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C.J.M. Lawley[1], R.A. Creaser[2], V. McNicoll[1], B. Dubé[3], P. Mercier-Langevin[3], S. Pehrsson[1], and D. Vaillancourt[4]

[1]Natural Resources Canada, Geological Survey of Canada, 601 Booth Street, Ottawa, Canada

[2]Department of Earth and Atmospheric Sciences, University of Alberta, 1-26 Earth Sciences Building, Edmonton, Alberta, Canada
[3]Ressources naturelles Canada, Commission géologique du Canada, 490 rue de la Couronne, Québec, Canada
[4]Agnico-Eagle Mines Limited, 765 chemin de la Mine Goldex, Val D'Or, Québec, Canada

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41st Annual Yellowknife Geoscience Forum, November 19th to 21st 2013

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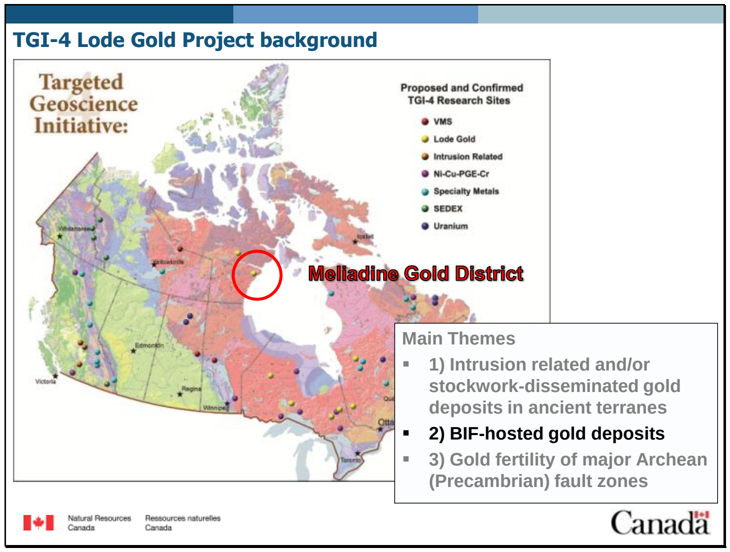
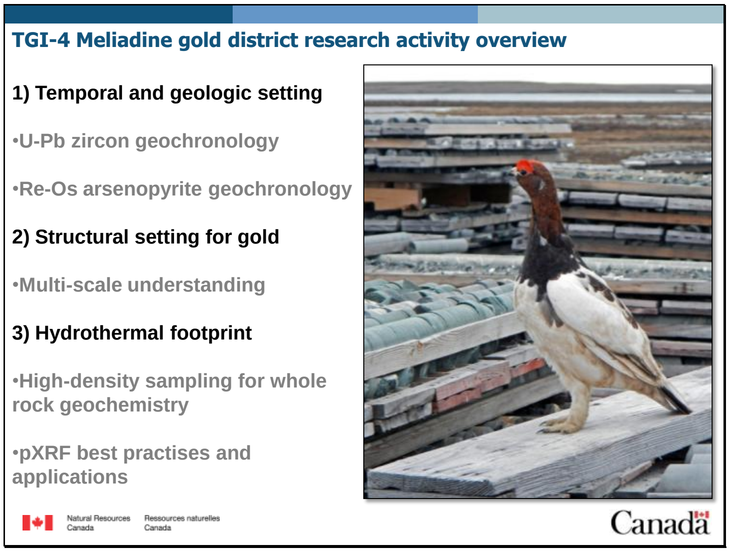
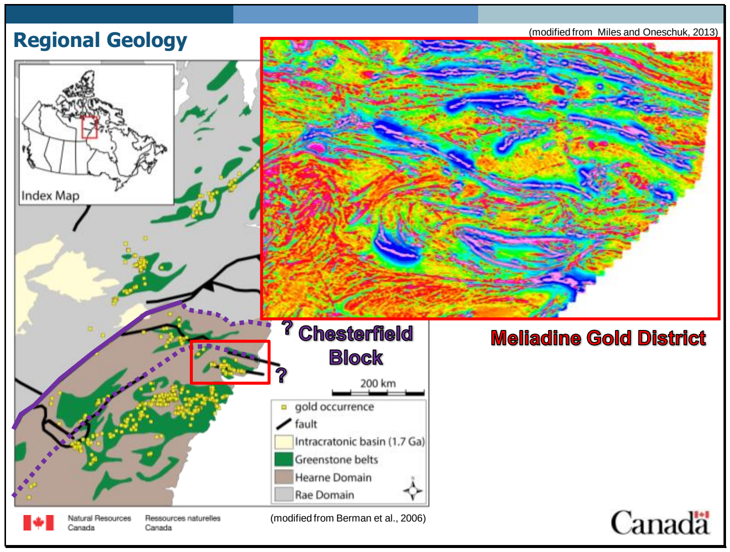


