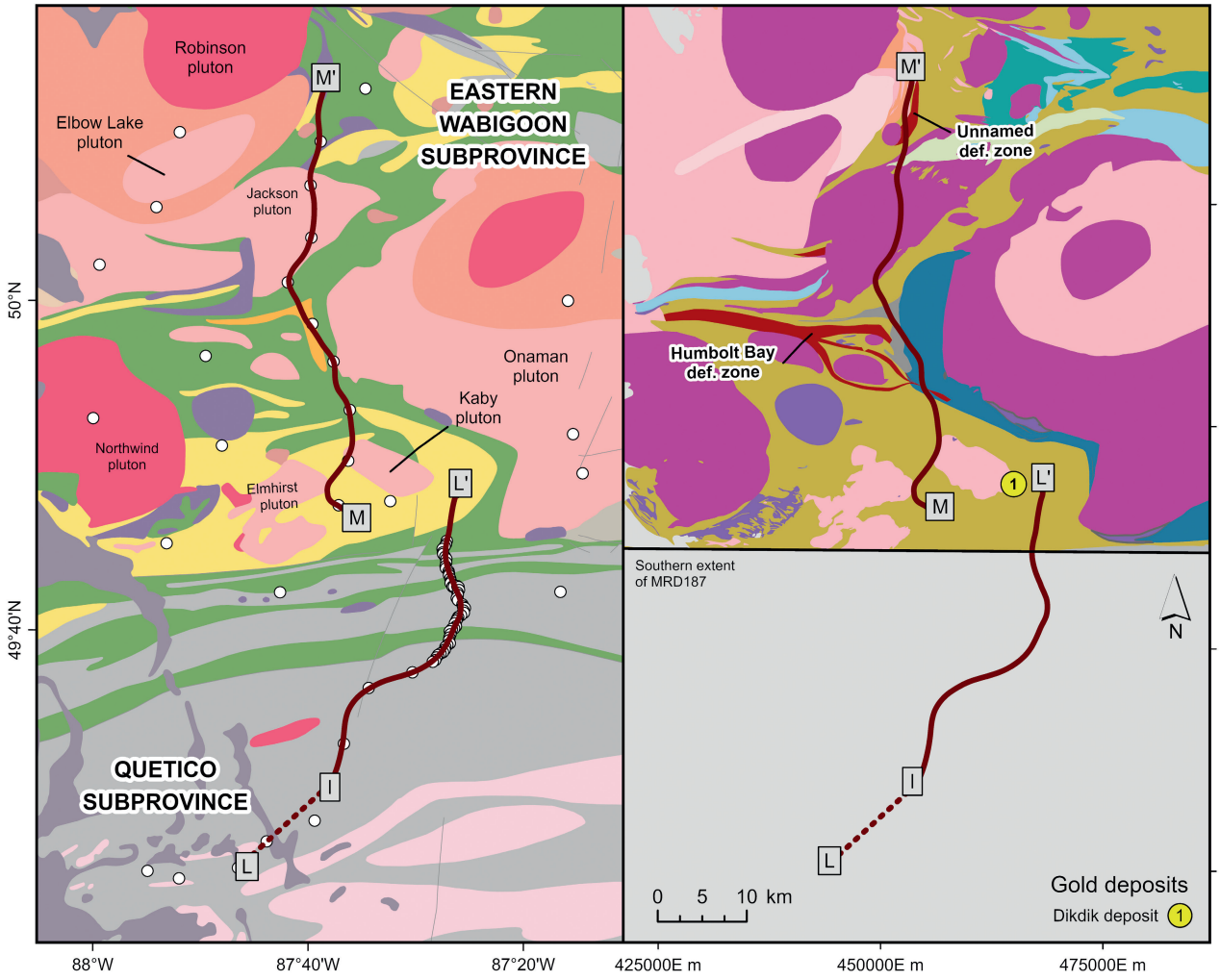
The reader is referred to publications by Tóth et al. (2022, 2023) for interpretations of the geology of the Beardmore-Geraldton belt.

Figure 9. Geological maps of the Beardmore-Geraldton and Onaman-Tashota greenstone belts (eastern Wabigoon subprovince) in central Ontario, showing the locations of the South Geraldton [L–L'] and North Geraldton [M–M'] R1 seismic and BBMT sections. Map data sourced from the Metal Earth compilation of Montsion et al. (2018; lithological data) and the Geological Survey of Canada compilation by Sanborn-Barrie and Skulski (2005; assemblage data).

I — I South Geraldton R1 seismic section (Line 301)
L - - - L' South Geraldton broadband MT section
M — M North Geraldton R1 seismic (Line 311) and broadband MT section
○ Broadband MT and audio-frequency MT stations

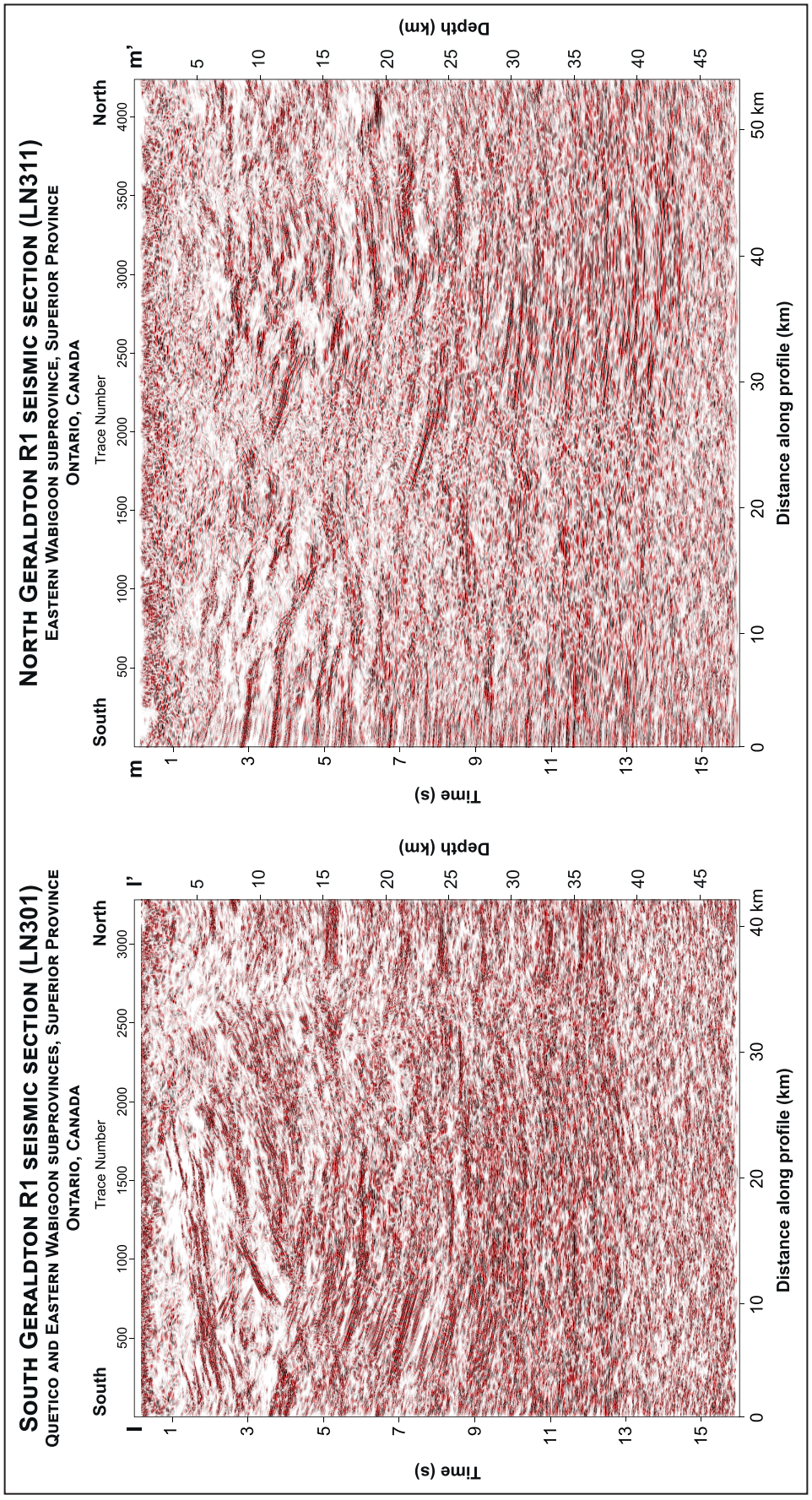
GERALDTON TRANSECT

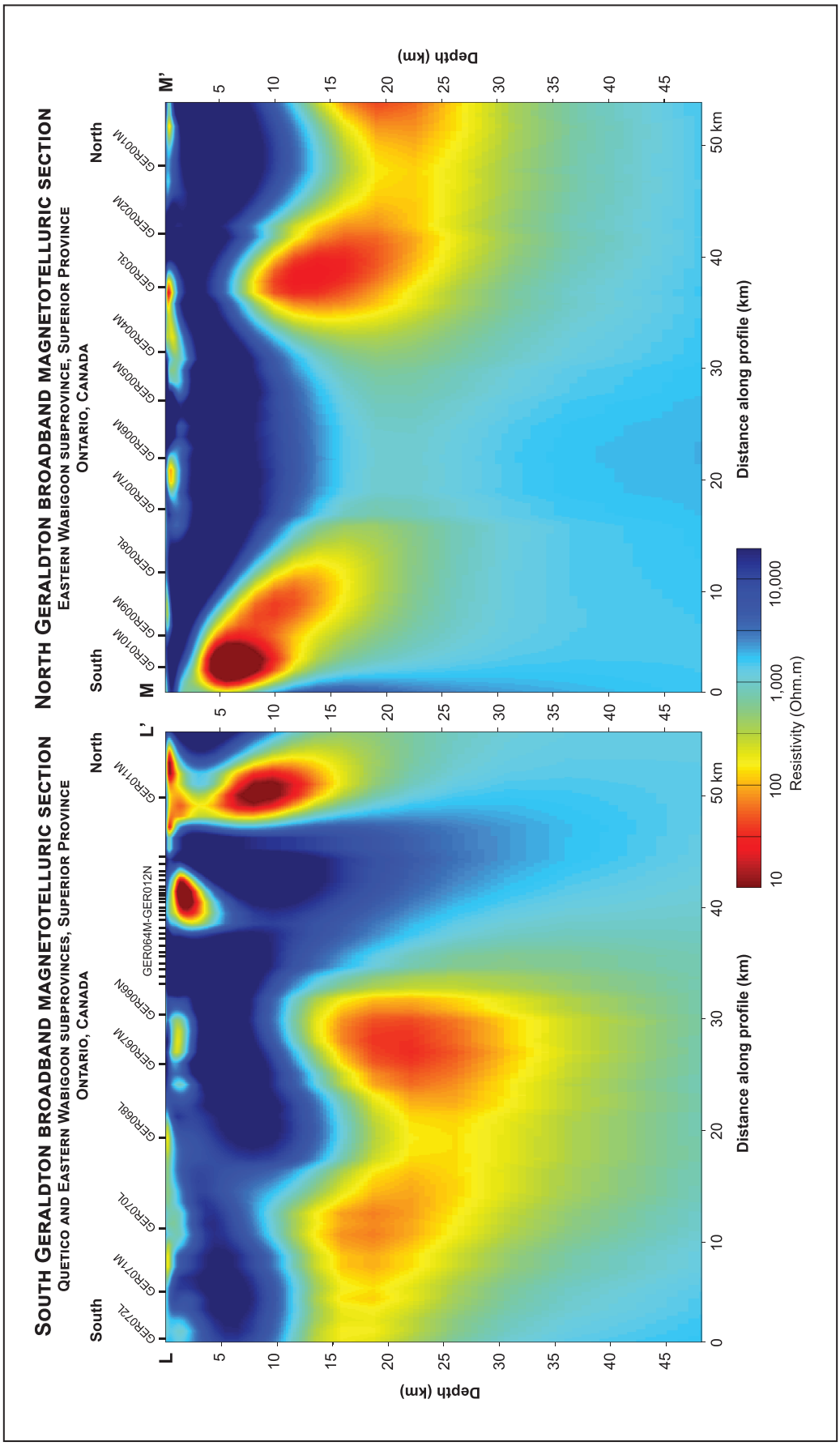
E WAGIBOON SUBPROVINCE, SUPERIOR PROVINCE
ONTARIO, CANADA

