GEOLOGICAL SURVEY OF CANADA

OPEN FILE 7409

U-Pb Geochronology of Archival Rock Samples from the Queen Maud Block, Thelon Tectonic Zone and Rae Craton, Kitikmeot Region, Nunavut, Canada

W.J. Davis, R.G. Berman and A. MacKinnon

2013

Natural Resources Canada Ressources naturelles Canada

Canada

GEOLOGICAL SURVEY OF CANADA
OPEN FILE 7409

U-Pb Geochronology of Archival Rock Samples from the Queen Maud Block, Thelon Tectonic Zone and Rae Craton, Kitikmeot Region, Nunavut, Canada

W.J. Davis, R.G. Berman and A. MacKinnon

2013

©Her Majesty the Queen in Right of Canada 2013

doi:10.4095/292663

This publication is available for free download through GEOSCAN (http://geoscan.ess.nrcan.gc.ca/).

Recommended citation

Davis, W.J., Berman, R.G., and MacKinnon, A., 2013. U-Pb Geochronology of archival rock samples from the Queen Maud block, Thelon tectonic zone and Rae Craton, Kitikmeot Region, Nunavut, Canada; Geological Survey of Canada, Open File 7409, doi:10.4095/292663

Publications in this series have not been edited; they are released as submitted by the author.

TABLE OF CONTENTS

INTRODUCTION 2

REGIONAL GEOLOGICAL SETTING 3

SUMMARY OF RESULTS 5

ANALYTICAL METHODS 6

SAMPLE DESCRIPTIONS AND ANALYTICAL RESULTS 8

Sample 10651 8
Sample 10652 11
Sample 10653 14
Sample 10654 17
Sample 10655 20
Sample 10656 23
Sample 10657 25
Sample 10658 28
Sample 10659 30
Sample 10660 33

ACKNOWLEDGEMENTS 36

REFERENCES 36

DIGITAL DATA

Appendix I containing the U-Pb analytical results is included as a digital data file in Microsoft Excel 2003 format.

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, 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). As part of this project U-Pb zircon geochronological investigations were carried out on archival samples originally collected as part of regional mapping projects of the Geological Survey of Canada in the 1950's and 1960's (Heywood, 1961; Fraser, 1964). The samples were archived at the GSC facility in Ottawa and geological information for the samples, with the exception of sample descriptions and lithology names, is derived from the original field and traverse notes.

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 = Chesterfiled 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.

This report presents U-Pb ages of zircon for ten samples that comprise a roughly east-west transect across the Thelon tectonic zone, Queen Maud block, and 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 interpretation of the U-Pb data are presented for each individual sample in following sections. The U-Pb analytical data are presented in Appendix 1.

Regional Geological Setting

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 to Prince of Wales and western Somerset Island. The similarities in magnetic fabrics and age of plutonic rocks suggest that the Ttz may have continuity with the Taltson magmatic zone

Figure 2. Regional aeromagnetic map showing locations of samples in this study and boundaries of principal tectonic domains discussed in text. Ages are indicated below lab number, regular font = igneous age, red italic font = metamorphic age. Ages and errors are rounded values from Table 1. See Table 1 for sample details. Abbreviations: Pb = plutonic belt, Sb = Sherman basin, fz = fault zone, tz = tectonic 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 collision of the Slave craton (Hoffman, 1988). An alternative model based on compositions of plutonic rocks proposes that this zone formed 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°N (van Breemen et al, 1987a, van Breemen and Henderson, 1988, James et al., 1988, Henderson and van Breemen, 1992), a central region between 66 °N and 67°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 Breemen 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 Breemen, 1990), and syntectonic, S-type granite was emplaced at 1908 ± 2 Ma (van Breemen et al., 1987) during granulite-facies metamorphism dated at 1906 ± 2 Ma (Roddick and van Breemen, 1994).

Queen Maud block (QMb):

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 very 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 (2007) report Nd model ages of 2.8-3.1 Ga for rocks in the northeastern part of the block. Recent U-Pb geochronological work based on geological transects in the eastern and northern part of the block is published by Schultz et al. (2007) and Tersmette (2012), respectively.

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 area of commonly orthopyroxene-magnetite-bearing, 2.52–2.45 Ga plutonic rocks corresponds to a NNE-striking magnetic high (Pb on Figure 2) (Schultz et al., 2007; Tersmette, 2012). To the east, this belt abuts a pronounced magnetic low associated with the Sherman group supracrustal rocks (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 indicate that the region to the west of the plutonic belt and east of the Ttz, dubbed the Perry River belt, consists dominantly of ca. 3.2-3.1 Ga granitoid gneiss intruded by 2.7 Ga plutons.

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 (Skulski et al., 2003) and Woodburn Lake groups (Fraser, 1988, Zaleski et al, 2000). The most voluminous component of the extensive granitoid domains is a suite of ca. 2.62 – 2.58 Ga plutons of dominantly monzogranitic composition (Skulski et al., 2003; Hinchey et al., 2011 and references therein). 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 therein). A northeast-striking foliation is characteristic of the region and is demonstrated to be a Paleoproterozoic fabric (Berman et al., 2005; 2012). Indentation of the Slave craton (Henderson et al., 1990) is considered to have driven dextral latest movement in the Chantrey fault zone (Hoffman, 1989; Frisch, 2000) and the Amer fault zone (Tella, 1994).

Summary of Results

A more complete geological synthesis of the area is ongoing and will follow this report. The main geological highlights resulting from this study are summarized below.

- The 3247 ± 10 Ma age for a sample of granitoid gneiss (10657) in the western part of the QMb significantly extends to the south the Mesoarchean crustal block identified along the Arctic coast by Tersmette (2012).

- Three granitoid samples (10659, 10658, 10660) yielded ca. 2580-2595 Ma crystallization ages, extending the regional distribution of this widespread plutonic event in the Rae further west than previously known.

