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Introduction

The Geo-Mapping Frontiers project was initiated in 2011 within the Geomapping for Energy and Minerals (GEM) 2008-2013 program to improve the geological understanding of some of the more remote and poorly understood regions of Canada's north. The Chantrey area (Figure 1), mostly within the Kitikmeot region of western Nunavut (parts of NTS million sheets 76 , 66, and 56) was one of the areas targeted (Figure 1). Initial geochronological results for samples from the GSC archival collection were published in Davis et al. (2013). This report presents U-Pb zircon geochronological results for a regional sample suite collected during helicopter reconnaissance visits in the summer of 2012.

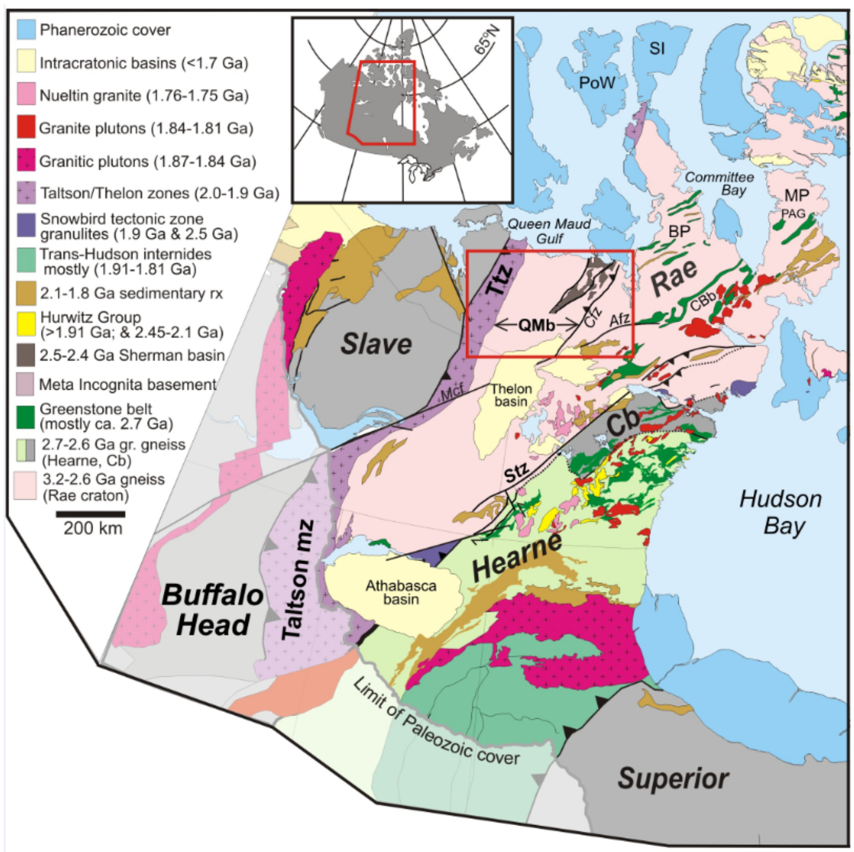

Figure 1: Regional geological map of northwest Laurentia. Area of Figure 2 highlighted by red box. Abbreviations: Afz = Amer fault zone, BP = Boothia Peninsula, Cb = Chesterfield block, Cfz = Chantrey fault zone, Mcf = Macdonald fault, MP = Melville Penisula, PAG - Prince Albert Group, PoW = Prince of Wales Island, QMb = Queen Maud block, SI = Somerset Island, Stz = Snowbird tectonic zone, Ttz = Thelon tectonic zone.

U-Pb zircon ages are reported for seventeen samples collected along an east-west transect (Figure 2) across the Thelon tectonic zone, Queen Maud block, and the adjacent Rae craton (Hoffman, 1988). The locations of samples are shown in Figure 2 and a summary of age results is presented in Table 1. Sample information and the presentation and interpretation of the U-Pb data are provided for each individual sample in the following sections. The U-Pb analytical data are presented in Appendix 1.

Geological Setting

The study area includes components of three principal crustal domains, the Thelon tectonic zone (Ttz), the Queen Maud block, and the Rae craton (Figure 1). The Queen Maud block is further subdivided into the metasedimenary rock dominated Sherman basin (Sb), the Queen Maud granitoid belt (QMg) and the Mesoarchean domain (Md).

Thelon tectonic zone:

Thelon tectonic zone (TTZ; Figure 1) comprises a series of pronounced, NNE-striking magnetic anomalies that extend ~500 km from the MacDonald fault to Queen Maud Gulf, and appear to continue northward to Prince of Wales Island. The similarities in magnetic fabrics and age of plutonic rocks suggest that the TTZ may have continuity with the Taltson magmatic zone south of the MacDonald fault (Hoffman, 1988). The Thelon zone has been postulated to represent a continental arc built on the western flank of Rae craton and subsequently intensely deformed during ca. 1.97 Ga collision of the Slave craton (Hoffman, 1988). An alternative model based on compositions of plutonic rocks proposes that this zone represents an intracontinental mountain belt far removed from an active plate boundary (Chacko et al., 2000; Schultz et al., 2007).

Geochronological data for the Ttz are available from three widely separated areas: a southern region between the MacDonald fault and 65^{o}N (van Breeman et al, 1987a, van Breemen and Henderson, 1988, James et al., 1988, Henderson and van Breemen, 1992), a central region between 66 ^{o}N and 67^{o}N (van Breemen et al., 1987b; Frith and van Breemen, 1990) that in part coincides with the western part of the Chantrey transect, and a single outcrop along the coast of Queen Maud Gulf (Tersmette, 2012). Geochronological data in each area document high-grade metamorphism and/or granitoid plutonism at 2.01-2.00 Ga. In the southern region, syn-tectonic plutonism occurred at 1957 +9/-5 (James et al., 1988) and 1920 ± 4 Ma (van Breeman et al, 1987a). In the central region, K-feldspar megacrystic granite crystallized at 1994 +6/-4 Ma (Frith and van Breemen, 1990), massive to weakly foliated clinopyroxene granodiorite at 1978 ± 2 Ma (Frith and van Breeman, 1990), and syntectonic, S-type granite was emplaced at 1908 ± 2 Ma (van Breemen et al., 1987a) during granulite-facies metamorphism dated at 1906 ± 2 Ma (Roddick and van Breeman, 1994).

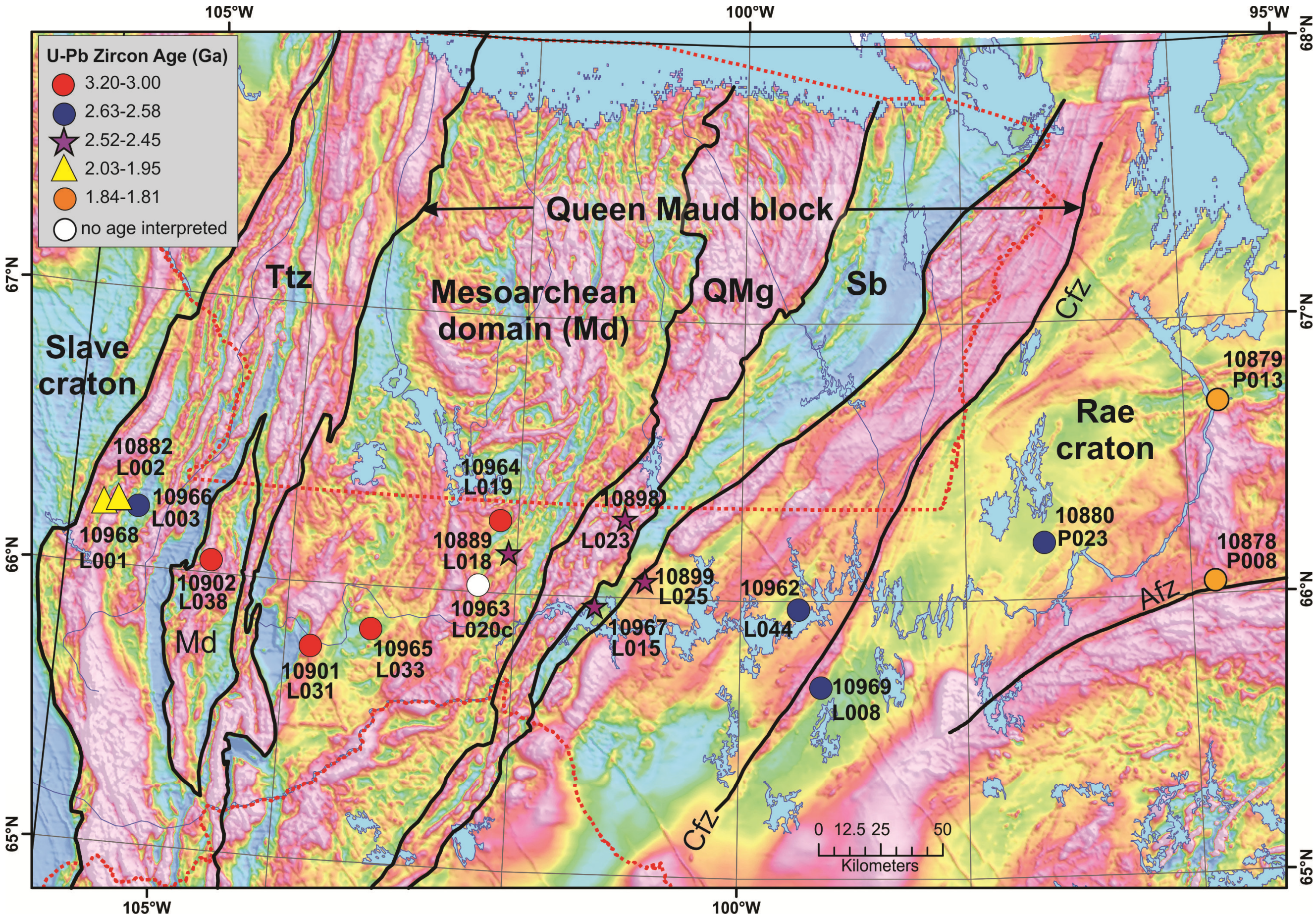

Figure 2: Regional aeromagnetic map showing locations of samples in this study and boundaries of principal tectonic domains discussed in text. Samples are shown by GSC lab# and abbreviated sample number; these can be cross-referenced in Table 1. Symbols are coded to reflect approximate igneous age. See Table 1 for sample details. Abbreviations: Afz = Amer fault zone; Cfz = Chantrey fault zone; QMg = Queen Maud granitoid belt, Sb = Sherman basin, Ttz = Thelon tectonic zone.

Queen Maud block:

The Queen Maud block (Heywood and Schau, 1978) or uplift (Hoffman, 1988), was distinguished by Heywood and Schau (1978) on the basis of its high metamorphic grade relative to adjacent areas (Committee and Armit blocks) of the northern Churchill province. Originally defined to extend north of the MacDonald fault and east to the Chantrey fault zone (Heywood and Schau, 1978), Schultz et al. (2007) suggested that the eastern boundary shift further west to a prominent magnetic lineament interpreted to reflect the eastern limit of a newly discovered ca. 2.5 Ga plutonic belt. The northern limit is unconstrained as the Precambrian geology is concealed beneath water or Paleozoic rocks of the Arctic islands. It may extend to northern Boothia Peninsula based on correlation of magnetic fabrics.

The geology of the area is poorly known with no systematic mapping accomplished since the initial helicopter surveys in the 1950's and 1960's. A number of K-Ar ages were reported in the 1960's which gave Paleoproterozic metamorphic cooling ages but little information on the age of the rocks. A small number of Nd isotopic analyses of archival samples by Theriault et al. (1994) identified significant 3.6-3.1 Ga crustal signatures in the southwestern part of the QMB, and Schultz et al. (2007) report Nd model ages of 2.8-3.1 Ga for rocks in the northeastern part of the block. Recent U-Pb geochronological data are reported for geological transects in the eastern (Schultz et al., 2007), northern (Tersmette, 2012), and central (Davis et al., 2013) Queen Maud block.

Hoffman (1988) interpreted the Queen Maud block as the exhumed part of a tectonic plateau developed behind the Thelon tectonic zone as a consequence of Himalayan-style, ca. 1.97 Ga collision of the Slave and Rae provinces. This model was challenged by Schultz et al. (2007) and Tersmette (2012) who identified a significant 2.5–2.3 Ga plutono-metamorphic history in the area, indicating that much of the high-grade metamorphism predates the Thelon orogeny and instead forms part of the Arrowsmith orogen that developed on the western margin of the Rae (Berman et al. 2005, Berman et al. 2012). A major corridor of commonly orthopyroxene-magnetite-bearing, 2.52–2.45 Ga granitoid rocks corresponds to a NNE-striking magnetic high (QMg on Figure 2) (Schultz et al., 2007; Tersmette, 2012, Davis et al. 2013). To the east, this zone abuts a pronounced magnetic low associated with metasedimentary rocks of the Sherman group (Sb on Figure 2), which are considered to have been deposited in a rift basin after 2.45 Ga (youngest detrital zircon) and before ca. 2.39 Ga, the time of metamorphic monazite growth (Schultz et al., 2007). Tersmette (2012) refers to the plutonic belt and Sherman group as the Paalliq belt. His geochronological data and data reported in Davis et al. (2013) indicate that the region to the west of the plutonic belt, and east of the Ttz, termed the Perry River belt, consists dominantly of ca. 3.2-3.1 Ga granitoid gneiss intruded by 2.7 Ga plutons. This region is identified in this report as the Mesoarchean domain.

Rae Craton:

The Rae craton west of Hudson Bay is dominated by Neoarchean supracrustal and granitoid rocks with lesser Mesoarchean basement gneiss. With the notable exception of the ca. 2.97 Ga Prince Albert group on Melville Peninsula (Frisch, 1983; Wodicka et al., 2011), supracrustal belts are dominantly Neoarchean and include quartzite-komatiite supracrustal rocks of the 2.72-2.68 Ga Committee Bay belt (Sanborn-Barrie et al. 2014; Skulski et al., 2003) and Woodburn Lake groups (Fraser, 1988, Zaleski et al., 2000). The most voluminous component of the extensive granitoid domains is ca. 2.62 – 2.58 Ga plutons of dominantly monzogranitic composition (Skulski et al., 2003; Hinchey et al., 2011 Sanborn-Barrie et al., 2014). Metamorphosed remnants of what is thought to have been an extensive ca. 2.1–1.9 Ga Palaeoproterozoic sedimentary cover include the Amer, Ketyet River, Montressor, Chantrey, and Penrhyn groups (Rainbird et al., 2010 and references within). Two Paleoproerozoic plutonic suites, the ca. 1.83 Hudson and the ca. 1.75 Ga Nueltin suites are locally common. A northeast-striking foliation is characteristic of the region and is demonstrated to be dominantly a Paleoproterozoic fabric (Berman et al., 2005; 2008; 2010). Indentation of the Slave craton (Henderson et al., 1990) is considered to have driven dextral latest movement in the Chantrey fault zone (Hoffman, 1989; Tella et al., 1994; Frisch, 2000) and the Amer fault zone (Tella et al., 1994). The latter has a ductile component active between 1.83 -1.75 Ga, and a brittle component post Nuletin granite.