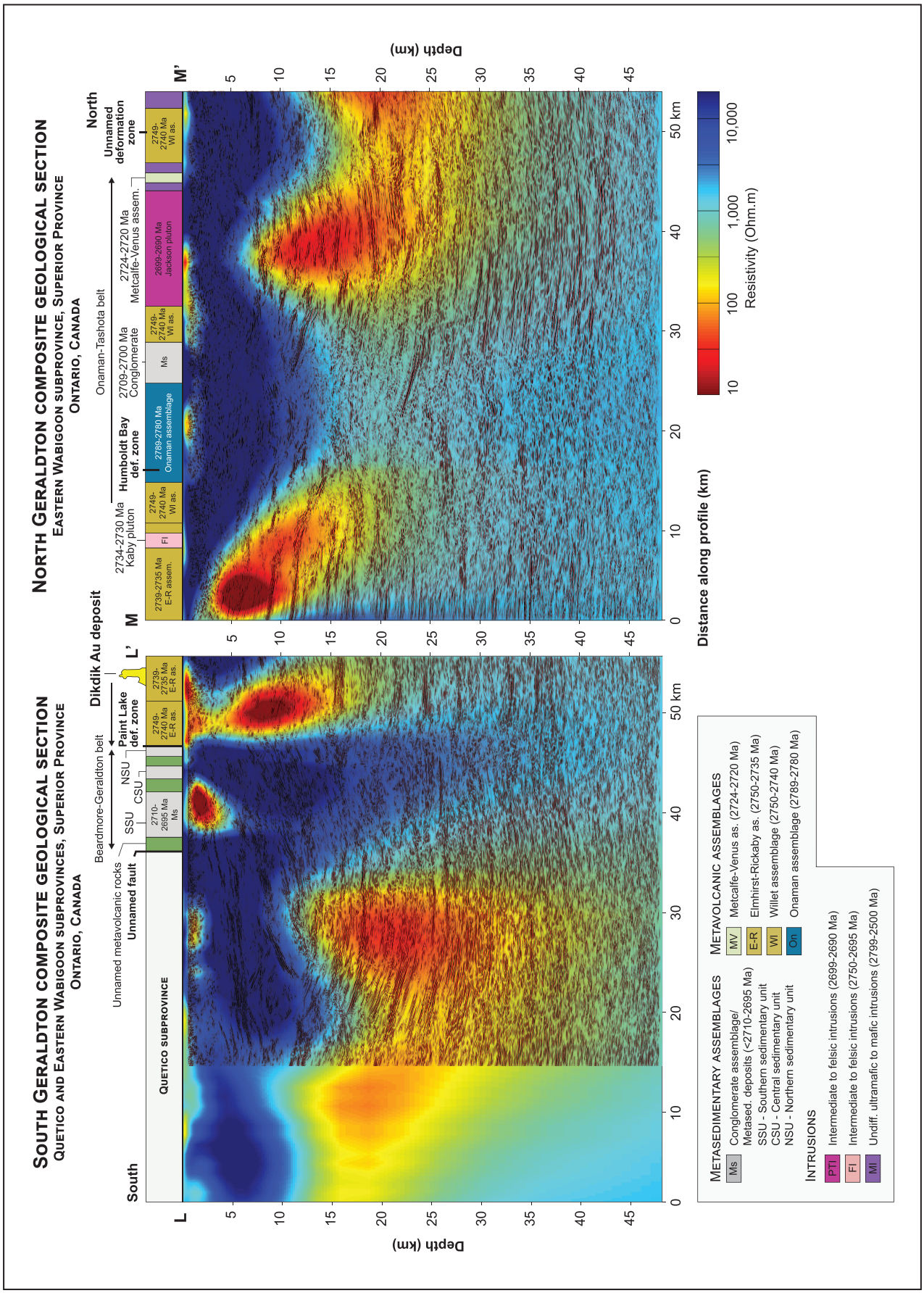


Coordinate system: NAD83 UTM16N

Lithological classification	Assemblage classification
Mafic intrusions	1599–1000 Ma Nipigon dyke swarm/Sibley assemblage
Coarse clastic metasedimentary rocks	2700–2690 Ma Quetico assemblage
Massive granodiorite to granite	2700–2690 Ma Intermediate to felsic intrusions
Diorite-monzonite-granodiorite suite	2709–2700 Ma Conglomerate assemblage
Muscovite-bearing granitic rocks	2709–2700 Ma Albert-Gledhill/Humboldt assemblages
Foliated tonalite suite	2724–2720 Ma Metcalfe-Venus assemblage
Foliated to gneissic tonalite and granodiorite	2734–2720 Ma Metcalfe-Venus assemblage
Mafic intrusions	2749–2730 Ma Willet/Elmhirst-Rickaby/ Metcalfe-Venus/Marshall assemblages
Migmatized successor basin units	2789–2760 Ma Onaman assemblage
Coarse-grained clastic successor basin units	2800–2690 Ma Ultramafic to mafic intrusions
Fine-grained clastic successor basin units	2800–2700 Ma Intermediate to felsic intrusions
Mafic to intermediate metavolcanics	2999–2900 Ma Tashota/Toronto assemblage
Felsic to intermediate metavolcanics	4000–2500 Ma Gneissic plutonic suite


SOUTH GERALDTON R1 SEISMIC SECTION (LN301)
QUETICO AND EASTERN WABIGOON SUBPROVINCES, SUPERIOR PROVINCE
ONTARIO, CANADA
South
North
Trace Number
l
l'
Time (s)
Depth (km)
Distance along profile (km)
40 km
NORTH GERALDTON R1 SEISMIC SECTION (LN311)
EASTERN WABIGOON SUBPROVINCE, SUPERIOR PROVINCE
ONTARIO, CANADA
South
North
Trace Number
m
m'
Time (s)
Depth (km)
Distance along profile (km)
50 km


SOUTH GERALDTON BROADBAND MAGNETOTELLURIC SECTION
QUETICO AND EASTERN WABIGOON SUBPROVINCES, SUPERIOR PROVINCE
ONTARIO, CANADA
NORTH GERALDTON BROADBAND MAGNETOTELLURIC SECTION
EASTERN WABIGOON SUBPROVINCE, SUPERIOR PROVINCE
ONTARIO, CANADA
South
North
L
L'
M
M'
GER072L
GER071M
GER070L
GER068L
GER067M
GER066N
GER064M-GER012N
GER011M
GER010M
GER009M
GER008L
GER007M
GER006M
GER005M
GER004M
GER003L
GER002M
GER001M
Depth (km)
Distance along profile (km)
50 km
Resistivity (Ohm.m)
10
100
1,000
10,000


South Geraldton composite geological section
Quetico and Eastern Wabigoon subprovinces, Superior Province
Ontario, Canada
North Geraldton composite geological section
Eastern Wabigoon subprovince, Superior Province
Ontario, Canada
South
Quetico subprovince
Unnamed metavolcanic rocks
Unnamed fault
Beardmore-Geraldton belt
SSU
CSU
NSU
Paint Lake def. zone
Dikdik Au deposit
2710-2695 Ma Ms
2749-2740 Ma E-R as.
2739-2735 Ma E-R as.
L
L'
M
M'
Onaman-Tashota belt
2734-2730 Ma Kaby pluton
Humboldt Bay def. zone
2709-2700 Ma Conglomerate
2724-2720 Ma Metcalfe-Venus assem.
North
Unnamed deformation zone
2739-2735 Ma E-R assem.
FI
2749-2740 Ma Wl as.
2789-2780 Ma Onaman assemblage
Ms
2699-2690 Ma Jackson pluton
Depth (km)
Distance along profile (km)
Resistivity (Ohm.m)
10
100
1,000
10,000
Metasedimentary assemblages
Ms
Conglomerate assemblage/ Metased. deposits (<2710-2695 Ma)
SSU - Southern sedimentary unit
CSU - Central sedimentary unit
NSU - Northern sedimentary unit
Intrusions
PTI
Intermediate to felsic intrusions (2699-2690 Ma)
FI
Intermediate to felsic intrusions (2750-2695 Ma)
MI
Undiff. ultramafic to mafic intrusions (2799-2500 Ma)
Metavolcanic assemblages
MV
Metcalfe-Venus as. (2724-2720 Ma)
E-R
Elmhirst-Rickaby as. (2750-2735 Ma)
Wl
Willet assemblage (2750-2740 Ma)
On
Onaman assemblage (2789-2780 Ma)

Useful references

DeWolfe, J.C., Lafrance, B., and Stott, G.M. 2007. Geology of the shear-hosted Brookbank gold prospect in the Beardmore–Geraldton belt, Wabigoon Subprovince, Ontario. Canadian Journal of Earth Sciences, **44**: 925–946. doi:https://doi.org/10.1139/e06-118.

Lemkow, D.R., Sanborn-Barrie, M., Stott, G.M., Percival, J.A., Stone, D., Tomlinson, K.Y., Skulksi, T., McNicoll, V., Davis, D.W., Whalen, J.B., and Hollings, P. 2005. GIS compilation of the geology and tectonostratigraphic assemblages, Wabigoon-Winnipeg River-Marmion transect, western Superior Province, Ontario. Geological Survey of Canada (GSC), Open File **OF4971**. doi:https://doi.org/10.4095/221526.

Mason, J., and White, G. 1986. Gold occurances, prospects, and deposits of the Beardmore-Geraldton area districts of Thunder Bay and Cochrane. Ontario Geological Survey (OGS), Open File Report **OFR5630**.

Montsion, R.M., Thurston, P., and Ayer, J. 2018. 1:2,000,000 Scale Geological Compilation of the Superior Craton - Version 1. Laurentian University Mineral Exploration Research Centre (MERC) ME-2018-017.

Sanborn-Barrie, M., and Skulski, T. 2005. Geology, Sturgeon Lake greenstone belt, western Superior Province, Ontario. Geological Survey of Canada (GSC), Open File **OF1763**. doi:https://doi.org/10.4095/221213.

Tóth, Z., Lafrance, B., and Dubé, B. 2023. Oblique lateral extrusion during dextral transpression along the Beardmore-Geraldton belt, Canada. Journal of Structural Geology, **169**: 104834. doi:https://doi.org/10.1016/j.jsg.2023.104834.

Tóth, Z., McNicoll, V., Lafrance, B., and Dubé, B. 2022. Early depositional and magmatic history of the Beardmore-Geraldton Belt: Formation of a transitional accretionary belt along the Wabigoon-Quetico Subprovince boundary in the Archean Superior Craton, Canada. Precambrian Research, **371**: e106579. doi:https://doi.org/10.1016/j.precamres.2022.106579.

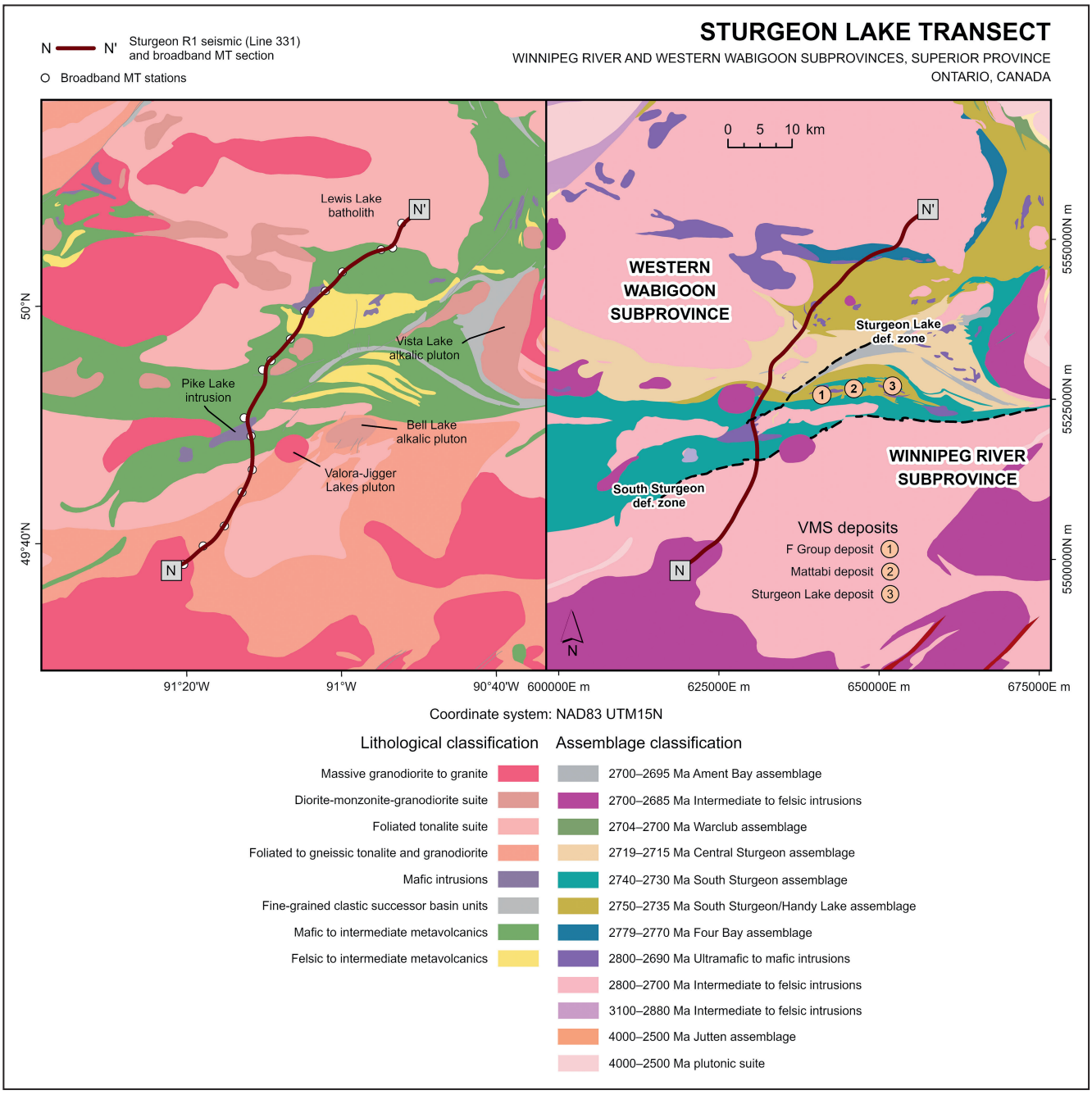
Folio 10
Sturgeon Lake transect

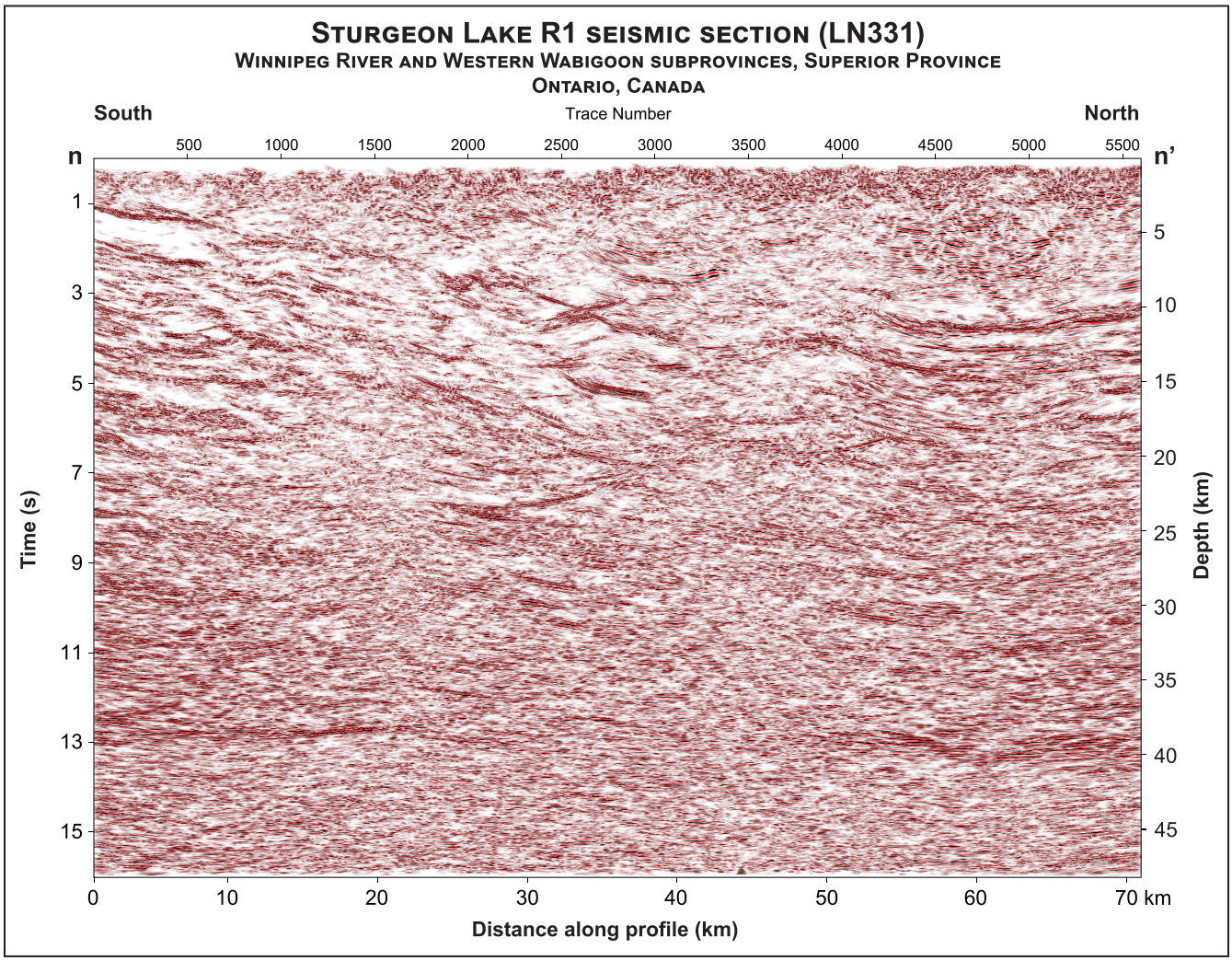
The ~74-km Sturgeon Lake transect [N–N'] is situated in western Ontario and extends northeast along Highway 599 from the Winnipeg River subprovince near Valeira Lake to Horizontal Bay within the western Wabigoon subprovince (**Figure 10**). The transect encompasses ~73 km of new R1 seismic reflection data [n–n'; line 331] and ~74 km of BBMT data [N–N'] that intersects the Sturgeon Lake deformation zone and the South Sturgeon deformation zone, which defines the boundary between the Winnipeg River and western Wabigoon subprovince. North of the South Sturgeon deformation zone, within the Sturgeon Lake greenstone belt of the western Wabigoon subprovince, the transect traverses metavolcanic deposits of the 2775 Ma Fourbay Lake, 2750–2740 Ma Handy Lake, 2735 Ma South Sturgeon, and the 2720–2715 Ma Central Sturgeon assemblages (Lemkow et al. 2005; Sanborn-Barrie and Skulski 2005; Ma et al. 2021).