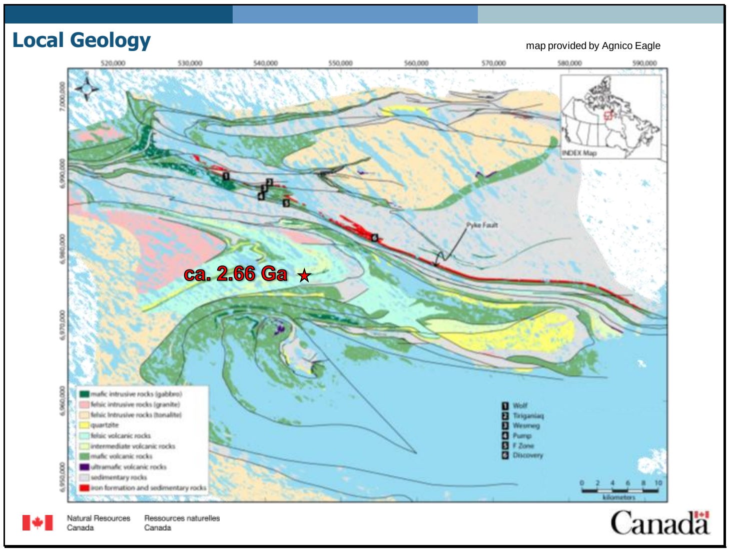
The Targeted Geoscience Initiative (TGI)-4 program is a collaborative federal geoscience program that is focused on developing innovative techniques and approaches that advance targeting efforts for mineral deposits under cover. The TGI-4 program is divided into a series of projects (shown here), which are further subdivided into a number of key themes. The lode gold project is focused on a number of world-class lode gold deposits located throughout Quebec, Ontario and Nunavut and is divided into three key themes: 1) Intrusion related and/or stockwork disseminated gold deposits in ancient terranes; 2) Banded Iron Formation (BIF)-hosted gold deposits; and 3) gold fertility of major Archean fault zones. The remaining presentation will focus on research activities currently underway at the Meliadine Gold District, which represents part of the BIF-hosted gold deposit theme.



TGI-4 Meliadine Gold District research activities are multifaceted, but can be broadly divided into three main areas of interest: 1) the temporal and geologic setting of gold; 2) the structural setting of gold; and 3) the hydrothermal footprint of BIF hosted gold deposits. The current presentation will focus on some preliminary U-Pb and Re-Os data sets for the Meliadine Gold District.