- Two samples of plutonic rocks (10656, 10655) yielded ages of 2470 and 2492 Ma, further highlighting the regional significance of the 2.51-2.47 Ga plutonic event in the QMb. One sample (10656) is from the prominent magnetic high previously associated with these rocks by Schulz et al. (2007), whereas a second sample (10655) occurs to the west indicating

that plutonic rocks of this age are not limited to the previously identified eastern domain (Figure 2).

- Significant zircon recrystallization at 2320 ± 7 Ma in sample 10657, located in the westernmost part of the QMb, further highlights the regional significance of 2.3-2.4 Ga metamorphism related to the Arrowsmith Orogeny within the QMb.

- A 2005 ± 5 Ma crystallization age for a hornblende granodiorite (10651) provides additional evidence that this age represents the dominant time of plutonism along much of the Thelon tectonic zone in this area.

- Significant 1.91 Ga metamorphic recrystallization of zircon is documented in three samples (10651, 10653, and 10657) from within and from areas to the east of the Thelon tectonic zone. A fourth sample of leucogranite (10654) has a crystallization age of 1905 ± 4 Ma. The full extent of this regional metamorphic event remains to be discovered.

Analytical Methods

Samples were processed by electropulse disaggregation using a Spark2 (CNT-MC Inc.) instrument at Overburden Drilling in Ottawa. followed by sieving, and density separation using heavy liquids at the Geochronology facility, GSC, Ottawa. Zircon were separated based on magnetic properties using a Frantz Isodynamic separator. 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 characterized 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). 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 6222 with values of 229 and 8200 ppm respectively. Details of the analytical session, including spot size, number of scans, calibration error and the application 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.

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

Lab #	Sample	Rock Type	Rock Description	UTM Zone	East	North	NTS Million	NTS 250	NTS 50	Age (Ma)	Error (Ma)	Age Material	Age Method	Age Qualifier	Age Interpretation
10651	55-CD-159	Plutonic	hornblende-bearing granitic gneiss	13	527562	7283614	76	H	9	1906.0	10.0	Zircon	U/Pb	Direct	Metamorphic
10651	55-CD-159	Plutonic	hornblende-bearing granitic gneiss	13	527562	7283614	76	H	9	2004.8	5.3	Zircon	U/Pb	Direct	Igneous Crystallization
10652	55-EA-261A	Sedimentary	Ms-Bt metapsammite	13	543235	7279776	76	H	9	1940.0	-	Zircon	U/Pb	Maximum Estimate	Depositional
10653	55-EA-261B	Plutonic	Peraluminous granite	13	543235	7279776	76	H	9	1911.5	5.6	Zircon	U/Pb	Estimate	Metamorphic
10653	55-EA-261B	Plutonic	Peraluminous granite	13	543235	7279776	76	H	9	2492.0	6.0	Zircon	U/Pb	Minimum Estimate	Igneous Crystallization
10654	55-EA-265	Plutonic	Garnetiferous leucogranite	13	537970	7294180	76	H	16	1905.1	4.4	Zircon	U/Pb	Direct	Igneous Crystallization
10655	62-FD-080	Plutonic	Hbl-opx granite gneiss	14	379618	7395318	66	K	12	2492.3	8.5	Zircon	U/Pb	Direct	Igneous Crystallization
10656	62-FD-084	Plutonic	Hornblende-biotite tonalite	14	421151	7392854	66	K	10	2469.9	6.9	Zircon	U/Pb	Direct	Igneous Crystallization
10657	62-FD-125	Plutonic	Granitic gneiss	13	544022	7349672	76	I	8	1904.6	8.8	Zircon	U/Pb	Direct	Metamorphic
10657	62-FD-125	Plutonic	Granitic gneiss	13	544022	7349672	76	I	8	2320.0	7.0	Zircon	U/Pb	Direct	Metamorphic
10657	62-FD-125	Plutonic	Granitic gneiss	13	544022	7349672	76	I	8	3247.0	10.0	Zircon	U/Pb	Estimate	Igneous Crystallization
10658	60-HF-272	Plutonic	Hornblende-biotite granite	14	504469	7379630	66	J	10	2587.0	13.0	Zircon	U/Pb	Direct	Igneous Crystallization
10659	60-HF-275A	Plutonic	Foliated granite	14	472212	7380277	66	J	12	2594.8	4.7	Zircon	U/Pb	Maximum Estimate	Igneous Crystallization
10660	60-HF-010	Plutonic	Orthopyroxene tonalite	15	370464	7382550	56	L	12	1845.0	18.0	Zircon	U/Pb	Direct	Metamorphic
10660	60-HF-010	Plutonic	Orthopyroxene tonalite	15	370464	7382550	56	L	12	2565.0	13.0	Zircon	U/Pb	Minimum Estimate	Igneous Crystallization
10660	60-HF-010	Plutonic	Orthopyroxene tonalite	15	370464	7382550	56	L	12	2611.0	35.0	Zircon	U/Pb	Maximum Estimate	Igneous Crystallization

UTM coordinates in NAD 27 projection

Sample Descriptions and Analytical Results

10651: Hornblende-magnetite granodiorite gneiss

Sample Number: 55-CD-159 **Geochronology Lab Number:** 10651

Location

Lat and Long NAD27	65° 40' 29.6"N 104°24'1.3"W
UTM NAD 27	Zone 13 E527562 N7283614
Map Sheet 76H	

Geological Domain: Thelon tectonic zone

Sampling History

Sampled in 1955 by B.G. Craig. Collected from GSC archives April 2012.

Sample Preparation

Sample size: hand sample.
Electronic pulse disaggregation (EPD) at Overburden Drilling Management Inc., Ottawa. Heavy liquid separation in Methyl Iodide (MI) followed by Frantz™ Magnetic Separator. Zircon were hand picked from the NONMAG @ MAX 10°ss and mounted on an epoxy puck (IP642).

