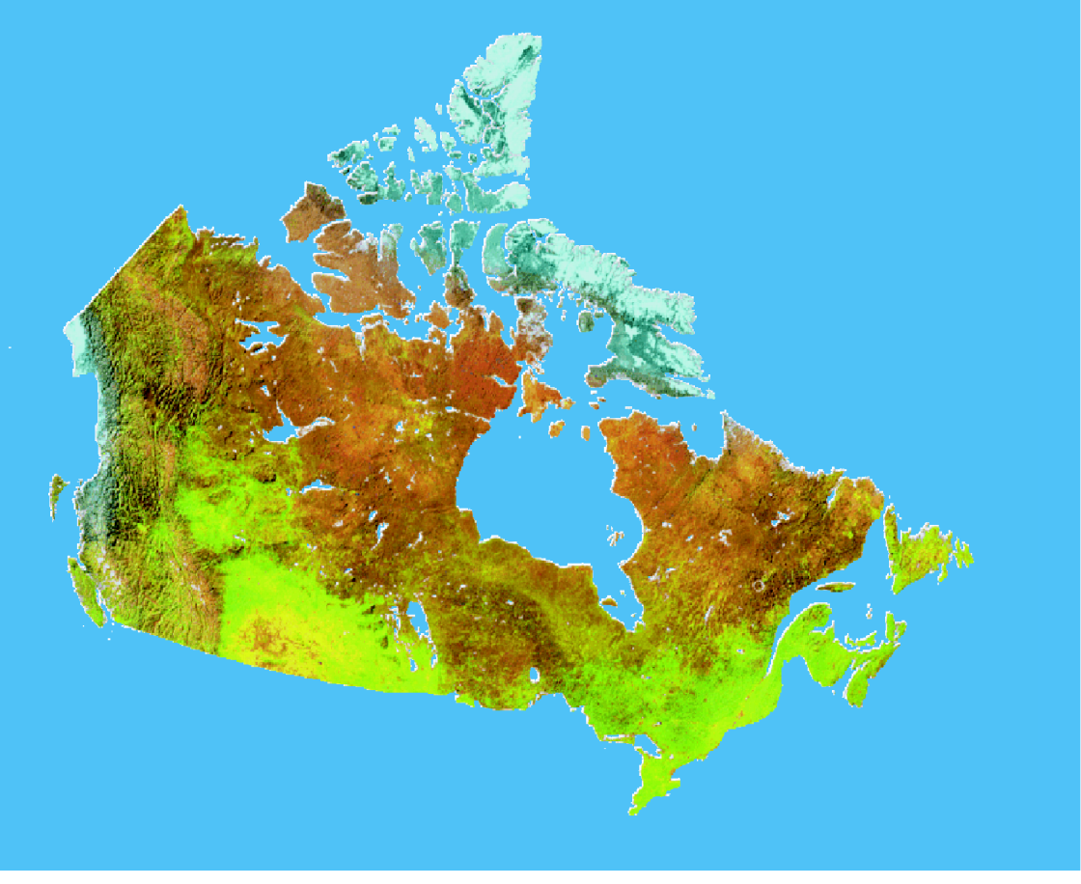
Exploring the Tehery region: correlating supracrustal sequences using detrital zircon geochronology, Rae Craton, Nunavut

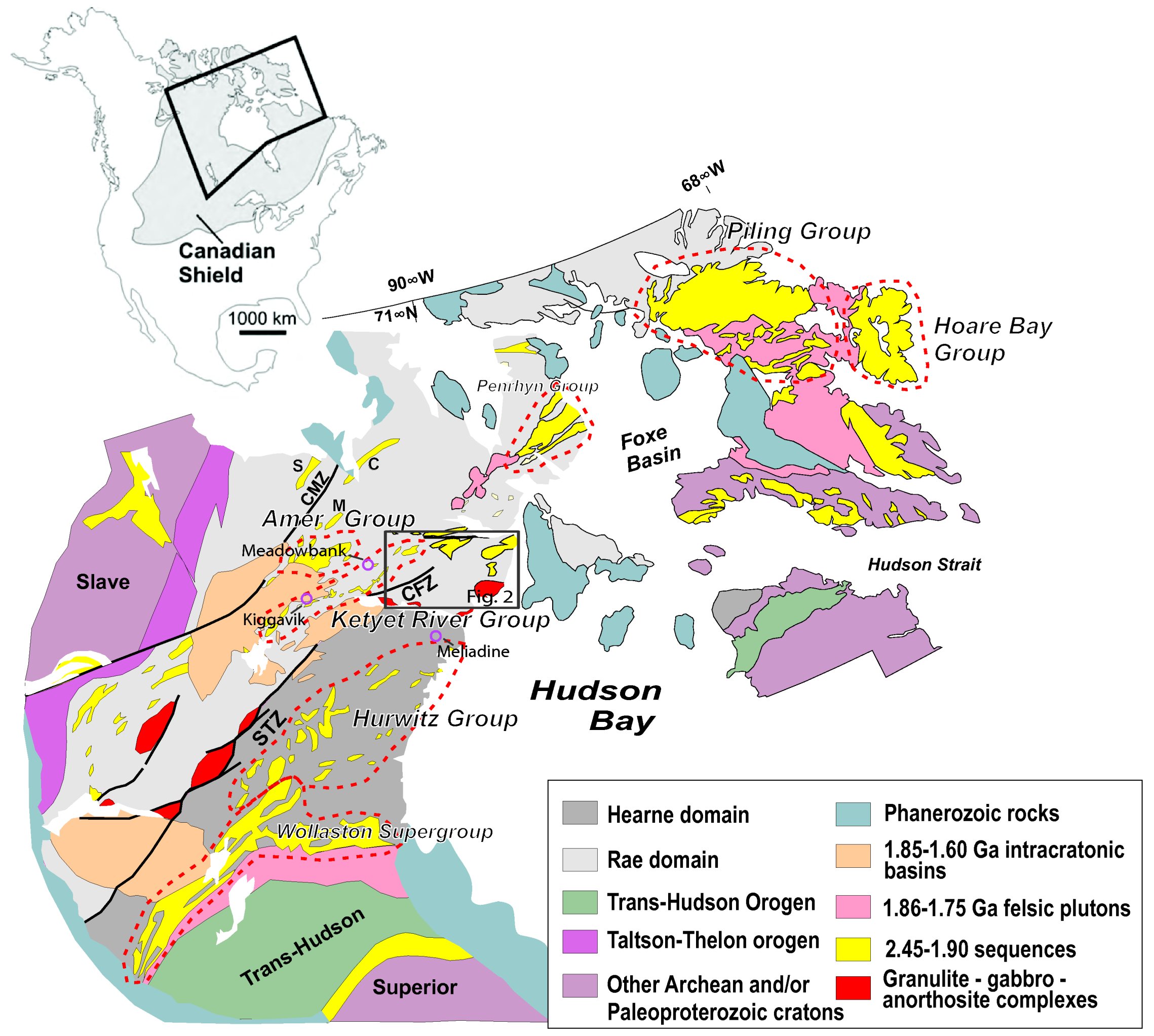
Ferderber, J.[1*], Kellett, D.A.[2], and Wodicka, N.[2]

[1] University of Ottawa: Department of Earth Sciences, 140 Louis-Pasteur, Ottawa, Ontario, [2] Geological Survey of Canada, 601 Booth Street, Ottawa, Ontario, [*] jessicaferderber@gmail.com.