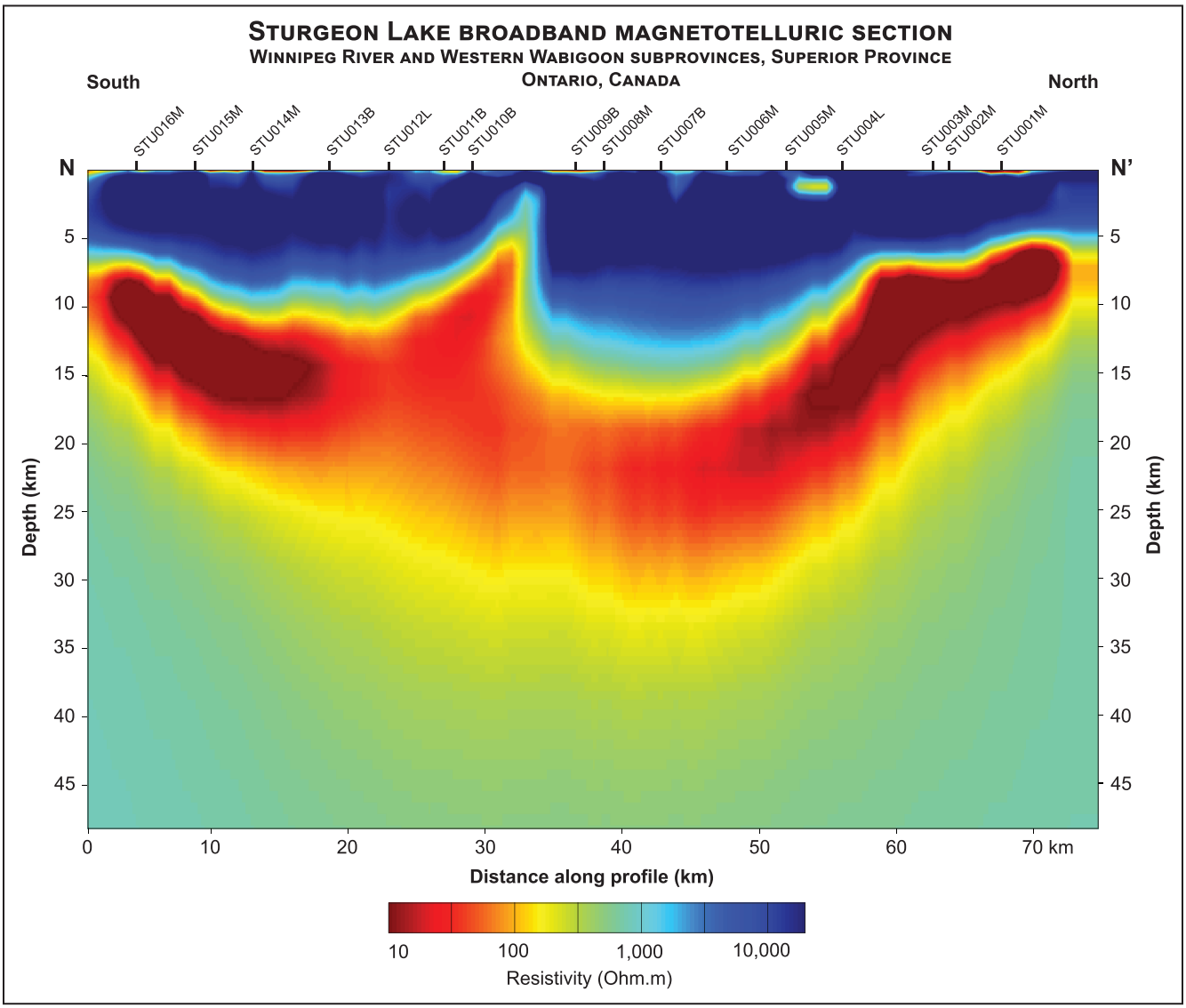
The Sturgeon Lake greenstone belt, in particular 2740–2730 Ma South Sturgeon assemblage, is host to a number of past-producing VMS deposits (e.g., F Group, Mattabi, and Sturgeon Lake deposits; Franklin et al. 1975; Morton et al. 1991; Galley et al. 2000; Mumin et al. 2007; Ma et al. 2021) and several small gold deposits and occurrences (Parsa et al. 2023). These deposits are older and generally smaller than the world-class VMS deposits of the Rouyn-Noranda camp in the Abitibi subprovince, which are hosted by metavolcanic deposits of the 2704–2701 Ma Lower Blake River assemblage. The new R1 seismic reflection and BBMT datasets provide a framework for comparing differential mineral endowment between VMS camps in the Sturgeon Lake and Abitibi greenstone belts. These datasets also provide an opportunity to evaluate the geometry of the South Sturgeon deformation zone, which defines the boundary between the Winnipeg River and western Wabigoon subprovinces.

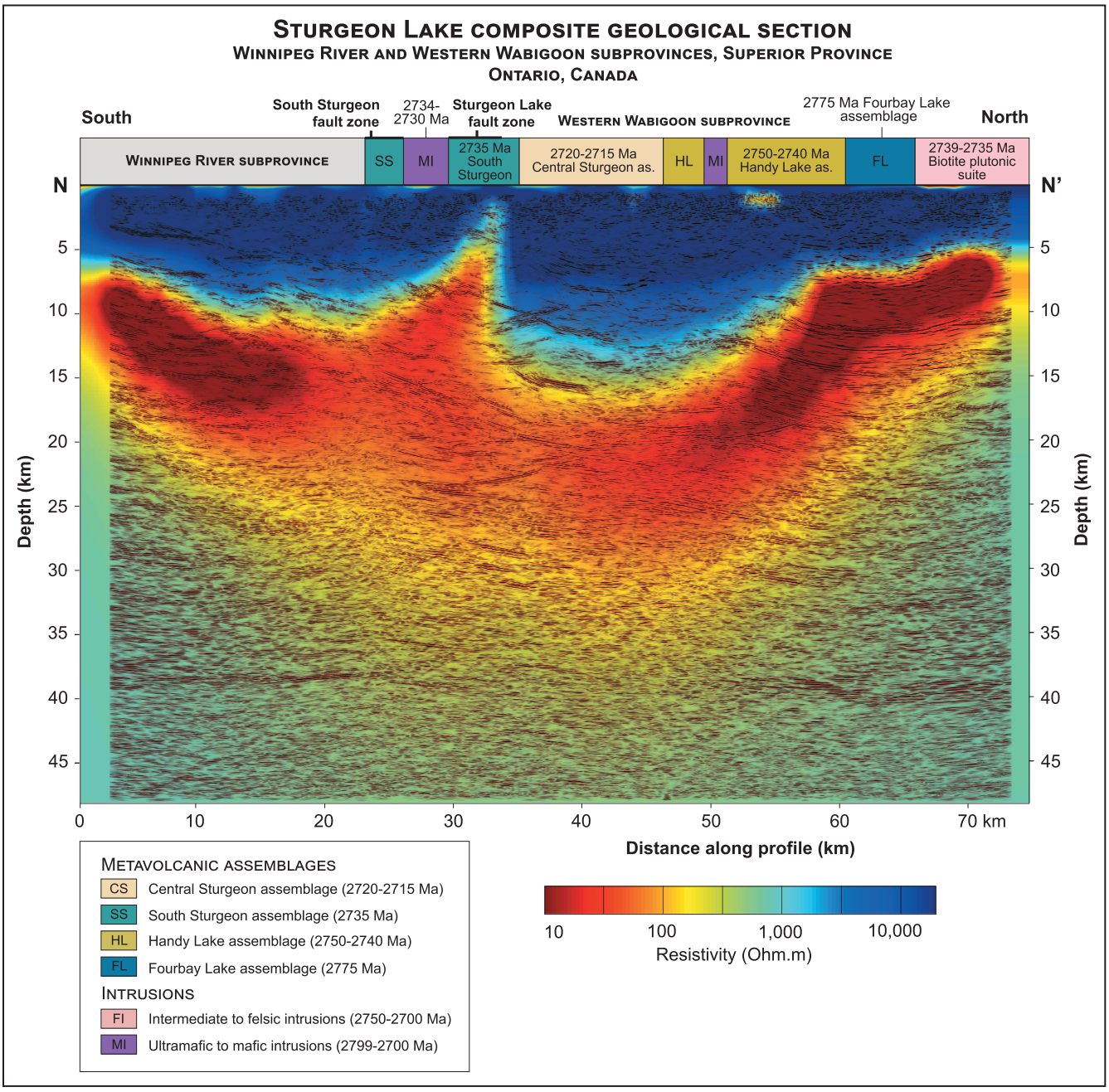
The reader is referred to a publication by Ma et al. (2021) for interpretations of Sturgeon R1 seismic [n–n'; line 331] and BBMT [N–N'] data. Refer to Parsa et al. (2023) for mineral prospectivity maps of the Sturgeon region.

Figure 10. Geological maps of the Sturgeon Lake greenstone belt (eastern Wabigoon subprovince) in western Ontario, showing the locations of the Sturgeon Lake R1 seismic [n–n'; line 331] and BBMT [N–N'] sections. Map data sourced from the Metal Earth compilation of Montsion et al. (2018; lithological data) and the Geological Survey of Canada compilation by Sanborn-Barrie and Skulski (2005; assemblage data).


STURGEON LAKE TRANSECT
WINNIPEG RIVER AND WESTERN WABIGOON SUBPROVINCES, SUPERIOR PROVINCE
ONTARIO, CANADA
N N' Sturgeon R1 seismic (Line 331) and broadband MT section
Broadband MT stations
0 5 10 km
Lewis Lake batholith
Vista Lake alkalic pluton
Pike Lake intrusion
Bell Lake alkalic pluton
Valora-Jigger Lakes pluton
WESTERN WABIGOON SUBPROVINCE
Sturgeon Lake def. zone
South Sturgeon def. zone
WINNIPEG RIVER SUBPROVINCE
VMS deposits
F Group deposit 1
Mattabi deposit 2
Sturgeon Lake deposit 3
50°N
49°40'N
91°20'W
91°W
90°40'W
600000E m
625000E m
650000E m
675000E m
5550000N m
5525000N m
5500000N m
Coordinate system: NAD83 UTM15N
Lithological classification
Massive granodiorite to granite
Diorite-monzonite-granodiorite suite
Foliated tonalite suite
Foliated to gneissic tonalite and granodiorite
Mafic intrusions
Fine-grained clastic successor basin units
Mafic to intermediate metavolcanics
Felsic to intermediate metavolcanics
Assemblage classification
2700–2695 Ma Ament Bay assemblage
2700–2685 Ma Intermediate to felsic intrusions
2704–2700 Ma Warclub assemblage
2719–2715 Ma Central Sturgeon assemblage
2740–2730 Ma South Sturgeon assemblage
2750–2735 Ma South Sturgeon/Handy Lake assemblage
2779–2770 Ma Four Bay assemblage
2800–2690 Ma Ultramafic to mafic intrusions
2800–2700 Ma Intermediate to felsic intrusions
3100–2880 Ma Intermediate to felsic intrusions
4000–2500 Ma Jutten assemblage
4000–2500 Ma plutonic suite


STURGEON LAKE R1 SEISMIC SECTION (LN331)
WINNIPEG RIVER AND WESTERN WABIGOON SUBPROVINCES, SUPERIOR PROVINCE
ONTARIO, CANADA
South
Trace Number
North
n
n'
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
1
3
5
7
9
11
13
15
Time (s)
5
10
15
20
25
30
35
40
45
Depth (km)
0
10
20
30
40
50
60
70 km
Distance along profile (km)


STURGEON LAKE BROADBAND MAGNETOTELLURIC SECTION
WINNIPEG RIVER AND WESTERN WABIGOON SUBPROVINCES, SUPERIOR PROVINCE
ONTARIO, CANADA
South
North
N
N'
STU016M
STU015M
STU014M
STU013B
STU012L
STU011B
STU010B
STU009B
STU008M
STU007B
STU006M
STU005M
STU004L
STU003M
STU002M
STU001M
Depth (km)
0
10
20
30
40
50
60
70 km
Distance along profile (km)
10
100
1,000
10,000
Resistivity (Ohm.m)


STURGEON LAKE COMPOSITE GEOLOGICAL SECTION
WINNIPEG RIVER AND WESTERN WABIGOON SUBPROVINCES, SUPERIOR PROVINCE
ONTARIO, CANADA
South
North
South Sturgeon fault zone
2734-2730 Ma
Sturgeon Lake fault zone
WESTERN WABIGOON SUBPROVINCE
2775 Ma Fourbay Lake assemblage
WINNIPEG RIVER SUBPROVINCE
SS
MI
2735 Ma South Sturgeon
2720-2715 Ma Central Sturgeon as.
HL
MI
2750-2740 Ma Handy Lake as.
FL
2739-2735 Ma Biotite plutonic suite
N
N'
Depth (km)
0
5
10
15
20
25
30
35
40
45
10
20
30
40
50
60
70 km
Distance along profile (km)
METAVOLCANIC ASSEMBLAGES
CS Central Sturgeon assemblage (2720-2715 Ma)
SS South Sturgeon assemblage (2735 Ma)
HL Handy Lake assemblage (2750-2740 Ma)
FL Fourbay Lake assemblage (2775 Ma)
INTRUSIONS
FI Intermediate to felsic intrusions (2750-2700 Ma)
MI Ultramafic to mafic intrusions (2799-2700 Ma)
10
100
1,000
10,000
Resistivity (Ohm.m)

Useful references

Franklin, J.M., Kasarda, J., and Poulsen, K.H. 1975. Petrology and chemistry of the alteration zone of the Mattabi massive sulfide deposit. Economic Geology, **70**: 63–79. doi:https://doi.org/10.2113/gsecongeo.70.1.63.