Sample Description

Figure 10651-1. Photograph of hand sample

The sample location corresponds to the western edge of a regionally extensive magnetic high that thins and becomes discontinuous ~9 km north of this location. This hornblende-magnetite granodiorite gneiss was collected from a small outcrop in an area with scant bedrock exposed. The rock has a weakly developed gneissosity with bands of hornblende and magnetite imperfectly segregated from aggregates of quartz, plagioclase, and K-feldspar (Figure 10651-1). Preferred shape fabric is largely absent, except for rare quartz and larger K-feldspar grains that are elongate parallel to the gneissosity. Within leucocratic layers, feldspar and quartz grains up to 5 mm in diameter are commonly surrounded by a fine-grained quartz-rich matrix. Magnetite grains up to 1 mm in diameter occur as inclusions in hornblende

and in the matrix along with minor ilmenite and pyrite. Biotite forms sparse isolated grains, but more commonly rims on magnetite and hornblende.

Zircon Description

The zircons recovered are of moderate overall quality and are prismatic stubby to elongate crystals (aspect ratio of 2-3:1). The grains are clear, colourless to light brown, and highly fractured. They range in size from 50 µm to 200 µm. Unidentified mineral inclusions are present in some grains (Figure 10651-2).

Figure 10651-2 Transmitted light image of zircon for sample 10651

In secondary electron microscope (SEM) backscatter electron (BSE) imaging the grains exhibit diffuse oscillatory zoning that is variably developed (Figure 10651-3B and 3C). Many grains contain brighter, relatively higher uranium interiors with darker, non-zoned outer rims. The contact between the zones is not generally sharp and the darker outer zones are interpreted as areas of recrystallization as opposed to new zircon growth.

Figure 10651-3 SEM BSE images of representative zircons from sample 10651
A) Grain 25, B) Grain 42,C) Grain 31.

Analytical details

Date analyzed	June 19-20, 2012.
Mount Number	642
Primary Calibration standard	6266
Error in Pb/U ratio from calibration	1.1%
External error in Pb/U ratio	0.31%
Data reduction software used	SQUID 2.22.08.04.30, rev. 30 Apr 2008
Kohler aperture	100 um
Spot size	~20 um
Primary Beam Intensity	4- 10 nA
Raster time	1.5 minutes
Scans per analysis	5
Secondary Standard	1242
Mass Fractionation value	No

Results and Age Interpretation

A total of 17 analyses were made on 12 individual grains. The analyses generally overlap the concordia curve and define two age populations which correspond to the two types of zircon domains described above. Eight analyses of the brighter interior domains yield a weighted mean age of = 2004.8 ± 5.3 Ma (0 of 8 rej. MSWD = 0.61, probability = 0.75). These analyses have U concentrations ranging from 240 to 620 ppm and Th/U ratios of 0.33-0.7. The darker outer parts of the zircon yield a younger weighted mean age of 1906 ± 10 Ma (0 of 8 rej. MSWD = 0.46, probability = 0.87). These analyses have lower U contents of 60-190 ppm. A single concordant analyses (white) has an intermediate age of 1968 Ma which could reflect overlapping of the two domains by the beam or incomplete Pb-loss from the area analyzed. The older age of 2004.8 ± 5.3 Ma is interpreted as the time of igneous crystallization of the rock, whereas the 1906 ± 10 Ma age is interpreted to reflect recrystallization of zircon during a younger metamorphic event.

Figure 10651-4 U-Pb Concordia diagram for sample 10651. Red ellipses represent analyses of darker outer domains, grey ellipses represent analyses of interior brighter domains.

10652: Ms-Bt Metapsammite

Sample Number: 55-EA-261A **Geochronology Lab Number:** 10652

Location

Lat and Long NAD27 65°38'19.5"N 104°3'38.4"W
UTM NAD27 Zone 13 E543235 N7279776
Map Sheet 76H

Geological Domain: Queen Maud block

Sampling History

Sampled in 1955 by K.E. Eade. Collected from GSC Archives March 2012.

Sample Preparation

Sample size: hand sample.
Electronic pulse disaggregation (EPD) at Overburden Drilling Management Inc., Ottawa. Heavy liquid separation in Methyl Iodide (MI) heavy liquids followed by Frantz™ Magnetic Separator. Zircon were hand picked from the MAG @ 1.0A and the NONMAG @ 1.0A fractions and mounted on an epoxy puck IP642.

Sample Description

The sample location is near the southern end of a 20 x 35 km magnetic low on the west side of Queen Maud block. This sample was originally descriped as a highly strained granitic gneiss but has been reinterpreted to be of metasedimentary origin. The outcrop consists of strongly foliated (065/40°) metapsammite, interpreted to have been intruded by a massive plutonic rock (z10653). The fine-grained metapsammite consists of mm-scale quartzofeldspathic bands alternating with bands rich in muscovite and biotite blades that are aligned parallel to the layering. The grain size is generally < 0.1 mm, except for some attenuated, foliation-parallel quartz crystals within leucocratic layers. Accessory minerals are monazite (abundant), apatite, and zircon.

Figure 10652-1 Photograph of sample z10652

Zircon Description

The zircon recovered are ovoid stubby to subhedral prismatic crystals (aspect ratio of 1-3:1). The grains are generally of poor quality, moderately turbid, light brown with some red-orange iron staining and show minor fracturing. Grain size ranges from 50 µm to 200 µm. Unidentified inclusions are present in some grains (Figure 10652- 2A and 2B).

In SEM BSE images the grains exhibit a high degree of alteration. Many grains show brighter zircon interiors with dark alteration around the margins. Occasionally the alteration develops as embayments into the grain interior (Figure 10652- 3A). Little internal zonation is revealed under BSE but faint oscillatory zoning is evident is some grains (Figure 10652- 3B). In some cases, well developed oscillatory zoning can be seen along with radial fracturing of rims due to metamictizaton (Figure 10652- 3C).