Summary of Results

The main geological highlights resulting from this study are summarized below.

- Four additional samples (10901; 10902; 10964; 10965) confirm the extent of the Mesoarchean crustal block immediately east of the Thelon tectonic zone. This area is dominated by rocks with a range of ages between 3.2 and 2.96 Ga, has rocks as young as ~2.7 Ga but has not yet yielded ages comparable to the widespread 2.6 Ga plutonic event within the Rae.

- Four granitoid samples (10880; 10962; 10966; 10969) yield ages between 2589 and 2630 Ma. Three of the samples occur east of the Chantrey fault zone within the Rae and have ages typical of the widespread Rae plutonic event at ca. 2.6 Ga. The 2.6 Ga Rae plutons are known to extend west of the Chantrey fault zone (Davis et al. 2013, Schultz et al. 2007) but have not been identified further to the west within the Mesoarchean domain or Sherman basin. Sample 10966 comes from within the Thelon tectonic zone and is separated from Rae plutons of similar age by over 200 km. Plutons of this age are also characteristic of the Slave craton and it is possible that sample 10966 may indicate that Slave crust extends further east within the Thelon zone, than previously considered. Additional work is required to test this hypothesis.

- Four samples of plutonic rocks (10898; 10889; 10899; 10967) yield ages between 2488 and 2525 Ma, further highlighting the regional significance of the 2.52-2.47 Ga plutonic event in the Queen Maud block (Davis et al. 2013; Schultz et al. 2007). These plutons stitch the Mesoarchean domain to the Rae margin by at least 2.5 Ga

- Five samples (10898; 10889; 10901; 10902; 10965) within the Queen Maud block record zircon recrystallization at ~2.34 Ga, ~2.38 Ga and ~ 2.43 Ga indicative of multiple episodes of metamorphic recrystallization coincident with the Arrowsmith orogeny within the QMB.

- Two igneous crystallization ages of plutonic rocks within the Thelon tectonic zone (10968; 10882), one at 1991 Ma and one at 2029 Ma document that 1.99-2.03 Ga magmatism within the magnetically high portions of the Thelon tectonic zone is dominant at the latitude of the transect. The 2029 Ma age is the oldest yet recorded within the Thelon zone.

- Zircon recrystallization ages between 1901.8 ± 9.1 Ma and <1937 ± 22 Ma are determined for samples within the Thelon tectonic zone (10966, 10968) and in adjacent domains as far east as the Chantrey fault zone (10901, 10902, 10899). Three of the samples yield relatively precise ages between 1901.8 ± 9.1 and 1907.9 ± 6.2 Ma, with the two older ages of 1927 and <1937 Ma being much less precise. This data supports results presented in Davis et al. (2013) and indicates that the Thelon zone and adjacent Queen Maud block underwent a relatively widespread thermal event at ca. 1.9 -1.93 Ga.

Table 1. Location information and summary of U-Pb age results for samples from this study.

Lab #	Sample #	Rock Type	Domain	Rock Description	UTM Zone	East	North	NTS 1M	NTS 250	NTS 50	Age (Ma)	Error (Ma)	Age Material	Age Method	Age Qualifier	Age Interpretation
10878	12PBA-008 A01	Plutonic	Rae	Unfoliated hornblende monzodiorite	15	373706	7328033	56	L	4	1822.0	5.4	Zircon	U/Pb	Direct	Igneous Crystallization
10879	12PBA-013 A01	Plutonic	Rae	Foliated garnet-orthopyroxene-biotite granodiorite diatexite	15	381502	7400025	56	L	12	1843.6	7.2	Zircon	U/Pb	Direct	Igneous Crystallization
10879	12PBA-013 A01	Plutonic	Rae	Foliated garnet-orthopyroxene-biotite granodiorite diatexite	15	381502	7400025	56	L	12	2813.0	14.0	Zircon	U/Pb	Estimate	Inheritance
10880	12PBA-023 A01	Plutonic	Rae	Foliated biotite-granodiorite	14	576600	7343971	66	I	3	2589.0	3.0	Zircon	U/Pb	Direct	Igneous Crystallization
10882	12NK-L002 A01	Plutonic	Thelon	Migmatic hornblende-clinopyroxene quartz monzonite gneiss	13	474573	7345494	76	I	4	1994.0	13.0	Zircon	U/Pb	Direct	Metamorphic Recrysatllization
10882	12NK-L002 A01	Plutonic	Thelon	Migmatic hornblende-clinopyroxene quartz monzonite gneiss	13	474573	7345494	76	I	4	2029.4	4.4	Zircon	U/Pb	Direct	Igneous Crystallization
10889	12NK-L018 B01	Plutonic	Queen Maud	Foliated biotite alkali feldspar granite	13	631882	7339312	66	L	1	2377.6	3.5	Zircon	U/Pb	Direct	Metamorphic
10889	12NK-L018 B01	Plutonic	Queen Maud	Foliated biotite alkali feldspar granite	13	631882	7339312	66	L	1	2487.5	5.4	Zircon	U/Pb	Minimum Estimate	Igneous Crystallization
10898	12NK-L023a	Plutonic	Queen Maud	Foliated biotite-magnetic-orthopyroxene tonalite	14	408116	7353224	66	K	6	2426.0	7.0	Zircon	U/Pb	Direct	Metamorphic
10898	12NK-L023a	Plutonic	Queen Maud	Foliated biotite-magnetic-orthopyroxene tonalite	14	408116	7353224	66	K	6	2525.0	3.5	Zircon	U/Pb	Direct	Igneous Crystallization
10899	12NK-L025a3	Plutonic	Queen Maud	Strongly foliated hornblende-biotite monzogranite	14	416049	7328152	66	K	2	1937.0	22.0	Zircon	U/Pb	Estimate	Metamorphic
10899	12NK-L025a3	Plutonic	Queen Maud	Strongly foliated hornblende-biotite monzogranite	14	416049	7328152	66	K	2	2506.0	2.5	Zircon	U/Pb	Direct	Igneous Crystallization
10901	12NK-L031a	Plutonic	Mesoarchean	Foliated hornblende granodiorite gneiss	13	556139	7294854	66	E	13	1907.9	6.2	Zircon	U/Pb	Direct	Metamorphic
10901	12NK-L031a	Plutonic	Mesoarchean	Foliated hornblende granodiorite gneiss	13	556139	7294854	66	E	13	2325.0	100.0	Zircon	U/Pb	Estimate	Metamorphic
10901	12NK-L031a	Plutonic	Mesoarchean	Foliated hornblende granodiorite gneiss	13	556139	7294854	66	E	13	3108.0	58.0	Zircon	U/Pb	Estimate	Igneous Crystallization
10902	12NK-L038a	Plutonic	Mesoarchean	Foliated orthopyroxene monzogranite orthogneiss	13	513231	7325306	76	I	2	1906.0	13.0	Zircon	U/Pb	Direct	Metamorphic
10902	12NK-L038a	Plutonic	Mesoarchean	Foliated orthopyroxene monzogranite orthogneiss	13	513231	7325306	76	I	2	2379.0	22.0	Zircon	U/Pb	Direct	Metamorphic
10902	12NK-L038a	Plutonic	Mesoarchean	Foliated orthopyroxene monzogranite orthogneiss	13	513231	7325306	76	I	2	3117.0	21.0	Zircon	U/Pb	Direct	Igneous Crystallization
10962	12NK-L044a3	Plutonic	Rae	Feldspar porphyroclastic monzogranite	14	477812	7316828	66	G	14	2630.4	3.3	Zircon	U/Pb	Direct	Igneous Crystallization
10964	12NK-L019A2	Plutonic	Mesoarchean	Orthopyroxene-biotite syenoogranite orthogneiss	13	627364	7352005	66	L	8	2963.7	7.3	Zircon	U/Pb	Direct	Igneous Crystallization
10965	12NK-L033A2	Plutonic	Mesoarchean	Biotite-hornblende tonalite gneiss	13	579622	7303828	66	E	14	2341.8	7.3	Zircon	U/Pb	Direct	Metamorphic recrystallization
10965	12NK-L033A2	Plutonic	Mesoarchean	Biotite-hornblende tonalite gneiss	13	579622	7303828	66	E	14	3158.0	42.0	Zircon	U/Pb	Direct	Igneous Crystallization
10966	12NK-L003A2	Plutonic	Thelon	Biotite-magnetite monzogranite orthogneiss	13	481942	7344251	76	I	3	1901.8	9.1	Zircon	U/Pb	Direct	Metamorphic
10966	12NK-L003A2	Plutonic	Thelon	Biotite-magnetite monzogranite orthogneiss	13	481942	7344251	76	I	3	2591.0	27.0	Zircon	U/Pb	Direct	Igneous Crystallization
10967	12NK-L015A3	Metamorphic	Sherman Basin	Clinopyroxene-hornblende quartz diorite gneiss	14	395794	7318138	66	F	14	2513.6	3.2	Zircon	U/Pb	Direct	Igneous Crystallization
10968	12NK-L001a2	Plutonic	Thelon	Foliated orthopyroxene- biotite monzogranite	13	468297	7344940	76	I	4	1927.0	26.0	Zircon	U/Pb	Direct	Metamorphic recrystallization
10968	12NK-L001a2	Plutonic	Thelon	Foliated orthopyroxene- biotite monzogranite	13	468297	7344940	76	I	4	1990.9	3.7	Zircon	U/Pb	Direct	Igneous Crystallization
10969	12NK-L008a3	Plutonic	Rae	Hornblende-biotite quartz monzodiorite	14	486859	7285374	66	G	11	2596.0	3.0	Zircon	U/Pb	Direct	Igneous Crystallization

UTM coordinates in NAD27 projection

Analytical Methods

Samples were processed by electropulse disaggregation using a CMT-100 instrument at Overburden Drilling in Ottawa. Zircon were concentrated by hand panning, at the Geochronology facility, GSC, Ottawa. SHRIMP analytical procedures followed those described by Stern (1997), with standards and U-Pb calibration methods following Stern and Amelin (2003). Details regarding the procedure, or any deviations from it, are noted in the section relating to specific samples. Briefly, zircons were cast in 2.5 cm diameter epoxy mounts (along with fragments of the GSC laboratory standard zircon (z6266, with $^{206}Pb/^{238}U$ age = 559 Ma). The mid-sections of the zircons were exposed using 9, 6, and 1 μm diamond compound, and the internal features of the zircons (such as zoning, structures, alteration, etc.) were imaged in back-scattered electron mode (BSE) utilizing a Zeiss Evo 50 scanning electron microscope. The count rates at eleven masses including background were sequentially measured with a single electron multiplier. Off-line data processing was accomplished using SQUID2 (version 2.22.08.04.30, rev. 30 Apr 2008). Information for individual analytical sessions is given in Appendix 2. The 1σ external errors of $^{206}Pb/^{238}U$ ratios reported in the data table incorporate the error in calibrating the standard. Common Pb correction utilized the Pb composition of the surface blank (Stern, 1997). Yb and Hf concentration data were calculated using sensitivity factors derived from standard 6266 with values of 69 and 8200 ppm respectively. Details of the analytical session, including spot size, number of scans, calibration error and the applications of any intra-element fractionation corrections are given with the samples. Isoplot v. 3.00 (Ludwig, 2003) was used to generate concordia plots and calculate regression ages and weighted means. The error ellipses on the concordia diagrams and the weighted mean errors are reported at 2σ.

Sample Descriptions and Analytical Results

12NK-L001: Foliated orthopyroxene-biotite monzogranite

Sample	12NK-L001
Lab Number:	10968
Rock Type	Plutonic
Description	Orthopyroxene-biotite monzogranite
Geological Province	Rae
Domain	Thelon tectonic zone
Location	13 468297E 7344940N
Map Sheet	76 I
Sampling History	Sampled by L. Nadeau 2012
Age	1990.9 ± 3.7
Interpretation	Igneous Crystallization
Age	1927 ± 26
Interpretation	Metamorphic recrystallization

Geological Field Relationships and Rock Description

The sample location is from the western flank of the Ttz and corresponds to an area characterized by a narrow aeromagnetic low between more extensive and prominent aeromagnetic highs. The excellent outcrop at this location exposes fairly homogeneous, medium-grained, granoblastic, orthopyroxene-biotite monzogranite (charnokite). A moderately developed foliation (150°/80°SW) is defined primarily by the shape fabric of larger K-feldspar and quartz crystals, and to a lesser extent by scattered grains of biotite and orthopyroxene. Many of the latter are rimmed by biotite. Lower grade alteration is limited to the partial chloritization of several biotite grains, and the formation of clays and/or sericite in <5% of feldspar grains.

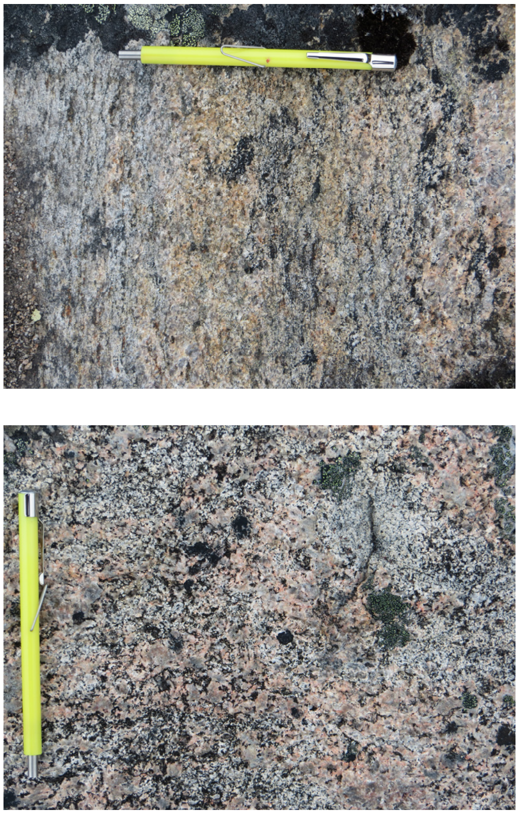

Figure 10968- 1: Photograph of outcrop of sample site. Top photograph shows moderately to well-developed foliation. Bottom picture shows typical rock texture.