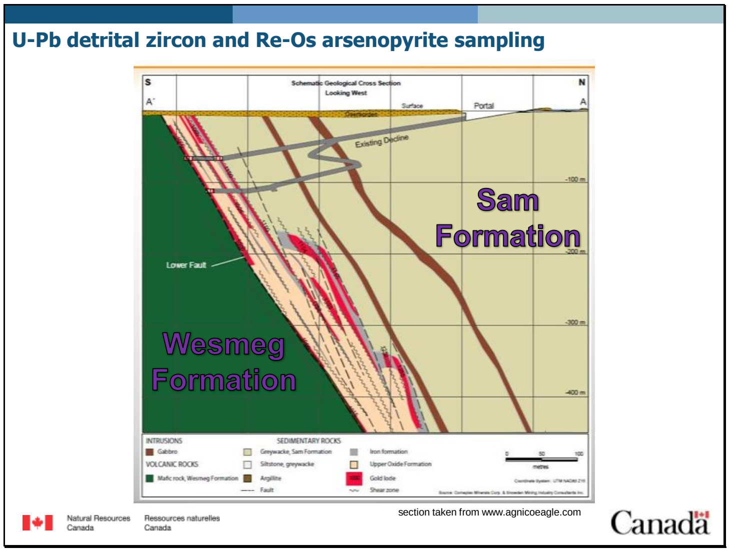


The Meliadine Gold District is situated within the western Churchill Province. Traditionally, the Neoarchean greenschist-amphibolite facies supracrustal rocks comprising the Meliadine Gold District are assigned to the Hearne Craton. However, recent metamorphic and tectonic investigations have suggested that the traditional breakdown of the western Churchill province into the Rae and Hearne Cratons is incomplete and should include a third domain referred to as the Chesterfield Block (formerly known as the northwest Hearne sub-domain). This new data raises the possibility that the Meliadine Gold District is located proximal to a major crustal break, which elsewhere are recognized as important tectonic controls on orogenic gold style mineralization. The purpose of this study is to identify the age of rocks hosting the Meliadine Gold District and to evaluate possible age correlations with rocks comprising the Rae and Hearne Cratons and/or the Chesterfield Block. The present study also reports new Re-Os arsenopyrite ages that further constrain the timing of gold at the Meliadine Gold District.



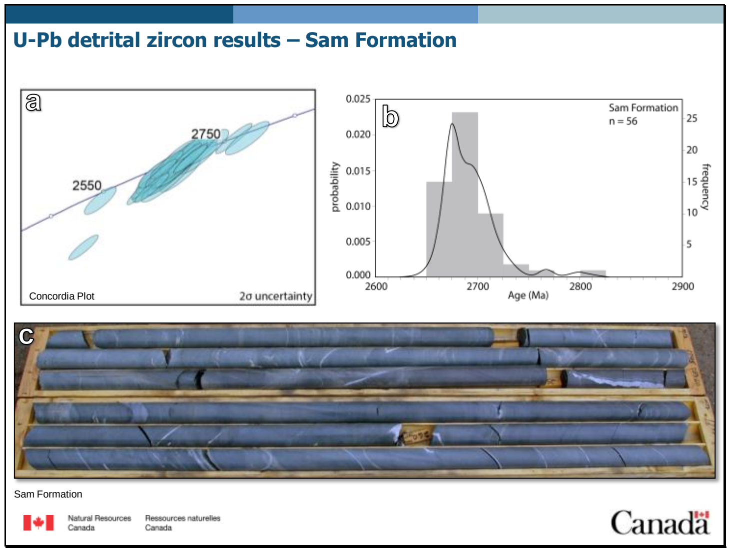
The Meliadine Gold District represents one of Canada's most important emerging gold districts and contains an estimated 3 Moz of contained gold (13.3 million tonnes at 7.0 g/t; www.agnicoeagle.com) in proven and probable resources within a larger mineral resource. The majority of known deposits within the Meliadine Gold District are situated adjacent to the WNW-ESE trending Pyke fault zone, which cuts Archean amphibolite-greenschist facies supracrustal rock packages of the Rankin Inlet Group. The only available age for this Rankin Inlet region is a U-Pb zircon age from a felsic horizon within the mafic volcanic rocks dated at 2.66 Ga (Tella et al., 1996).

Tiriganiaq is the largest of the known deposits within the Meliadine Gold District and occurs along an E-W trending and steeply north-dipping fault interpreted as a splay of the Pyke fault. The preliminary U-Pb and Re-Os ages reported as part of the current study were sampled from the Tiriganiaq deposit.