Figure 10652- 2 Transmitted light images of zircon A) Mag @ 1.0A fraction B) Non-mag @ 1.0A fraction

Figure 10652-3 SEM BSE images of representative zircon A) Grain 25 B) Grain 22 C) Grain 34

Analytical Details

Date analyzed	June 19-20, 2012.
Mount Number	642
Primary Calibration standard	6266
Error in Pb/U ratio from calibration	1.1%
External error in Pb/U ratio	0.31%
Data reduction software used	SQUID 2.22.08.04.30, rev. 30 Apr 2008
Kohler aperture	100 um
Spot size	~20 um
Primary Beam Intensity	4- 10 nA
Raster time	1.5 minutes
Scans per analysis	5
Secondary Standard	1242
Mass Fractionation value	No

Results and Age Interpretation

A total of 12 analyses were made on 12 individual grains. The analyses have a range of $^{207}Pb/^{206}Pb$ ages from about 2500 Ma to 1940 Ma (Figure 10652- 4). The $^{207}Pb/^{206}Pb$ model age does not correlate with a particular zircon texture or grain type. The sample is dominated by zircon with Paleoproterozoic ages and assuming that the zircon represent detrital material then this rock is Paleoproterozoic, with a maximum age given by the youngest concordant result at 2.0 Ga. However it is known that zircon from rocks in this area have experienced high-grade metamorphism at ~1.9 Ga which caused extensive Pb-loss from zircon at that time. Therefore, it remains possible that the metasedimentary rock is older and zircon lost Pb during a metamorphic recrystallization at or after ~1.94 Ga.

Figure 10652- 4 U-Pb Concordia diagram for sample 10652. Error ellipses are 2σ.

10653: Peraluminous Granite

Sample Number: 55-EA-261B **Geochronology Lab Number:** 10653

Location

Lat and Long NAD27	65° 38’ 19.5”N 104° 3’ 38.4”W
UTM NAD 27	Zone 13 E543235 N7279776
Map Sheet 76H	

Geological Domain: Queen Maud block

Sampling History

Sampled in 1955 by K.E. Eade. Collected from GSC archives April 2012.

Sample Preparation

Sample size: hand sample.
Electronic pulse disaggregation (EPD) at Overburden Drilling Management Inc., Ottawa. Heavy liquid separation in Methyl Iodide (MI) heavy liquids followed by Frantz™ Magnetic Separator. Zircon were hand picked from the NONMAG @ MAX 10°ss and the MAG @ MAX 10°ss fractions and mounted on an epoxy puck (IP642) for SHRIMP analysis.

Sample Description

The sample location is near the southern end of a 20 x 35 km magnetic low on the west side of Queen Maud block. At this sample location, a strongly foliated metapsammite (z10652) was interpreted to be intruded by a more massive-looking plutonic rock (z10653, this sample). The sample is a well-foliated peraluminous granite, with the foliation defined by highly attenuated quartz and K-feldspar crystals (up to 1 x 6 mm in size) surrounded by a fine-grained, recrystallized quartzofeldspathic matrix. Aluminous phases include anhedral, fractured garnet, prismatic sillimanite, and highly embayed Fe-rich spinel that is commonly rimmed by sillimanite . Ilmenite is common, and rutile is present.

Figure 10653-1 Photograph of sample 10653.

Zircon Description

The zircon recovered from this sample is of poor quality, and includes equant to prismatic crystals (aspect ratio of 1-2:1) with rounded terminations. The grains show a low to high turbidity and are colourless to light brown in colour. They range in size from 50 µm to 250 µm. Moderate fracturing and unidentified inclusions are present in some of the grains (Figure 10653-2).

Figure 10653-2 Transmitted light image of pre-mounted zircons from sample 10653

In SEM BSE images the grains generally exhibit bright interiors with either flat, homogenous texture (Figure 10653-3A) or oscillatory zoning (Figure 10653-3B). All grains have darker altered rims (Figure 10653-3A and 3B).

Figure 10653-3 SEM BSE images of representative zircons from sample 10653 A) Grain 4 B) Grain 5.

Analytical details

Date analyzed	June 20, 2012.
Mount Number	642
Primary Calibration standard	6266
Error in Pb/U ratio from calibration	1.1%
External error in Pb/U ratio	0.31%
Data reduction software used	SQUID 2.22.08.04.30, rev. 30 Apr 2008
Kohler aperture	100 um
Spot size	~20 um
Primary Beam Intensity	4- 10 nA
Raster time	1.5 minutes
Scans per analysis	5
Secondary Standard	1242
Mass Fractionation value applied	No

Results and Age Interpetation

A total of 14 analyses were made on 14 individual grains in the sample. The $^{207}Pb/^{206}Pb$ model ages range from 2492 Ma to about 1907 Ma. Uranium content is high and variable with values from 130 to 5600 ppm. Th/U ratios are variable (0.01-0.6). The three youngest analyses have

amongst the highest uranium contents (>900 ppm) but a consistent correlation of U and age is not observed. The younger analyses also tend to have higher Hf contents (>13000 ppm). The highest U content (5600 ppm) was determined from a darker zone that is altered and contains significant common Pb. The two youngest analyses have ages at 1911.5 ± 5.6 Ma. These analyses are from grains that have flat homogenous textures in BSE (e.g. grain 4; Figure 10653-3) which may indicate recrystallization as zircon with older apparent ages typically exhibit remnants of faint oscillatory zoning. The younger ages at ~1.91 Ga are interpreted to reflect metamorphic recrystallization of older zircon, and the spread in ages reflects variable degrees of Pb-loss. A 1.91 Ga metamorphic event is well documented regionally supporting this interpretation. The crystallization age of the rock is not determined but is likely to be older than 2.5 Ga.

Figure 10653-4 U-Pb Concordia diagram for sample 10653.

10654: Garnetiferous Leucogranite

Sample Number: 55-EA-265 **Geochronology Lab Number:** 10654

Location

Lat and Long NAD27 65°46'7"N 104°10'15.3"W
UTM NAD 27 Zone 13 E537970 N7294180
Map Sheet 76H

Geological Domain: Queen Maud block

Sampling History

Sampled in 1955 by K.E. Eade. Collected from the GSC archives in March, 2012

Sample Preparation

Sample size: hand sample
Electronic pulse disaggregation (EPD) at Overburden Drilling Management Inc., Ottawa. Heavy liquid separation in Methyl Iodide (MI) heavy liquids followed by Frantz™ Magnetic Separator. Zircons were hand picked from the NONMAG @ MAX 10°ss fraction and mounted on an epoxy puck (IP642) for SHRIMP analysis.