The outcrop also contains some coarser grained, more leucocratic granitic veins or mobilisate that is largely transposed parallel to the foliation.

Zircon Description

Zircon consist of colourless, clear to slightly turbid, subhedral prismatic crystals (Figure 10968-2). BSE SEM images identify that most crystals have well developed oscillatory zoning typical of igneous zircon. Secondary alteration along growth zones is common. Discrete areas of recrystallization are seen as bright zircon patches on some crystals (Figure 10968-3).

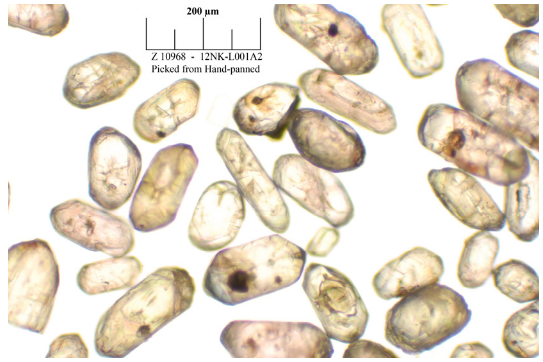

Figure 30968-2 Transmitted light microscope image of typical zircon

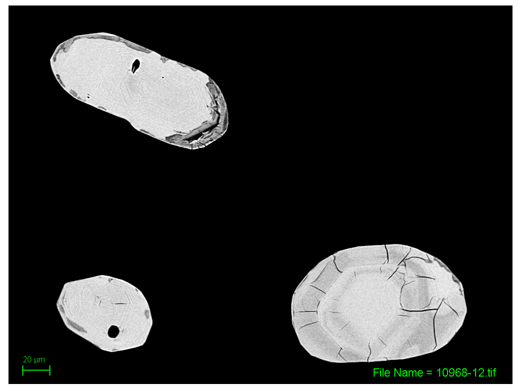

Figure 10968-3 BSE SEM images of typical zircon crystals showing oscillatory growth zoning. Scale bar is 20 µm.

Results and Interpretation

Data are presented on a concordia diagram in Figure 10968-4. Eighteen analyses of oscillatory zoned zircon yield a weighted mean $^{207}Pb/^{206}Pb$ age of 1990.9 ± 3.7 Ma (MSWD = 3.1, probability = 0.000). The relatively high MSWD indicates some degree of excess scatter in the data but there are no clear outliers. A single analyses of a brighter recrystallized zone on grain 6 yields a younger and less precise age of 1927 ± 26 Ma, interpreted as the time of metamorphic recrystallization.

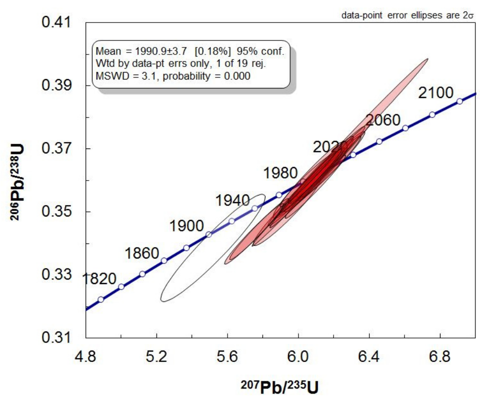

Figure 10968- 4 U-Pb concordia diagram. Red ellipses used to calculate weighted mean age.

12NK-L002: Migmatitic hornblende-clinopyroxene quartz monzonite gneiss

Sample	12NK-L002
Lab Number:	10882
Rock Type	Plutonic
Description	Quartz monzonite gneiss
Geological Province	Rae
Domain	Thelon tectonic zone
Location	13 474573E 7345494N
Map Sheet	76 I
Sampling History	Sampled by L. Nadeau 2012
Age	2029.4 ± 4.4
Interpretation	Igneous Crystallization

Geological Field Relationships and Rock Description

The sample location corresponds to an approximately 7 km wide aeromagnetic high that widens and extends south for more than 200 km in the western part of the Ttz. The outcrop consists of a dark, medium-grained, biotite-rich quartz monzonite intermingled with pink granitic mobilisate (Figure 10882-1). The granitic phase is less strained than the well foliated (217°/72°W) quartz monzonite, suggesting that melting occurred late with respect to deformation. In the quartz monzonite, leucocratic bands consist of larger, moderately elongate feldspars and elongate aggregates of recrystallized feldspars and quartz. Mafic bands consist of biotite, hornblende, clinopyroxene, and magnetite, without reaction relationships among these phases. Magnetite also fills late fractures. Apatite and zircon are abundant.

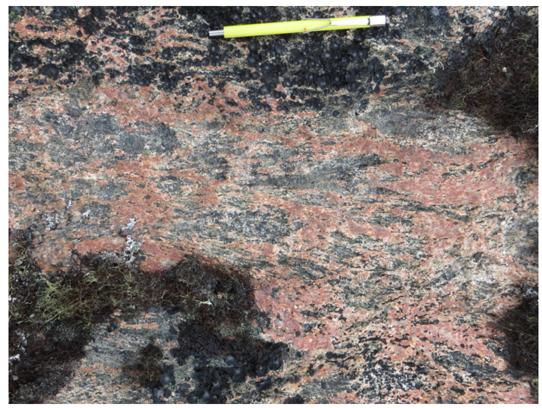

Figure 10882-1: Irregular patches of quartz monzonite (foliate, fine-grained, grey phase) in granitic mobilisate (coarse-grained, pink phase). Overprinting granitic melt forms ~30% of the view

Zircon Description

Zircon form fractured colourless, turbid subhedral prisms (Figure 10882-2). BSE images reveal a complex internal zonation with oscillatory zoned cores and a darker more homogeneous rim (10882-3). In places the darker rim material cross-cuts the interior zones, a texture consistent with recrystallization.

Figure 10882- 2: Transmitted light microscope image of typical zircon grains.

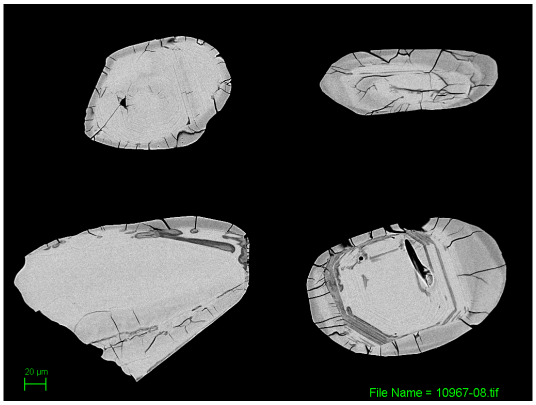

Figure 10882- 3: BSE SEM images of grains showing oscillatory zoned cores sometimes with darker rims.

Results and Interpretation

Data presented on a concordia diagram in Figure 10882-4 show a spread between ~2030 Ma and ~1970 Ma. The twelve oldest analyses of zoned cores yield a weighted mean age of 2029.4 ± 4.4 Ma (MSWD = 1.7, probability = 0.076). Some oscillatory zoned material has younger ages of 1994 Ma, which may indicate some Pb-loss perhaps associated with the ~1910 Ma metamorphism documented in the area. Alternatively these may represent the crystallization of the overprinting granitic melt at 1994 Ma, the age of sample L001.

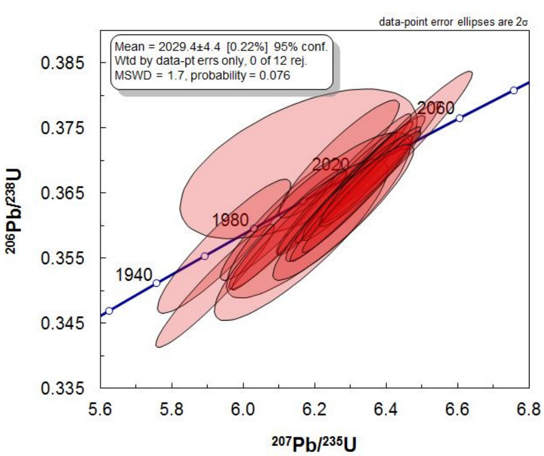

Figure 10882-4: U-Pb concordia diagram showing spread in ages between ~2050 and 1970 Ma. Age derived from mean of twelve oldest analyses.

12NK-L003: Biotite-magnetite monzogranite orthogneiss

Sample	12NK-L003
Lab Number:	10966
Rock Type	Plutonic
Description	Biotite-magnetite monzogranite orthogneiss
Geological Province	Rae
Domain	Thelon tectonic zone
Location	13 481942E 7344251N
Map Sheet	76 I
Sampling History	Sampled by L. Nadeau 2012
Age	2591 ± 27 Ma
Interpretation	Igneous Crystallization
Age	1901.8 ± 9.1
Interpretation	Metamorphic

Geological Field Relationships and Rock Description

The sample was collected from within an approximately 10 x 150 km long aeromagnetic low within the region considered as part of the Thelon tectonic zone. The outcrop consists of a migmatitic monzogranite orthogneiss interlayered on a cm to metre scale with amphibolite (mafic dyke?) layers (Figure 10966-1). The gneissosity (207°/88°) is defined


Figure 10966-1: Well foliated (S1) biotite granite orthogneiss matrix, with S1 parallel granitic veins and mafic layers, & irregular cross-cutting granitic patches and overprinting open (F2) folds.

by mafic layers with abundant biotite and magnetite (up to 0.4 mm in size) that are imperfectly separated from leucocratic layers comprising larger feldspar grains surrounded by elongate aggregates of recrystallized, granoblastic quartz. The gneissosity is warped by open folds and crosscut by irregular granitic patches. Accessory phases are apatite, titantite, and allanite.

Zircon Description

Zircon occurs as colourless clear euhedral to subhedral prisms (Figure 10966-2). Some grains have sharp well terminated faces, whereas others show irregular surfaces indicative of resorption. Zircon typically shows well developed oscillatory zoning, with some grains exhibiting a brighter outer rim (Figure 10966-3). The outer rim is concordant to discordant with the interior zoning.

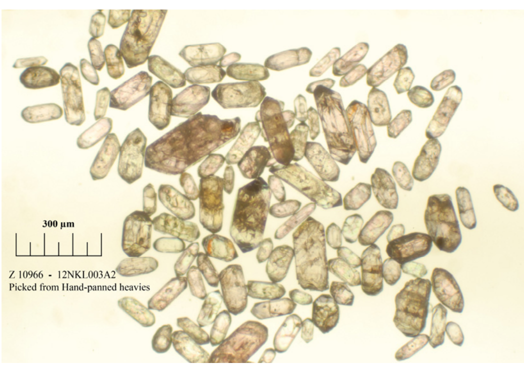

Figure 10966- 2: Transmitted light photomicrograph of typical prismatic zircon in sample.

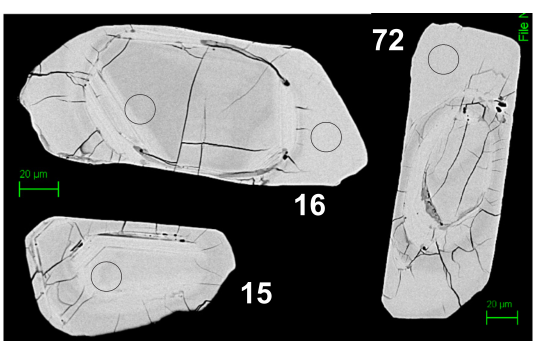

Figure 10966- 3: BSE SEM image of typical grain textures. Numbers refer to spot analyses in data table with circle indicating approximate location of analysis.

Results and Interpretation

Analyses of oscillatory-zoned core material define a discordant array with $^{207}Pb/^{206}Pb$ ages between 2.2 and 2.55 Ga (Figure 10966-4). The brighter rim material yields younger, mostly concordant ages. The five youngest give a weighted mean age of 1901.8 ± 9.1 Ma (MSWD = 1.8, probability = 0.13). Two

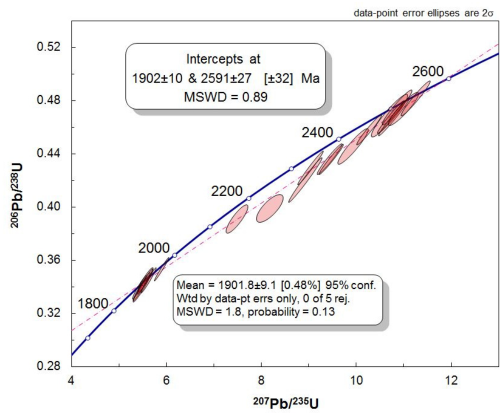

Figure 10966- 4: U-Pb concordia diagram showing discordant array of data from 2591 Ma to a cluster of concordant rim analyses at 1901.8 Ma

other analyses are more discordant with slightly older ages to 1.965 Ga and these may include a component of the older material. An age for the oscillatory zoned core material is determined by linear regression with a lower intercept fixed at the 1902 Ma age defined by the brighter rim material. The upper intercept of this array is 2591 ± 27 Ma (MSWD =0.89). This is interpreted as the igneous age of the protolith with the 1901.8 ± 9.1 Ma age interpreted as the age of metamorphic zircon growth, possibly during partial melting of the rock.

12NK-L008: Hornblende-biotite quartz monzodiorite

Sample	12NK-L008
Lab Number:	10969
Rock Type	Plutonic
Description	hornblende-biotite quartz monzodiorite
Geological Province	Rae
Domain	Rae craton
Location	15 373706E 7328033N
Map Sheet	56 L
Sampling History	Sampled by L. Nadeau 2012
Age	2595.7± 3
Interpretation	Igneous Crystallization

Geological Field Relationships and Rock Description

The sample location corresponds to the eastern edge of a northeast-striking aeromagnetic high which is cut by high strain zones within the Chantrey fault zone, western Rae craton. At this large, lakeshore outcrop, relatively unstrained, banded plutonic rock ranges in composition from diorite to tonalite. Preserved igneous textures include cross bedding due to channeled magma flow (Figure 10969-1a). The sample collected for geochronology is a porphyritic quartz monzodiorite with large, weakly aligned, euhedral, mostly sericitized plagioclase phenocrysts (up to 1 cm in length) set in a fine-grained matrix of quartz and feldspar (Figure 10969-1b). Mafic minerals include hornblende, biotite, and magnetite. Abundant needles of epidote are dispersed through the matrix and within some plagioclase grains. Titanite prisms are also present.