Galley, A., Breemen, O.v., and Franklin, J. 2000. The relationship between intrusion-hosted Cu-Mo mineralization and the VMS deposits of the Archean Sturgeon Lake mining camp, northwestern Ontario. Economic Geology, **95**: 1543–1550. doi:https://doi.org/10.2113/gsecongeo.95.7.1543.

Lemkow, D.R., Sanborn-Barrie, M., Stott, G.M., Percival, J.A., Stone, D., Tomlinson, K.Y., Skulksi, T., McNicoll, V., Davis, D.W., Whalen, J.B., and Hollings, P. 2005. GIS compilation of the geology and tectonostratigraphic assemblages, Wabigoon-Winnipeg River-Marmion transect, western Superior Province, Ontario. Geological Survey of Canada (GSC), Open File **OF4971**. doi:https://doi.org/10.4095/221526.

Ma, C., Naghizadeh, M., Adetunji, A.Q., Lodge, R.W.D., Snyder, D.B., and Sherlock, R. 2021. Imaging Neoarchean crustal structures: An integrated geologic-seismic-magnetotelluric study in the western Wabigoon and Winnipeg River terranes, Superior Craton. Precambrian Research, **364**: e106339. doi:https://doi.org/10.1016/j.precamres.2021.106339.

Montsion, R.M., Thurston, P., and Ayer, J. 2018. 1:2,000,000 Scale Geological Compilation of the Superior Craton - Version 1. Laurentian University Mineral Exploration Research Centre (MERC) **ME-2018-017**.

Morton, R.L., Walker, J.S., Hudak, G.J., and Franklin, J.M. 1991. The early development of an Archean submarine caldera complex with emphasis on the Mattabi ash-flow tuff and its relationship to the Mattabi massive sulfide deposit. Economic Geology, **86**: 1002–1011. doi:https://doi.org/10.2113/gsecongeo.86.5.1002.

Mumin, A.H., Scott, S.D., Somarin, A.K., and Oran, K.S. 2007. Structural controls on massive sulfide deposition and hydrothermal alteration in the South Sturgeon Lake Caldera, Northwestern Ontario. Exploration and Mining Geology, **16**: 83–107. doi:https://doi.org/10.2113/gsemg.16.1-2.83.

Parsa, M., Harris, J., and Sherlock, R. 2023. Improving mineral prospectivity model generalization: an example from orogenic gold mineralization of the Sturgeon Lake Transect, Ontario, Canada. Mathematical Geosciences, **55**: 943–961. doi:https://doi.org/10.1007/s11004-022-10038-6.

Sanborn-Barrie, M., and Skulski, T. 2005. Geology, Sturgeon Lake greenstone belt, western Superior Province, Ontario. Geological Survey of Canada (GSC), Open File **OF1763**. doi:https://doi.org/10.4095/221213.

Folio 11

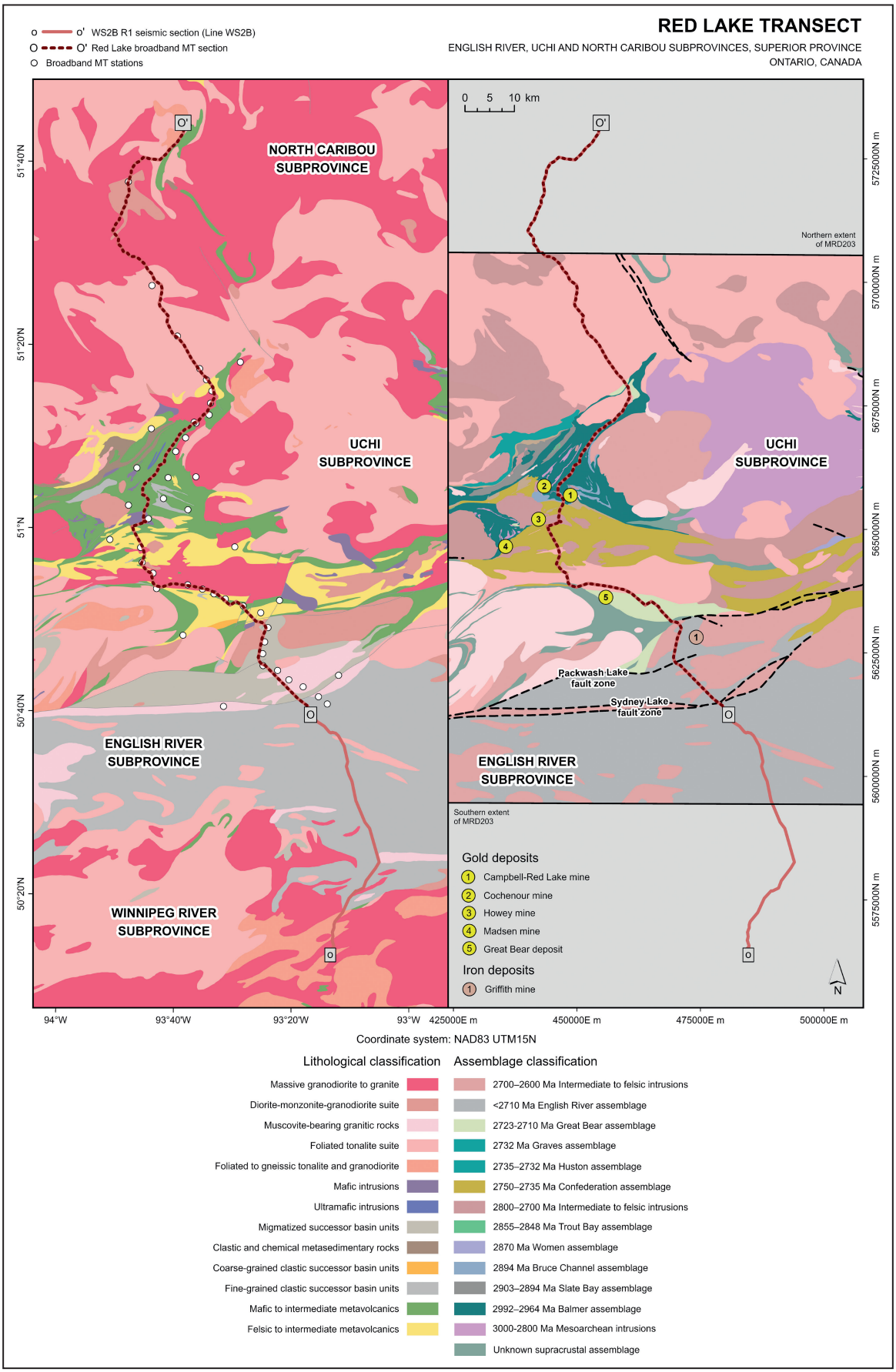
Red Lake transect

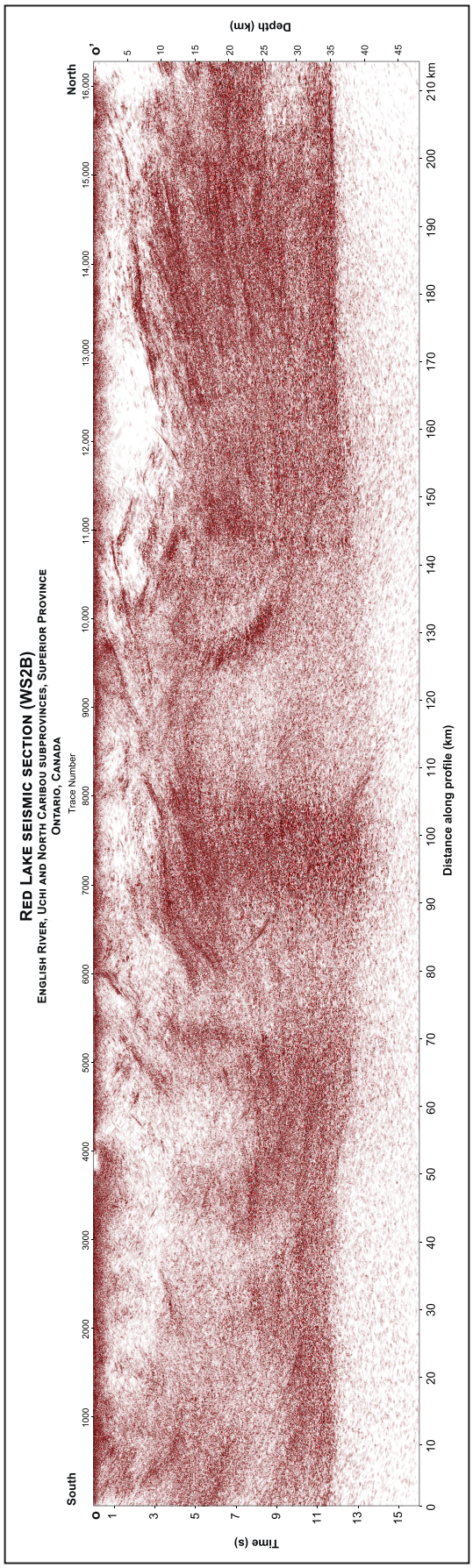
The ~215-km Red Lake transect [o–o'] is located in northwest Ontario, extending northward along Highway 105 from Perrault Falls within the Winnipeg River subprovince [n], across metasediments of the English River subprovince and the gold-endowed Red Lake greenstone belt of the Uchi subprovince, to Beren Lake within the North Caribou subprovince [n'; **Figure 11**]. This transect encompasses ~228 km of R1 seismic reflection data [o–o'; WS2B] that was collected in 2000 as part of the Lithoprobe program (see Calvert et al. 2004; Zeng and Calvert 2006 for survey details). BBMT stations were deployed along a ~169-km segment of the seismic line between Ear Falls within the English River subprovince [O] and Beren Lake within the North Caribou subprovince [O']. These sections intersect the Sydney Lake and Pacwash Lake fault zones of the English River subprovince and traverse multiple fault and unconformity-related gold deposits of the Meso- to Neoarchean Red Lake greenstone belt.

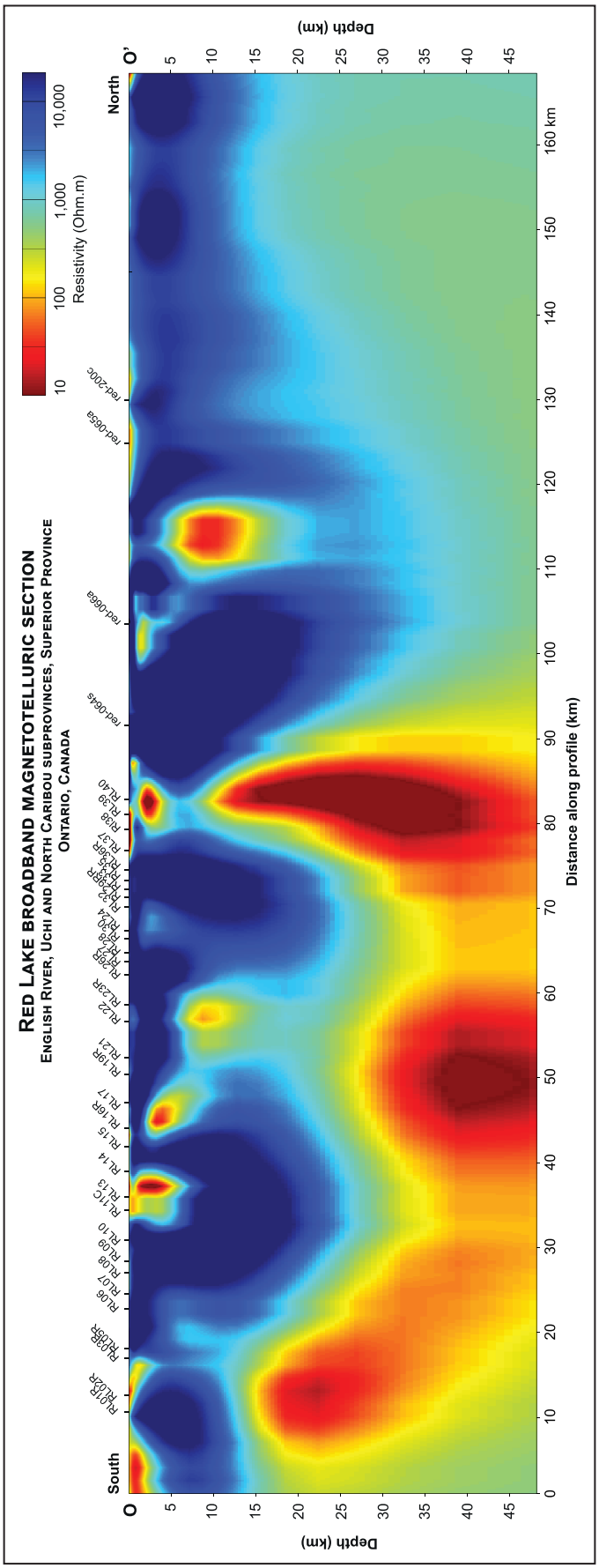
The Red Lake greenstone belt hosts some of the largest orogenic gold deposits in Canada (>29.6 Moz. Au), most notably the Cochenour (1939–1971, 2021–present) and Campbell-Red Lake (1949–present) gold mines (>17 Moz. Au; Malegus et al. 2022), and the newly discovered Great Bear deposit (~6.1 Moz. Au; Pfeiffer et al. 2023). The reprocessed R1 seismic reflection data and the new BBMT section provides an opportunity to evaluate the boundaries between subprovinces, the lower to upper crustal footprint of gold mineralisation, and the structural setting of world-class gold deposits.