Sample Description

The sample was collected from an area of abundant outcrop within a well-defined 20 x 35 km magnetic low on the west side of Queen Maud block. The outcrop contains massive to weakly foliated (005/90) garnet leucogranite interspersed with pink granitic gneiss. The leucogranite sample contains ~5 % equant, < 3 mm-diameter garnet grains that commonly have fractures filled with very fine-grained biotite needles. A moderate shape fabric is displayed by larger quartz grains set in a fine-grained matrix. Zircon and monazite form large grains up to 0.2 x 0.4 mm in size.

Figure 10654-1 Photograph of sample 10654.

Zircon Description

The zircon recovered from this sample are of moderate quality and consist of euhedral, stubby to elongate crystals (aspect ratio of 1.5-3:1). Some rounded equant grains were also present. The grains are clear and colourless to light brown showing minimal fracturing and very few inclusions (Figure 10654-2).

Figure 10654-2 Transmitted light images of zircon from sample 10654.

Figure 10654-3 SEM BSE images of representative zircons from sample 10655 A) Grain 7 B) Grain 23 C) Grain 60

The SEM BSE images reveal bright interiors and darker altered margins. Some grains appear to be highly altered around the perimeter (Figure 2A and 2B) and occasionally penetrating into grain interios (Figure 2A). Oscillatory zoning of the margins is sometimes present but weakly defined (Figure 2C).

Analytical details

Date analyzed	June 19-20, 2012.
Mount Number	642
Primary Calibration standard	6266
Error in Pb/U ratio from calibration	1.1%
External error in Pb/U ratio	0.31%
Data reduction software used	SQUID 2.22.08.04.30, rev. 30 Apr 2008
Kohler aperture	100 um
Spot size	~20 um
Primary Beam Intensity	4- 10 nA
Raster time	1.5 minutes
Scans per analysis	5
Secondary Standard	1242
Mass Fractionation value	No

Results and Age Interpretation

Ten analyses of high uranium zircon yield a single age population with a weighted mean $^{207}Pb/^{206}Pb$ age of 1905.1 ± 4.4 (MSWD = 2.6, probability = 0.006). The zircon are enriched in uranium with contents of 500-1800 ppm and Th/U ratios of 0.1 to 0.2. The grains show evidence of sector and oscillatory zoning and the age is interpreted as the crystallization age of the rock.

Figure 10654-4 U-Pb Concordia diagram for sample 10654.

10655: Hornblende-orthopyroxene Granite Gneiss

Sample Number: 62-FD-080 **Geochronology Lab Number:** 10655

Location

Lat and Long NAD27	66°39'16.6"N 101°43'22.5"W
UTM NAD 27	Zone 14 E379618 N7395318
Map Sheet 66K	

Geological Domain: Queen Maud block

Sampling History

Sampled in 1955 by J. A. Fraser. Collected from GSC archives April 2012.

Sample Preparation

Sample size: hand sample
Electronic pulse disaggregation (EPD) at Overburden Drilling Management Inc., Ottawa. Heavy liquid separation in Methyl Iodide (MI) heavy liquids followed by Frantz™ Magnetic Separator. Zircon were hand picked from the NONMAG @ MAX 10°ss and mounted on an epoxy puck (IP642) for SHRIMP analysis.

Sample Description

The location where this sample was collected corresponds to a ~8 km-long magnetic high that is oriented approximately parallel to the 335/30° foliation measured in outcrop, at a high angle to the magnetic fabric immediately to the west. In this medium-grained (< 1 mm) sample, aggregates of equant to somewhat elongate grains of hornblende occur with sparse orthopyroxene, ilmenite, and magnetite. Whereas orthopyroxene commonly rims magnetite, a consistent reaction relationship between hornblende and orthopyroxene is not evident. The leucocratic component of the rock consists of irregular, equant grains of K-feldspar, plagioclase, and lesser quartz, suggesting post-tectonic recrystallization.

Figure 10655-1 Transmitted light images of zircon from sample 10655

Zircon Description

The zircon recoverd from this sample is of good to excellent quality, well faceted to subhedral, prismatic to elongate crystals (aspect ratio of 2-3:1). The grains are clear and colourless with some iron staining, minor fracturing and fluid and mineral inclusions.

The SEM BSE images reveal irregular zoning with darker interiors and brighter margins. Grain interiors exhibit faint oscillatory and sometimes sector zoning (Figure 10655-3B). The brighter margins are flat and homogenous (Figure 10655-3A). The contacts between the interior and exterior areas are generally faded, irregular and tend to follow the zone boundaries.

Figure 10655-2 BSE SEM images and individual ages for grains 34 (A) and 65 (B)

Analytical details

Date analyzed	June 19-20, 2012.
Mount Number	642
Primary Calibration standard	6266
Error in Pb/U ratio from calibration	1.1%
External error in Pb/U ratio	0.31%
Data reduction software used	SQUID 2.22.08.04.30, rev. 30 Apr 2008
Kohler aperture	100 um
Spot size	~20 um
Primary Beam Intensity	4- 10 nA
Raster time	1.5 minutes
Scans per analysis	5
Secondary Standard	1242
Mass Fractionation value	No

Results and Age Interpretation

Twenty-seven analyses were made on nineteen grains targeting the dark grain interiors as well as the brighter grain margins. Thirteen of the analyses of grain interiors (red ellipses in Figure 10655-3) define a concordant cluster with a weighted mean age of 2492.3 ± 8.5 Ma (MSWD = 1.4, probability = 0.17) which is interpreted as the crystallization age of the rock (red ellipses Figure 10655-3). Nine analyses of the brighter zones have younger ages between 2430 and 2380 Ma and have higher Hf contents and lower Th/U ratios. These zones are interpreted to represent recrystallized areas of the older zircon. The analyses do not define a coherent age population and the timing of the recrystallization is undetermined. It could be as old as 2380 Ma or as young as 1900 Ma as the younger analyses plot along a reference discordia to a lower intercept of ~1900

Ma which may reflect partial Pb-loss at that time. A 2380 Ma age is consistent with estimates for high-grade metamorphism in some parts of the QMb (Schultz et al. 2007).