Figure 10969-1 A) Modal / compositional layering within a ~ 50 cm deep magmatic erosional channel (top). B) Close up of the sample outcrop showing weakly foliated relict porphyritic texture (below). Magnet pen 12.5 cm for scale.

Zircon Description

Zircons occur as euhedral, well terminated, colourless, clear prisms (Figure 10969-2). Some grains are fractured and slightly discoloured. BSE images reveal broad internal zoning with no evidence of core-rim relationships (Figure 10969-3)

Figure 10969-2: Transmitted light photomicrograph showing typical euhedral zircon. Scale bar is 300 µm.

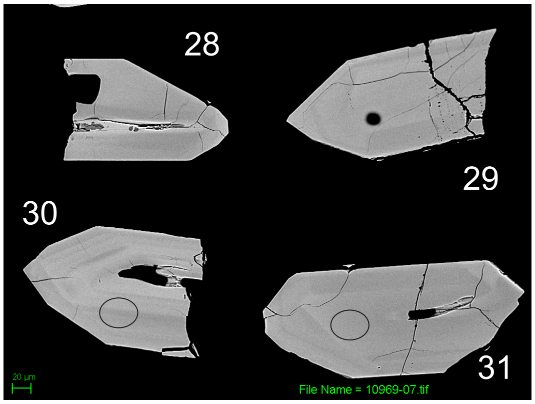

Figure 10969-3: BSE SEM images showing sharp igneous terminations and internal growth zoning. Scale bar in lower left is 20 µm.

Results and Interpretation

U-Pb analyses define a single concordant age population with a weighted mean age of 2595.7 ± 3 Ma (2 of 35 rej. MSWD = 1.05, probability = 0.39), interpreted as the time of igneous crystallization (Figure 10969-4).

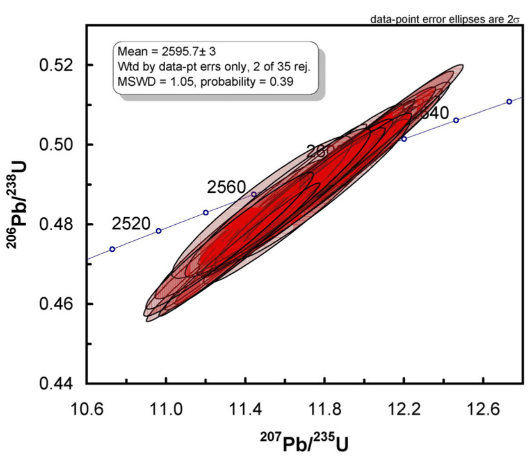

Figure 10969-4: U-Pb concordia diagram showing tight cluster of concordant results.

12NK-L015: Clinopyroxene-hornblende quartz diorite gneiss

Sample	12NK-L015
Lab Number:	10967
Rock Type	Plutonic
Description	Well foliated, clinopyroxene-hornblende quartz diorite gneiss
Geological Province	Rae
Domain	Sherman Basin
Location	14 395794E 7318138 N
Map Sheet	66 F
Sampling History	Sampled by L. Nadeau 2012
Age	2513.6 ± 3.2
Interpretation	Igneous Crystallization

Geological Field Relationships and Rock Description

This sample was collected from within the southern end of a pronounced aeromagnetic low that characterizes the Sherman basin. The sample collected for geochronology represents the oldest component of a polydeformed orthogneiss which comprises an early, grey dioritic phase (sample 10967) invaded by a mostly concordant K-feldspar porphyritic, monzogranitic phase (Figure 10967-1). A crenulated, strong gneissosity (159°/46°SW) is evident in outcrop, and is defined within the diorite by the separation of elongate grains of quartz and plagioclase from aligned aggregates of clinopyroxene, hornblende, and biotite. Biotite also defines a weak crenulatation. Rare crystals of orthopyroxene are surrounded by clinopyroxene and/or hornblende. K-feldspar forms rare, anhedral interstitial grains. Accessory minerals include apatite, zircon (up to 0.5 mm in length) and minor allanite. Alteration is limited to chlorite rims on some biotite grains.

Figure 10967- 1: Polydeformed orthogneiss comprised of an early, grey dioritic phase that was invaded by a mostly concordant K-feldspar porphyritic, monzogranitic phase. Dated sample is from older diorite phase.

Zircon Description

Zircons occur as pale brown to colourless, suhedral prismatic grains (Figure 10967-2).

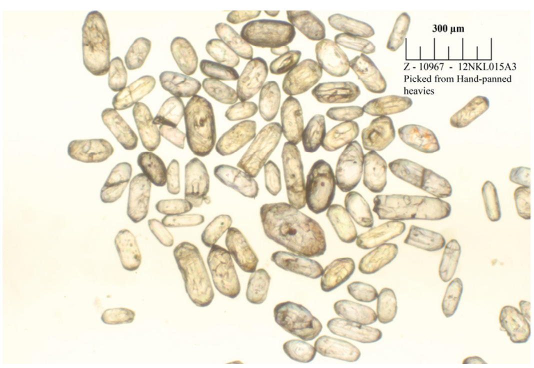

Figure 10967- 2: Transmitted light photomicrograph of typical zircon grains.

Most grains exhibit extensive fractures and variable alteration. BSE SEM images reveal oscillatory zoning typical of igneous crystallization (Figure 10967-3).

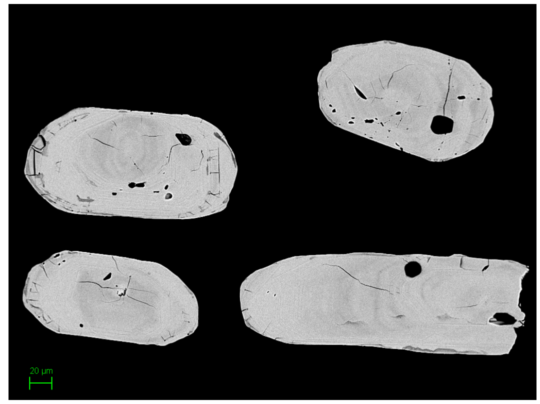

Figure 10967- 3: BSE SEM images of tyical zircon grains showing oscillatory growth zoning. Scale bar in lower left = 20 µm.

Results and Interpretation

The analyses form a cluster of concordant ages with $^{207}Pb/^{206}Pb$ ages between 2507 and 2544 Ma (Figure 10967-4).

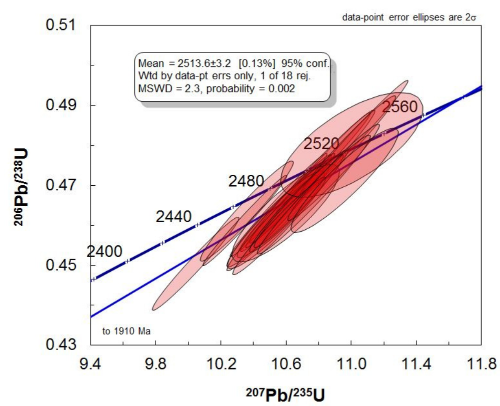

Figure 10967- 4: Concordia diagram showing cluster of concordant analyses with minor Pb-loss to a ca. 1.91 Ga lower intercept (blue line)

A weighted mean of seventeen of eighteen analyses give an age of 2513.6 ± 3.2 Ma (MSWD = 2.3l, POF = 0.002). The oldest age is excluded from the mean and is presumed to include an inherited component. Four analyses have slightly more discordant ages less than 2500 Ma, plot along a reference discordia to ~1.9 Ga and are presumed to have lost Pb at that time. The igneous crystallization age is interpreted to be 2513.6 ± 3.2 Ma.

12NK-L018: Foliated biotite alkali feldspar granite

Sample	12NK-L018
Lab Number:	10889
Rock Type	Plutonic
Description	Foliated biotite alkali feldspar granite
Geological Province	Rae
Domain	Mesoarchean block
Location	13 631882E 7339312N
Map Sheet	66 L
Sampling History	Sampled by L. Nadeau 2012
Age	2487.5 ± 5.4
Interpretation	Minimum Igneous Crystallization
Age	2377.6 ± 3.5
Interpretation	Metamorphic crystallization

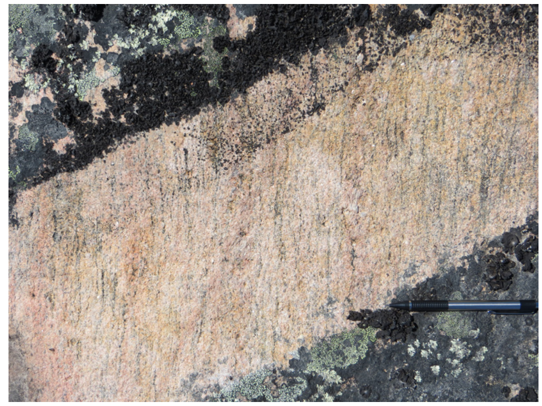

Figure 10889- 1: Outcrop photo of well foliated, medium-grained, granoblastic biotite granite

Geological Field Relationships and Rock Description

This sample location is within a small magnetic low that is partially surrounded by discontinuous magnetic highs within the eastern flank of the Mesoarchean block. The outcrop consists of fine- to medium-grained, foliated alkali feldspar granite (Figure 10889-1). Irregular mafic-rich patches that may represent remnants of transposed dykes are locally observed. The well-developed foliation (275°/70°N) is defined primarily by the alignment of biotite as dispersed flakes and some more continuous bands. Feldspars are largely recrystallized into granoblastic aggregates, although rare porphyroclasts of K-feldspar up to 1 cm in size are present. Accessory minerals are fluorite, apatite, rutile, zircon, and allanite.

Zircon Description

The zircons recovered are of moderate overall quality and form subhedral, equant to elongate crystals (Figure 10889-2). The grains are clear, colourless to light brown, and moderately fractured. They range in long dimension from 70 µm to 200 µm. Unidentified mineral inclusions are present in some grains.

Figure 10889- 2: Transmitted light photomicrograph of typical zircon recovered from the sample.

In SEM backscatter electron (BSE) imaging the more elongate grains exhibit diffuse oscillatory zoning that is variably developed (Figure 10889-3). Equant grains tend to be well faceted and have a less prominent zoning (Figure 10889-3).

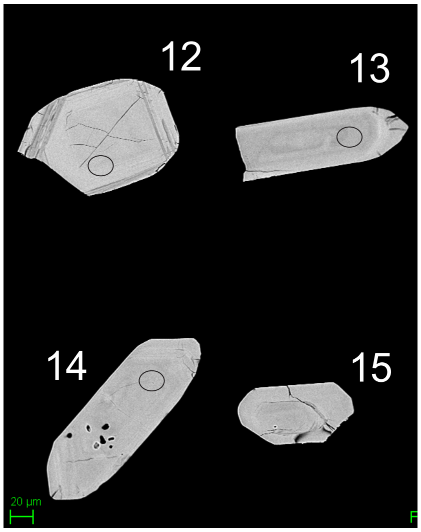

Figure 10889- 3: BSE SEM images of selected grains. Numbers refer to analyses numbers in data table, circle indicates approximate position of analysis.

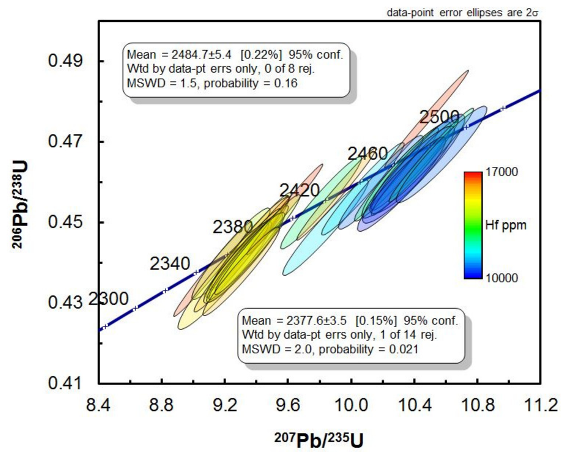

Figure 10889- 4: U-Pb concordia diagram. Ellipses are colour coded based on Hf concentration. Zircon with higher Hf concentrations yield younger ages compared to prismatic, oscillatory- zoned, crystals (blue ellipses).

Results and Interpretation

The data define two compositionally distinct age groupings which broadly correlate with grain morphology. A younger group consists of analyses of the more equant zircon with less prominent zoning and higher Hf contents (Figure 10889-4). Thirteen of the fourteen youngest analyses yield a weighted mean age of 2377.6 ± 3.5 Ma (MSWD = 2.0, probability =0.02). The rejected analysis is the youngest in the group at 2355 ± 6 Ma. Although concordant within the estimated error, the analyses may have experienced a small amount of Pb-loss. The older group consists of more elongate crystals which preserve variably developed oscillatory zoning. The eight oldest analyses yield a weighted mean $^{207}Pb/^{206}Pb$ age of 2487.5 ± 5.4 Ma (MSWD = 1.5, probability = 0.16). Six analyses yield intermediate ages which may reflect partial Pb-loss of older zircon during the younger event. Since the older zircon may have also undergone some Pb-loss, the 2487.5 ± 5.4 Ma age must be treated as a minimum estimate for the age of the rock. The younger event involves the formation of new zircon and may represent crystal growth at ~2378 Ma.

12NK-L019: Foliated orthopyroxene-biotite syenogranite

Sample	12NK-L019
Lab Number:	10964
Rock Type	Plutonic
Description	Orthopyroxene-biotite monzogranitic orthogneiss
Geological Province	Rae
Domain	Mesoarchean block
Location	13 627364E 7352005N
Map Sheet	66 L
Sampling History	Sampled by L. Nadeau 2012
Age	2963.7 ± 7.3
Interpretation	Igneous Crystallization

Geological Field Relationships and Rock Description

This sample is located within a small, 6 km-diameter, circular magnetic low that appears to form the core of a northeast-trending fold outlined by a strongly magnetic unit near the east side of the Mesoarchean block. The outcrop consists of very homogenous syenogranite which displays a strong foliation defined by the segregation into layers of elongate aggregates of quartz, K-feldspar, and plagioclase (Figure 10964-1) that are parallel to scattered biotite blades and anhedral grains of orthopyroxene. The foliation is oriented (270°/60°N) parallel to that in sample 12NKL-018 to the south, and at a high angle to the northeast strike that prevails near the eastern boundary of the Mesoarchean domain. There is no evidence of migmatization or an overprinting fabric, although recrystallization of quartz and feldspars is pronounced and the main fabric is overprinted by biotite that appear to have formed from reaction with orthopyroxene. The main oxide is ilmenite, but magnetite less than 0.1 mm in size is also present. Allanite crystals up to 0.1 mm in length are common.

