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## REFINING THE HISTORY OF THE MATACHEWAN LIP EVENT AND SUBSEQUENT PALEOPROTEROZOIC ALTERATION EVENTS WITH HIGH-PRECISION U-Pb GEOCHRONOLOGY

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## **ABSTRACT**

The 2.49-2.44 Ga Matachewan Large Igneous Province (LIP) rifted the Z 375000m E Superior and Baltic cratons and formed the Huronian Supergroup basin. Distinct elements of this LIP include emplacement of the Matachewan dike swarm, mafic layered intrusions of the East Bull Lake intrusive suite, and eruption of several mafic and bimodal volcanic sequences

In spring 2015, International Montoro Resources Inc. drilled 2 deep (PDH-1:996m and PDH-2:1317m) drill holes through the lower Huronian Supergroup into a 3.5km x 1.5km aeromagnetic high (Pecors Magnetic anomaly) located ~15km east of Elliot Lake. Both drill holes intersected a medium-grained, homogeneous, non-layered gabbro intrusion >680m thick. The entire intrusion is altered to an albite-epidote-chlorite rock with large (~1 mm) titanite grains. Macroscopic examination of the drill core was unable to relate the gabbro to any Matachewan LIP rock or

Nipissing intrusion (ca. 2.2 Ga). Small (<30µm) baddeleyite grains rimmed by zircon found in samples from the upper 50m of drill hole PDH-1 were selected for U-Pb analysis. All 7 analyzed baddeleyite grains define an age of 2475±14 Ma, with the 4 most concordant data giving an age of 2480±5 Ma. The data indicate a significant Pb loss event after ca. 1.8 Ga; perhaps as young as ca. 1 Ga. These data indicate that the gabbro is part of the Matachewan LIP, and geochemical analyses of the gabbro indicate a near identical chemistry to the Matachewan dikes, not the East Bull Lake intrusive suite.

To better constrain the timing of the alteration event that affected the gabbro, an albitite dike that cuts the Matinenda Formation (Huronian Supergroup) above the roof of the intrusion, was also studied. Zircons from the dike are ca. 2660 Ma, consistent with inheritance from the host Matinenda Formation. A near-concordant monazite grain is 1966±18 Ma, with 3 other grains defining a Pb loss line towards 0 Ma. The 1.966 Ga age does not correspond to any known regional event, whereas the circa 1.8 Ga time of Pb loss in the gabbro is coincident with the peak of the Penokean orogeny (ca. 1.835 Ga) and the Sudbury impact event (1.85 Ga). The U-Pb and geochemical data indicate that the gabbro is a subsurface magma chamber for part of the Matachewan dike swarm. More work is needed to better constrain the post-emplacement alteration history of the intrusion and adjacent rocks.

## ACKNOWLEDGMENTS

International Montoro Resources Inc., D.R. Hawke and D. Patrie are thanked for allowing access to drill core for observations and sampling. D.R. Hawke assisted in the collection of the geochronology sample from diamonddrill hole P15-22 (PDH-1). S.A. Clarke and D.C. Crabtree of the OGS Geoscience Laboratories, Sudbury, assisted in the acquisition of SEM imagery.

The senior author first met Sam Bowring in the Wopmay Orogen in July 1979 when Sam was just beginning his PhD studies. I remember specifically having a discussion regarding some rocks that I had seen that were worth geochronological study — this discussion eventually led to Sam sampling what turned out to be the Actasa gneiss, which yielded the oldest U-Pb ages in North America. This was my first real introduction to U-Pb geochronology, and Sam's work served to inspire a life-long interest in the subject. Although we never had the opportunity to collaborate directly on a project together, I always followed Sam's work with great interest.