Figure 10655-3 U-Pb Concordia diagram for sample 10655. Red ellipses are analyses of grain interiors.

10656: Hornblende-Biotite Tonalite

Sample Number: 62-FD-084 **Geochronology Lab Number:** 10656

Location

Lat and Long NAD27	66°38'45.5"N 100°46'57.4"W
UTM NAD 27	Zone 14 E421151 N7392854
Map Sheet 66K	

Geological Domain: Queen Maud block

Sampling History

Sampled in 1962 by J. A. Fraser and collected from GSC archives April 2012.

Sample Preparation

Sample size: hand sample
Electronic pulse disaggregation (EPD) at Overburden Drilling Management Inc., Ottawa. Heavy liquid separation in Methyl Iodide (MI) heavy liquids followed by Frantz™ Magnetic Separator. Zircons were hand picked from the NONMAG @ MAX 10°ss and mounted on an epoxy puck (IP646) for SHRIMP analysis.

Sample Description

This sample location corresponds to the west flank of a strong, regionally extensive, NNE-striking magnetic high on the east side of Queen Maud block, just north of Armark Lake. A 155/55° foliation was measured in the outcrop. In this sample randomly oriented, phenocrysts of plagioclase up to 5 mm in length are set in a finer grained (< 1 mm) matrix of quartz, plagioclase, hornblende, and biotite. A weak foliation is defined by most biotite and some elongate hornblende grains. Where biotite appears to have formed from hornblende breakdown, it defines a second fabric at a high angle to the first. Apatite is abundant, allanite occurs as inclusions in hornblende, and magnetite is sparse.

Figure 10656-1 Transmitted light image of zircon from sample 10656

Zircon Description

The zircon recovered is of poor to moderate quality, well faceted to subhedral, stubby to prismatic crystals (aspect ratio of 1.5-2:1) (Figure 10656-1). The grains are clear to moderately turbid and colourless to light brown. Some inclusions are present and most grains are highly fractured. They range in size from 100 µm to 400 µm in the long dimension.

In SEM BSE imaging the grains generally exhibit concentric to irregular zoning (Figure 10656-2a, b). Some grains have brighter interiors surrounded by darker margins (Figure 10656-2C).

Figure 10656-2 SEM BSE images of representative zircons from sample 10656 A) Grain 5, B) Grain 38, C) Grain 7.

Analytical details

Date analyzed	June 27, 2012
Mount Number	646
Primary Calibration standard	6266
Error in Pb/U ratio from calibration	1.36%
External error in Pb/U ratio	: 0.34%
Data reduction software used	SQUID 2.22.08.04.30, rev. 30 Apr 2008
Kohler aperture	100 um
Spot size	~20 um
Primary Beam Intensity	7-8 nA
Raster time	1.5 minutes
Scans per analysis	5
Secondary Standard	1242
Mass Fractionation value	No

Results and Age Interpretation

A total of 21 analyses were completed on 20 grains. Uranium contents vary from 120 to 700 ppm with Th/U ratios of 0.4-1.1. A single age population is defined with a weighted mean $^{207}Pb/^{206}Pb$ age of 2469.9 ± 6.9 Ma (MSWD = 2.0, probability = 0.005, 20 of 21). There is some excess scatter in the data as indicated by the low probability of fit, which may be due to minor Pb-loss. The age is interpreted as the time of crystallization of the granite (Figure 10656-3).

Figure 10656-3 U-Pb Concordia diagram.

10657: Feldspar porphyroclastic Granitic Gneiss

Sample Number: 62-FD-125 **Geochronology Lab Number:** 10657

Location

Lat and Long NAD27	66°15'56.2"N 104°1'11.5"W
UTM NAD 27	Zone13 E544022 N7349672
Map Sheet 76I	

Geological Domain: Queen Maud block

Sampling History

Sampled in 1962 by J. A. Fraser. Collected from GSC archives April 2012.

Sample Preparation

Sample size: hand sample
Electronic pulse disaggregation (EPD) at Overburden Drilling Management Inc., Ottawa. Heavy liquid separation in Methyl Iodide (MI) heavy liquids followed by Frantz™ Magnetic Separator. Zircons were hand picked from the NONMAG @ MAX 10°ss and mounted on an epoxy puck (IP647) for SHRIMP analysis.

Sample Description

This sample locality from the west side of QMb corresponds to the north-striking, west flank of a region that appears from its magnetic fabric to have been complexly folded. A 355/55° foliation was measured in outcrop. This granite gneiss is characterized by K-feldspar and plagioclase porphyroclasts up to 7 mm in length that are enveloped by fine-grained biotite, feldspars, and attenuated quartz that define a crenulated, strong foliation. Abundant epidote forms texturally early crystals in places folded around plagioglase porphyroclasts, as well as late crystals that have overgrown foliation-defining biotite. Accessory phases include apatite, titanite, magnetite, pyrite, and pyrrhotite.

Zircon Description

Zircon recovered from this rock is of poor to moderate quality. Grain morphology is dominated by well faceted subequant to elongate prismatic crystals (aspect ratio of 2-3:1). The grains are clear to highly turbid and light brown to dark brown in colour. Many grains exhibit extensive metamictization. Some unidentified inclusions are present and most grains are extensively fractured. They range in size from 50 to 400 µm in the long dimension (Figure 10657-1).

In SEM BSE imaging the zircons display highly variable textures. A significant population preserves well defined oscillatory zoning which is in places recrystallized to a homogenous, brighter zircon (Figure 10657-2A). Many grains show extensive zones of recrystallization that appear as irregular brighter BSE zones (Figure 10657-2B). These zones may be confined to the outer rim of crystals, or penetrate irregularly throughout the grain interior.

Figure 10657-1 Transmitted light image of pre-mount zircons from sample 10657.