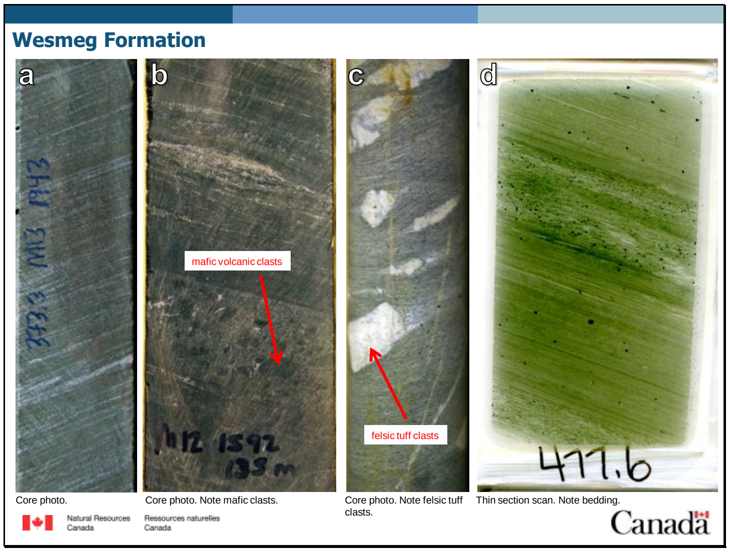


The Tiriganiaq Deposit is primarily BIF-hosted (Upper Oxide Formation), but is also hosted by quartz veins cutting the greenschist facies supracrustal rocks comprising the deposit's hanging wall and footwall. The hanging wall at Tiriganiaq comprises a bedded sequence of greywacke and siltstone known as the Sam Formation; whereas the deposit footwall comprises an interbedded sequence of mafic volcaniclastic and volcanic rocks referred to as the Wesmeg Formation. Both formations are cut by deformed gabbroic dikes (shown cutting the hanging wall here) and relatively un-deformed lamprophyre dikes (not shown). The latter are interpreted as post-ore dikes and, if related to the regionally significant Christopher Island Formation may suggest that gold is ≥1.84 Ga (Peterson et al., 1994). Samples of arsenopyrite collected from the 1100 lode, which is hosted by the Upper Oxide Formation that separates the Sam and Wesmeg Formations, will further constrain the timing of gold within the Meliadine Gold District.

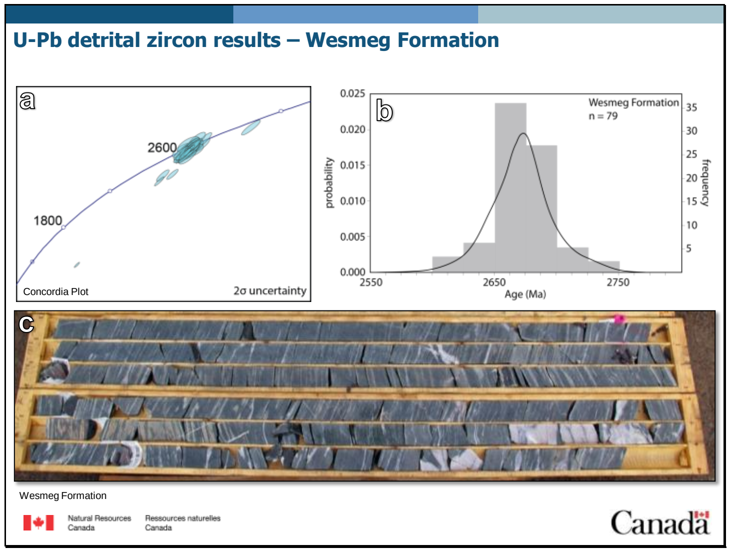
The Sam Formation comprises interbedded greywacke-siltstone (a) and represents the hanging wall of the Tiriganiaq deposit. Bedding is recognizable despite overprinting sericite-quartz-pyrite-chlorite hydrothermal alteration (a) and suggests that the deposit stratigraphy is overturned (Carpenter and Duke, 2004; this study). Finer grained horizons within the Sam Formation exhibit a pronounced crenulation cleavage (b, c, d) that is notably absent in coarser grained horizons.



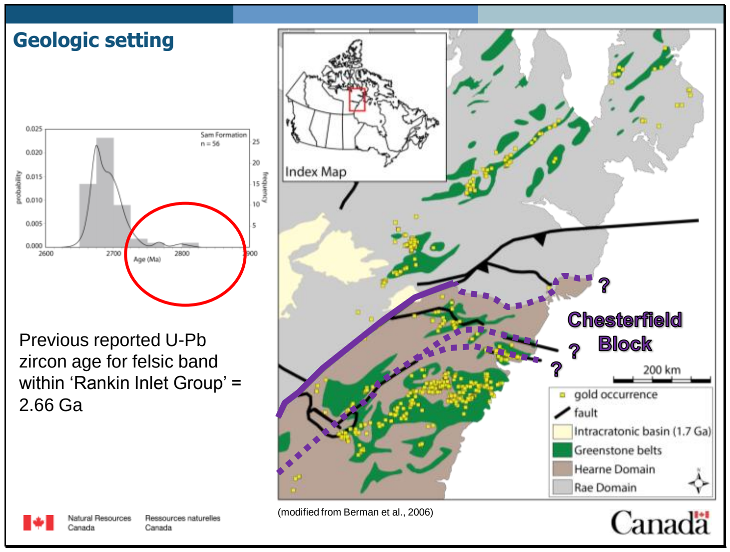
The Concordia plot in the top left (a) shows the complete dataset obtained from zircons separated from the Sam Formation sample (c). Anomalously young zircons were re-analyzed in order to evaluate the oldest possible age for deposition. The probability plot on the right (b) excludes discordant analyses (100 ± 5% concordant analyses were included) and also excludes the anomalously young U-Pb age since this age was not reproducible upon re-analysis and likely records non-zero lead-loss. Together, the available ages suggest that the Sam Formation must have been deposited ≤2.66 Ga, which is broadly consistent with the only other available age for the Rankin Inlet Group at ca. 2.66 Ga (Tella et al., 1996).