Figure 10964- 1: Photgraph of outcrop from sample site of the monzogranitc orthogneiss.

Zircon Description

Zircon occurs as colourless to pale brown subhedral prisms (Figure 10964-2).

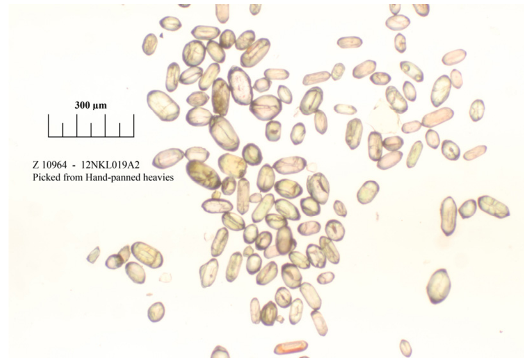

Figure 10964- 2: Transmitted light photomicrograph of typical zircon recovered from the sample.

SEM images demonstrate relatively flat to broad oscillatory zonation with significant alteration in some grains (Figure 10964-3).

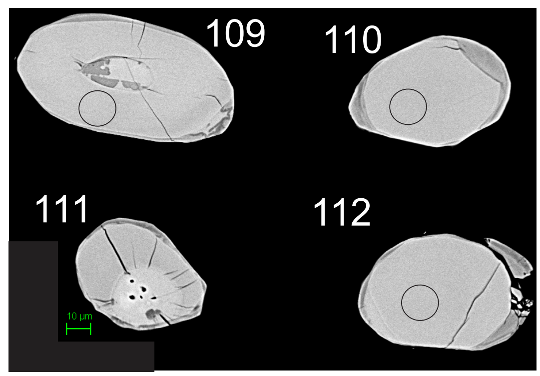

Figure 10964- 3: BSE SEM images of selected grains. Numbers refer to analyses numbers in data table, circle indicates approximate position of analysis

Results and Interpretation

The data yield a range of ages from ~2.8 Ga to 3.12 Ga with a dominant cluster between 2.94 and 2.98 Ga (Figure 10964-4). A weighted mean of eleven analyses within this group yields an age of 2963.7±7.3 (MSWD = 1.5, probability = 0.13) which is interpreted as the age of the rock. An upper intercept age of 2970 ± 35 Ma is similar but less precise than the weighted average. A small number of zircon grains (3) have older ages which are interpreted to reflect inheritance of ~3.1 Ga material. The remaining analyses are interpreted to have lost

Pb during a Paleoprotoerozoic event approximated by the lower intercept age of 2263 ± 220 derived from a regression of the data (red ellipses in Figure 10964-4).

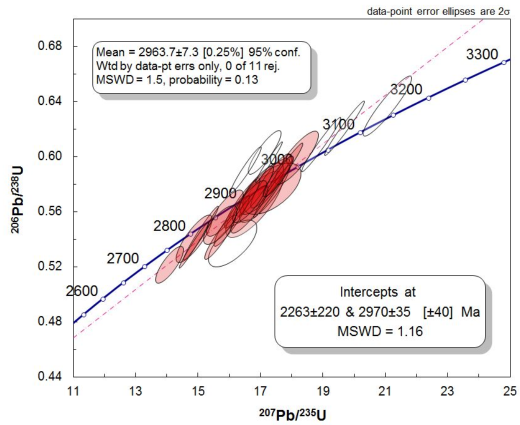

Figure 10964-4: U-Pb Concordia diagram. Red ellipses show data used in linear regression calculation.

12NK-L020c: Strongly foliated S-type alkali feldspar granite

Sample	12NK-L020c
Lab Number:	10963
Rock Type	Plutonic
Description	Strongly foliated S-type granite
Geological Province	Rae
Domain	
Location	13 621003E 7325348N
Map Sheet	66 L
Sampling History	Sampled by L. Nadeau 2012
Age	No age interpreted

Geological Field Relationships and Rock Description

The sample location corresponds to a small aeromagnetic low on the flank of a regionally extensive magnetic high towards the eastern side of the Mesoarchean block. The outcrop is dominated by migmatitic, gossanous paragneiss which displays rootless isoclinal folds indicative of a complex deformation history. The S-type granite collected here forms a small plutonic body as well as m-scale, more resistant sheets that are concordant with the 010°/80°E foliation of the host paragneiss. The granite is strongly foliated with highly attenuated quartz and feldspar grains parallel to elongate garnet crystals and scattered biotite and sillimanite (Figure 10963-1).

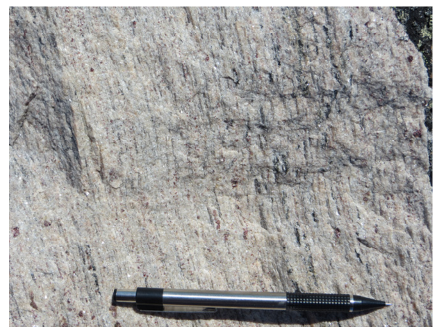

Figure 10963-1: Photograph of outcrop of S-type granite showing strong foliation.

Zircon Description

Zircon occurs as subhedral prisms, many with slightly rounded terminations (Figure 10964-2). Many grains are discoloured indicating alteration. In BSE imaging grains show oscillatory zoning which is locally disrupted by secondary alteration particularly at grain margins (Figure 10963-3).

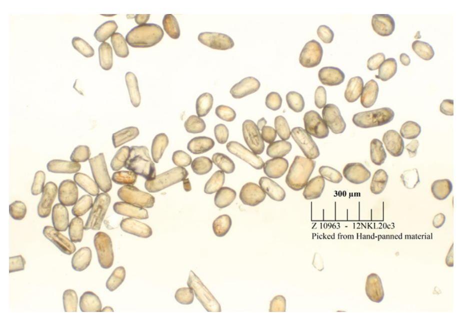

Figure 10963-2: Transmitted light photomicrograph of typical zircon recovered from the sample.

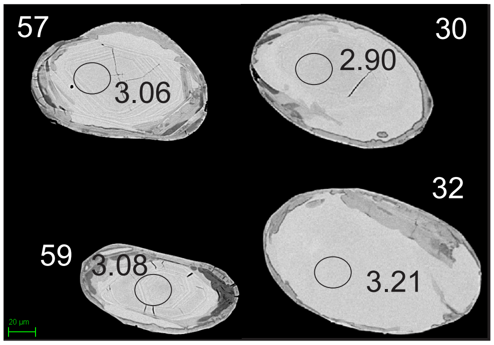

Figure 10963- 3: BSE SEM images of selected grains showing oscillatory zoning. White numbers refer to analyses numbers in data table, circle indicates approximate position of analysis, and black numbers are the $^{207}Pb/^{206}Pb$ age for that spot in Ga.

Results and Interpretation

The zircon yield a range of ages between ~2.8 Ga and 3.2 Ga. The distribution of ages along the concordia does not permit an unambiguous age interpretation as there is no single dominant age population (Figure 10963-4).

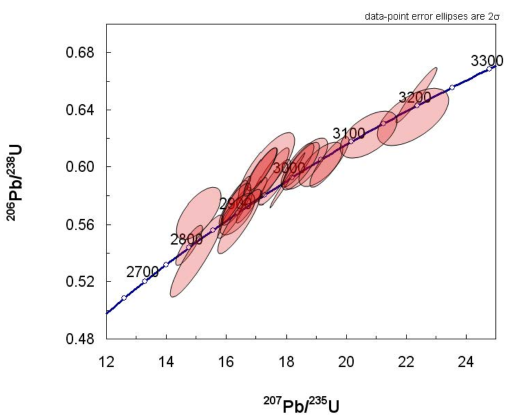

Figure 10963-4: U-Pb Concordia diagram showing spread of results along Concordia curve between 3.2 Ga and 2.8 Ga. No dominant age is interpreted.

Zircon with similar zoning and morphology may have very different ages. Given that this is a metasedimentary-derived granite within a migmatite outcrop it is not possible to ascertain whether any of the zircon analyses record the igneous crystallization age. They may all be inherited. No age is interpreted. The predominance of pre-2.8 Ga zircon indicates a Mesoarchean source, and a maximum age of the granite.

12NK-L023: Foliated biotite-magnetite-orthopyroxene tonalite

Sample	12NK-L023
Lab Number:	10898
Rock Type	Plutonic
Description	Foliated biotite-magnetite-orthopyroxene tonalite
Geological Province	Rae
Domain	QM granitoid belt?
Location	14 408116E 7353224N
Map Sheet	66 K
Sampling History	Sampled by L. Nadeau 2012
Age	2524.5 ± 3.5
Interpretation	Igneous crystallization
Age	2426 ± 7.0 Ma
Interpretation	Maximum age of metamorphic recrystallization

Geological Field Relationships and Rock Description

The sample is located within the Queen Maud granitoid belt (Schultz et al., 2007), a prominent, northeast-striking magnetic high that lies between the Mesoarchean block and the Sherman basin. The outcrop is a layered orthogneiss with a well foliated (115°/35°) biotite-magnetite-orthopyroxene tonalite representing the main component (Figure 10898-1). Coarse-grained to pegmatitic, undeformed granite forms m-scale, concordant layers. The strong foliation in the tonalite is defined by the alignment of biotite, magnetite, and less abundant orthopyroxene and ilmenite. Plagioclase and quartz have a moderate shape fabric, whereas K-feldspar forms smaller, interstitial grains. Orthopyroxene is commonly fractured and variably replaced by chlorite.

Figure 10898-1: Photograph of outcrop biotite-magnetite tonalite.

Zircon Description

Zircon occurs as relatively large, euhedral to subhedral prismatic crystals of moderate to poor quality. Many are slightly turbid and fractured (Figure 10898-2). BSE images reveal complex morphologies for the zircon. Many grain exhibit oscillatory zoned cores (Figure 10898-3). Some grains show brighter areas in which the oscillatory zoning is overprinted by flatter homogenous zircon. A minority of grains have well developed dark rims.

Figure 10898-2: Transmitted light photomicrograph of typical zircon recovered from the sample.

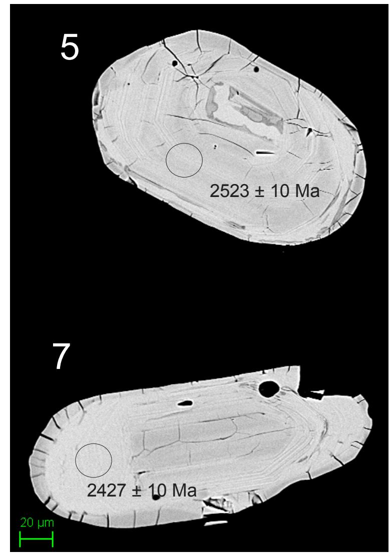

Figure 10898-3: BSE SEM images showing oscillatory zoning (grain 5), in some cases overprinted by brighter, more homogenous zones (grain 7). Analytical spot positions indicated by circles with ages ± 1 σ errors.

Results and Interpretation

Analyses yield a range of concordant data from 2.30 to 2.53 Ga (Figure 10898-4). The eight oldest analyses, from zircon with well-defined oscillatory zoning, define a tight group with an age of 2524.5±3.5 Ma (MSWD = 0.56, probability = 0.79) interpreted as the igneous crystallization of the tonalite. The remaining analyses spread along the Concordia curve, and their age cannot be entirely predicted based on internal zoning patterns. Some analyses such as grain 7 show clear evidence for being recrystallized (Figure 10898-3), whereas others may preserve some igneous zonation. A significant number of analyses fall between 2.45 and 2.4 Ga. A weighted mean of twelve analyses give an age of 2425.6 ± 7.0 (MSWD = 2.0, probability = 0.028). However these analyses may only be partially reset and the time of resetting may be younger in the 2.30-2.35 Ga range.

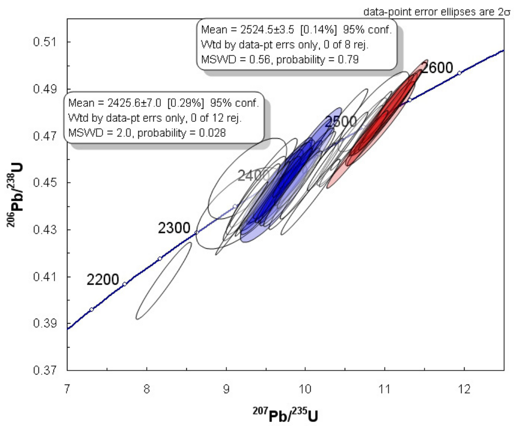

Figure 10898-4: U-Pb concordia diagram showing spread of analytical results along the concordia curve. Red ellipses are from analyses of oscillatory zoned zircon and form a cluster at upper end of the array and are interpreted as the age of the rock. Blue ellipses may reflect time of recrystallization or partial recrystallization.

12NK-L025: Strongly foliated hornblende-biotite monzogranite

Sample	12NK-L025
Lab Number:	10899
Rock Type	Plutonic
Description	Strongly foliated, hornblende – biotite monzogranite
Geological Province	Rae
Domain	Rae craton
Location	14 416049E 7328152N
Map Sheet	66 K
Sampling History	Sampled by L. Nadeau 2012
Age	2506.0 ± 2.5
Interpretation	Igneous crystallization
Age	1937 ± 22 Ma
Interpretation	Metamorphic recrystallization (maximum)

Geological Field Relationships and Rock Description

This sample is located within a muted aeromagnetic high that appears to interrupt pronounced, northeast-striking aeromagnetic highs in the Rae craton just east of the Sherman basin. With the exception of several dispersed mafic xenoliths, the well-foliated (340°/30°NW) K-feldspar porphyritic monzogranite collected at this location is uniform and notable for its absence of comagmatic phases or melt stringers (Figure 10899-1). The foliation is defined both by the strong attenuation of feldspars and quartz and the alignment of biotite blades with aggregates of subequant, anhedral hornblende that is commonly partially rimmed by biotite and epidote. Epidote also forms small, irregular grains associated with dispersed titanite. Magnetite occurs as scattered grains up to 1 mm in size. Apatite and pyrite are minor phases.