Introduction

The Tehery region, situated between Chesterfield Inlet and Wager Bay, Nunavut (Figs. 1,2), is an area of the Rae craton that has been only superficially mapped. In the summer of 2012, new reconnaissance field mapping as part of the Geo-mapping Frontiers project of the Geological Survey of Canada (Geo-mapping for Energy and Minerals program) identified a number of supracrustal sequences. Regionally, supracrustal rocks of the Rae craton contain important commodities: Archean supracrustal rocks in the region host economic gold deposits (e.g. Meadowbank), and Proterozoic supracrustal rocks are exploration targets for base metals and uranium (e.g. Kiggavik; Fig. 1). This study compares two supracrustal packages in the Tehery region with better-studied sequences with the aim of better understanding the tectonic evolution of the Rae craton, as well as identifying the area's economic potential for future mineral exploration. Detrital zircon geochronology is used to characterize the provenance of supracrustal packages, as well as to constrain maximum deposition ages for the successions.



STZ= Snowbird Tectonic Zone   CFZ= Chesterfield Fault Zone   CMZ= Chantrey Mylonite Zone

Figure 1: Geology of the western Churchill Province and adjacent regions highlighting the location and regional distribution of the Paleoproterozoic cover sequences. Modified from Rainbird et al., 2010.

Background geology

The Tehery region (Fig. 2) within the Rae craton, is dominated by amphibolite- and higher-grade granitic gneiss and plutonic rocks, ranging in age from Archean to Paleoproterozoic. A folded supracrustal assemblage within the study area informally named the Armit Lake belt and composed of quartzite (12WGA-N047B01), amphibolite, marble, skarn-like bodies and metapelite, is potentially Paleoproterozoic in age (Wodicka et al., 2013). A separate package of supracrustal rocks in the northwest of the study area (informally named the Pennington Lake belt) is composed of a thick, white quartzite (12WGA-N029A02) that is overlain by a psammite to pelite succession. This package lies east and along strike from the Ketyet River Group, a previously-studied sequence composed of a thick succession of siliciclastic and mafic volcanic rocks (e.g. Rainbird et al., 2010).