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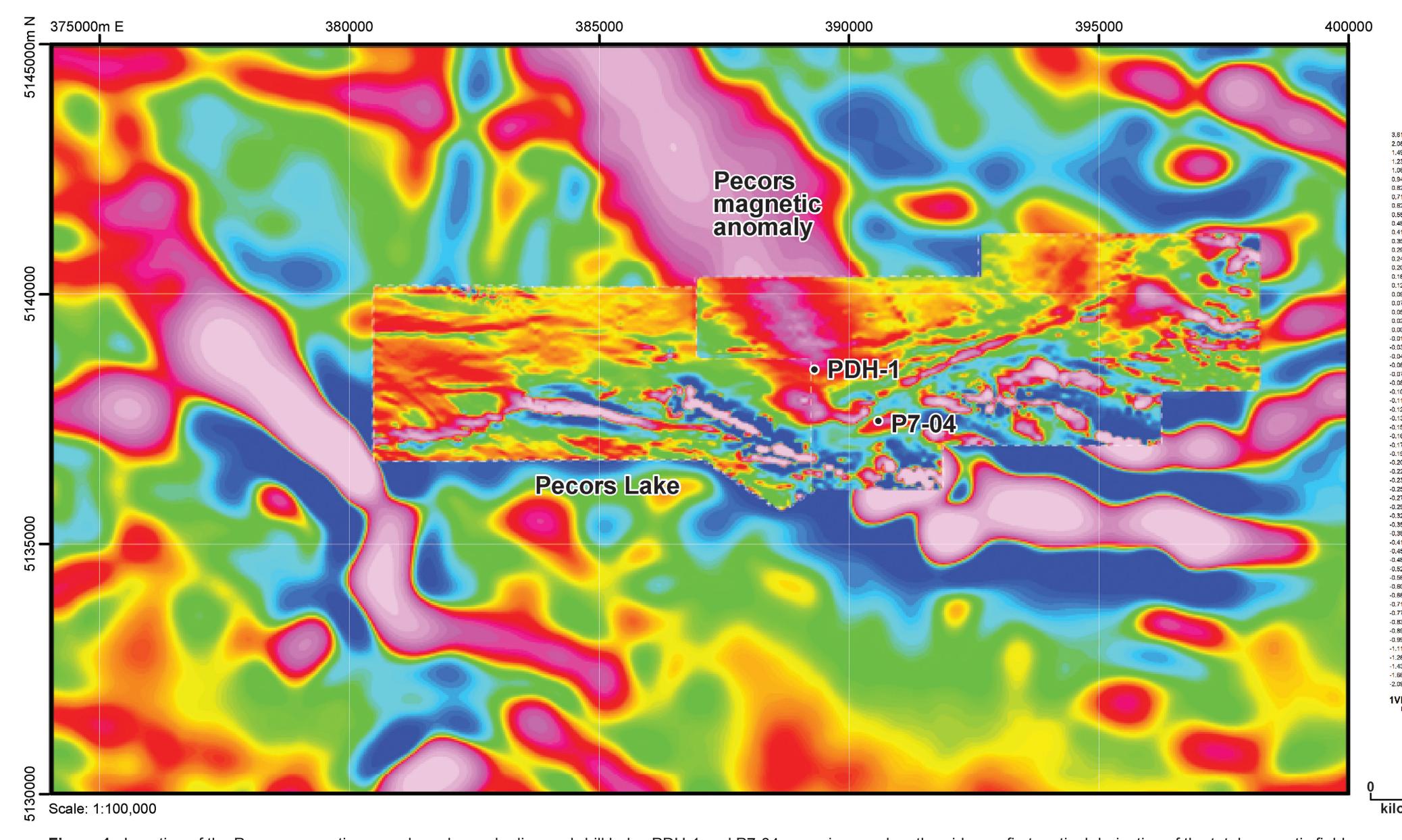
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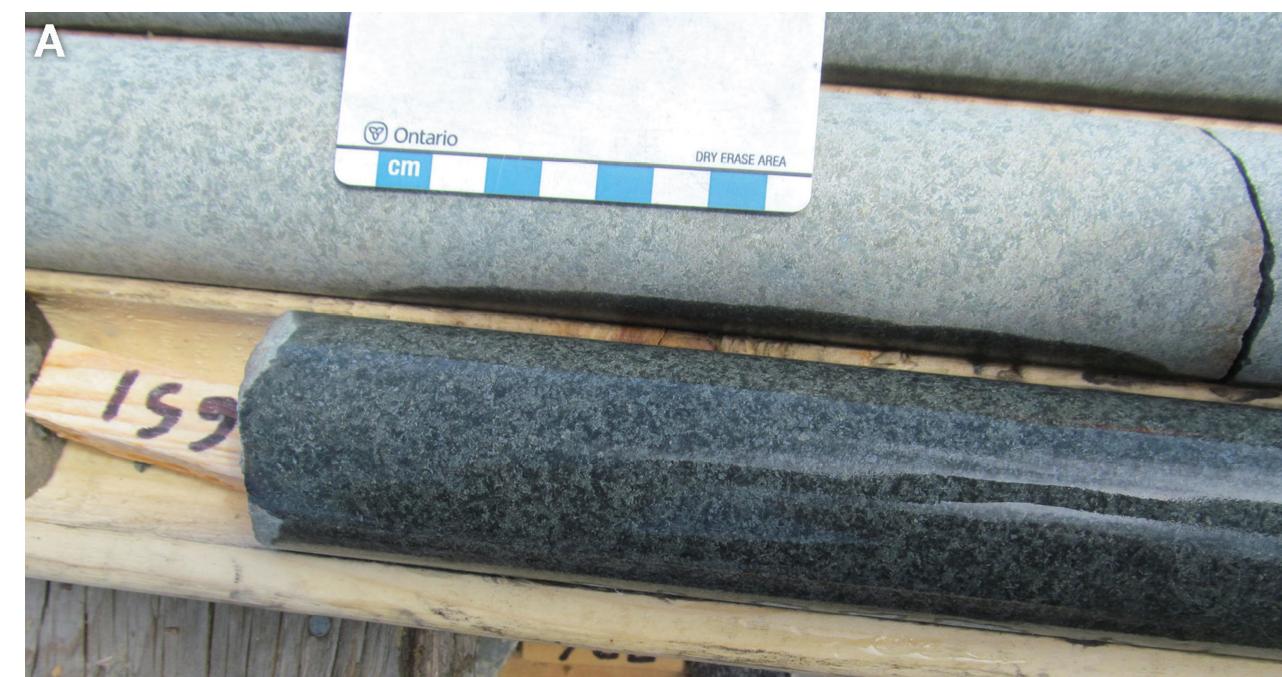
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## GEOLOGICAL SETTING AND SAMPLE CHARACTERISTICS