The Wesmeg Formation comprises an interbedded sequence of mafic volcanic and mafic volcaniclastic rocks, which together constitute the footwall of the Tiriganiaq Deposit. Primary sedimentary features include bedding (a,d), and rare mafic-felsic clasts (b-c) interbedded within volcaniclastic horizons.

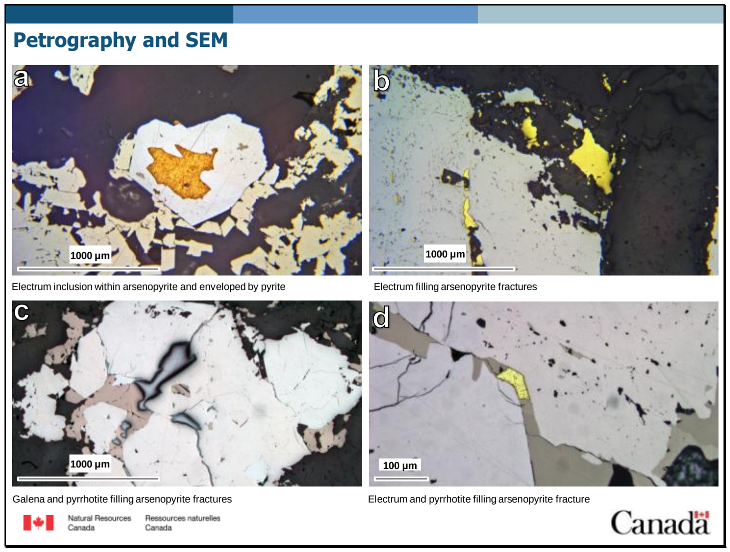


The Concordia plot in the top left (a) shows the complete dataset obtained from zircons separated from the Wesmeg Formation sample (c). Anomalously young zircons were re-analyzed in order to evaluate the oldest possible age for deposition. The probability plot on the right (b) excludes discordant analyses (100 ± 5% concordant analyses were included), but includes ostensibly young zircon ages that were broad within analytical uncertainty at 2σ. The latter may record minor non-zero lead-loss. Together, the available ages suggest that the Wesmeg Formation must have been deposited ≤2.66 Ga, which is broadly consistent with the only other available age for the Rankin Inlet Group at ca. 2.66 Ga (Tella et al., 1996).



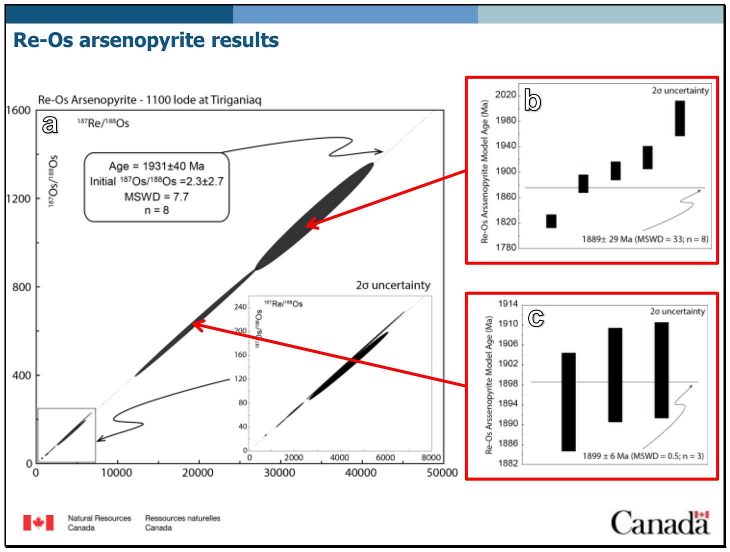
New U-Pb detrital zircon datasets are consistent with the interpreted age of the Rankin Inlet Group at 2.66 Ga and suggests that the volcano-sedimentary formations hosting Tiriganiaq were deposited ≤2.66 Ga. These new ages also cast doubt on the previous assertion that the Rankin Inlet Group represents the northernmost extension of the Hearne Craton. Mesoproterozoic U-Pb zircon ages (2.9−2.8 Ga) from the Meliadine Gold District are inconsistent with the Neoarchean ages that characterize the rest of the Hearne Craton and share more similarities with the Rae Craton and/or Chesterfield Block to the north. Our results suggest that the Chesterfield block extends further south than previously recognized and also highlight the possibility that the Pyke Fault may also represent a major terrane boundary.