Figure 10657-2 SEM BSE images of representative zircon from sample 10657

Analytical details

Date analyzed	June 28-29, 2012
Mount Number	647
Primary Calibration standard	6266
Error in Pb/U ratio from calibration	1.25%
External error in Pb/U ratio	0.30%
Data reduction software used	SQUID 2.22.08.04.30, rev. 30 Apr 2008
Kohler aperture	100 um
Spot size	~20 um
Primary Beam Intensity	6-8 nA
Raster time	1.5 minutes
Scans per analysis	5
Secondary Standard	1242
Mass Fractionation value	No

Results and Age Interpretation

Thirty-two analyses were made on twenty individual crystals. Three principal age groupings were determined (Figure 10657-3): 1) zircon with Archean ages from 2.75 Ga to 3.25 Ga; 2) a group of zircon of variable composition with ages between 2.31 and 2.39 Ga; and 3) zircon with ages between 1.90 and 1.95 Ga. None of the three groups define a single age population. The

Archean zircons typically preserve oscillatory zoning and occur as individual crystals or as cores within partially recrystallized grains. The U-Pb data for these analyses spread along a reference discordia from 3247 ± 10 Ma, the weighted mean age of the two oldest analyses, to ~2350 Ma, a time of extensive zircon recrystallization and partial Pb-loss. The 3247 ± 10 Ma age is the preferred estimate for the original crystallization age of the sample with the other Archean grains recording variable amounts of Paleoproterozoic Pb-loss. Fifteen analyses of zircon have ages between 2392 ± 10 Ma and 2305 ± 10 Ma. These analyses include zircon with variable textures and a wide range in Th/U composition between 0.01 and 1.4. The eleven youngest of these analyses have relatively high Th/U ratios (>0.1) and define an age of 2320 ± 7 Ma (MSWD = 2.4, probability = 0.008). The four older analyses have lower Th/U ratios, recrystallized textures and ages of ca. 2370-2390 Ma. The data argue for episodic metamorphic recrystallization during this interval. A second metamorphic episode is recorded by the five youngest analyses is dated at 1904.6 ± 8.8 Ma (MSWD = 1.2, probability = 0.30). As with the ~2.3 Ga metamorphic event, the data do not define a single age population pointing to inheritance and/or protracted metamorphic recrystallization over the interval 1970 -1905 Ma.

Figure 10657-3 Concordia diagram for sample 10657. Dashed line is reference discordia between 3.25 and 2.35 Ga. Mean ages are $^{207}Pb/^{206}Pb$ ages.

10658: Hornblende-biotite Granite

Sample Number: 60-HF-272 **Geochronology Lab Number:** 10658

Location

Lat and Long NAD27	66°32'14.7"N 98°53'57.9"W
UTM NAD 27	Zone 14 E504469 N7379630
Map Sheet 66J	

Geological Domain: Queen Maud blcok

Sampling History

Sampled in 1960 by W.W. Heywood. Collected from GSC archives April 2012.

Sample Preparation

Sample size: hand sample
Electronic pulse disaggregation (EPD) at Overburden Drilling Management Inc., Ottawa. Heavy liquid separation in Methyl Iodide (MI) heavy liquids followed by Frantz™ Magnetic Separator. Zircon were hand picked from the NONMAG @ MAX 10°ss and mounted on an epoxy puck (IP647) for SHRIMP analysis.

Sample Description

The location of this sample corresponds to a pronounced magnetic high more than 20 x 180 km in size and striking northeast on the east side of the Sherman basin. This medium-grained (< 2 mm) granite has a moderately developed foliation defined by thin bands of hornblende and biotite and a weak shape fabric in feldspar and quartz crystals. Magnetite forms anhedral, interstitial grains less than 0.1 mm in size. Accessory minerals include titanite, apatite, epidote, and pyrite.

Zircon Description

Zircon is of poor to moderate quality, well faceted to subhedral and prismatic to elongate crystals (aspect ratio of 2-3:1). The grains are highly fractured, clear to somewhat turbid and colourless to light brown. They range in size from 50 µm to 400 µm in long dimension (Figure 10658-1).

In SEM BSE imaging the grains display bright interiors with concentric zoning typical of magmatic crystallization (Figure 10658-2A, B, C). Radial fracturing of outer margins from metamictization is present in some grains (Figure 10658-2A). There is no evidence for extensive recrystallization.

Figure 10658-1 Transmitted light image of zircon from sample 10658.

Figure 10658-2 SEM BSE images of representative zircons from sample 10658.

Analytical details

Date analyzed	June 28-29, 2012
Mount Number	647
Primary Calibration standard	6266
Error in Pb/U ratio from calibration	1.25%
External error in Pb/U ratio	0.30%
Data reduction software used	SQUID 2.22.08.04.30, rev. 30 Apr 2008
Kohler aperture	100 um
Spot size	~20 um
Primary Beam Intensity	6-8 nA
Raster time	1.5 minutes
Scans per analysis	5
Secondary Standard	1242
Mass Fractionation value	No

Results and Age Interpretation

A total of thirteen analyses yield a weighted mean $^{207}Pb/^{206}Pb$ age of 2594 ± 13 Ma (MSWD = 3.3 probability = 0). The population exhibits excess scatter. Three analyses have slightly older ages of ~2.62 Ga and may represent xenocrysts (Figure 10658-3). Excluding these three analyses yields a weighted mean age of 2581 ± 12 Ma (MSWD = 1.5, probability = 0.14). The Tukey biweight means age is 2587 ± 13 Ma, overlaps the weighted mean ages. As this method is more resistant to outliers it is taken as the preferred age of the rock.

Figure 10658- 3 U-Pb Concordia diagram for sample 10658.

10659: Foliated Granite

Sample Number: 60-HF-275A **Geochronology Lab Number:** 10659

Location

Lat and Long NAD27 66°32'31.2"N 99°37'31.9"W
UTM NAD 27 Zone 14 E472212 N7380277
Map Sheet 66J

Geological Domain: Queen Maud block

Sampling History

Sampled in 1960 by W.W. Heywood. Collected from GSC archives April 2012

Sample Preparation

Sample size: hand sample
Electronic pulse disaggregation (EPD) at Overburden Drilling Management Inc., Ottawa. Heavy liquid separation in Methyl Iodide (MI) heavy liquids followed by Frantz™ Magnetic Separator. Zircon were hand picked from the NONMAG @ MAX10°ss and mounted on an epoxy puck (IP648) for SHRIMP analysis.