- Pecors magnetic anomaly (Figure 1) is underlain by a large gabbro intrusion which was subjected to a deep diamond drilling program by International Montoro Resources Inc, in the spring of 2014.
- Intrusion is greater than 680 m thick, variably magnetic, and is overlain by several hundred metres of Huronian Supergroup metasedimentary rocks.
- The gabbro itself is medium-grained, homogeneous, non-layered gabbro intrusion (Photo 1A). In thin section, it is apparent that the entire intrusion is altered to an albite-epidote-chlorite rock.





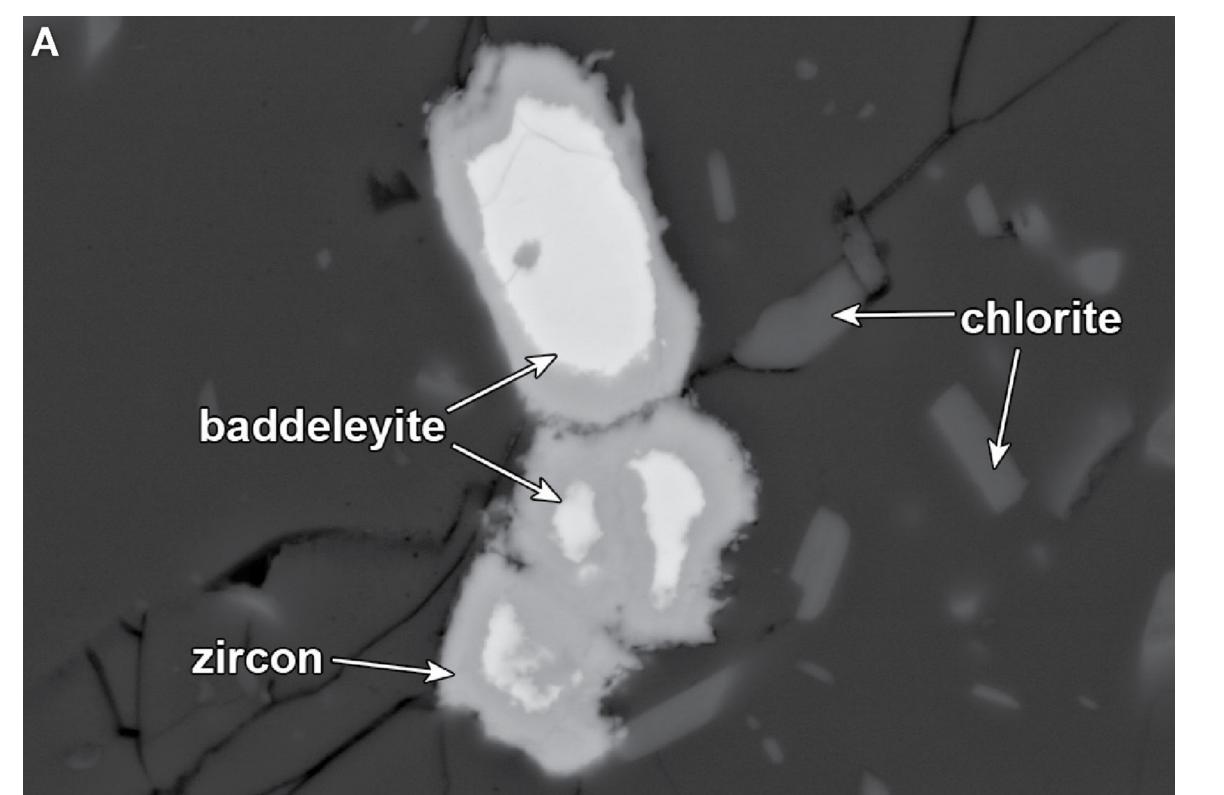
section sampled for geochronology. B) Close-up view of albitite sample 15RME-8003 from diamond-drill hole P7-04.