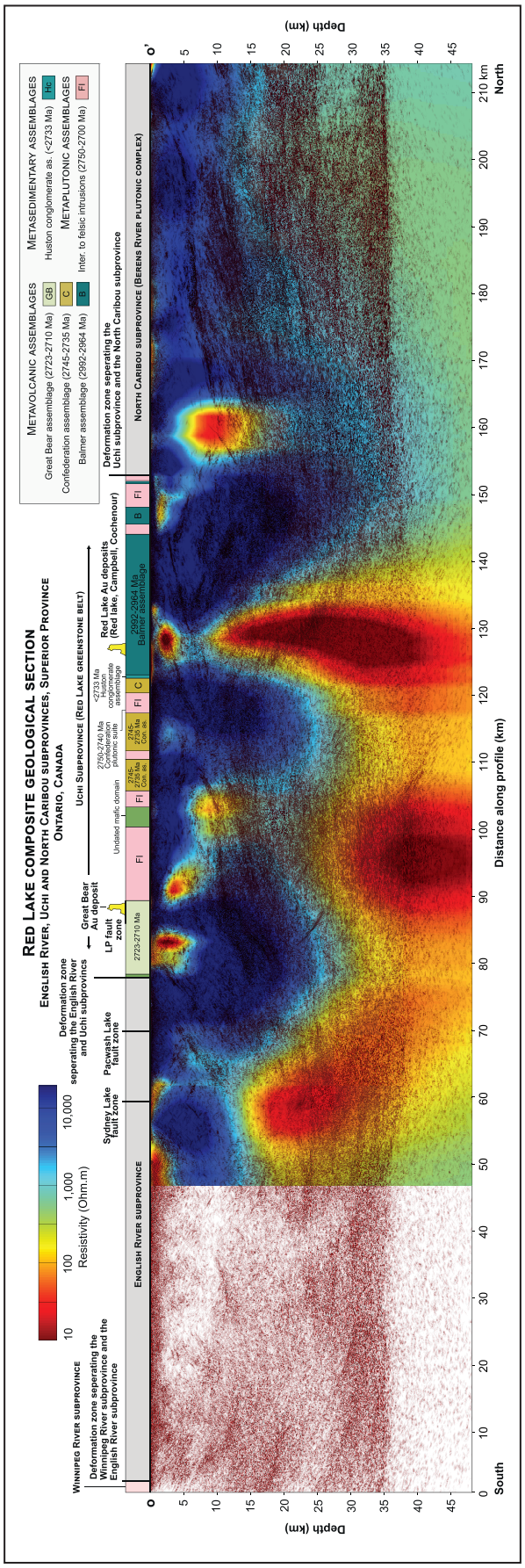
The reader is referred to publications by Calvert et al. (2004) and Zeng and Calvert (2006) for interpretations of the WS2B Lithoprobe R1 seismic reflection data [o–o'] and Adetunji et al. (2023) for interpretations of the R1 seismic–broadband MT sections.

Figure 11. Geological maps of the Red Lake greenstone belt (Uchi subprovince) in northwest Ontario, showing the locations of the existing Lithoprobe R1 seismic section [o–o'; line WS2B] and the Metal Earth BBMT section [O–O'] with respect to major crustal-scale faults and gold deposits. Map data sourced from the Metal Earth compilation of Montsion et al. (2018; lithological data) and the Geological Survey of Canada compilation by Sanborn-Barrie et al. (2004; assemblage data).


o o' WS2B R1 seismic section (Line WS2B)
O O' Red Lake broadband MT section
O Broadband MT stations
RED LAKE TRANSECT
ENGLISH RIVER, UCHI AND NORTH CARIBOU SUBPROVINCES, SUPERIOR PROVINCE
ONTARIO, CANADA
0 5 10 km
NORTH CARIBOU SUBPROVINCE
UCHI SUBPROVINCE
ENGLISH RIVER SUBPROVINCE
WINNIPEG RIVER SUBPROVINCE
Northern extent of MRD203
Southern extent of MRD203
Packwash Lake fault zone
Sydney Lake fault zone
Gold deposits
1 Campbell-Red Lake mine
2 Cochenour mine
3 Howey mine
4 Madsen mine
5 Great Bear deposit
Iron deposits
1 Griffith mine
N
51°40'N
51°20'N
51°N
50°40'N
50°20'N
94°W
93°40'W
93°20'W
93°W
425000E m
450000E m
475000E m
500000E m
5725000N m
5700000N m
5675000N m
5650000N m
5625000N m
5600000N m
5575000N m
Coordinate system: NAD83 UTM15N
Lithological classification
Massive granodiorite to granite
Diorite-monzonite-granodiorite suite
Muscovite-bearing granitic rocks
Foliated tonalite suite
Foliated to gneissic tonalite and granodiorite
Mafic intrusions
Ultramafic intrusions
Migmatized successor basin units
Clastic and chemical metasedimentary rocks
Coarse-grained clastic successor basin units
Fine-grained clastic successor basin units
Mafic to intermediate metavolcanics
Felsic to intermediate metavolcanics
Assemblage classification
2700–2600 Ma Intermediate to felsic intrusions
<2710 Ma English River assemblage
2723-2710 Ma Great Bear assemblage
2732 Ma Graves assemblage
2735–2732 Ma Huston assemblage
2750–2735 Ma Confederation assemblage
2800–2700 Ma Intermediate to felsic intrusions
2855–2848 Ma Trout Bay assemblage
2870 Ma Women assemblage
2894 Ma Bruce Channel assemblage
2903–2894 Ma Slate Bay assemblage
2992–2964 Ma Balmer assemblage
3000-2800 Ma Mesoarchean intrusions
Unknown supracrustal assemblage


RED LAKE SEISMIC SECTION (WS2B)
ENGLISH RIVER, UCHI AND NORTH CARIBOU SUBPROVINCES, SUPERIOR PROVINCE
ONTARIO, CANADA
South
North
o
o'
Trace Number
Distance along profile (km)
Time (s)
Depth (km)
210 km


Red Lake broadband magnetotelluric section
English River, Uchi and North Caribou subprovinces, Superior Province
Ontario, Canada
10
100
1,000
10,000
Resistivity (Ohm.m)
South
North
O
O'
Depth (km)
Distance along profile (km)
0
160 km
RL01R
RL02R
RL08R
RL08bR
RL06
RL07
RL08
RL09
RL10
RL11C
RL13
RL14
RL15
RL16R
RL17
RL19R
RL21
RL22
RL23R
RL28R
RL27
RL29
RL30
RL24
RL31
RL32
RL33R
RL34R
RL35R
RL36R
RL37
RL38
RL39
RL40
red-06as
red-06aa
red-06sa
red-20dc


Red Lake composite geological section
English River, Uchi and North Caribou subprovinces, Superior Province
Ontario, Canada
Winnipeg River subprovince
English River subprovince
Uchi Subprovince (Red Lake greenstone belt)
North Caribou subprovince (Berens River plutonic complex)
Deformation zone separating the Winnipeg River subprovince and the English River subprovince
Sydney Lake fault zone
Pacwash Lake fault zone
Deformation zone separating the English River and Uchi subprovinces
LP fault zone
Great Bear Au deposit
Undated mafic domain
2750–2720 Ma Confederation plutonic suite
<2733 Ma Huston conglomerate assemblage
Red Lake Au deposits (Red lake, Campbell, Cochenour)
Deformation zone separating the Uchi subprovince and the North Caribou subprovince
2723-2710 Ma
2745-2735 Ma
2892-2964 Ma Balmer assemblage
Fl
C
B
Resistivity (Ohm.m)
10
100
1,000
10,000
Depth (km)
Distance along profile (km)
South
North
210 km
Metavolcanic assemblages
Great Bear assemblage (2723-2710 Ma)
Confederation assemblage (2745-2735 Ma)
Balmer assemblage (2892-2964 Ma)
GB
C
B
Metasedimentary assemblages
Huston conglomerate as. (<2733 Ma)
Hc
Metaplutonic assemblages
Inter. to felsic intrusions (2750-2700 Ma)
Fl

Useful references

Adetunji, A.Q., Launay, G., Ferguson, I.J., Simmons, J.M., Ma, C., Ayer, J., and Lafrance, B. 2023. Crustal conductivity footprint of a world-class orogenic gold district in the Red Lake Greenstone Belt, western Superior Craton. Geology, 51: 377–382. doi:https://doi.org/10.1130/G50660.1.

Calvert, A.J., Cruden, A.R., and Hynes, A. 2004. Seismic evidence for preservation of the Archean Uchi granite–greenstone belt by crustal-scale extension. Tectonophysics, **388**: 135–143. doi:https://doi.org/10.1016/j.tecto.2004.07.043.

Malegus, P.M., Amyotte, E.G., Adrianwalla, C.J., Wiebe, K.E., Bousquet, P., Daniels, C.M., Pettigrew, T.K., and Dorland, G. 2022. Report of Activities, 2021 Resident Geologist Program, Red Lake Regional Resident Geologist Report: Red Lake and Kenora Districts. Ontario Geological Survey (OGS), Open File Report **OFR6381**.

Montsion, R.M., Thurston, P., and Ayer, J. 2018. 1:2,000,000 Scale Geological Compilation of the Superior Craton - Version 1. Laurentian University Mineral Exploration Research Centre (MERC) **ME-2018-017**.

Pfeiffer, N., Sims, J., Breau, Y., Greenwood, R., and Prawasono, A. 2023. Great Bear Gold Project, Ontario, Canada - Voluntary National Instrument 43-101 Technical Report. Kinross Gold Corporation.

Sanborn-Barrie, M., Rogers, N., Skulski, T., Parker, J.R., and Devaney, J. 2004. Geology and Tectonostratigraphic Assemblages, East Uchi Subprovince, Red Lake and Birch-Uchi Belts, Ontario. Geological Survey of Canada (GSC), Open File **OF4256**. doi:https://doi.org/10.4095/215111.

Zeng, F., and Calvert, A.J. 2006. Imaging the upper part of the Red Lake greenstone belt, northwestern Ontario, with 3-D traveltime tomography. Canadian Journal of Earth Sciences, **43**: 849–863. doi:https://doi.org/10.1139/e06-027.

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Dryden and North Dryden transects

The Dryden [P–P'] and North Dryden [Q–Q'] transects are located in southwest Ontario within the western Wabigoon subprovince. The ~83-km Dryden transect [P–P'] extends north from Pekagoning Lake [P] to Harman Lake [P'] across Mesoarchean basement gneisses and Neoarchean assemblages of the western Wabigoon subprovince (**Figure 12**). The transect encompasses ~74 km of new R1 seismic reflection data [p–p'; line 341] that traverses mafic to intermediate metavolcanics of the 2735–2730 Ma Wapageisi and 2720 Ma Boyer Lake groups, and metasedimentary deposits of the 2705–2695 Ma Stormy Lake group. These metavolcanic and metasedimentary groups are bound by major deformation zones, most notably the Mosher Bay Washeibemaga deformation zone and the Manitou-Dinorwic deformation zone (Montsion et al. 2021a). BBMT stations were also deployed along the entire transect [P–P'], including the p–p' Dryden R1 seismic survey line, resulting in a conductivity section across the Abram-Minnitaki greenstone belt. The ~7-km Q–Q' North Dryden transect (located west of P') lies north of the town of Wabigoon along Nursery Road and encompasses new R2 seismic reflection [q–q'] and AMT [Q–Q'] data. The transect traverses metasedimentary and metavolcanic rocks of the 2710-2695 Ma Thunder Lake group and is bound in the south by the Wabigoon deformation zone (Montsion et al. 2018, 2021a).

The Dryden transect area, which encompass the Abram-Minnitaki greenstone belt, is host to several small orogenic gold deposits and prospects, including the Goliath and Goldlund deposits, and the Kenwest prospect (McRae 2022; Zammit et al. 2022). The Dryden R1 seismic and BBMT sections consequently provide an opportunity to examine the tectonic evolution of a poorly endowed greenstone belt. The North Dryden transect also provides an opportunity to directly evaluate the footprint associated with gold mineralisation at the Goliath deposit.

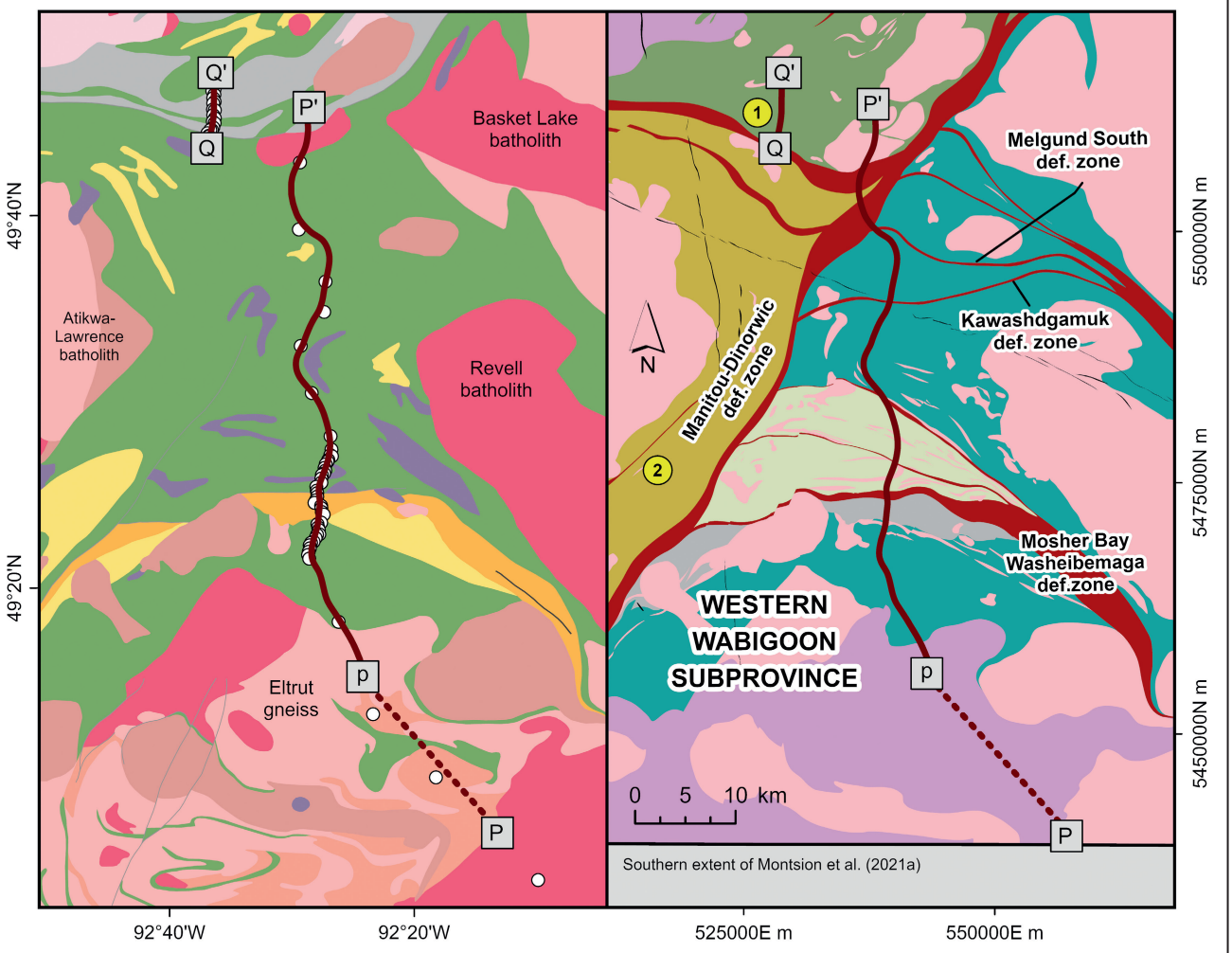
The reader is referred to a presentation by Frieman (2019) and publications by Montsion et al. (2021a, 2021b, 2024) for interpretations of the geology of the Dryden transect area and potential discriminating factors controlling mineral endowment.