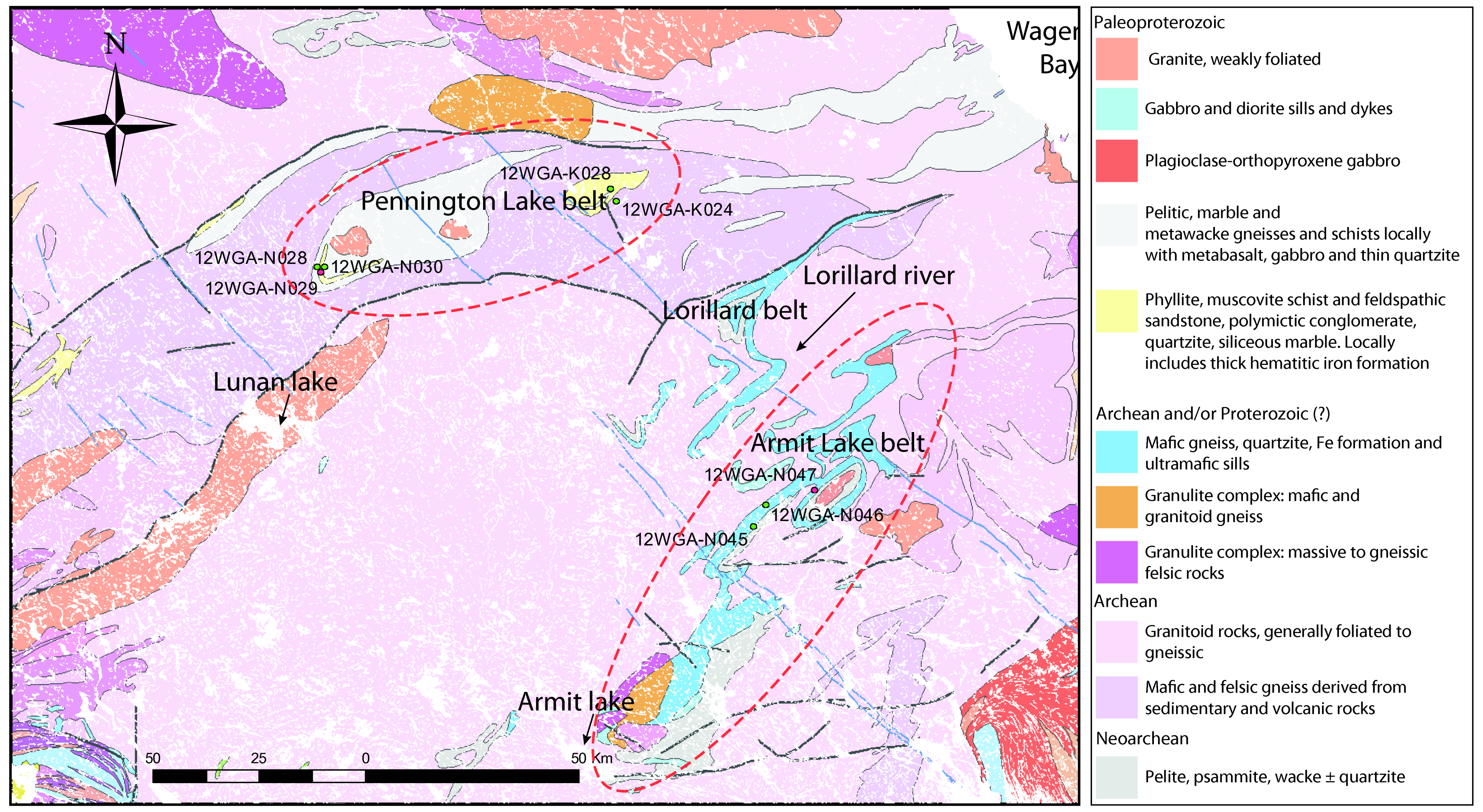
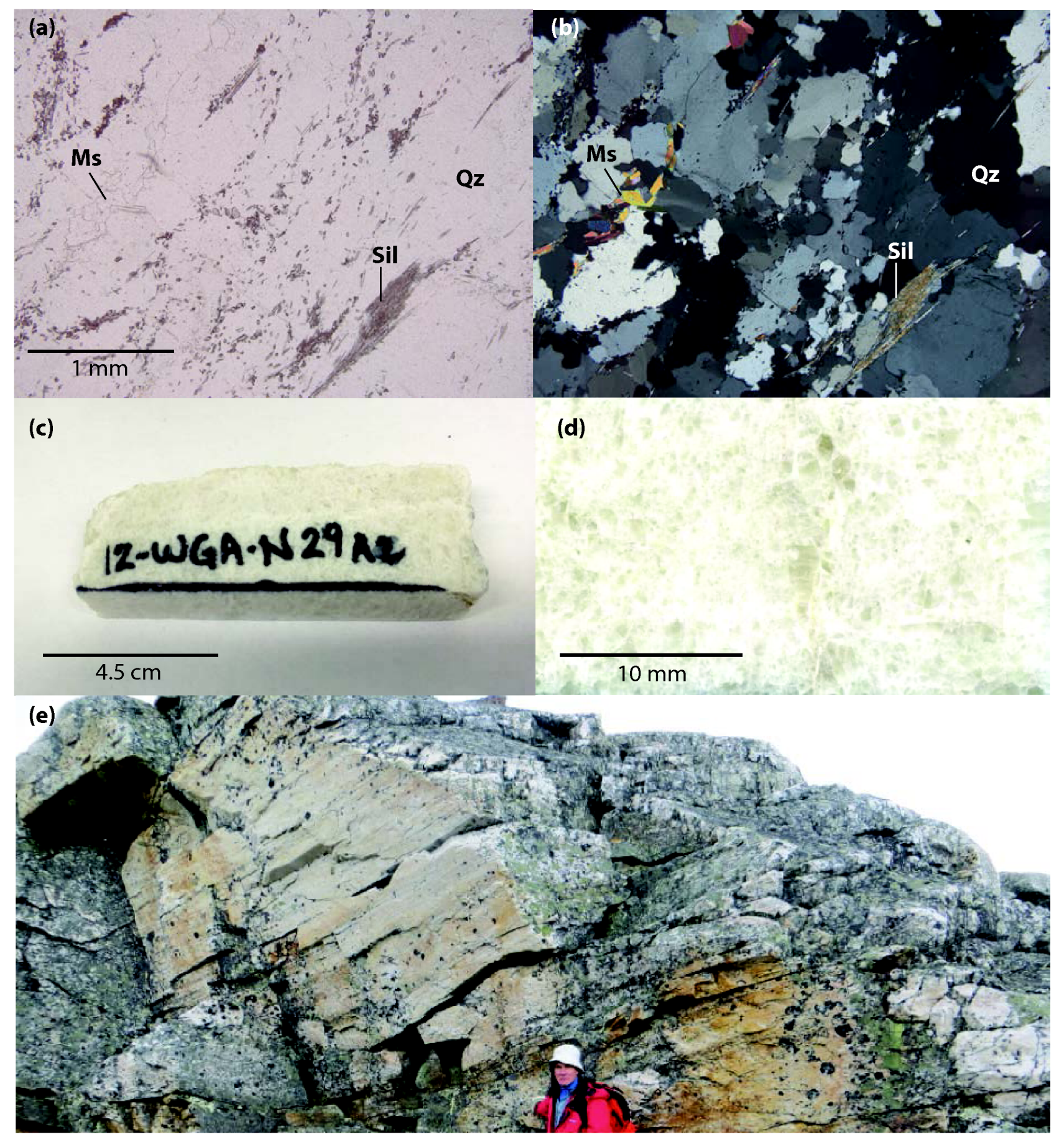


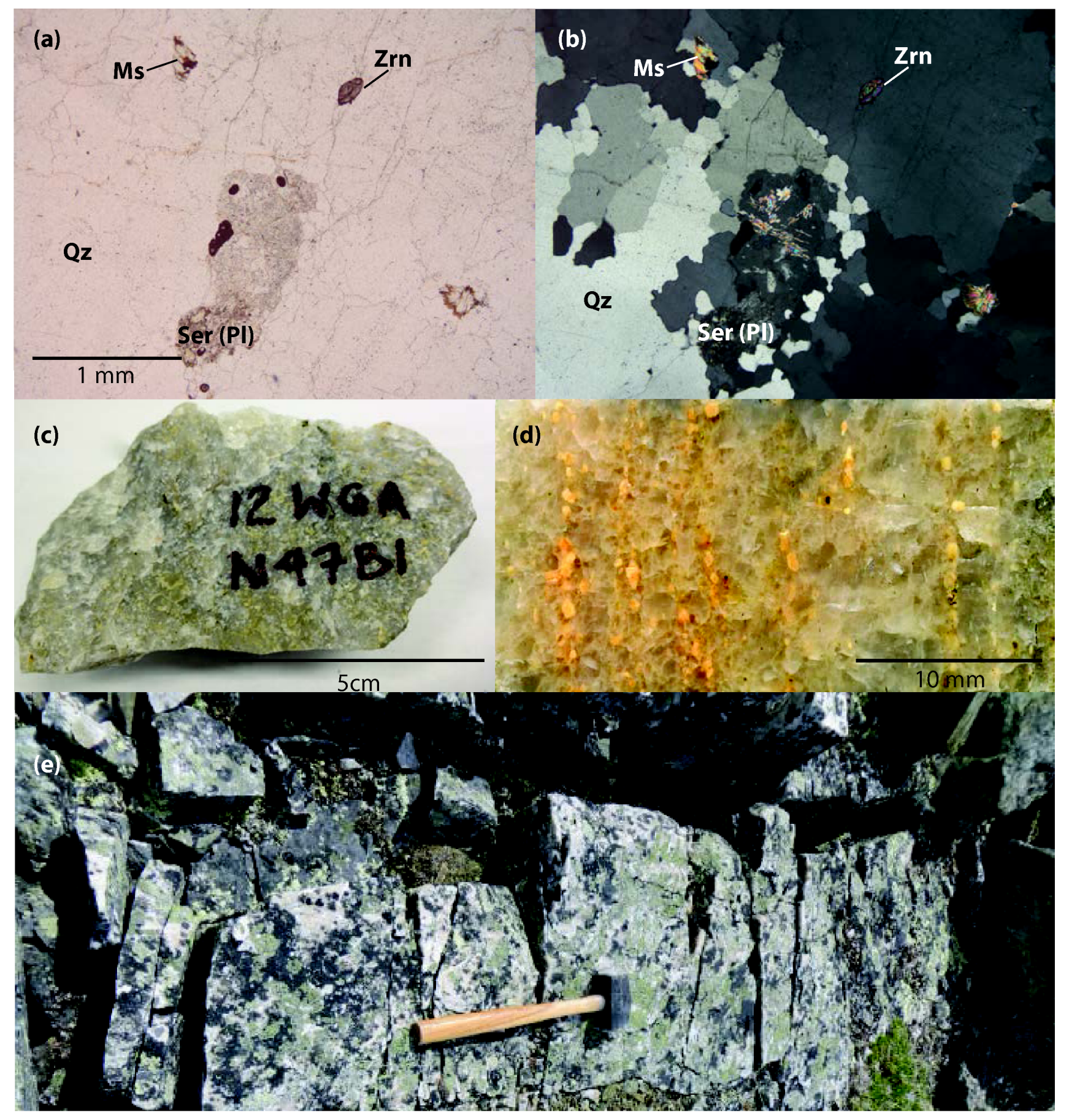
Figure 2: Remote predictive map for the Tehery region, displaying locations of samples from the Pennington Lake and Armit Lake (circled) supracrustal packages. Samples dated for detrital zircon are indicated in red. Modified from Skulski et al. (in prep).