Figure 10899-1: Photograph of outcrop at the monzogranite sample site. Camera lens for scale in upper left.

Zircon Description

Zircon occur as subhedral, prismatic colourless to pale brown crystals with variable turbidity (Figure 10899-2).

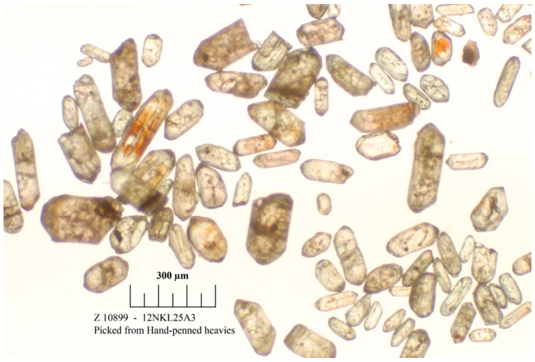

Figure 10899- 2: Transmitted light photomicrograph of zircon from sample 10899.

BSE images indicate oscillatory zoned crystals, some with sector zoning. Some grains have brighter, higher uranium zones that are discordant to oscillatory zoning and are presumed to reflect recrystallization (Figure 10899-3 grain 53). Grain 45 (Figure 10899-3) has a bright, flat homogenous BSE response which is also interpreted as a recrystallization texture.

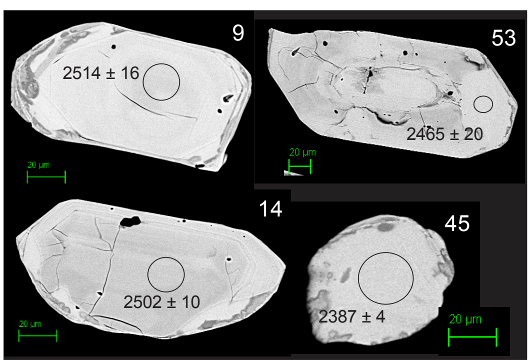

Figure 10899- 3: BSE SEM images of typical zircon grains showing oscillatory zoning (grain 9 and 14) with brighter recrystallized zones (grain 53 right end of grain; grain 45). Spot locations and ages as indicated. Scale bar = 20 µm.

Results and Interpretation

Twenty of twenty-one analyses of oscillatory zoned zircon yield a weighted mean $^{207}Pb/^{206}Pb$ age of 2506.0 ± 2.5 Ma (MSWD = 1.8, probability = 0.020), interpreted as the crystallization age of the rock (Figure 10899-4). Five analyses, mostly of brighter, recrystallized zones shown in Figure 10899-3, have younger ages from 2480 Ma to 1937 Ma, indicating minor to significant Pb-loss accompanying recrystallization. Grain 45 has a concordant age of 2387 Ma,

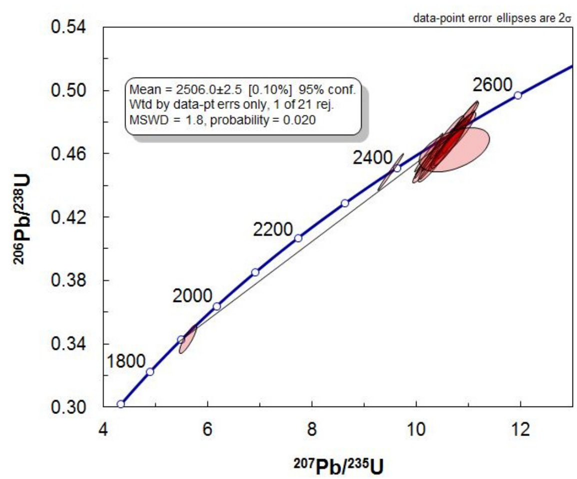

Figure 10899- 4: U-Pb Concordia diagram showing cluster of concordant results at 2506 Ma and much younger analyses from recrystallized areas.

which may reflect recrystallization at that time, however there are insufficient analyses to support that this represents a significant event. The concordant analysis at 1937 ± 22 Ma indicates recrystallization, although it must be considered a maximum age as it is possible that it is not completely reset.

12NK-L031: Foliated hornblende granodiorite

Sample	12NK-L031
Lab Number:	10901
Rock Type	Plutonic
Description	Foliated hornblende granodiorite
Geological Province	Rae
Domain	Mesoarchean block
Location	13 556139E 7294854N
Map Sheet	66 E
Sampling History	Sampled by L. Nadeau 2012
Age	3108±53
Interpretation	Igneous crystallization
Age	2325 ± 100
Interpretation	Metamorphic recrystallization
Age	1907.9 ± 6.2
Interpretation	Metamorphic recrystallization

Geological Field Relationships and Rock Description

The sample location corresponds to the south end of an irregular shaped aeromagnetic high near the west side of the main Mesoarchean domain. The sample consists of a very homogeneous, non-migmatitic, pinkish-grey, medium-grained, foliated hornblende granodiorite (Figure 10901-1). The well developed foliation (010°/54°E) is defined by hornblende-rich layers and leucocratic layers consisting of larger porphyroclasts of plagioclase surrounded by quartz and feldspars with a strong shape fabric. Scattered, small biotite flakes also parallel the foliation, as do aligned inclusions of allanite and titanite in hornblende. Pyrite, apatite and zircon are abundant.

Figure 10901-1: Outcrop photograph of porphyroclastic granodiorite. One dollar coin for scale in lower left = 25 mm.

Zircon Description

The zircons recovered are of moderate to poor quality and form subhedral, equant to elongate crystals (Figure 10901-2). The grains are moderately turbid to clear, colourless to light brown, and moderately fractured. They range in long dimension from 100 µm to 200 µm. Unidentified mineral inclusions are present in some grains.

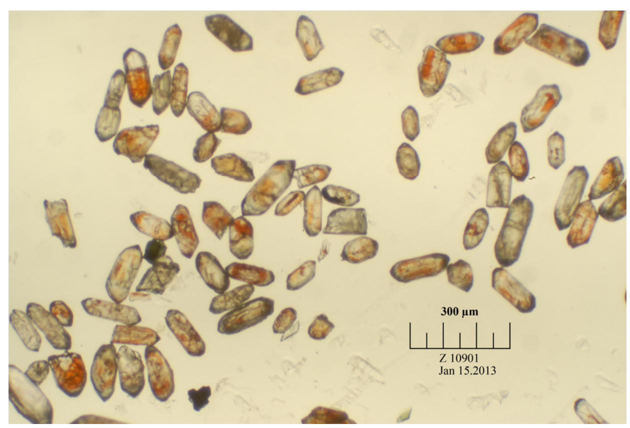

Figure 10901- 2 Transmitted light photomicrograph of zircon grains. Note high degree of alteration.

In SEM BSE images many zircon grains exhibit well-developed oscillatory growth zoning typical of igneous zircon. Many of the grains have alteration which preferentially occurs along the growth zones. A subset of grains have brighter rims which also show evidence of finer oscillatory zoning (Figure 10901-3, grains 11, 13, 37, 48).

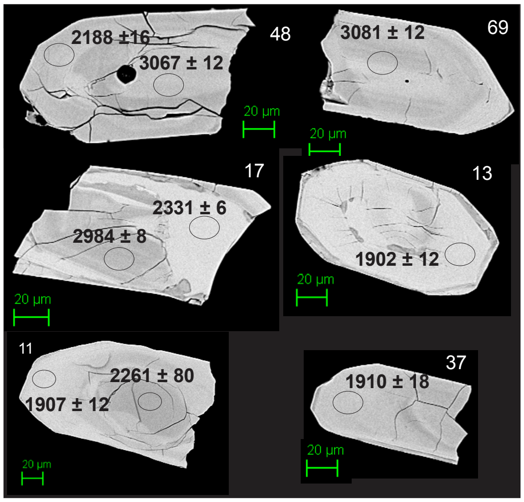

Figure 10901-3: BSE SEM images of typical zircon grains. Oscillatory-zoned cores with brighter outer rims. Analytical locations and $^{207}Pb/^{206}Pb$ age and 1 standard deviation error shown.

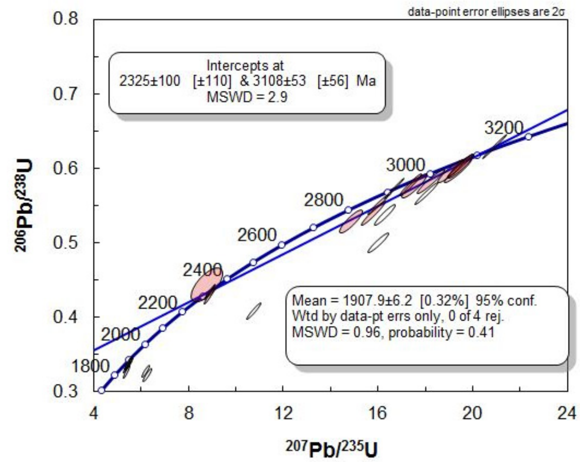

Figure 10901-4: U-Pb concordia diagram showing cluster of data between 3000 and 3100 Ma along regression line to ~ 2325 Ma. Brighter rimes cluster at 1907.6 ± 6.2 Ma.

Results and Interpretation

The dominant population of oscillatory-zoned zircon cores has Archean ages ranging from 2750 Ma to 3126 Ma. Some analyses have elevated ^{204}Pb contents presumably caused by intersection of altered areas with fractures; these analyses tend to be discordant. The data, excluding analyses with high ^{204}Pb, define a discordia array with an upper intercept age of 3108 ± 53 Ma (MSWD = 2.9, probability of fit = 0.000) and a lower intercept of 2325 ± 100 Ma (Figure 10901-4). The upper intercept is the best estimate for the age of crystallization of the granodiorite. The lower intercept is similar in age to a group of 4 analyses that plot on or near concordia between 2260 ± 80 and 2351 ± 10 Ma. These analyses may reflect zircon recrystallization (e.g. Figure 10901-3 grain 17) that produced the Pb-loss evident in the Archean array.

In addition a group of four concordant analyses of the brighter unzoned zircon rims (Figure 10901-3 grains 11, 13, 37), yield a weighted mean age of 1907.9 ± 6.2 Ma. In one case the rim is on an older Archean core. Grain 48 has a similar bright outer rim which yields a discordant age of 2218 Ma, only partially drawn down to the 1907.9 Ma age of recrystallization. These rims are interpreted as metamorphic in origin.

12NK-L033: Biotite-hornblende tonalite gneiss

Sample	12NK-L033
Lab Number:	10965
Rock Type	Plutonic
Description	Biotite-hornblende tonalite gneiss
Geological Province	Rae
Domain	Mesoarchean block
Location	13 579622E 7303828N
Map Sheet	66 E
Sampling History	Sampled by L. Nadeau 2012
Age	3158 ± 42
Interpretation	Igneous crystallization
Age	2341.8 ± 7.3
Interpretation	Metamorphic recrystallization

Geological Field Relationships and Rock Description

This sample is located in the south-central part of the Mesoarchean block within an ~10 km diameter, roughly circular magnetic low that is flanked to the south by a subdued, east-striking magnetic high and to the north by a more pronounced, regionally extensive, north-northeast striking aeromagnetic high.

The dominant component of this lithologically heterogeneous outcrop is a grey tonalitic orthogneiss that hosts varied aplitic to pegmatitic granitic phases and boudinaged amphibolite, and is cut by late mafic dykes. The gneissosity (033°/58°) is defined in outcrop by alternating granitic and tonalitic layers (Figure 10965-1), and within the tonalite by the separation of biotite and minor hornblende from granoblastic aggregates of quartz and plagioclase, although some larger plagioclase grains are elongated parallel to the gneissosity. Accessory minerals include titanite, which forms abundant inclusions in biotite, and minor apatite, zircon, and pyrite. Fine needles of epidote commonly rim biotite or scattered grains of calcite.

Figure 10965- 1: Early Bt-Hbl tonalite (grey) with irregular granite pods defining folded layering (orange).

Zircon Description

Zircon occur as colourless to pale brown, elongate prismatic grains 100 to >300 µm in length (Figure 10965-2). SEM BSE imaging reveal well developed oscillatory zoning (Figure 10965-3 grains 19, 47, 61) in many grains. In addition brighter, homogenous zircon occur as more equant grains (Figure 10965-3 grain 17 and 88) or as patchy recrystallization of the oscillatory zoned material (Figure 10965-3 grain 113).

Figure 10965-2: Transmitted light photomicrograph of zircons recovered from the sample. Note variation in grain zize and alteration.

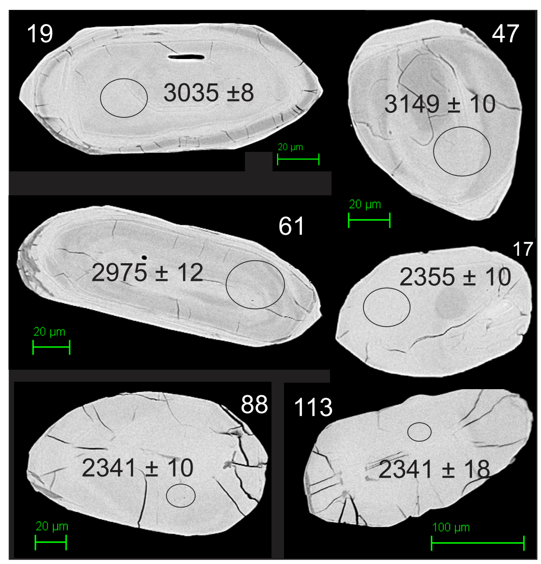

Figure 10965- 3: BSE SEM images of typical grain textures. Circle indicates approximate position of analyses, ages are given in Ma with 1 σ error.

Results and Interpretation

Analyses of the oscillatory zoned grains yield a range of concordant to discordant ages between 2975 and 3207 Ma (Figure 10965-4).

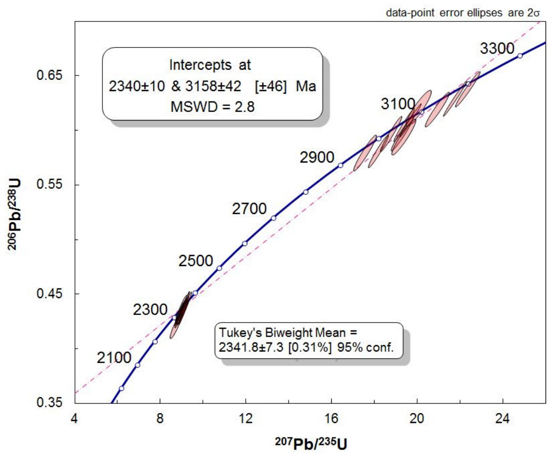

Figure 10965-4: U-Pb Concordia diagram showing discordance of Mesoarchean zircon cores towards 2341 Ma lower intercept.