Figure 12. Geological maps of the Abram-Minnitaki greenstone belt (western Wabigoon subprovince) in southwest Ontario, showing the locations of the Dryden R1 seismic [p–p'; line 341] and BBMT [P–P'] sections and the North Dryden R2 seismic [q–q'; line 341] and audio-frequency MT [Q–Q'] sections. Map data sourced from the Metal Earth compilations of Montsion et al. (2018; lithological data) and Montsion et al. (2021a; assemblage data).

p — p' Dryden R1 seismic section (Line 341)
P - - - P' Dryden broadband MT section
Q — Q' North Dryden R2 sesimic (Line 341) and audio-frequency MT section
○ Broadband MT and audio-frequency MT stations

DRYDEN TRANSECT

WESTERN WABIGOON SUBPROVINCE, SUPERIOR PROVINCE
ONTARIO, CANADA



Coordinate system: NAD83 UTM15N

Lithological classification

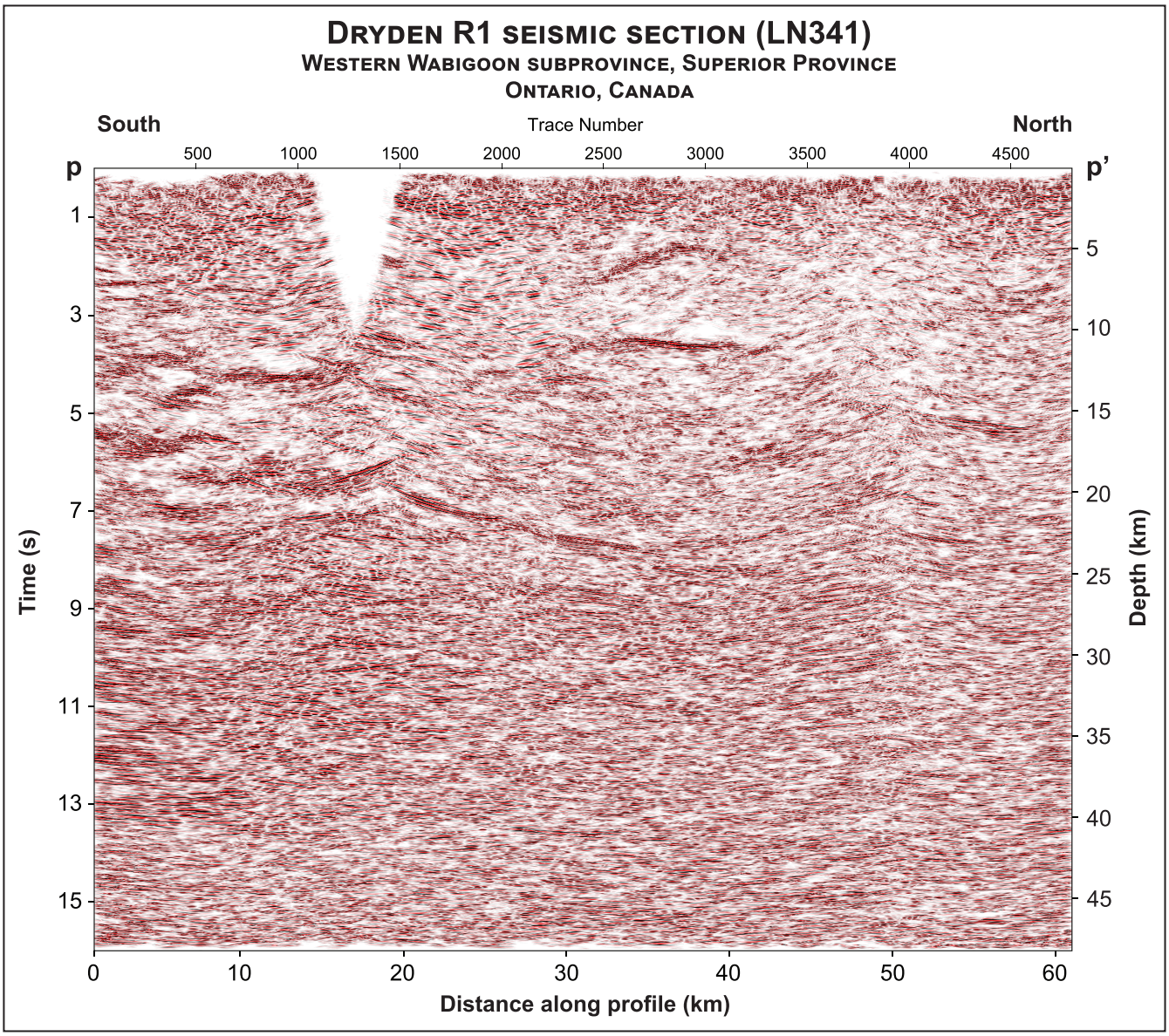
- Massive granodiorite to granite
- Diorite-monzonite-granodiorite suite
- Muscovite-bearing granitic rocks
- Foliated tonalite suite
- Foliated to gneissic tonalite and granodiorite
- Mafic intrusions
- Iron formation
- Coarse-grained clastic successor basin units
- Fine-grained clastic successor basin units
- Mafic to intermediate metavolcanics
- Felsic to intermediate metavolcanics

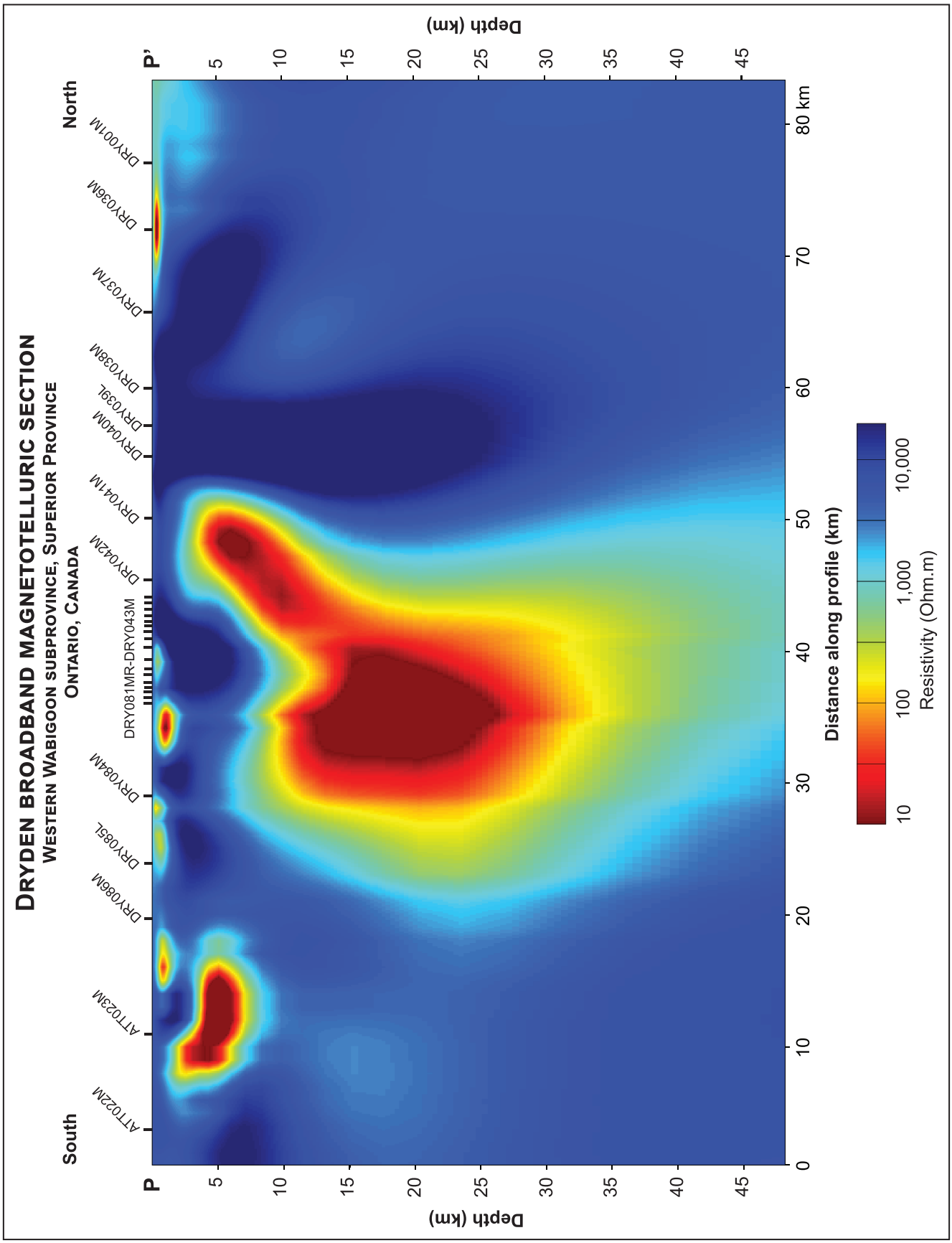
Assemblage classification

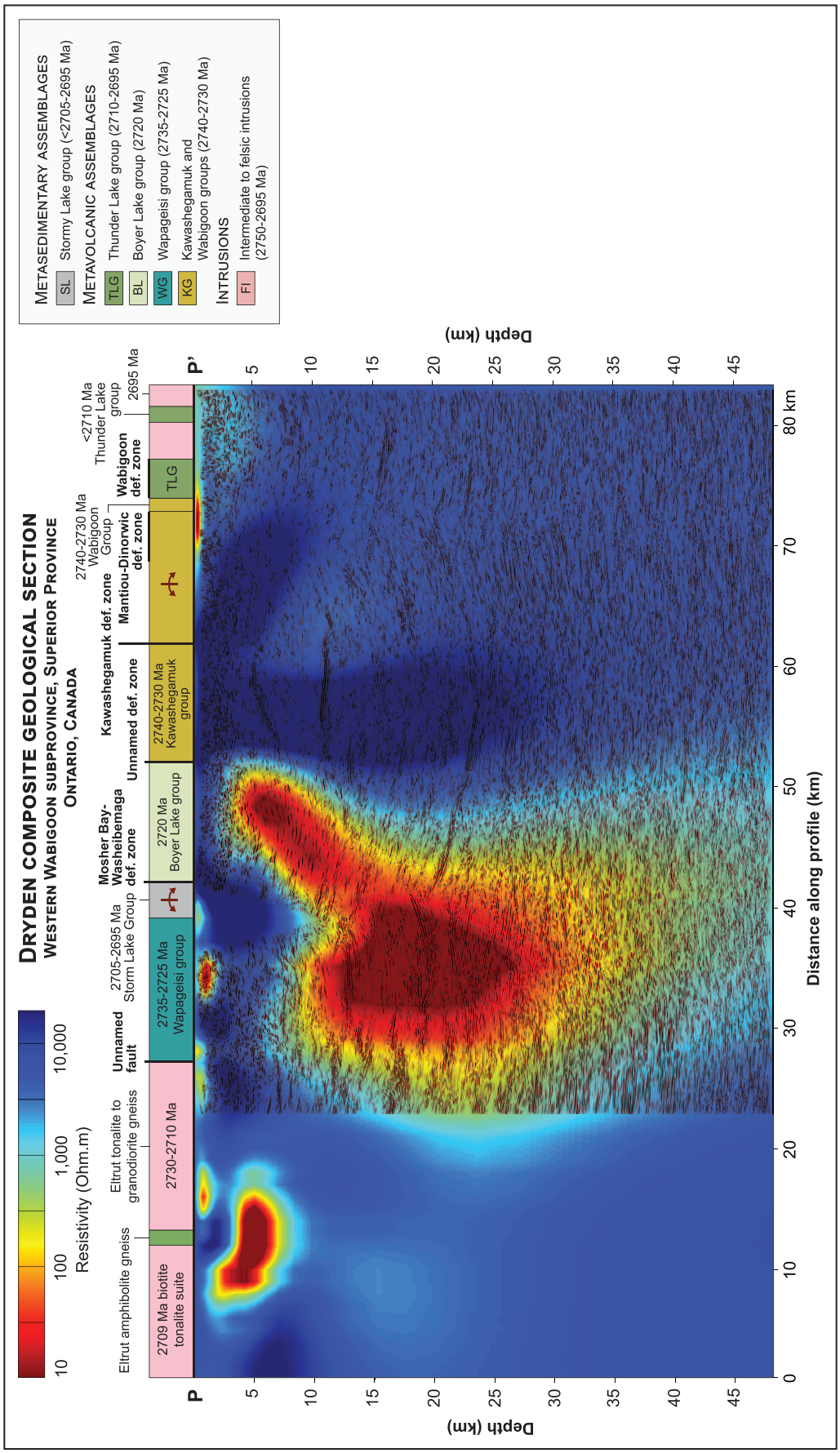
- 2705–2695 Ma Stormy Lake group
- <2710 Ma Thunder Lake group
- 2720 Ma Boyer Lake group
- 2735–2730 Ma Kawashegamuk and Wapageisi groups
- 2750–2735 Ma Wabigoon, Pincher Lake, Blanchard Lake and Upper Manitou Lake groups
- 2750–2695 Ma Intermediate to felsic intrusions
- <2900 Ma Basement gneissic plutonic rocks