The highest gold grades at Tiriganiaq are hosted by hydrothermally altered BIF (a) and associated quartz veins (b). Arsenopyrite porphyroblasts are disseminated adjacent to cutting quartz veins and also occur as sulphide rich domains apparently devoid of quartz veining. In general, coarse idioblastic arsenopyrite crystals (a, b) are indicative of significant gold grade, however significant gold grades also occur in the absence of arsenopyrite.



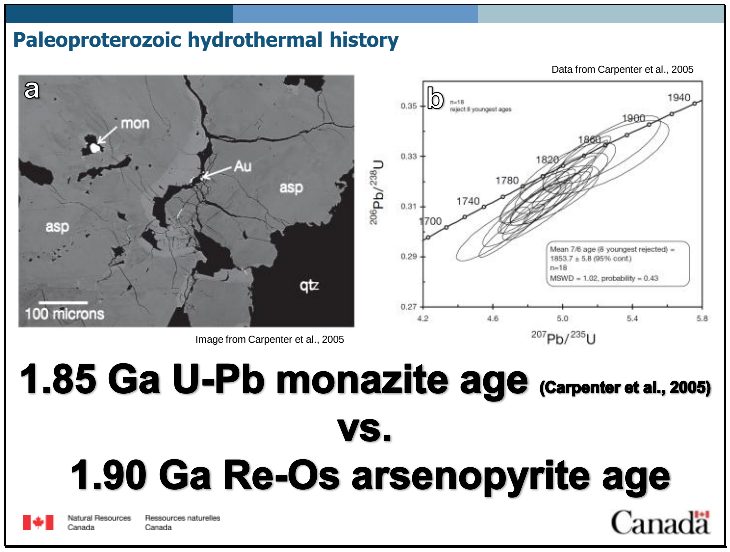
Gold predominately occurs as free gold (b), inclusions within arsenopyrite (a) ± pyrrhotite ± Fe-Ti oxide minerals ± Fe-Mg carbonate minerals ± chlorite ± quartz and is also observed filling idioblastic arsenopyrite crystal fractures along with pyrrhotite and lesser galena ± chalcopyrite (c, d). The occurrence of gold as inclusions and fracture-filling arsenopyrite supports a broadly contemporaneous relationship between these two minerals, whereas gold occurring as arsenopyrite fracture-fills may provide evidence for a relatively late and undated gold mobilization.

Petrography and relative timing relationships between sulphide-silicate mineral phases do not provide any evidence for temporally distinct arsenopyrite porphyroblasts. However, Re-Os dating relies on the bulk analysis of approximately 400 mg aliquots of arsenopyrite mineral separates and, if these disparate arsenopyrite generations exist, they would be grouped during mineral separation.