PENNINGTON LAKE SAMPLE 12 WGA-N029A02



Sample 12WGA-N029A02 (a) under PPL (b) under XPL, (c) in hand sample, (d) as scanned thin section, (e) in outcrop. Amphibolite-facies sillimanite-bearing quartzite. Mineralogy includes quartz, sillimanite, muscovite and traces of rutile. Sillimanite shows pervasive fabric visible throughout the thin section. Grain boundary migration and sub-grain rotation recrystallization in quartz. Sandstone protolith.

ARMIT LAKE SAMPLE 12 WGA-N047B01



Sample 12WGA-N047B01 (a) under PPL (b) under XPL, (c) in hand sample, (d) as scanned thin section, (e) in outcrop. Quartzite, composed primarily of quartz with sericitized plagioclase, muscovite, zircon and interstitial hematite. Quartz displays grain boundary migration and sub-grain rotation recrystallization. Sandstone protolith.

Methodology

Two quartzite samples, 12-WGA-N029A02 and 12-WGA-N047B01 (Fig. 2 and above), were processed for detrital zircon geochronology. Standard separation techniques were performed, including the crushing and grinding of samples, separation using Wilfley table and heavy liquid techniques as well as separation by magnetic susceptibility using a Frantz isodynamic separator. Representative zircon populations were hand-picked from each sample, mounted on a grain mount and imaged using a scanning electron microscope (SEM). Both back-scattered electron and cathodoluminescence images were produced in order to examine the morphology and internal structure of the zircon grains and determine ideal spot placement for sensitive high-resoution ion microprobe (SHRIMP) analyses. ~60 analyses were performed on each sample and U-Pb isotopic age data produced. Complementary petrographic descriptions were completed for 13 thin sections from associated rocks in order to form a stratigraphic framework for the supracrustal packages (Ferderber, 2013).

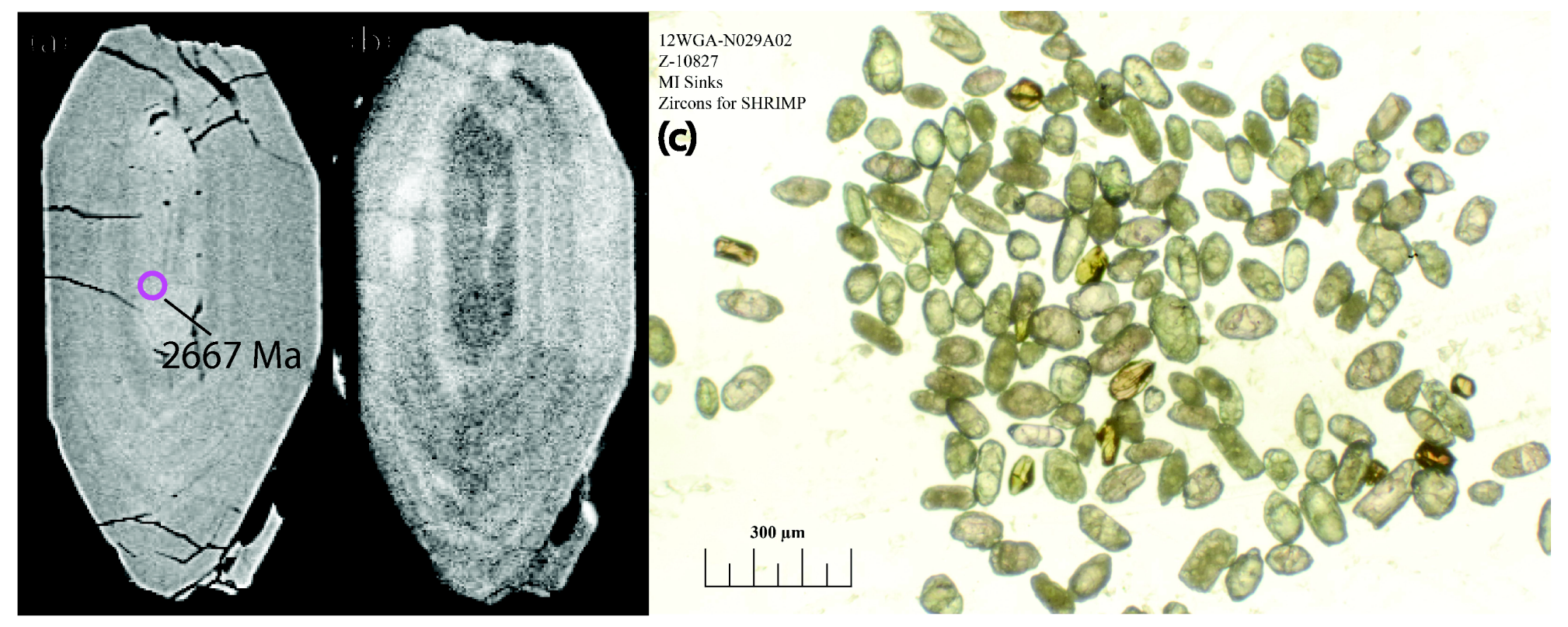


Figure 3: Zircon grain 12 from12-WGA-N029A02 (a) back scattered electron and (b) cathodoluminescence images produced by SEM (c) detrital zircon separate.