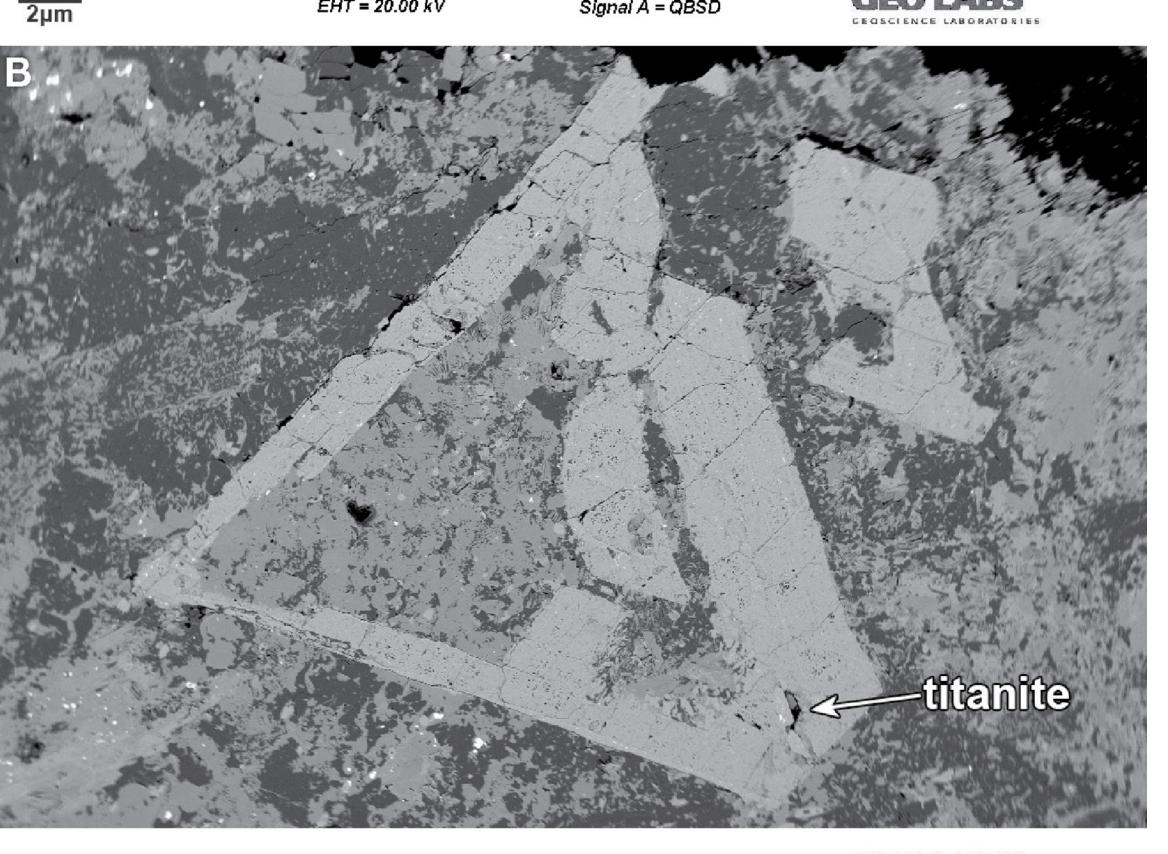
Photo 1. A) Close-up view of diamond-drill core from PDH-1 showing texture in gabbro (wet and dry) from part of

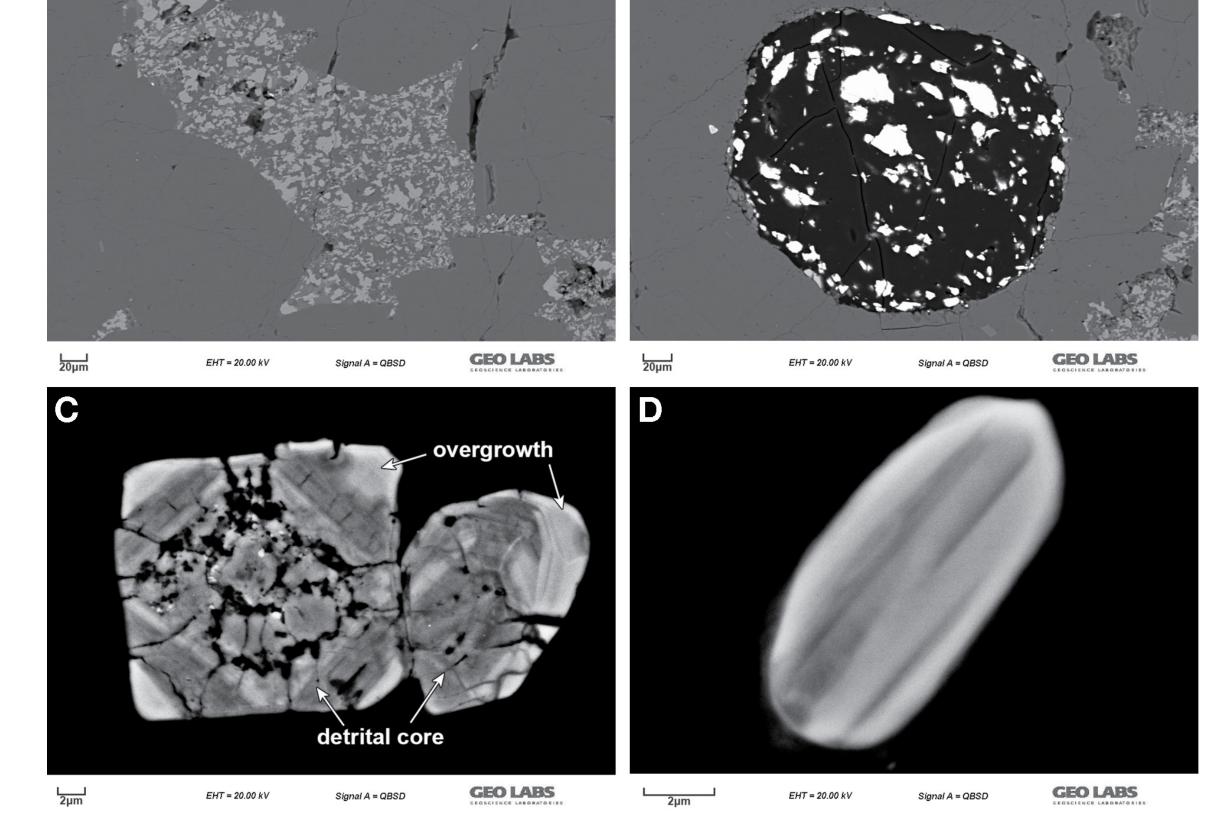
## Small baddelevite grains (10 to 3 microns) (Photo 2A) were only found in samples from the upper 75 m of the