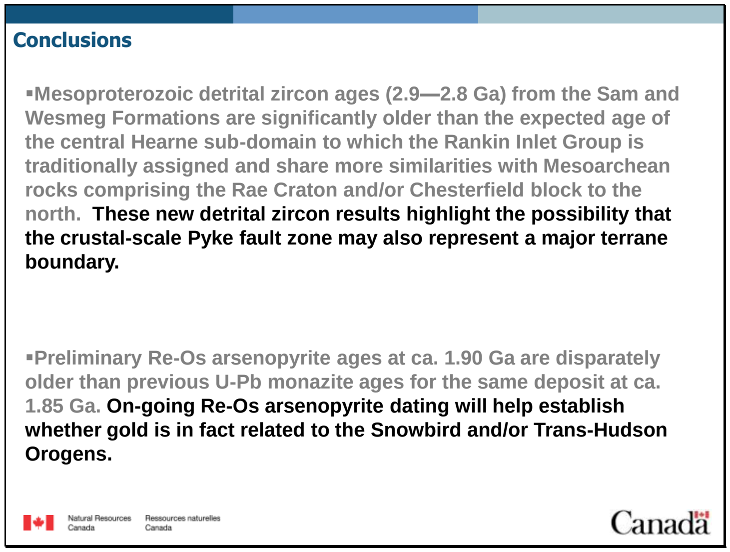


Here we report Re-Os arsenopyrite results for six arsenopyrite samples from the Tiriganiaq Deposit. All six samples were collected along strike of the 1100-lode, which occurs proximal to the Lower Fault that separates the Wesmeg and Sam Formations. A regression through all eight analyses (i.e., six samples and two replicate analyses) yields a $^{187}Re/^{188}Os$ vs. $^{187}Os/^{188}Os$ isochron age of 1931 ± 40 Ma (MSWD = 7.7; n = 8). Two of these samples are extremely radiogenic and yield $^{187}Re/^{188}Os$ ratios >5,000 and suggests that common Os is virtually absent for these samples. As a result, for these two highly-radiogenic samples we assumed that all of the ^{187}Os resulted from the decay of ^{187}Re and these samples were subsequently reanalyzed following an approach that is analogous to Re-Os molybdenite dating.

The results of these replicate analyses are presented as weighted average Re-Os arsenopyrite model ages (b, c) that are both broadly within analytical uncertainty at 2σ with the Re-Os isochron age (a). One of these samples (b) exhibits significant scatter between calculated model ages although three of these ages are reproducible at the 2σ level of uncertainty and are in close agreement with three replicate analyses of the other highly radiogenic sample (c). The cause of this excess data-point scatter is unclear, buy may be related to the difficulty in accurately determining the Re-Os isotopic composition of such Re-poor samples (ca. 1 ppb Re). Nevertheless, new Re-Os arsenopyrite ages suggest that arsenopyrite and, locally gold, were deposited at ca. 1.90 Ga.



Previous dating at the Tiriganiaq Deposit yielded U-Pb hydrothermal monazite ages, interpreted to be co-genetic with gold, at ca. 1.85 Ga (Carpenter et al., 2005). This interpreted age is broadly coincident with the 1.9−1.8 Ga Tran-Hudson Orogen and may indicate hydrothermal phosphate and gold were deposited during the terminal phase of collision between the western Churchill and Superior Provinces. Preliminary Re-Os arsenopyrite ages reported here are disparately older, but are broadly contemporaneous with the Thelon Orogen which occurred at 2.0−1.9 Ga and marked the collision between the western Churchill Province and the Slave Craton. Both orogenic cycles are recorded across large swaths of the western Churchill province although the exact spatial distribution of these tectono-thermal events awaits further study. At least two plausible scenarios could explain these disparate ages: 1) monazite and arsenopyrite ages record different hydrothermal events and are both geologically meaningful. The latter scenario would imply at least two temporally distinct gold pulses since gold occurs as inclusions within arsenopyrite and was also linked paragenetically to monazite by Carpenter et al. (2005); 2) arsenopyrite ages may be disturbed due Re and/or Os loss/gain. The latter scenario would imply that Re-Os arsenopyrite model ages are geologically meaningless. On-going Re-Os arsenopyrite dating at the other major known gold deposits along the Pyke break may help to identify whether Re-Os arsenopyrite ages are recording a true geologic event.



Mesoproterozoic detrital zircon ages (2.9—2.8 Ga) from the Sam and Wesmeg Formations are significantly older than the expected age of the central Hearne sub-domain to which the Rankin Inlet Group is traditionally assigned and share more similarities with Mesoarchean rocks comprising the Rae Craton and/or Chesterfield block to the north. These new detrital zircon results highlight the possibility that the crustal-scale Pyke fault zone may also represent a major terrane boundary.

Preliminary Re-Os arsenopyrite ages at ca. 1.90 Ga are disparately older than previous U-Pb monazite ages for the same deposit at ca. 1.85 Ga. On-going Re-Os arsenopyrite dating will help establish whether gold is in fact related to the Snowbird and/or Trans-Hudson Orogens.

Acknowledgements

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