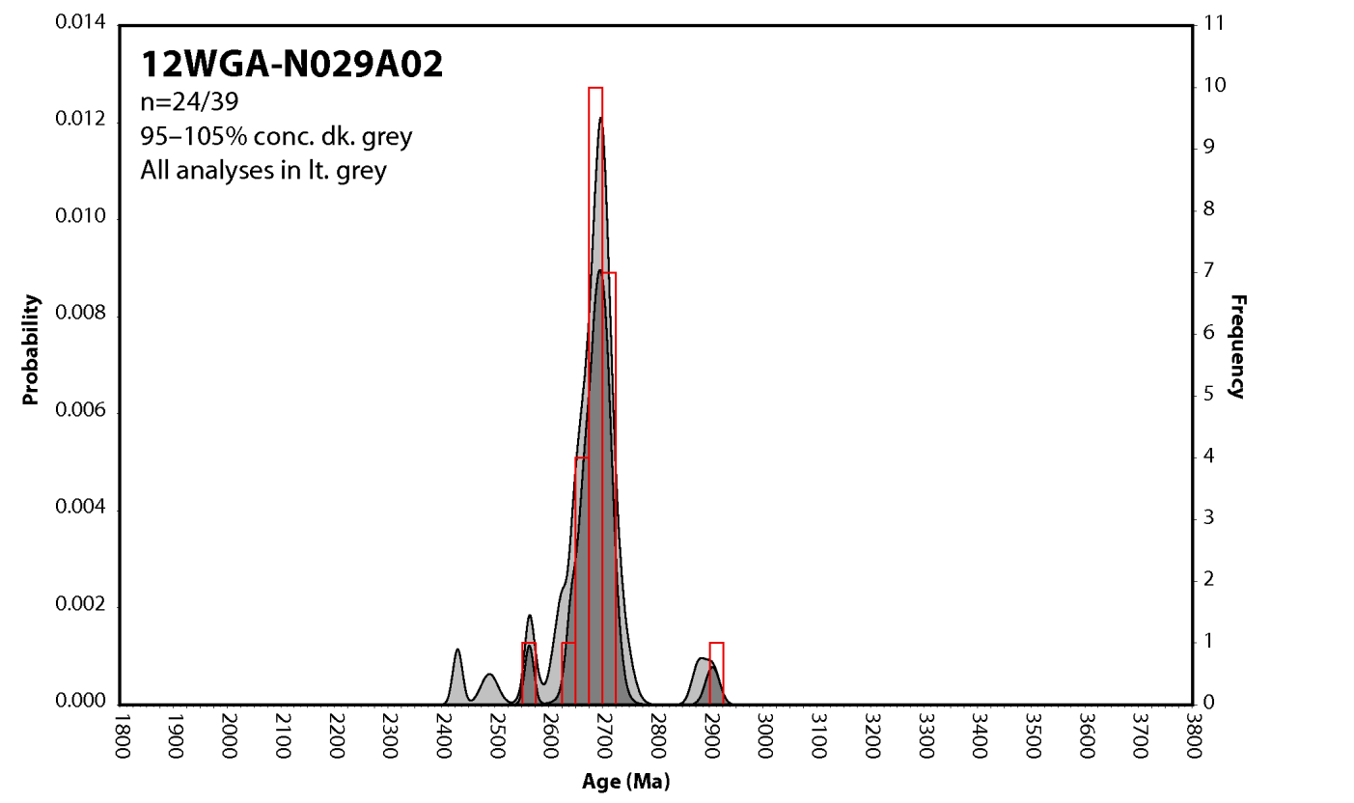


Figure 4: Sample 12WGA-N029A02 probability density plot showing U–Pb age distributions of detrital zircons

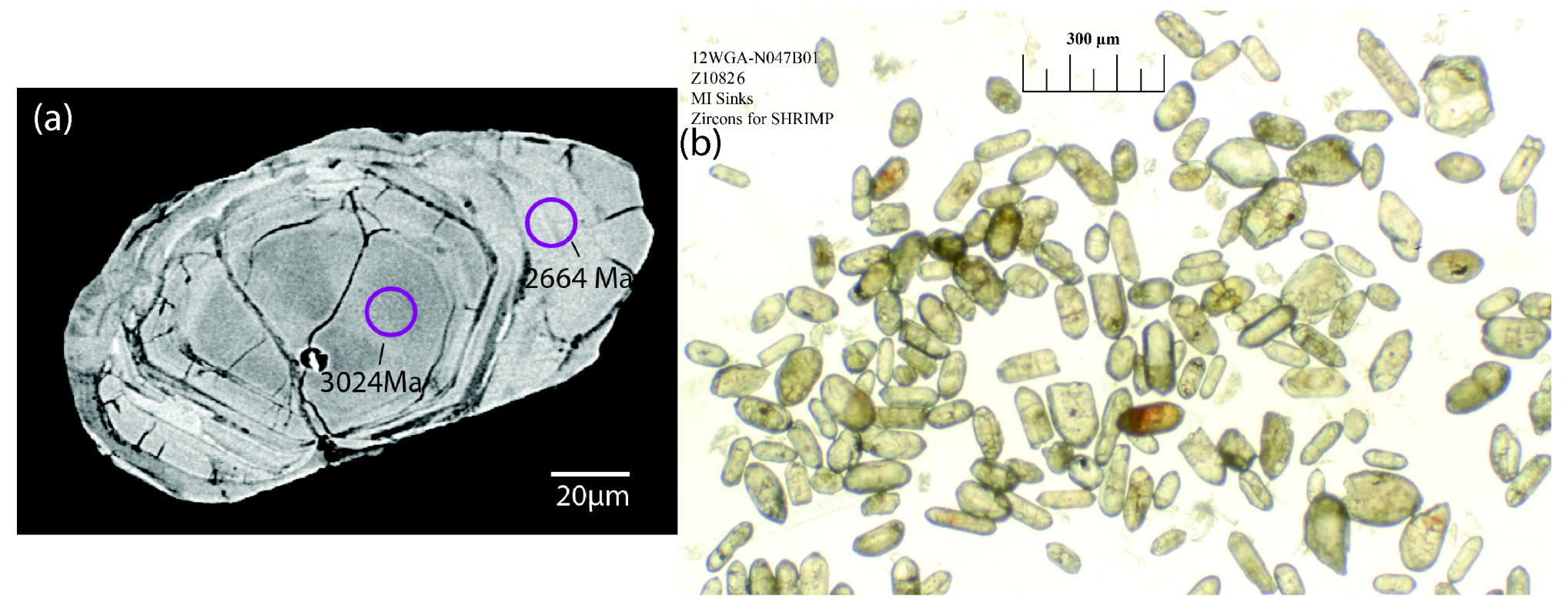


Figure 5: (a) Zircon grain 101 from 12-WGA-N047B01: back scattered electron image produced by SEM (b) detrital zircon separate.

