Noranda Transect

Taus R.C. Jørgensen*, Marina D. Schofield, Adrian Rehm, Jonathan Sutton, Andrew Bradley, and Aidan Paleczny

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Outline: Metal Earth Noranda Transect

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- Location
- Transect overview
 - Stratigraphy
 - Structures
 - Mineralization
- Research activities
 - Seismic profile (part of the transect work)
 - Previous seismic work
 - Metal Earth seismic profile
 - Transect projects
- Conclusions



Location



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Transect overview: Stratigraphy

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• Abitibi Subprovince

- Kinojevis Group (ca. 2718-2722 Ma)
 - Fe- and Mg-tholeiites, basalts, andesites, rhyolites, and komatiites
 - Note the age overlap with Kidd-Munro and Stoughton-Roquemaure
- Blake River Group (ca. 2704-2695 Ma)
 - Tholeiitic, transitional, and calc-alkaline volcanic successions, several generations of plutons and mafic to intermediate dikes and sills
- Timiskaming Group (ca. 2679-2669 Ma)
 - Conglomerate and wacke

Pontiac Subprovince

- Pontiac Group (ca. 2682 Ma)
 - Graywacke and minor mafic- to ultramafic volcanic rocks

Major crustal scale structures

- Porcupine-Destor Fault
- Cadillac-Lader Lake Deformation Zone (and Piché Structural Complex)



After Thurston et al. (2008)

Transect overview: Deformation

- Early shortening (>2680 Ma): pre-Timiskaming terrane accretion; tilting and folding of the BRG (e.g., Benn et al., 1994; Daigneault et al., 2002; Bleeker, 2012).
- Extension (~2678-2672 Ma): Timiskaming deposition and syn-sedimentary magmatism (e.g., Davis, 2002; Pilote et al., 2014; De Souza et al., 2015). Possible initiation of the PDFZ and CLLFZ as normal faults (e.g., Bleeker, 2012).
- N-S shortening (~2672-2665 Ma):
 Reactivation of the major breaks as thick-skinned thrusts; CLLFZ nucleation by linking of early structures during thrusting (Bleeker, 2012; Bedeaux et al., 2017).
- Extension (local?): Reactivation of the major breaks as normal faults Mainly observed in the Rouyn-Noranda area. Uplift of the Pontiac (Daigneault et al., 2002; Bedeaux et al., 2017)
- **NW-SE shortening:** Reactivation of the major breaks by final dextral transpression.



Transect overview: Mineralization

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- **PDF:** Only Au-showings near the transect
- Noranda Camp:
 - 20 VMS (inground metal endowment of 2.7 Mt Cu, 3.0 Mt Zn, 20.1 Moz Au, and ~146 Moz Ag)
 - 19 orogenic Au deposits and several intrusionhosted Cu-Mo deposits (e.g., Don-Rouyn and St. Jude)
- CLLDZ: Au deposits
 - Astoria: 180,000 t grading 5.15 g/t Au and ~0.5 g/t Ag
 - McWatters: 333,750 t grading 11.07 g/t Au and 1.44 g/t Ag



Research activities: Seismic profile

- Collect geological data (lithological, structural, geochemical, geochronological, mineralization, alteration, compile previous work)
- Integrate newly acquired geological and geophysical data (seismic, MT, gravity) with historical data, to produce a crust to mantle cross-section through the transect
- Compare the Rouyn-Noranda crosssection to other transects to establish differences between endowed and lessendowed greenstone belts



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Modified after Système d'information géominière of Québec (2017)

- LITHOPROBE regional seismic survey:
 - Line 21 (E-W striking) NE Blake River Group, D'Alembert shear zone Western limit of the Lac Dufault granodiorite Central Volcanic Complex Hunter Creek fault Northern tip of the Flavrian pluton From the Hunter Creek fault line 21 runs parallel to the volcanic stratigraphy and then across relatively flat-lying and esites and rhyolites
 - Line 14 (N-S striking)
 Porcupine-Destor fault zone
 Blake River Group
 Cadillac-Lader Lake fault zone
 Pontiac Group



Verpaelst et al. (1995; Can. J. Earth. Sci. 32: 167-176)

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- LITHOPROBE highresolution data in the Noranda central camp:
 - Line 21-1 (~E-W across the central volcanic complex of the Blake River Group
 - Line 14b (N-S striking across the Larder Lake – Cadillac break, Rouyn-Noranda, and ends ~5 km north of the Lake Dufault granodiorite)