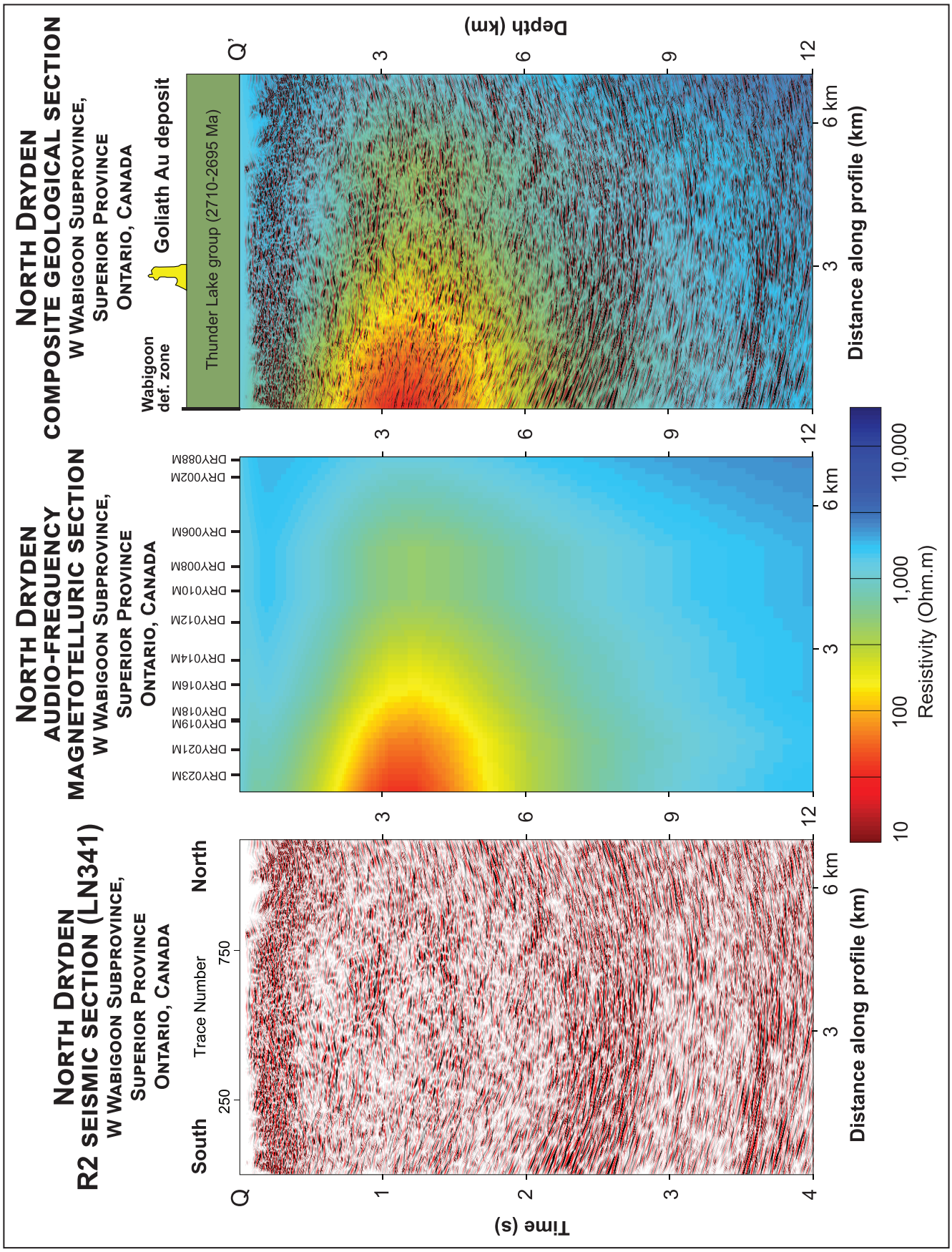
Gold deposits

1. Goliath deposit
2. Kenwest prospect


DRYDEN R1 SEISMIC SECTION (LN341)
WESTERN WABIGOON SUBPROVINCE, SUPERIOR PROVINCE
ONTARIO, CANADA
South
Trace Number
North
500
1000
1500
2000
2500
3000
3500
4000
4500
p
p'
1
3
5
7
9
11
13
15
5
10
15
20
25
30
35
40
45
Time (s)
Depth (km)
0
10
20
30
40
50
60
Distance along profile (km)


DRYDEN BROADBAND MAGNETOTELLURIC SECTION
WESTERN WABIGOON SUBPROVINCE, SUPERIOR PROVINCE
ONTARIO, CANADA
South
North
P
P'
ATT022M
ATT023M
DRY086M
DRY086L
DRY084M
DRY081MR-DRY043M
DRY042M
DRY041M
DRY040M
DRY039L
DRY038M
DRY037M
DRY036M
DRY001M
Depth (km)
0
5
10
15
20
25
30
35
40
45
Distance along profile (km)
0
10
20
30
40
50
60
70
80 km
10
100
1,000
10,000
Resistivity (Ohm.m)


DRYDEN COMPOSITE GEOLOGICAL SECTION
WESTERN WABIGOON SUBPROVINCE, SUPERIOR PROVINCE
ONTARIO, CANADA
METASEDIMENTARY ASSEMBLAGES
SL Stormy Lake group (<2705-2695 Ma)
METAVOLCANIC ASSEMBLAGES
TLG Thunder Lake group (2710-2695 Ma)
BL Boyer Lake group (2720 Ma)
WG Wapageisi group (2735-2725 Ma)
KG Kawashegamuk and Wabigoon groups (2740-2730 Ma)
INTRUSIONS
FI Intermediate to felsic intrusions (2750-2695 Ma)
Resistivity (Ohm.m)
10
100
1,000
10,000
Eltrut amphibolite gneiss
2709 Ma biotite tonalite suite
Eltrut tonalite to granodiorite gneiss
2730-2710 Ma
Unnamed fault
2735-2725 Ma Wapageisi group
2705-2695 Ma Storm Lake Group
Mosher Bay-Washeibemaga def. zone
2720 Ma Boyer Lake group
Unnamed def. zone
2740-2730 Ma Kawashegamuk group
Kawashegamuk def. zone
Mantiou-Dinorwic def. zone
2740-2730 Ma Wabigoon Group
Wabigoon def. zone
TLG
<2710 Ma Thunder Lake group
2695 Ma
P
P'
Depth (km)
Distance along profile (km)
0
10
20
30
40
50
60
70
80 km
5
15
25
35
45


North Dryden
R2 seismic section (LN341)
W Wabigoon Subprovince,
Superior Province
Ontario, Canada
South
Trace Number
North
250
750
Q
1
2
3
4
Time (s)
3
6
9
12
6 km
Distance along profile (km)
North Dryden
Audio-frequency
Magnetotelluric section
W Wabigoon Subprovince,
Superior Province
Ontario, Canada
DRY023M
DRY021M
DRY019M
DRY018M
DRY016M
DRY014M
DRY012M
DRY010M
DRY008M
DRY006M
DRY002M
DRY088M
10
100
1,000
10,000
Resistivity (Ohm.m)
North Dryden
Composite geological section
W Wabigoon Subprovince,
Superior Province
Ontario, Canada
Wabigoon def. zone
Thunder Lake group (2710-2695 Ma)
Goliath Au deposit
Q'
Depth (km)

Useful references

Frieman, B.M. 2019. Dryden Transect of the western Wabigoon subprovince: regional significance, preliminary results and future work. Mineral Exploration Research Centre, Laurentian University. doi:https://hub.arcgis.com/documents/1987997e19934e7cab4a3272bc53c67b/explore.

McRae, M. 2022. Chemostratigraphy and structural framework for gold mineralization at the Goliath Deposit, Western Wabigoon Subprovince, Ontario. Laurentian University.

Montsion, R.M., Thurston, P., and Ayer, J. 2018. 1:2,000,000 Scale Geological Compilation of the Superior Craton - Version 1. Laurentian University Mineral Exploration Research Centre (MERC) **ME-2018-017**.

Montsion, R.M., Perrouty, S., and Frieman, B.M. 2021a. Geological and geophysical data compilation for the western Wabigoon and southern Abitibi subprovinces of the Superior Province, Ontario, Canada. Data in Brief, **37**: e107159. doi:https://doi.org/10.1016/j.dib.2021.107159.

Montsion, R.M., Perrouty, S., Lindsay, M.D., Jessell, M.W., and Frieman, B.M. 2021b. Mapping structural complexity using geophysics: A new geostatistical approach applied to greenstone belts of the southern Superior Province, Canada. Tectonophysics, **812: e**228889. doi:https://doi.org/10.1016/j.tecto.2021.228889.

Montsion, R.M., Perrouty, S., Lindsay, M.D., Jessell, M.W., and Sherlock, R. 2024. Development and application of feature engineered geological layers for ranking magmatic, volcanogenic, and orogenic system components in Archean greenstone belts. Geoscience Frontiers, **15**: 101759. doi:https://doi.org/10.1016/j.gsf.2023.101759.

Zammit, K., Perrouty, S., Frieman, B.M., Marsh, J.H., and Holt, K.A. 2022. Structural and geochronological constraints on orogenic gold mineralization in the western Wabigoon subprovince, Canada. Canadian Journal of Earth Sciences, **59**: 278–299. doi:https://doi.org/10.1139/cjes-2021-0042.

Folio 13
Rainy River transect

The ~68-km Rainy River transect [R–R] is located in southwest Ontario, extending north across the Rainy River greenstone belt along Highway 71 from the Canada–USA border to Kakagi Lake within the western Wabigoon subprovince (**Figure 13**). The transect encompasses ~33 km of new R1 seismic reflection data [r–r'; line 361] that intersects the Quetico deformation zone, which is spatially associated with the Rainy River Cu–Au deposit, and the Helena-Pipestone deformation zone. The seismic section also traverses the metasedimentary 2704–2692 Ma Coutchiching group of the Mather basin and older fault-bound 2775–2716 Ma metavolcanic assemblages of the Rainy River greenstone belt. BBMT stations were deployed along the entire transect [R–R], including the r–r' Rainy River R1 seismic survey line, resulting in a conductivity section that also traverses the 2723–2720 Ma Sabaskong TTG, the older Mesoarchean Morson dome, and the Sabaskong Bay deformation zone.

With the exception of the ~3.7 Moz Au Rainy River deposit (Pelletier 2016), the Rainy River greenstone belt is host to few significant mineral deposits. The belt is also dominated by >2716 Ma metavolcanic assemblages, which is comparable to other transects in the Wabigoon Subprovince, but older than many metavolcanic assemblages of the Abitibi subprovince. The Rainy River R1 seismic and BBMT sections consequently provide an opportunity to examine the structural setting of poorly endowed greenstone belt.

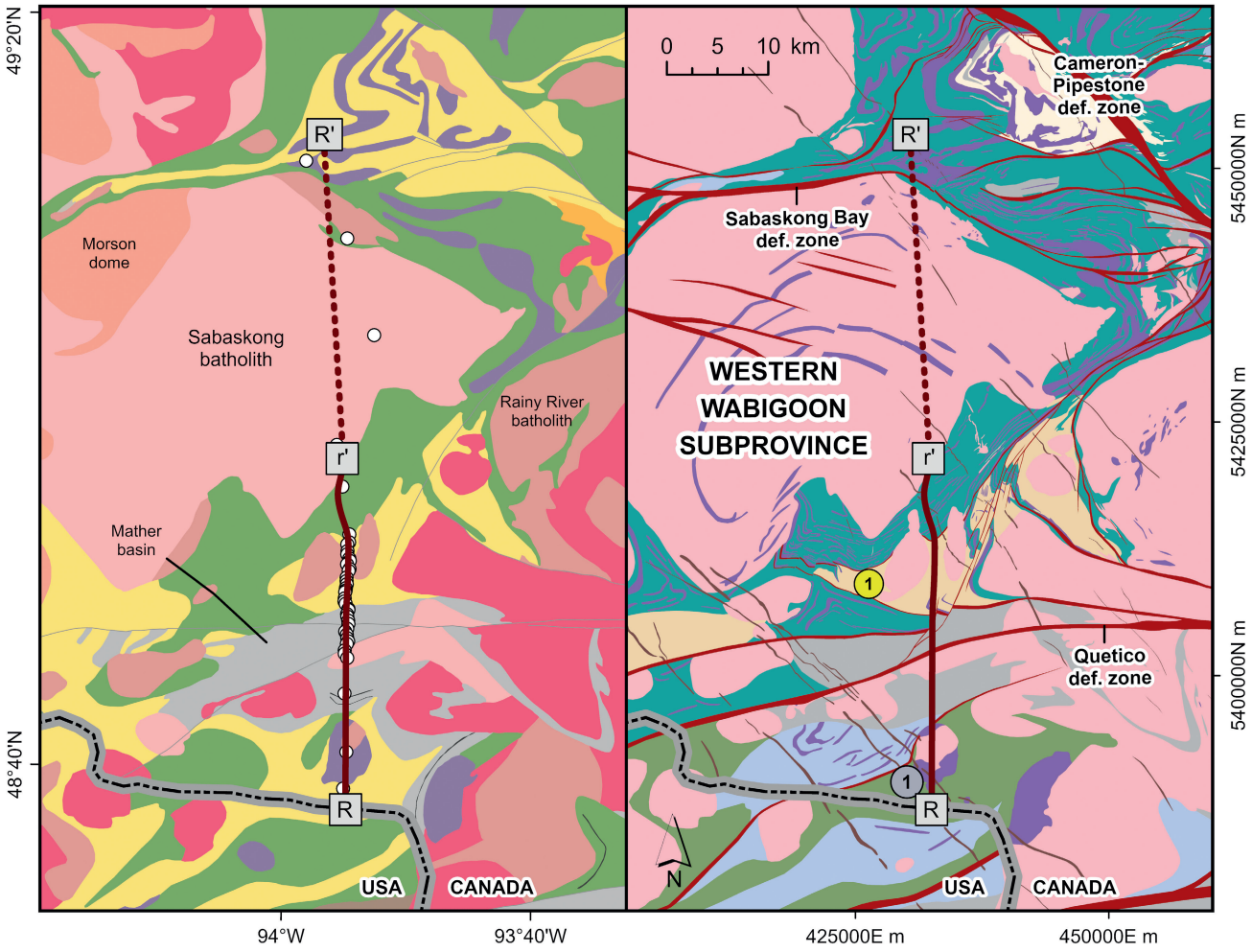
The reader is referred to a presentation by Launay et al. (2021) for interpretations of Rainy River R1 seismic and BBMT data. Refer to Behnia et al. (2023) for a discussion on mineral prospectivity mapping in the Rainy River region.