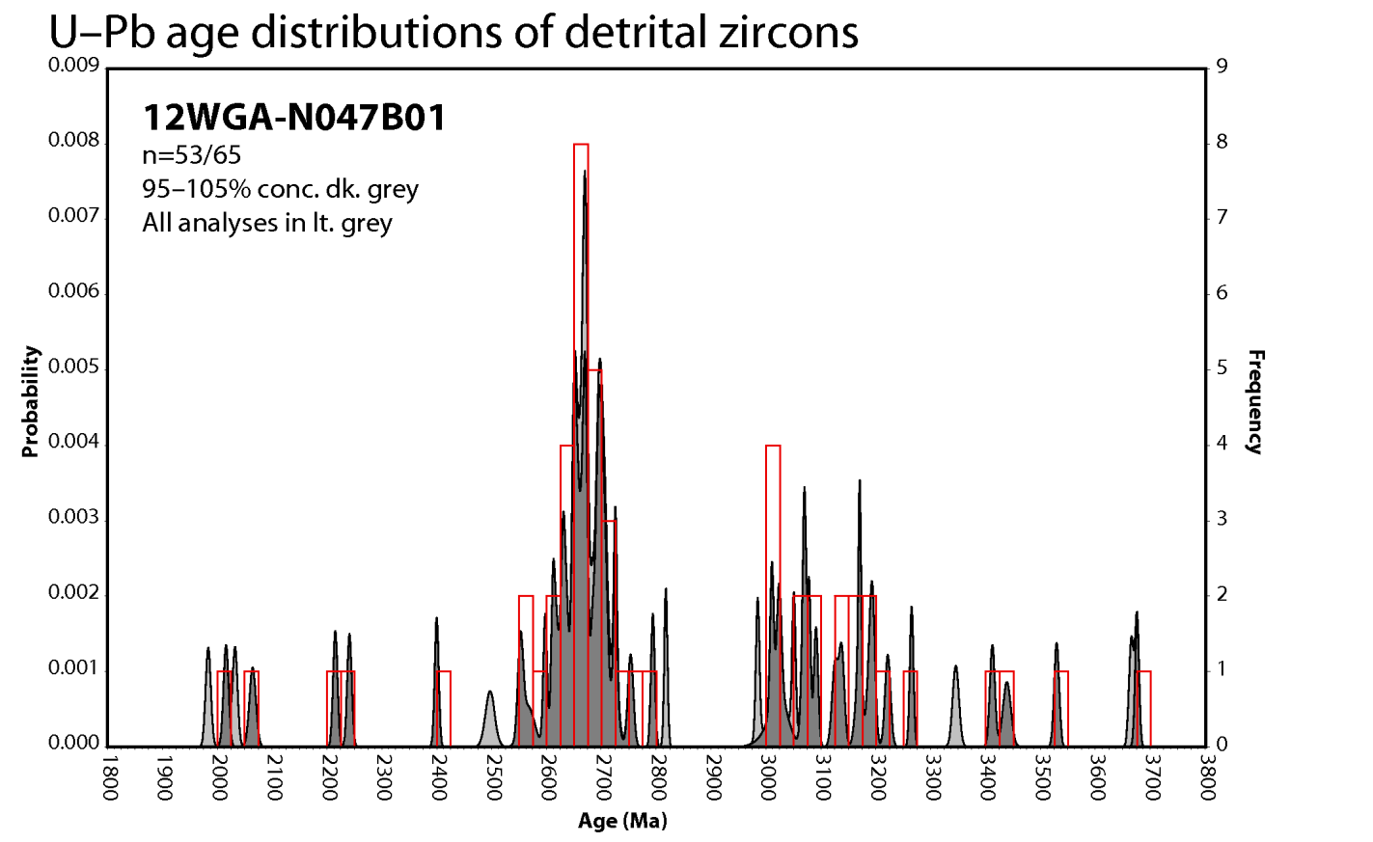


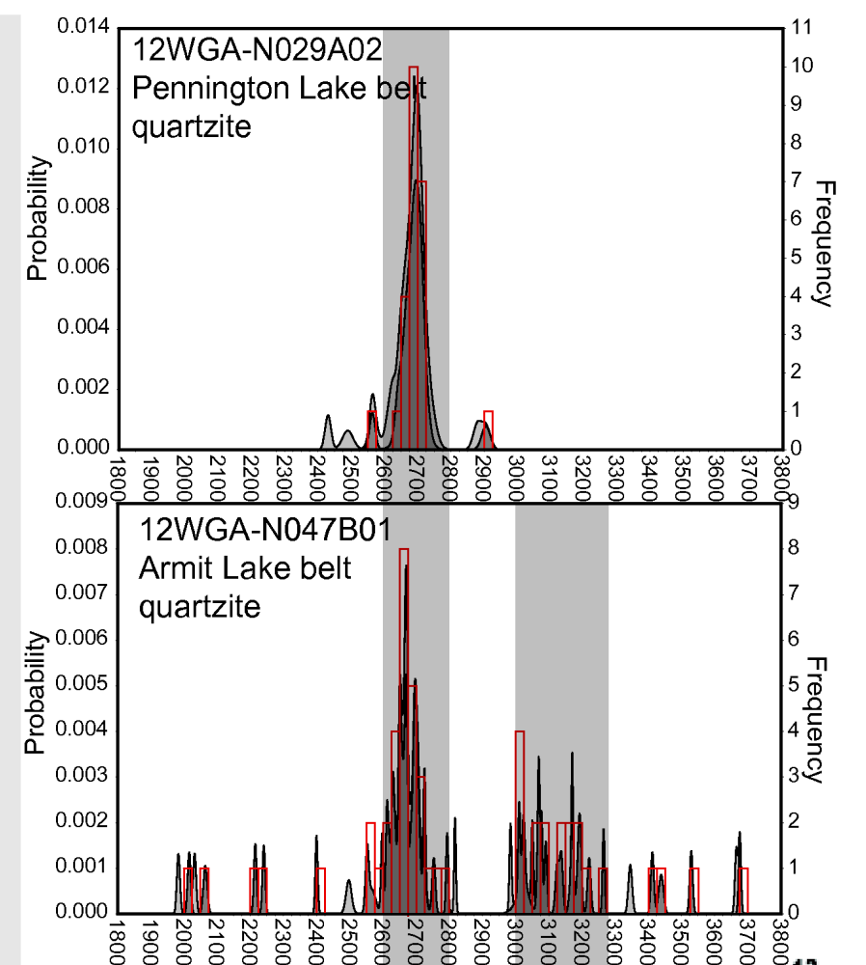
Figure 6: Sample 12WGA-N047B01 probability density plot showing U–Pb age distributions of detrital zircons

Results

Sample 12WGA-N029A02 displays a narrow range of zircon ages from ca. 2800-2600 Ma (Fig. 4). Though 54 analyses were performed, only 39 yielded acceptable results due to common Pb occurring within fractures of highly fragmented grains (e.g. Fig. 3). The age data from the most concordant of 39 analyses (24 in total) is sufficient to characterize the zircon population as having a prominent peak at ca. 2700 Ma (Fig. 4). Sample 12WGA-N047B01 yielded a much wider range of ages, from ca. 3700-2000 Ma, with the most statistically significant populations appearing at 2800-2550 Ma and 3250-3000 Ma (Fig. 6). Numerous zircon grains in this sample displayed core-rim textures visible by CL and back-scattered electron imaging (Fig. 5a).