Adam et al. (2000; Can. J. Earth. Sci. 37: 503-516)

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- Noranda/Xstrata Canada high-resolution seismic profiles:
 - Amulet and Ribago (E-W striking across the Noranda Formation)
 - Part of the Targeted Geoscience Initiative 3 (TGI-3) Abitibi project



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Bellefleur et al. (2014; Econ. Geol. 109: 103-119)

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- Acoustic impedance and reflection coefficients
 - A difference in acoustic impedance of 2.5 corresponds to a reflection coefficient of 0.06
 - A reflection coefficient of 0.06 is considered the minimum value necessary to produce an observable reflection under signal-to-noise conditions, typical of hardrock settings
 - Strongest reflections should occur between the two lithologies separated by the greatest distance measured normal to the impedance contours
 - Strongest reflection should arise at the boundaries between:
 - Diorites and rhyolites: RC ~0.11
 - Diorites and tonalite: RC ~0.09
 - Only an RC ~0.05 produced at contacts between andesite and other common rock types



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Perron and Calvert (1998; GEOPHYSICS 63: 379-391)



Metal Earth Rouyn-Noranda Line 141 R1 Seismic Transect



Metal Earth seismic profile

1000 1250 CDP 1100 700 CDP 1050 750 008 850 006 1000 GL)- 0 500 0.25 Debth (m) 1000 0.50 1500 500 m 2000 0.75 25 200 CDP1100 1050 1000 550 900 800 TEO 700 EDP 850











Introduction: Research activities

- Outstanding geologic problems in transect area
- PhD Candidate Marina Schofield (2017-present) Metallogeny of the Powell block, Blake River Group, Rouyn-Noranda
- MSc Candidate Adrian Rehm (2017-present) Emplacement history of metavolcanic rocks in the Pontiac Subprovince, Lac Bellecombe area
- MSc Candidate Jonathan Sutton (2017-present) Volcanic reconstruction of the Duprat-Montbray formation, Blake River Group, Rouyn-Noranda
- **BSc candidate Andrew Bradley** (2018-present) Lamprophyre facies unit in the Granada Formation, Timiskaming Group, Rouyn-Noranda
- **BSc candidate Aidan Paleczny** (2018-present) Characterization of zinc mineralized interval intercalated with metavolcanic rocks, Pontiac Subprovince, Lac Bellecombe area



 Rationale: Further define the volcanic stratigraphy in the Duprat-Montbray formation and determine the relationship between the Fabie pluton and the two VMS deposits in the area





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MSc Candidate



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- **Rationale: Further define** • the volcanic stratigraphy in the Duprat-Montbray formation and determine the relationship between the Fabie pluton and the two VMS deposits in the area
- The orientation and facing • of the DMF strata define an open, steeply inclined anticline
- A new U-Pb zircon age for • the lower rhyolite constrain volcanism to ca. 2701



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- A new U-Pb zircon age for the lower rhyolite constrain volcanism to ca. 2701
- Alteration mapping has defined discordant VMS up-flow zones
- One up-flow zone is previously unrecognized and unexplored



- **Rationale:** • Metallogeny of the Powell block (PB) and further define the volcanic and deformation history of the PB
- Cu-quartz vein ٠ mineralization occur along NE oriented structures
- Orogenic style quartz-٠ carbonate-Au vein mineralization occur along NW oriented structures



Modified after Ministère des Ressources naturelles et de la Faune (2017)

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- Rationale: Metallogeny of the Powell block (PB) and further define the volcanic and deformation history of the PB
- Establish PB stratigraphy by constructing several stratigraphic sections
- Establish a chemostratigraphy
- U-Pb dating of zircons (TIMS) from key units representing time-gaps in the stratigraphy
- Structural and alteration overlay
- Recent work on the Powell fault suggests synvolcanic movement



Modified after Morris (1958)

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- Rationale: Characterization and petrogenesis of an enriched Mg-Cr-Ni unit in the Granada Formation, Timiskaming Group and potential relationship to the CLLDZ
- Most recently described as a mafic volcanoclastic sandstone (Diop, 2011, unpub. PhD)







Modified after Système d'information géominière of Québec (2017)

Andrew Bradley BSc Candidate



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Rationale: Characterization and petrogenesis of an enriched Mg-Cr-Ni unit in the Granada Formation, Timiskaming Group and potential relationship to the CLLDZ