Figure 13. Geological maps of the Rainy River greenstone belt in the western Wabigoon subprovince in western Ontario, showing the location of the Rainy River R1 seismic [r–r'; line 361] and BBMT [R–R'] sections. Map data sourced from the Metal Earth compilations of Montsion et al. (2018; lithological data) and publications by Launay et al. (2021) and Behnia et al. (2023; assemblage data).

r r' Rainy River R1 seismic section (Line 361)
R R Rainy River broadband MT section
Broadband MT and audio-frequency MT stations

RAINY RIVER TRANSECT

W WABIGOON SUBPROVINCE, SUPERIOR PROVINCE
ONTARIO, CANADA



Coordinate system: NAD83 UTM15N

Lithological classification

- Massive granodiorite to granite
- Diorite-monzonite-granodiorite suite
- Foliated tonalite suite
- Foliated to gneissic tonalite and granodiorite
- Mafic intrusions
- Migmatized successor basin units
- Iron formation
- Coarse-grained clastic successor basin units
- Fine-grained clastic successor basin units
- Mafic to intermediate metavolcanics
- Felsic to intermediate metavolcanics

Assemblage classification

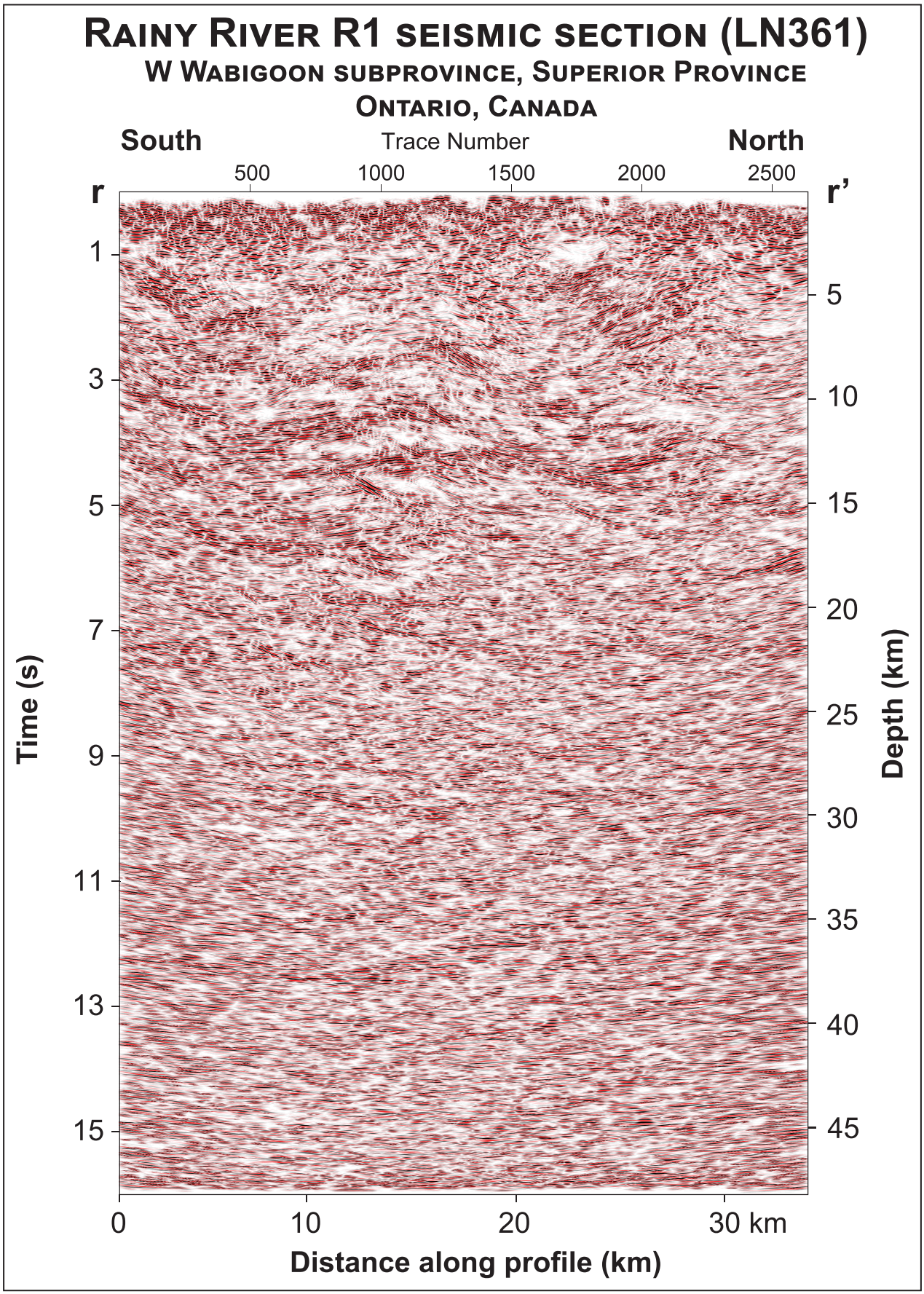
- Proterozoic intrusions
- <2704-2692 Ma Metasedimentary rocks
- 2704-2701 Ma Metavolcanic rocks
- 2714-2711 Ma Metavolcanic rocks
- 2721-2714 Ma Metavolcanic rocks
- 2775-2721 Ma Metavolcanic rocks
- Neoarchean metavolcanic rocks
- Neoarchean mafic plutonic rocks
- Neoarchean felsic plutonic rocks
- Mesoarchean gneissic plutonic rocks

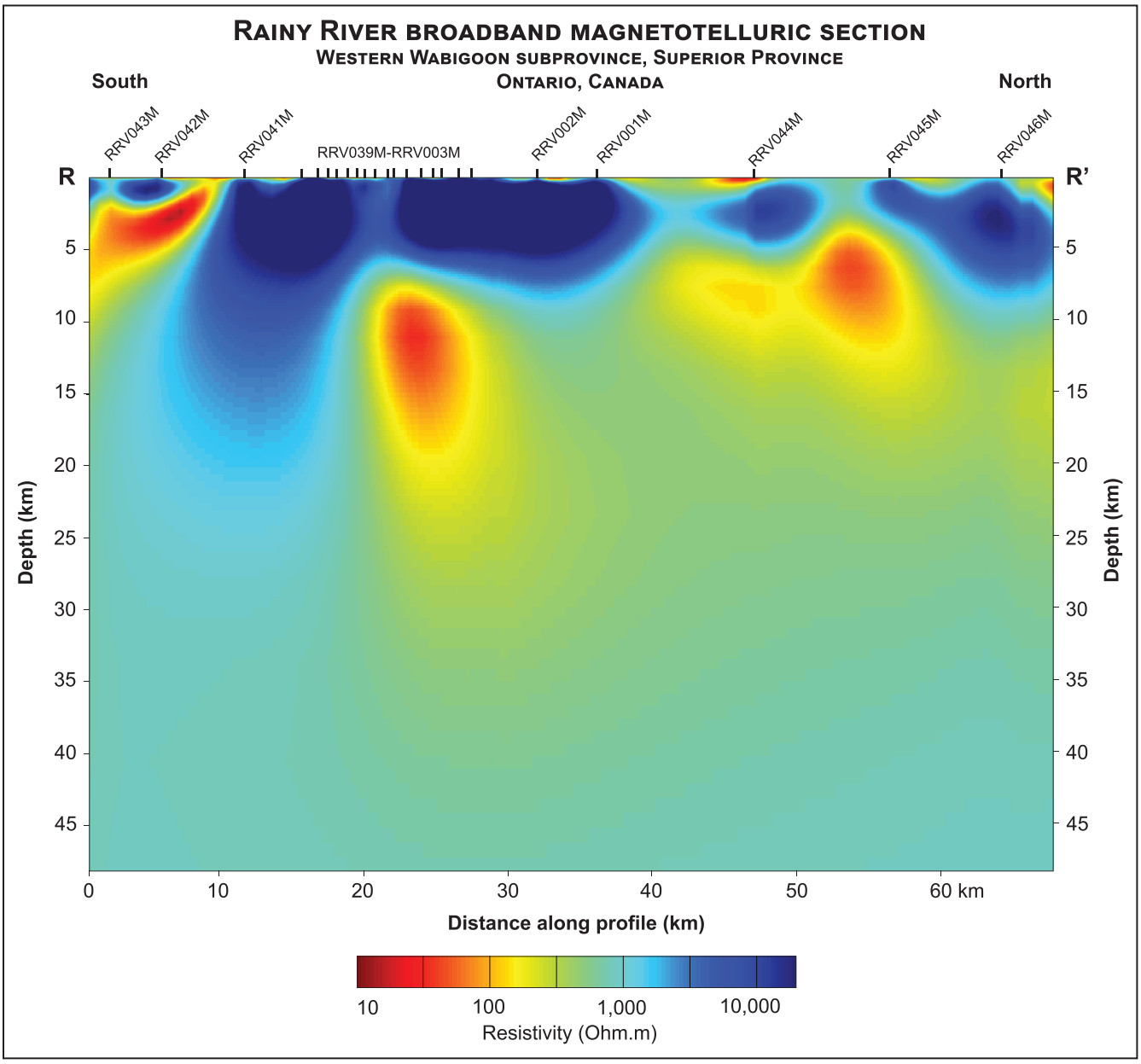
Gold deposits

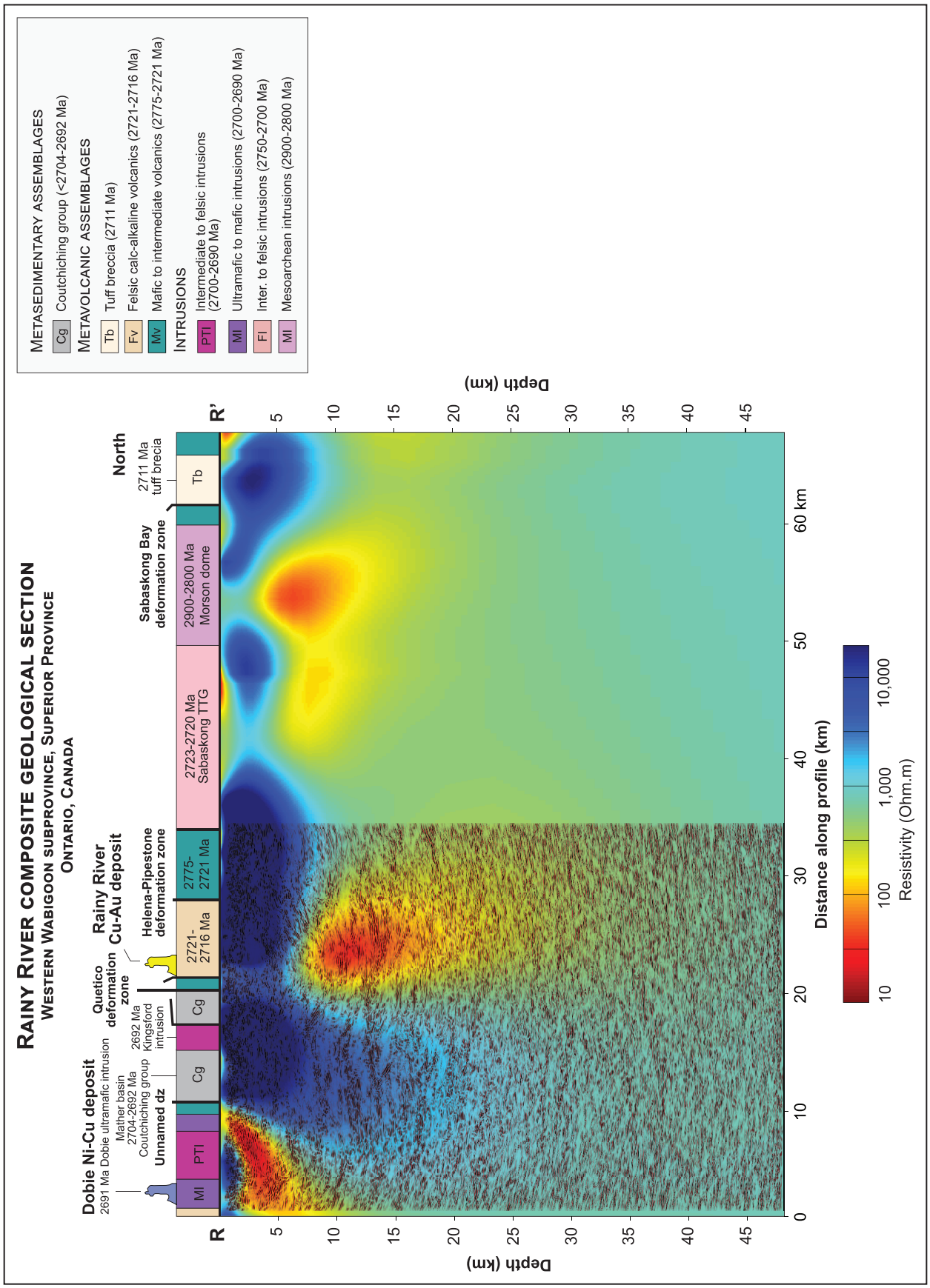
(1) Rainy River deposit

Ni-Cu deposits

(1) Dobie deposit


RAINY RIVER R1 SEISMIC SECTION (LN361)
W WABIGOON SUBPROVINCE, SUPERIOR PROVINCE
ONTARIO, CANADA
South
Trace Number
North
500
1000
1500
2000
2500
r
r'
1
3
5
7
9
11
13
15
Time (s)
5
10
15
20
25
30
35
40
45
Depth (km)
0
10
20
30 km
Distance along profile (km)


RAINY RIVER BROADBAND MAGNETOTELLURIC SECTION
WESTERN WABIGOON SUBPROVINCE, SUPERIOR PROVINCE
ONTARIO, CANADA
South
North
RRV043M
RRV042M
RRV041M
RRV039M-RRV003M
RRV002M
RRV001M
RRV044M
RRV045M
RRV046M
R
R'
Depth (km)
0
5
10
15
20
25
30
35
40
45
60 km
Distance along profile (km)
10
100
1,000
10,000
Resistivity (Ohm.m)


RAINY RIVER COMPOSITE GEOLOGICAL SECTION
WESTERN WABIGOON SUBPROVINCE, SUPERIOR PROVINCE
ONTARIO, CANADA
METASEDIMENTARY ASSEMBLAGES
Cg Coutchiching group (<2704-2692 Ma)
METAVOLCANIC ASSEMBLAGES
Tb Tuff breccia (2711 Ma)
Fv Felsic calc-alkaline volcanics (2721-2716 Ma)
Mv Mafic to intermediate volcanics (2775-2721 Ma)
INTRUSIONS
PTI Intermediate to felsic intrusions (2700-2690 Ma)
MI Ultramafic to mafic intrusions (2700-2690 Ma)
FI Inter. to felsic intrusions (2750-2700 Ma)
MI Mesoarchean intrusions (2900-2800 Ma)
Dobie Ni-Cu deposit
2691 Ma Dobie ultramafic intrusion
Mather basin
2704-2692 Ma
Coutchiching group
Unnamed dz
2692 Ma
Kingsford
intrusion
Quetico
deformation
zone
Rainy River
Cu-Au deposit
Helena-Pipestone
deformation zone
2721-
2716 Ma
2775-
2721 Ma
2723-2720 Ma
Sabaskong TTG
Sabaskong Bay
deformation zone
2900-2800 Ma
Morson dome
North
2711 Ma
tuff brecia
MI
PTI
Cg
Cg
Tb
R
R'
Depth (km)
Depth (km)
0
10
20
30
40
50
60 km
Distance along profile (km)
10
100
1,000
10,000
Resistivity (Ohm.m)

Useful references

Behnia, P., Harris, J., Sherlock, R., Naghizadeh, M., and Vayavur, R. 2023. Mineral prospectivity mapping for orogenic gold mineralization in the rainy river area, Wabigoon Subprovince. Minerals, **13: e**13101267. doi:https://doi.org/10.3390/min13101267.

Launay, G., McRae, M.L., and Sherlock, R.L. 2021. Stratigraphy, Metallogeny and Crustal Architecture of the Rainy River Greenstone Belt. Mineral Exploration Research Centre, Laurentian University. doi:https://merc.laurentian.ca/sites/default/files/mepresentationrainyriver2021_seg_v2.pdf.

Montsion, R.M., Thurston, P., and Ayer, J. 2018. 1:2,000,000 Scale Geological Compilation of the Superior Craton - Version 1. Laurentian University Mineral Exploration Research Centre (MERC) **ME-2018-017**.

Pelletier, M. 2016. The Rainy River gold deposit, Wabigoon Subprovince, western Ontario: Style, geometry, timing and structural controls on ore distribution and grades. Institut National de la Recherche Scientifique (INRS).