 Geochemistry on the metagabbro indicates it is most similar to dikes of the Matachewandikeswarm (Figure 2A, see also Easton 2015). The Matachewan dike swarm was emplaced at circa 2460 Ma (Bleeker et al. 2015), but has an age range from 2473 to 2443 Ma (Heaman

- Aplite dikes (Photo 1B) cut Matinenda Formation sandstones above the gabbro intrusion that defines the Pecors magnetic anomaly.
- Aplite dikes consist almost entirely of albite, with minor quartz and rutilequartz aggregates (Photo 3A).
- The aplite dikes contain pyrobitumen (Photo 3B).
- The rare earth element patterns of the aplite dikes (Figure 3B) are atypical of any felsic magma, and sugges that the albitite veins are of probable hydrothermal origin.







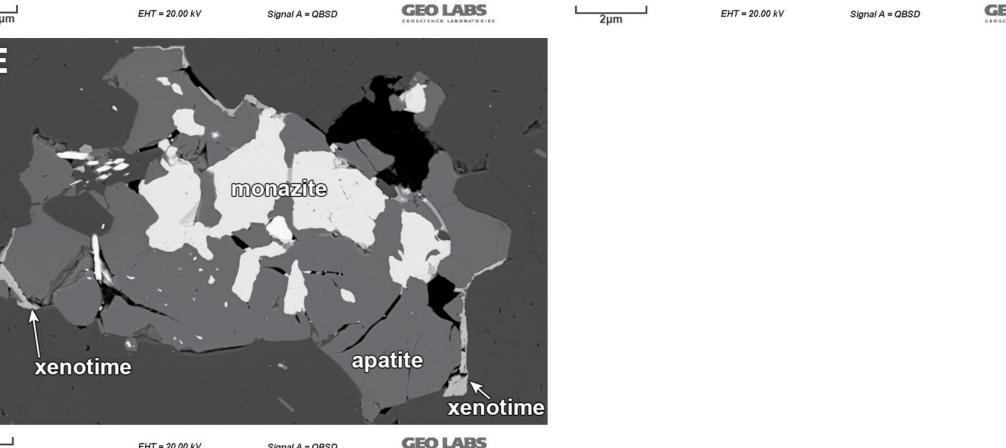
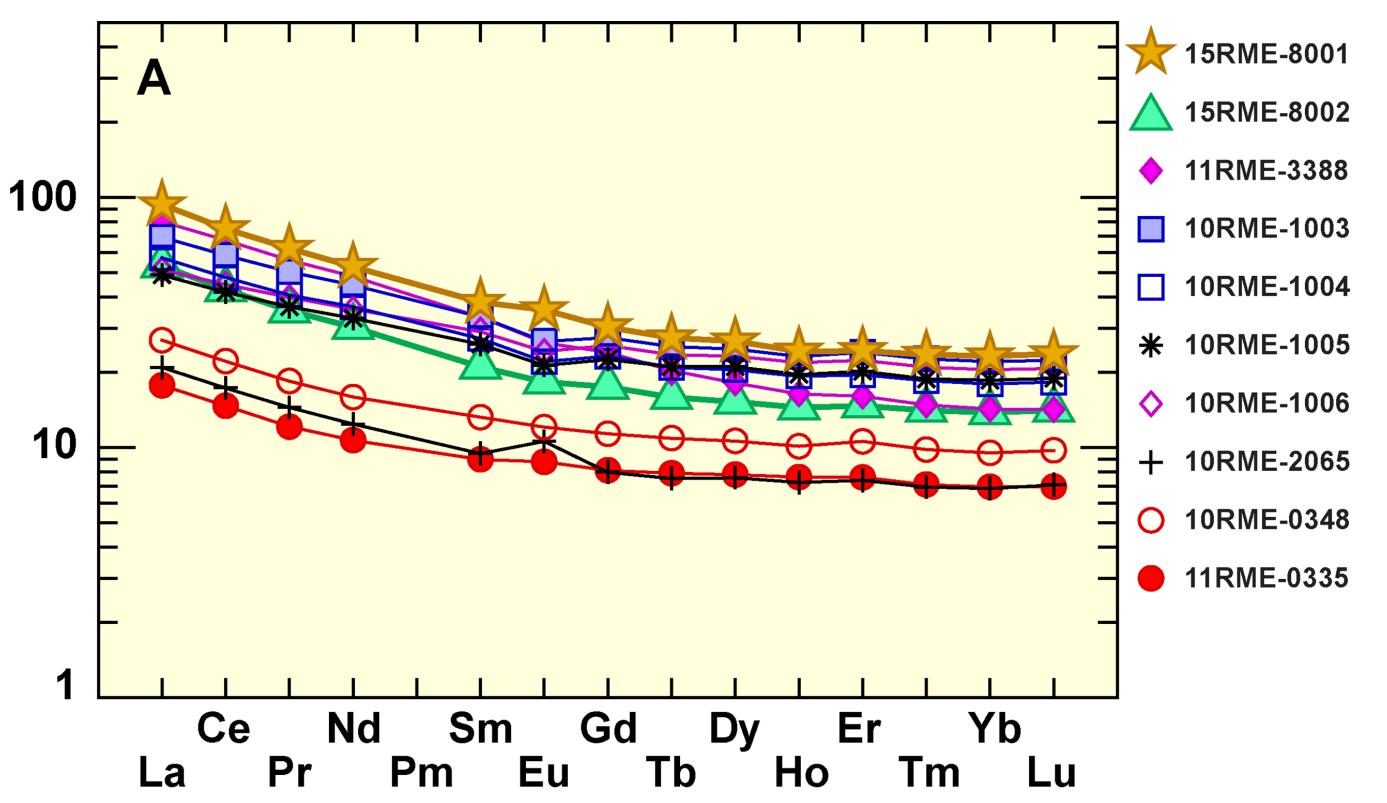
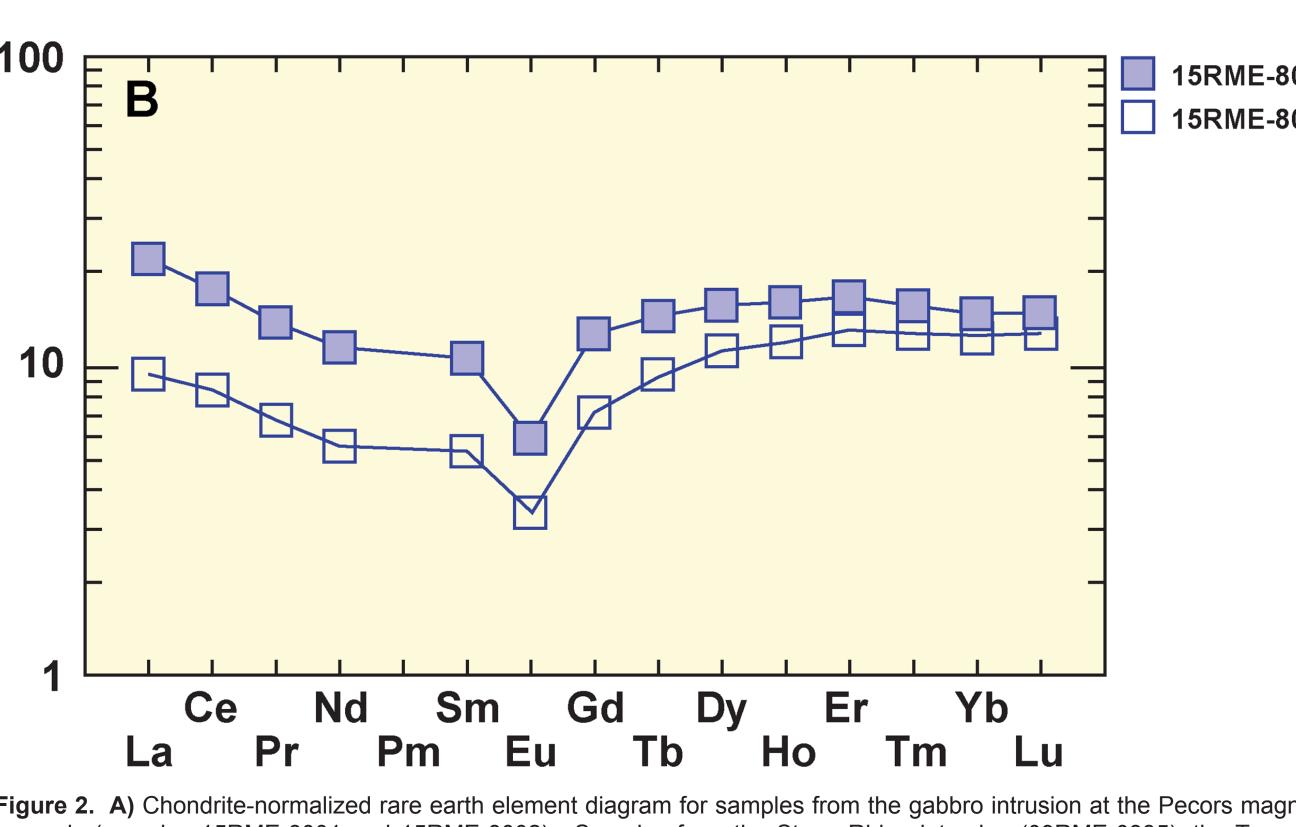