New mapping, petrography, and geochemistry is inconclusive but a lamprophyre facies unit must be considered as one possible origin for the enriched Mg-Cr-Ni unit





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- Rationale: Characterization and petrogenesis of an enriched Mg-Cr-Ni unit in the Granada Formation, Timiskaming Group and potential relationship to the CLLDZ
- The unit exhibit the same structural elements as those observed in the CLLDZ
- The strain intensity is relatively high in the Mg-Cr-Ni unit, particularly near the contact/transition zone to metagreywacke
- Regardless of its origin the Mg-Cr-Ni unit might represent the physical expression of a subsidiary structure to the CLLDZ



- Rationale: Reassess the emplacement history of metavolcanic rocks in the Pontiac Subprovince, Lac Bellecombe area
- Historically the metavolcanic belts have been viewed as tectonically emplaced



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Adrian Rehm MSc Candidate



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- Locally, well-preserved spinifex textures in ultramafic rocks





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Rock/Chondrite

 Observations supported by geochemistry from key outcrops



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- Observations supported by geochemistry from key outcrops
- Implies rifting and major crustal scale structure



- **Rationale: Characterization and** petrogenesis of a previously undocumented Zn mineralized interval intercalated with metavolcanic rocks in the Pontiac Subprovince, Lac Bellecombe area
- Approximately ~3 m wide interval with a strike length of at least ~250 m in the study area
- Samples show anomalous Zn values ~3000 ppm
- Petrographic observations suggest a • pre-D1 formation and thus a stratabound interval
- Similar mineralized intervals • described in Ontario at the Pense Township Zn occurrence (DDH intersection of 1.93% Zn and 0.18% Cu over 28.9 ft)
- Consistent with a syn-sedimentary ٠ emplacement of the metavolcanics





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Aidan Paleczny BSc Candidate





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-	_280 cm	Zinc (ppm)	Copper (ppm)
-	_240 cm	3270	304
_	_200 cm	1470	224
_	_160 cm	488	193
_	_120 cm	1110	427
_	_80 cm	1260	337
_	_40 cm	429	134
_	<u>0 cm</u>	886	291



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- **Rationale: To improve** the geochronological constraints on the Kinojevis Group in the transect corridor
- Does it belong to the • Kidd-Munro (host VMS) or Stoughton-Roquemaure (no VMS)?
- A 2722.1 ± 1.1 Ma is consistent with Stoughton-Roquemaure assemblage
- Dominated by high-Fe Tholeiite basalts
- Reactive host rock (high • Fe/Mg) similar to those at Cheminis



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(Pacaud)

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>2750 Ma

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Modified after Système d'information géominière of Québec (2017)

- Rationale: Assessing differential metal endowment along the CLLDZ in the Rouyn-Noranda area
- Well-constrained geochemical sampling at Bouzan, Astoria, and Augmitto
- Evaluate variables controlling Au mineralization along part of the CLLDZ with a relatively consistent orientation

Quartz-Carbonate veins (Au)

AS - Astoria (1992-95) AU - Augmitto BA - Bazooka DO - Dovercliff DU - Durbar EO - East O'Neill FO - Forbex LF - Lac Fortune LP - Lac Pelletier MW - McWatters (1934-44) NR - New Rouyn Merger (1948-49) OT - O'Neill-Thompson (1936) SR - Senator Rouyn (1940-55) ST - Stadacona (1936-58)





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- Rationale: Evaluate changes in the detrital zircon population along transect in the Pontiac Subprovince
- Significant range in Mesoarchean zircon grains from ~5% to ~45%
- Overall decrease in Mesoarchean zircon grains from north to south
- Internal variation in provenance for the Pontiac assemblage
- Change in detritus influx from hinterland during the geodynamic evolution
- Transect sampling across Archean successor basins might unlock the full potential of detrital zircon geochronology



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- 1. New seismic profile adds detail to the reflections in the middle and lower crust also observed by LITHOPROBE and provides an important framework for further interpretation with the imminent arrival of MT data
- 2. The new discoveries in the Pontiac Subprovince suggest a younger rifting event than previously recognized which requires the presence of deep crustal scale structures
- 3. Continued refinement of the Blake River Group stratigraphy facilitates the construction of the best possible crust-mantle cross-section through a metal-endowed part of the Abitibi Greenstone Belt paramount for the overarching goal of Metal Earth

Acknowledgments



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Thank you.

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