Interpretation

The narrow range of detrital zircon ages for Pennington Lake quartzite 12WGA-N029A02 suggests that the zircon grains are of local provenance and derived from an igneous rock source. The detrital zircon age range is similar to that in quartz arenite from the lower succession of both the Ketyet River Group and the Amer Group (Ayagaq Lake Fm., Figs. 1, 9, 10). The zircon grains can be linked to the age of the extensive granitoid plutons that compose much of the study area (van Breemen et al., 2007; Wodicka et al., *in prep*). Based on concordant analyses of youngest zircon grains, the maximum possible age of deposition is 2.64 Ga. In contrast, the zircon population from Armit Lake sample 12WGA-N047B01 is polymodal, ranging from 3700-2000 Ma, indicating a more diverse provenance. Grains lacking core-rim relationships yielded Neoarchean ages, while core-rim paired analyses consistently indicate Paleo- to Mesoarchean cores mantled by Neoarchean rims. Paleo- to Mesoarchean zircon grainss are not well represented in the Amer or Ketyet River groups. One possible source for the older grains may be basement rocks east of Armit Lake - zircon from a basement rock yielded 3050 Ma cores and 2710 Ma rims (Wodicka et al., *in prep*), and model ages in the area are typically 3.3-3.0 Ga (van Breemen et al., 2007). The youngest ages from the Armit Lake sample were obtained from overgrowths with low Th concentrations and low Th/U ratios, which yielded non-reproducible ages spanning 2400-1980 Ma, interpreted as mixed ages. These rims may indicate a possible predepositional metamorphic event at ca. 1900 Ma, which implies deposition post 1900 Ma.



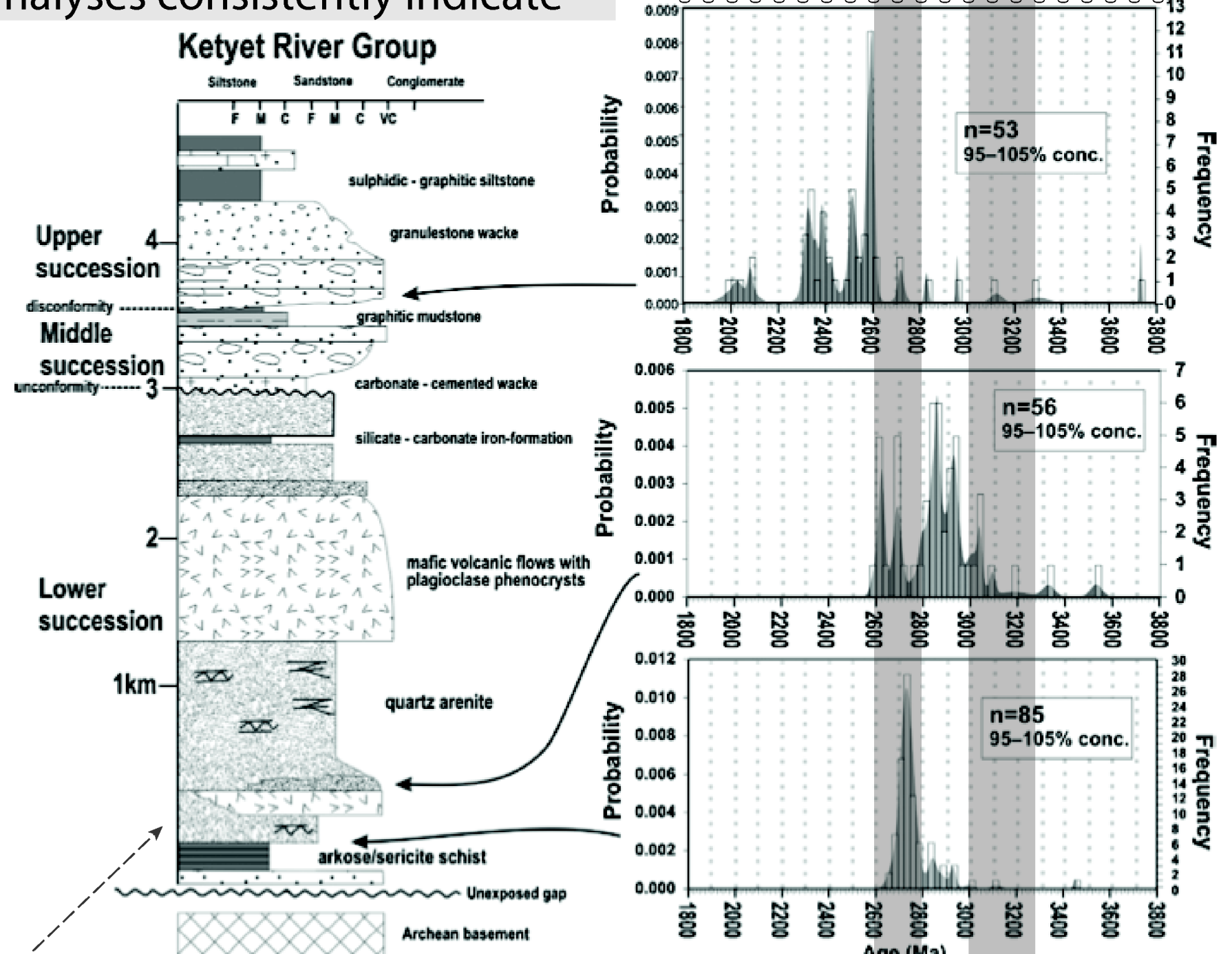


Figure 9: Generalized stratigraphy of the Ketyet River Group in the Ketyet Fold belt with probability density U–Pb age distributions for SHRIMP detrital zircon analyses (from Rainbird et al., 2010).

Figure 7: Outcrop photo of Pennington Lake quartzite 12WGA-N029A02

Figure 8: Outcrop photo of Armit Lake quartzite 12WGA-N047B01.