In contrast eleven analyses of the brighter unzoned zircon domains yield younger concordant ages that give a Tukeys biweight mean age of 2341.8 ± 7.3 Ma. This age is interpreted as the time of metamorphic recrystallization of the rock, possibly accompanying intrusion of the granitic dykelets. The igneous crystallization age of the tonalite is estimated by linear regression of the data from the oscillatory zoned crystals utilizing a fixed lower intercept at 2340 ± 10 Ma. The upper intercept of 3158 ± 42 (MSWD = 2.8) provides the best estimate of the crystallization age of the fine-grained grey tonalite background phase.

12NK-L038a: Foliated Orthopyroxene monzogranite

Sample	**12NK-L038a**
Lab Number:	10902
Rock Type	Plutonic
Description	**Orthopyroxene monzogranite**
Geological Province	**Rae**
Domain	Mesoarchean block
Location	13 513231E 7325306N
Map Sheet	76 I
Sampling History	Sampled by L. Nadeau 2012
Age	3117 ± 21
Interpretation	Igneous crystallization
Age	2379 ± 22
Interpretation	Metamorphic recrystallization
Age	1906 ± 13
Interpretation	Metamorphic recrystallization

Geological Field Relationships and Rock Description

This sample locality is within a major, north to northeast-striking magnetic high that extends for over 100 km near the western side of the Mesoarchean block. The outcrop is a fairly homogeneous, medium-grained, well foliated, migmatitic granitic gneiss with approximately 20% leucocratic stringers (Figure 10902-1). Mesoscopic folds define an early fabric that has been largely transposed into the main foliation (185°/40°) defined by the alignment of dispersed larger (< 0.5 mm) grains of orthopyroxene and ilmenite and less abundant magnetite and small biotite flakes. Some larger feldspar and quartz grains have a moderate shape fabric, but most have recrystallized to aggregates of equant grains. Orthopyroxene is variably fractured and rimmed by chlorite. Apatite is abundant.

Figure 10902- 1a: Orange rusty color on weathered surface reflecting disseminated magnetite alteration

Figure 10902- 1: Photograph of hand sample.

Zircon Description

Zircon occur as suhedral, prisms. Grains are generally of poor quality, with some turbidity and many fractures (Figure 10902-2). SEM BSE images reveal complex internal zonation. A significant subset of grains have prismatic habit and well developed oscillatory zoning (e.g. grains 3 and 81, Figure 10902-3). A subset of grains have more homogenous zones or rims that may preserve faint zoning.

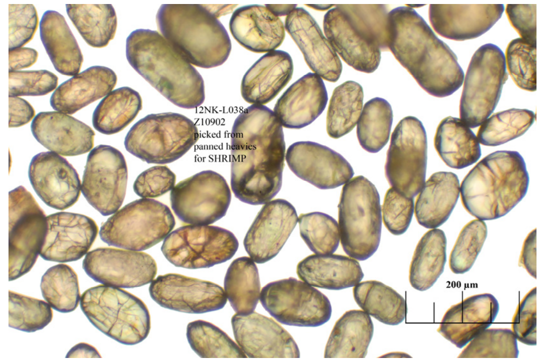

Figure 10902- 2: Transmitted light photomicrograph of zircon.

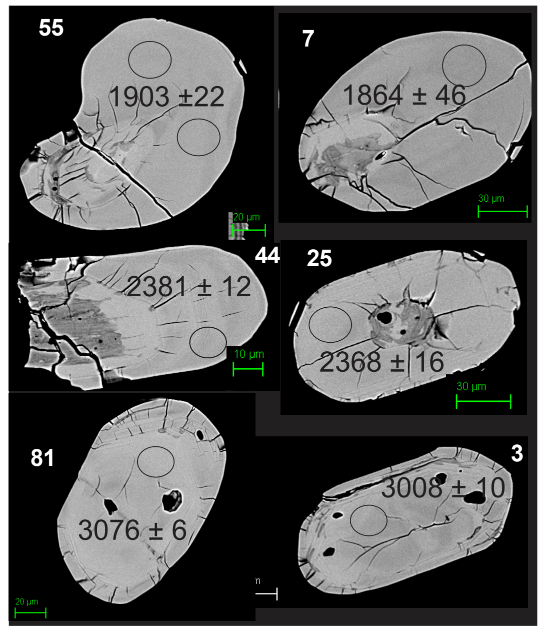

Figure 10902- 3: BSE SEM images of zircon textures. Ellipses indicate approximate location of analyses, ages are given in Ma with 1 σ error.

Results and Interpretation

Three different ages are recorded in this sample (Figure 10902-4). A Mesoarchean age population is derived from the oscillatory zoned prismatic zircon which yield discordant ages between 2.8 and 3.1 Ga. These data plot along a discordia array trending to a ~1.9 Ga lower intercept. Linear regression of these data (red ellipses) yields an upper intercept age of 3117 ±21 Ma (MSWD = 1.5), assuming a fixed lower intercept of 1906 ± 13 Ma (see below). A distinct population of zircon, also with oscillatory zoning (e.g grains 44 and 25, Figure 10902-3) yield concordant to discordant ages between ~2430 and 2217 Ma. The four oldest analyses (blue ellipses) yield an age of 2379 ± 22 Ma (MSWD = 2.5, probability = 0.055), with the younger ages along a discordia to a ~1.9 Ga lower intercept. The oscillatory zoning argues for growth from melt and these zircon may be associated with the leucosome phase described at this outcrop. Alternatively the 2379 ma zircon could date the rock itself with the Mesoarchean zircon being inherited. This interpretation is not favoured owing to the relative abundance of the two populations and the apparent unimodal age of the Mesoarchean zircon. Eight analyses from seven grains with homogenous rims yield a weighted mean age of 1906 ± 13 (MSWD = 1.8, probability = 0.079), interpreted as a second metamorphic event.

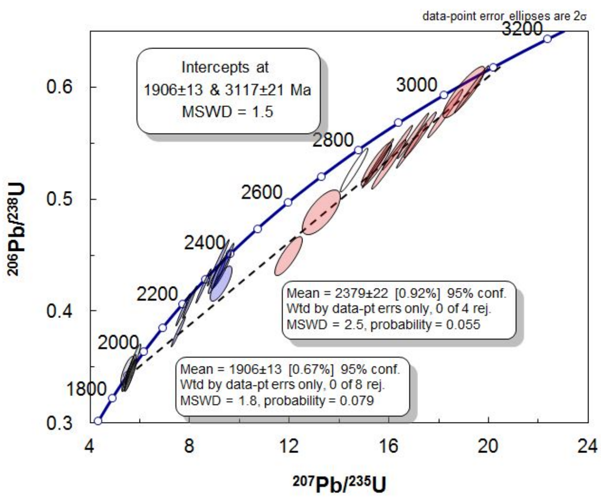

Figure 10902-4: U-Pb Concordia diagram showing Pb-loss from Mesoarchean zircon to 1906 Ma lower intercept. Note cluster at 2379 Ma.

12NK-L039: Peraluminous alkali feldspar granite tectonite

Sample	12NK-L039
Lab Number:	10903
Rock Type	Plutonic
Description	Peraluminous alkali feldspar granite tectonite
Geological Province	Rae
Domain	Mesoarchean block
Location	13 535615E 7324148N
Map Sheet	76 I
Sampling History	Sampled by L. Nadeau 2012
Age	No age.
Interpretation	zircon too altered

Geological Field Relationships and Rock Description

This sample is located in the western part of the Mesoarchean block, an area associated with a distinct, 25 x 10 km, north-striking magnetic low. The outcrop consists of a fairly homogenous, medium-grained (1-5 mm) alkali granite with a single very strong foliation (185/60W) and lineation (225°/35°) (Figure 10903-1). The very strong planar fabric is primarily defined by quartz ribbons with aluminous minerals (Fe-rich spinel and less abundant sillimanite) also forming discontinuous, concordant bands. Biotite is locally present, commonly with rims of spinel and either rutile or ilmenite. Feldspar occurs as granoblastic aggregates and rare porphyroclasts up to 1 cm long.

Figure 10903- 1: Photograph of rock sample. Coin for scale is 25 mm diameter.

Zircon Description

Zircon form subhederal altered crystals (Figure 10903-2). BSE SEM images show high degrees of alteration which precluded further analyses (Figure 10903-3).

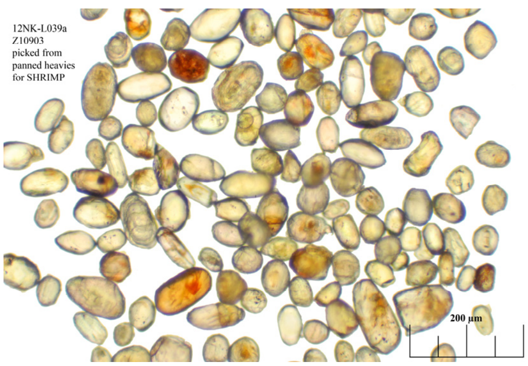

Figure 10903- 2: Transmitted light photomicrograph of zircon.

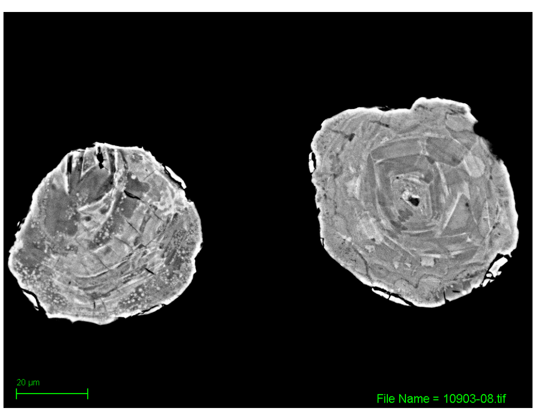

Figure 10903- 3: BSE SEM image of highly altered zircon.

Results and Interpretation

No data collected for this sample.

12NK-L044: Feldspar porphyroclastic monzogranite

Sample	12NK-L044
Lab Number:	10962
Rock Type	Plutonic
Description	Feldspar porphyroclastic monzogranite
Geological Province	Rae
Domain	Rae craton
Location	14 477812E 7316828N
Map Sheet	66 G
Sampling History	Sampled by L. Nadeau 2012
Age	2630.4 ± 3.3 Ma
Interpretation	Igneous crystallization

Geological Field Relationships and Rock Description

This sample was collected from the north shore of Lower Garry Lake, between the Chantrey fault zone and the Sherman basin. The area is characterized by a moderately low aeromagnetic fabric that is characteristic of the Rae craton in this region (Figure 2). The large outcrop at this location consists of a fairly homogenous, medium to coarse-grained, weakly foliated feldspar-porphyroclastic monzogranite (Figure 10962-1). In thin section, seriticized K-feldspar and plagioclase crystals up to 1 cm in length are partly to completely surrounded by a strongly foliated, fine-grained matrix of elongate quartz and plagioclase with green biotite, some larger brown biotite blades, and less abundant muscovite, epidote, and calcite. Rotation during deformation is indicated by many feldspar grains which are stepped along internal domains providing evidence of systematic offset along fractures.

Figure 10962- 1: Field photograph of weathered surface of outcrop.

Zircon Description

Zircon occur as colourless to pale brown, sunhedral, elongate prisms (Figure 10962-2). Most are strongly fractured and altered. BSE images reveal euhedral crystals with oscillatory zoning (figure 10962-3). There is no evidence of recrystallization although a number of grains show secondary alteration, particularly following original growth zoning.

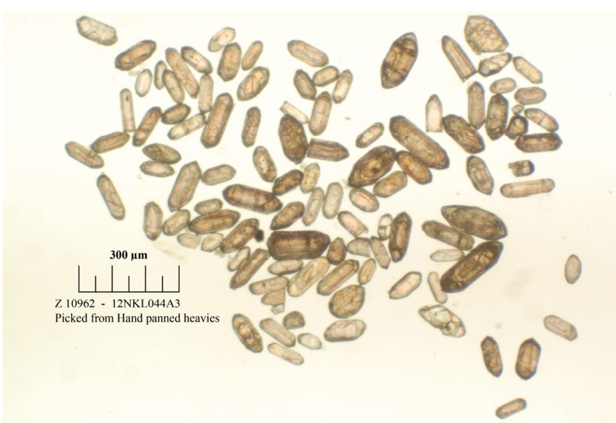

Figure 10962- 2: Transmitted light photomicrograph of typical zircon recovered from the sample.

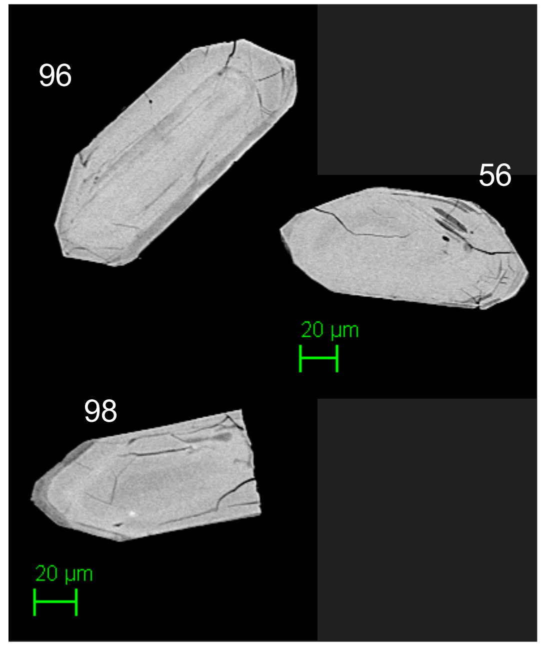

Figure 10962- 3: BSE SEM images of typical zircon crystals showing oscillatory zoning with areas of secondary alteration (darker) along original growth zones.

Results and Interpretation

Sixteen analyses yield a range of ages between ~2600 Ma and 2645 Ma (Figure 10962-4). Seven of the analyses of these analyses have overlapping ^{207}Pb/^{206}Pb ages with a weighted mean of 2630.4 ± 3.3 Ma (MSWD = 0.79, probability = 0.58). Three grains are older at 2645 Ma. The data plot along an array to ca. 2.3 Ga. If all grains have experienced some Pb-loss, the crystallization age may be as old as 2670 Ma.