Photo 3. Backscattered electron images of minerals in diamond-drill core P07-04. All images are from sample 15RME-8003, except for image B, which is from 15RME-8004. A) Intergrown quartz and rutile surrounded by albite. B) Sphere of thucholite in sample 15RME-8004. Dark material is hydrocarbon. Light materials are uranium and thorium mixtures. C) Zircon grain with a rounded core (detrital grain) rimmed by zirco overgrowth. D) Euhedral zircon grain that may have formed during emplacement of the aplite vein. E) Apatite high tension; kV, kilovolts; QBSD, quadrant backscatter detector.



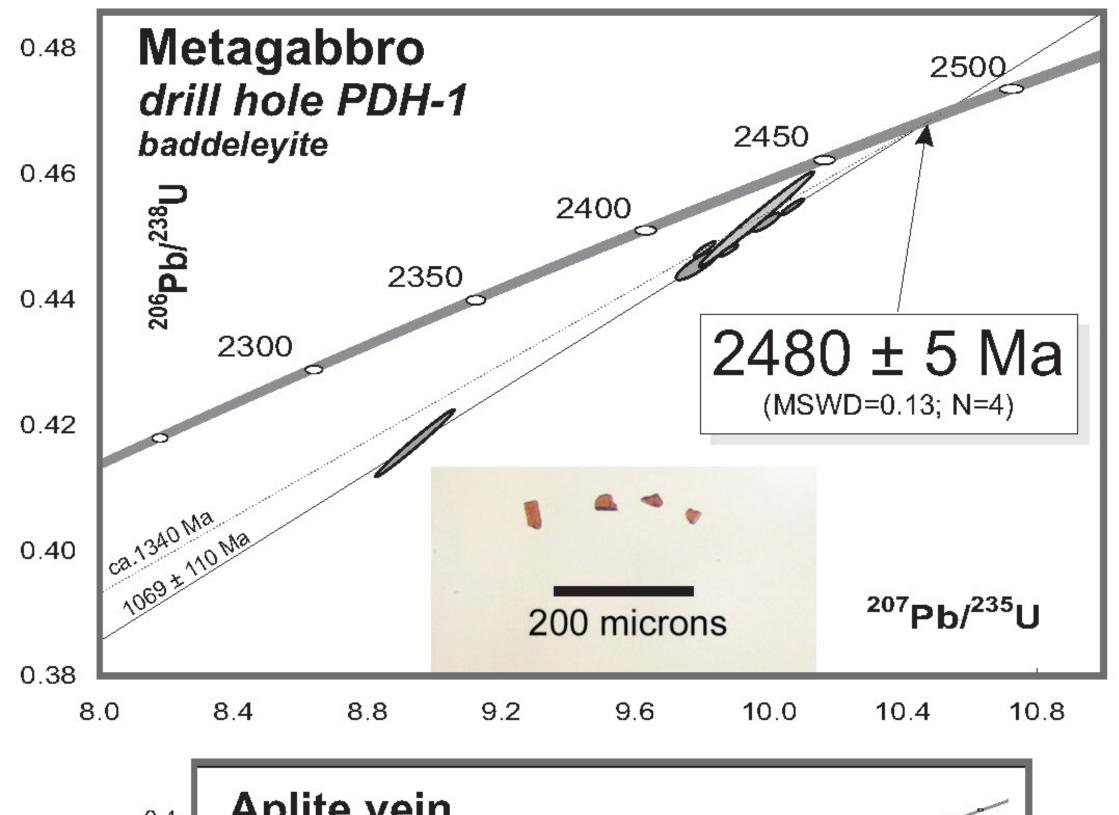


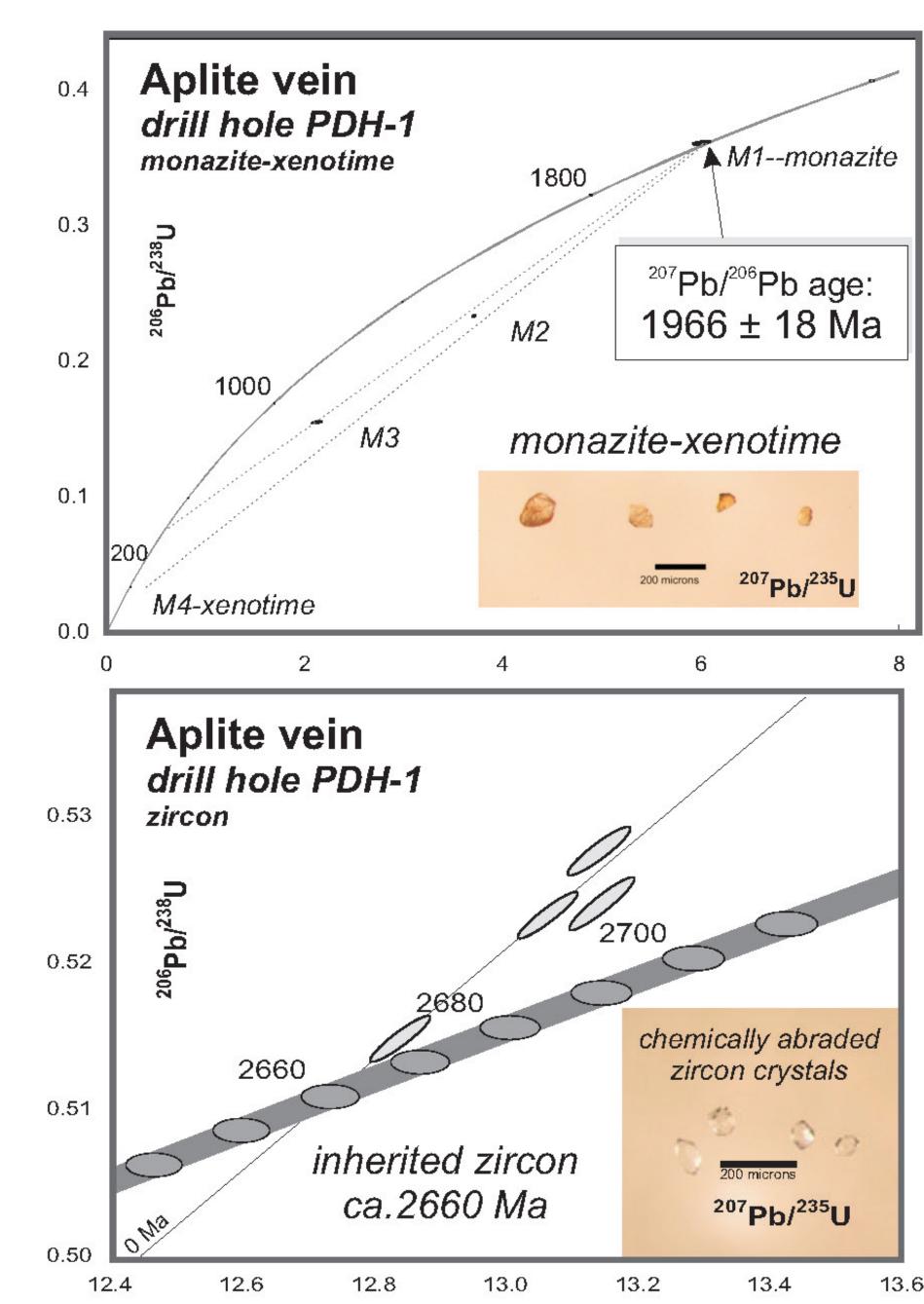
atinenda Formation proximal to the Pecors magnetic anomaly. Data are from Easton (2015). Both diagrams use the normalizing

# 2510 to 2440 Ma Mafic Igneous Activity Extent of mainly Karelia 2470-2510 Ma Wyoming

arelian cratons. Note the possible presence of an older, broader belt of activity, and a younger, centralized belt of activity. Modified from Heaman (1997).

## U-Pb GEOCHRONOLOGY





notime grains from sample 15 RMF-8004 diamond-drill core P07-04 aplite vein Lower) Concordia for inherited zircon grains from sample 15 RME-8004, diamond-drill core P07-04, aplite vein.

### Metagabbro

- All 7 analyzed baddeleyite grains define an age of 2475±14 Ma (Photo 2A, Figure 4 upper)
- The 4 most concordant data giving an age of 2480±5 Ma (Figure 4 upper)
- The data indicate a significant Pb loss event after circa 1.8 Ga (Penokean); perhaps as young as circa 1 Ga (Grenvillian) (Figure 4 upper)

- Zircons from the dike are circa 2660 Ma, consistent with inheritance from the host Matinenda Formation. (Photo 3C, 3D, Figure 4 lower)
- A near-concordant monazite grain is 1966±18 Ma, with 3 other grains defining a Pb loss line towards 0 Ma (Figure 4 middle). Phosphate phases in the sample are intimately intergrown (Photo 3E)
- The 1.966 Ga age does not correspond to any known regional event, whereas the circa 1.8 Ga time of Pb loss in the gabbro is coincident with the peak of the Penokean orogeny (circa 1.835 Ga)

## REFERENCES