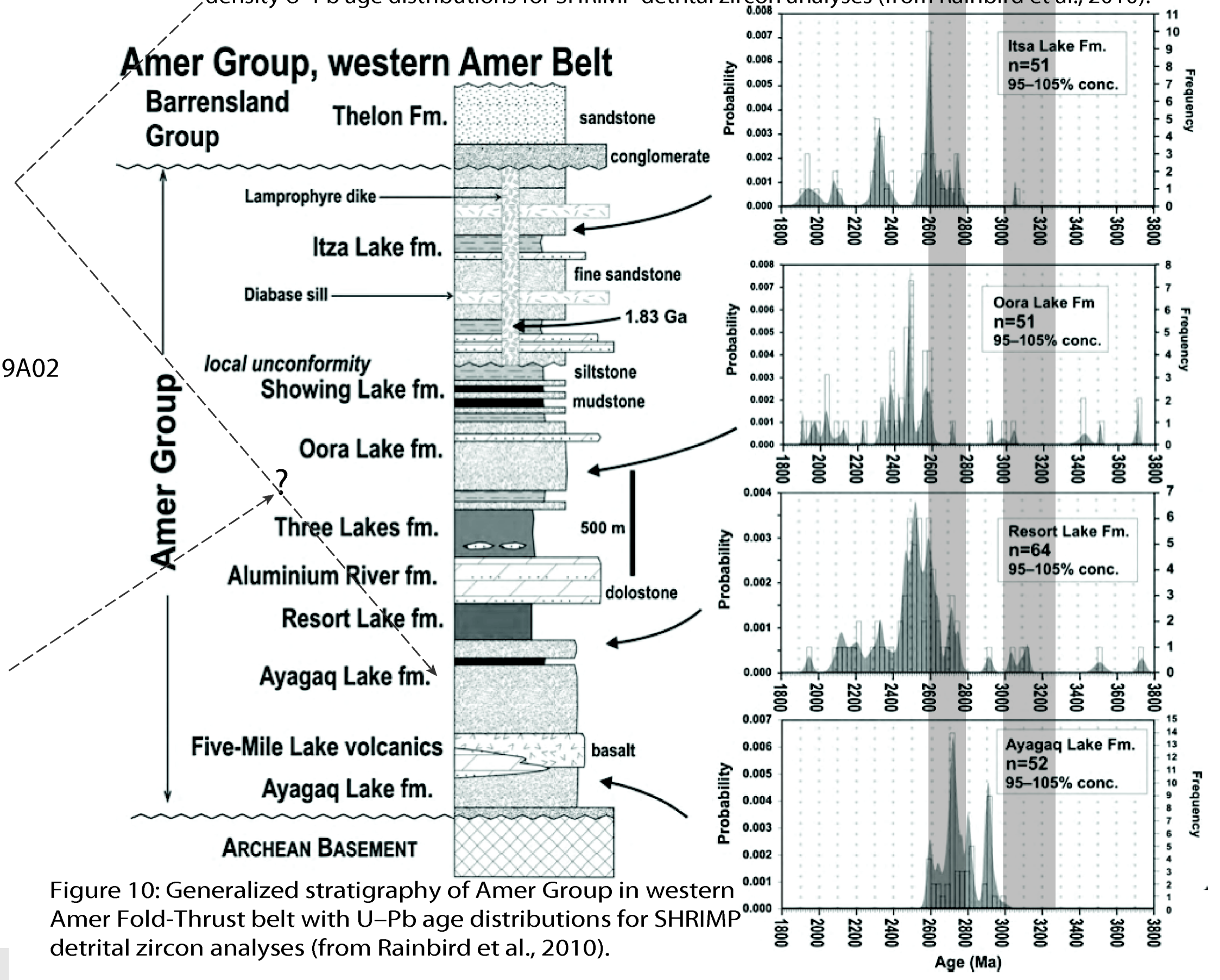


Figure 10: Generalized stratigraphy of Amer Group in western Amer Fold-Thrust belt with U–Pb age distributions for SHRIMP detrital zircon analyses (from Rainbird et al., 2010).

Conclusions

1. Both the Pennington Lake and Armit Lake supracrustal packages were likely deposited in the Paleoproterozoic.
2. Quartzite from both packages contain zircon similar in age to local Tehery region ca. 2.7 Ga basement rocks
3. Zircon from the Armit Lake belt sample also contains Paleo- to Mesoarchean cores that may have been sourced from east Tehery basement, although other, more distal sources are possible.
4. The Pennington Lake sample is similar in composition and age to basal quartzite of the Amer and Ketyet River groups, while the Armit Lake sample may not be a basal quartzite but a younger facies.
4. Both packages were deformed and metamorphosed to at least amphibolite facies following deposition, possibly post-1900 Ma, during the Trans-Hudson orogen.

References

Federber, J. (2013). Exploring the Tehery region: Correlating supracrustal sequences using detrital zircon geochronology, Rae craton, Nunavut. Unpublished BSc thesis, University of Ottawa.
Rainbird, R. , Davis, W., Pehrsson, S., Wodicka, N., Rayner, N. , and Skulski, T. (2010), Early Paleoproterozoic supracrustal assemblages of the Rae domain, Nunavut, Canada: Intracratonic basin development during supercontinent break-up and assembly.
Skulski, T., et al. (In prep.): Bedrock geology and regional synthesis of the north-central Rae domain, western Churchill Province, Nunavut, Canada.; Geological Survey of Canada, Open File 5577, 1:550,000 scale.
Wodicka, N., Whalen, J.B., Kellett, D., McMartin, I., Day, S., Percival, J.A., Buenviaje, R., Hillary, B., Girard, É., Joseph, J., and Bazor, D. (2013), Summary and highlights of 2012 activities in the Tehery area, Nunavut: a contribution to the Operation GEM project.
van Breemen, O., Perhsson, S., and Peterson, T. (2007). Reconnaissance U-Pb SHRIMP geochronology and Sm-Nd isotope analyses from the Tehery-Wager Bay gneiss domain, western Churchill Province, Nunavut. GSC Current Research. 2007-F2, 15 p.

Acknowledgments

Tom Pestaj, Bill Davis, Julie Peressini, Alexandre Zargorevski, Michelle English & Alexander MacKinnon

OPEN FILE
DOSSIER PUBLIC
7424
GEOLOGICAL SURVEY OF CANADA
COMMISSION GÉOLOGIQUE DU CANADA
2013

Recommended citation
Federber, J., Kellett, D.A., and Wodicka, N., 2013. Exploring the Tehery region: correlating supracrustal sequences using detrital zircon geochronlogy, Rae craton, Nunavut; Geological Survey of Canada, Open File 7424, poster. doi:10.4095/292709

Natural Resources Canada   Ressources naturelles Canada