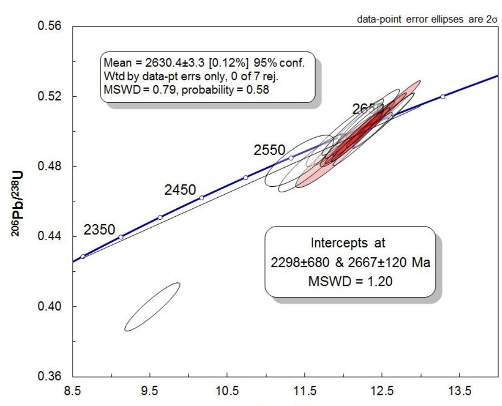

Figure 10962- 4: U-Pb Concordia diagram. Red ellipses used to calculate weighted mean age.

12PBA-008: Unfoliated hornblende monzodiorite

Sample	12PBA-008
Lab Number:	10878
Rock Type	Plutonic
Description	Hornblende monzodiorite
Geological Province	Rae
Domain	Rae craton
Location	15 373706E 7328033N
Map Sheet	56 L
Sampling History	Sampled by J. Percival 2012
Age	1822.3 ± 5.4 Ma
Interpretation	Igneous crystallization

Geological Field Relationships and Rock Description

The rock is a medium-grained, massive to weakly foliated hornblende monzodiorite (Figure 10878-1). It forms part of a ca. 1 x 3 km body of intermediate-composition rocks ranging from diorite to monzodiorite. Outcrops are variably transected by thin brittle-ductile shears. In thin section the rocks show pervasive alteration of mafic minerals to chlorite-epidote and feldspars to sausserite and sericite. The sample was collected to provide a maximum age constraint for movement on the Amer mylonite zone, located about 1 km to the south.

Figure 10878-1: Outcrop photograph of rock texture.

Zircon Description

Zircon recovery was very poor with most zircon occurring as subhedral, fractured prisms. Many grains show high degrees of alteration (Figure 10878-2).

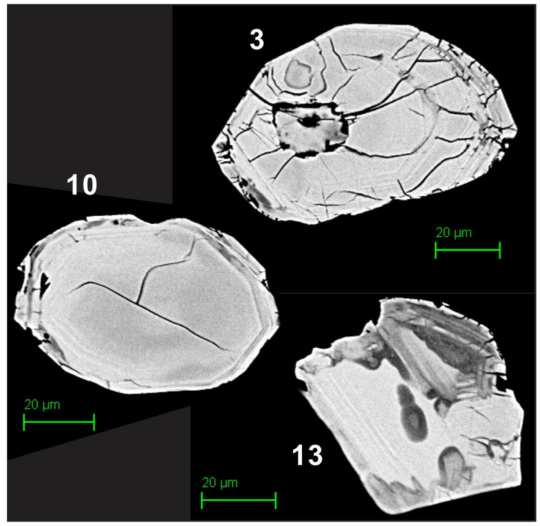

Figure 10878- 2: BSE SEM images of zircon showing oscillatory growth zoning and alteration.

BSE images highlight the significant alteration and reveal that unaltered portions of crystals preserve original igneous growth zoning (Figure 10878-2).

Results and Interpretation

Owing to the very poor quality of the zircon recovered only four analyses were undertaken on four grains. All four analyses plot within error of the concordia curve (Figure 10878-3) and give a weighted mean $^{207}Pb/^{206}Pb$ age of 1822.3 ± 5.4 Ma (MSWD = 0.58, probability = 0.62). Based on the oscillatory zoned nature of the crystals analyzed this is interpreted as the crystallization age of the pluton.

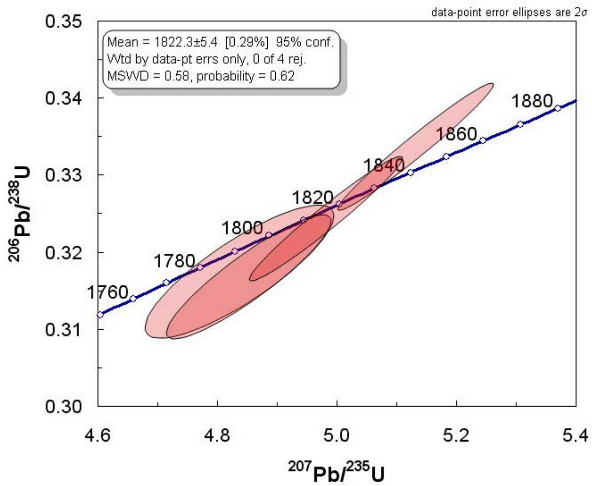

Figure 10878- 3: U-Pb Concordia diagram showing four concordant analyses to calculate age.

12PBA-013: Foliated garnet-orthopyroxene-biotite granodiorite diatexite

Sample	12PBA-13
Lab Number:	10879
Rock Type	Plutonic
Description	garnet-orthopyroxene-biotite granodiorite (diatexite)
Geological Province	Rae
Domain	Rae craton
Location	15 381502E 7400025N
Map Sheet	56 L
Sampling History	Sampled by J. Percival 2012
Age	2813.0 ±14.0 Ma
Interpretation	Inheritance
Age	1843.6 ± 7.2
Interpretation	Igneous crystallization

Geological Field Relationships and Rock Description

The sample was collected from the mouth of the Back River (Figure 2). The rock is a rusty weathering, medium to coarse-grained, sparsely K-feldspar porphyritic, weakly foliated, garnet-orthopyroxene-biotite granodiorite (diatexite, Figure 10879-1). Sparse biotite-rich layers and schlieren occur in parts of the outcrop. This ca. 1 km-wide, linear unit with low magnetic susceptibility is interlayered with more magnetic, hornblende-clinopyroxene –orthopyroxene quartz diorite orthogneiss, forming prominent magnetic lineaments in the Chantrey Inlet area. The sample was collected to determine the crystallization age of this sheet-like plutonic unit.

Figure 10879- 1: Photograph of outcrop rock texture.

Zircon Description

Zircon forms equant, subhedral to rounded grains ranging in size from 50 µm to 250 µm. Grains are of extremely poor quality, turbid, with numerous fractures (Figure 10879-2). In SEM BSE images most grains show oscillatory zoning with large areas of alteration preferentially developed along growth zones (Figure 10879-3). Many grains have homogenous outer rims that are less altered and appear to replace the oscillatory zoned cores (Grain 30, Grain 107).

Figure 10879- 2: Transmitted light photomicrograph of zircon prior to mounting.

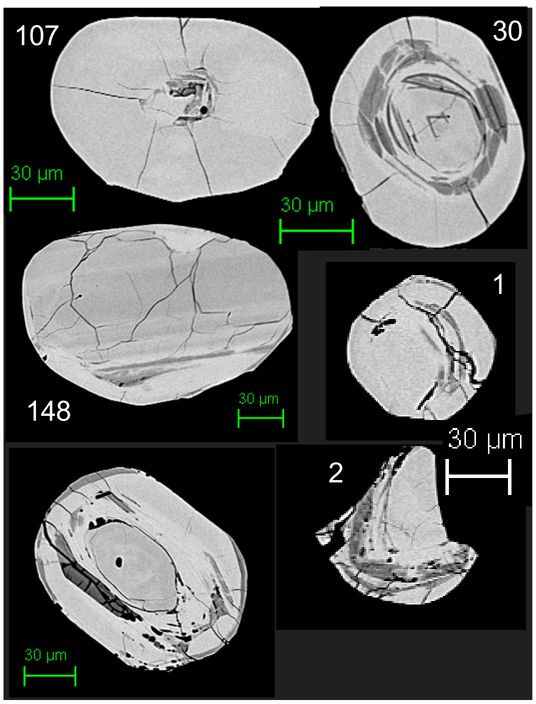

Figure 10879- 3: BSE SEM images of zircon showing internal zones with oscillatory growth zoning (enhanced by alteration in grain 30) with more homogenous outer rims.

Results and Interpretation

Data are plotted on a Concordia diagram in Figure 10879-4. Data from this sample is of poor overall quality owing to the poor quality of the target zircon. Analyses of the outer recrystallized rims give the most coherent results with eight concordant analyses yielding a weighted mean age of 1843.6 ± 7.2 Ma (MSWD = 0.65, probability = 0.71). A ninth analyses has a similar age but is more discordant, indicative of recent Pb-loss. The age is interpreted as the time of melting of the metasedimentary protolith and crystallization of the granodiorite sheet. Zircon of this age have low and homogenous Yb contents (40-60 ppm) and slightly elevated Hf contents (12000 ppm) and define a coherent compositional as well as age grouping.

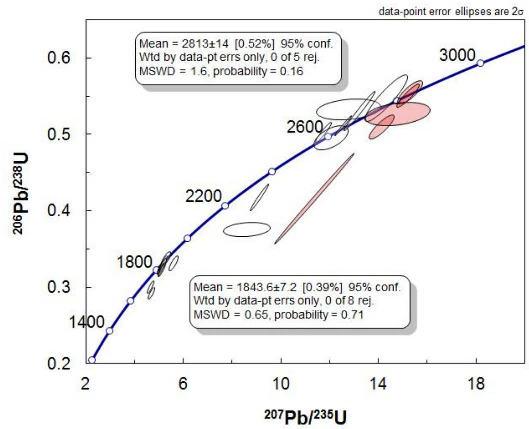

Figure 10879- 4: U-Pb Concordia diagram

Non-altered parts of oscillatory zones remaining within otherwise highly altered grains have a range of concordant to discordant ages from ~2.6 Ga to 2.85 Ga. A number of these analyses have measurement errors well above those expected from simple counting statistics suggesting Pb redistribution as a result of alteration or partial recrystallization (Davis et al. 2008; Valley et al. 2014). The five oldest analyses have a weighted mean $^{207}Pb/^{206}Pb$ age of 2813 ± 14 Ma (MSWD = 1.6, probability = 0.16), but only two of these analyses are concordant. The other Neoarchean analyses spread along or above the concordia curve to ages of ~2.6 Ga. The distribution of ages suggests that these analyses most likely represent the ages of detrital zircon in the metasedimentary protolith to the diatexite. The 2813 ± 14 Ma is the best estimate for the oldest grains within the rock.

12PBA-023: Foliated biotite granodiorite

Sample	12PBA-23
Lab Number:	10880
Rock Type	Plutonic
Description	Biotite granodiorite
Geological Province	**Rae**
Domain	Rae craton
Location	14 576600E 7343971N
Map Sheet	66 I
Sampling History	Sampled by J. Percival 2012
Age	2588.8 ± 3.0 Ma
Interpretation	Igneous crystallization

Geological Field Relationships and Rock Description

The rock is a pale grey weathering, medium-to coarse-grained, K-feldspar porphyritic, foliated biotite granodiorite (Figure 10880-1). It was collected to establish an age from a plutonic region of the Rae craton characterized by an homogeneous, low total magnetic field intensity.

Figure 10880-1: Photograph of outcrop showing weathered surface. Pen tip at left for scale.

Zircon Description

Zircon forms relatively clear, light brown euhedral prisms (Figure 10880-2). Oscillatory zoning is apparent in more turbid grains indicating some alteration.

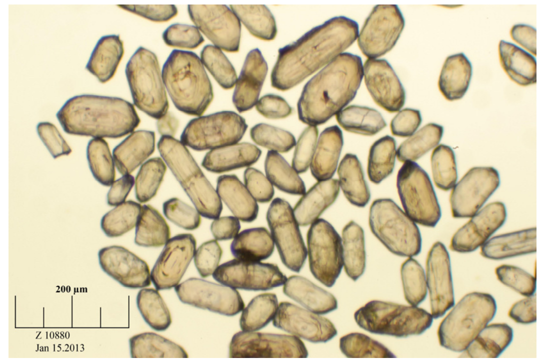

Figure 10880- 2: Transmitted light photomicrograph of zircon.

SEM BSE images reveal fine oscillatory zoning in most grains typical of igneous zircon growth (Figure 10880-3).

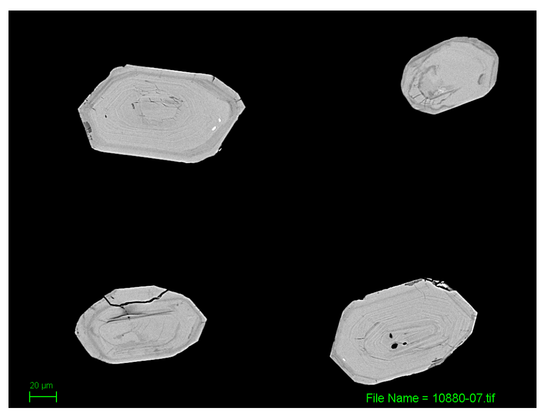

Figure 10880- 3: BSE SEM images of typical zircon grains showing oscillatory growth zoning.

Results and Interpretation

Twenty-three analyses of twenty-three grains have high U contents, with a median value of 650 ppm, and Th/U ratios of 0.1 -.02 consistent with a single igneous population. The measured U-Pb ages are concordant to <4% discordant (Figure 10880-4) with a weighted mean $^{207}Pb/^{206}Pb$ age of 2588.8 ± 2.0 Ma (1 of 23 rejected, MSWD = 3.7, probability = 0.000).

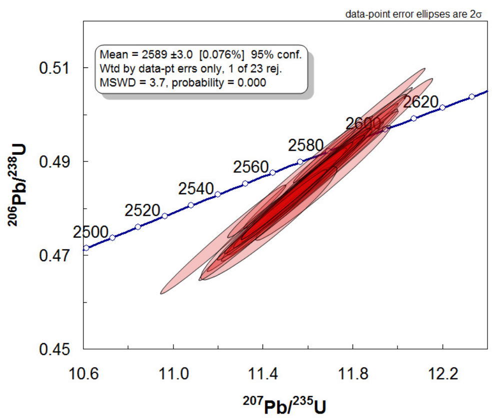

Figure 10880-4: U-Pb concordia diagram.

The high MSWD indicates excess scatter in the population which could indicate small amounts of Pb-loss, or the presence of antecrysts. The calculated error is significantly lower than the laboratories long term external reproducibility estimate of ± 3 Ma at 2.7 Ga. For this reason the error is increased to the external estimate and the age of the rock is 2588.8 ± 3.0 Ga.

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