Sample Description

This sample is located near the northern edge of a small, but pronounced magnetic high that is truncated by the eastern boundary of the Sherman basin. This strongly foliated granite has feldspar crystal up to 2 mm in diameter surrounded by a finer-grained matrix in which many feldspars grains, but particularly quartz crystals show a strong shape fabric. Fine-grained biotite blades are generally aligned with the foliation, as is the more abundant chlorite. Epidote forms small crystals at a high angle to the foliation, suggesting post-tectonic greenschist-facies metamorphism that involved biotite and plagioclase breakdown to chlorite and sericite, respectively. Magnetite is abundant, with grains up to 0.3 mm long aligned with the foliation. Accessory minerals include sparse titanite, apatite, and ilmenite.

Figure 10659-1Transmitted light image of zircon from sample 10659.

Zircon Description

The selected zircons are of poor quality, subhedral and prismatic to elongate crystals (aspect ratio of 2-3:1). They are turbid and light brown to dark brown in colour. Their size

Figure 10659-2 SEM BSE images of representative zircons from sample 10659.

ranges from 50 x 100 µm to 100 x 300 µm (Figure 10659-1). Unidentified inclusions are present in some grains.

The SEM BSE images reveal that almost all of the zircon population displays oscillatory zoning. Most of the grains are partially metamict and most grains were not suitable for analyses. Some grain show distinct core rim relationships.

Analytical details

Date analyzed	July 12, 2012
Mount Number	648
Primary Calibration standard	6266
Error in Pb/U ratio from calibration	1.0%
External error in Pb/U ratio	0.24%
Data reduction software used	SQUID 2.22.08.04.30, rev. 30 Apr 2008
Kohler aperture	70 um
Spot size	~15 um
Primary Beam Intensity	2.3-2.5 nA
Raster time	1.5 minutes
Scans per analysis	5
Secondary Standard	1242
Mass Fractionation value	1.0029

Results and Age Interpretation

Twenty-four analyses of twenty-three grains yield a range of concordant ages from 2955 to 2478 Ma. Uranium content is high and variable from 170 to 1700 ppm with variable Th/U ratios from 0.01 to 0.78. There is no clear correlation of age with composition. The two youngest analyses are slightly reversely discordant. The data do not define a dominant age population. The two oldest analyses represent core material, although in both cases the surrounding zircon was too altered to afford analysis. Distinct age groups cluster at 2705 Ma, 2638 Ma, and 2595 Ma, with three analyses having younger ages to 2478 Ma (Figure 10659-3, 4). It is unclear how to interpret the data. It is possible that the igneous age is given by the zircon population at 2594.8 ± 4.7 Ma, in which case the older analyses would represent inherited material with the younger analyses reflecting some Pb-loss

Figure 10659-3 Concordia diagram for sample 10659. Red ellipses identify a group of seven analyses used to calculate a maximum igneous crystallization age. Yellow elleipses are two analyses of younger zircon of uncertain significance.

Figure 10659-4 Probability density plot (red) with histogram (blue) showing range of ages and principal modes.

10660: Orthopyroxene-bearing Tonalite

Sample Number: 60-HF-010 **Geochronology Lab Number:** 10660

Location

Lat and Long NAD27 66°32'11.4"N 95°54'58.2"W
UTM NAD 27 Zone 15 E370464 N7382550
Map Sheet 56L

Geological Domain: Rae craton
Sampling History

Sampled in 1960 by W.W. Heywood. Collected from GSC archives April 2012.

Sample Preparation

Sample size: hand sample
Electronic pulse disaggregation (EPD) at Overburden Drilling Management Inc., Ottawa. Heavy liquid separation in Methyl Iodide (MI) heavy liquids followed by Frantz™ Magnetic Separator. Zircon were hand picked from the NONMAG @ 0.5A and mounted on an epoxy puck (IP648) for SHRIMP analysis.

Sample Description

The location of this sample is near the north end of a distinct, ~30 x 60 km magnetic high that extends north of the Amer shear zone. At the sample location, well foliated (020/90) granitic gneiss was noted to have a lighter colour and lower mafic content than typical of this general region. The sample consists largely of medium-grained (< 2 mm) plagioclase and quartz, which commonly form elongate crystals (aspect ratio up to 4:1), and sparse K-feldspar. Anhedral, mostly embayed crystals of orthopyroxene less than 0.1 mm in length may be partly rimmed by fine-grained biotite. Ilmenite forms irregular, interstitial grains less than 0.2 mm in size.

Figure 10660-1 Transmitted light image of pre-mounted zircons from sample 10660.

Zircon Description

Very few zircon (~60) were recovered from this sample and they are of exceptionally poor quality. Zircon are subhedral to

rounded and form subequant to elongate prismatic crystals (aspect ratio of 1.5-3:1). The grains are mostly turbid and dark brown in colour. A subset are clearer and colourless. Grain size ranges from 50 x 100 µm to 100 x 300 µm (Figure 10660-1).

The SEM BSE images show extensive alteration of the crystals with only minor remnants of primary zircon preserved. Alteration is persistent in patches throughout the grains as well as extensive fracturing. Often zircon cores are extensively altered with numerous inclusions or porosity (Figure 10660-2C). The rims around the high uranium cores exhibit radial fracturing. Faint oscillatory zoning is visible in outer margins of the grains indicating an igneous origin (Figure 10660-2A, 2B and 2C).

Figure 10660-2 SEM BSE images of representative zircons from sample 10660

Analytical details

Date analyzed	July 12, 2012
Mount Number	648
Primary Calibration standard	6266
Error in Pb/U ratio from calibration	1.0%
External error in Pb/U ratio	0.24%
Data reduction software used	SQUID 2.22.08.04.30, rev. 30 Apr 2008
Kohler aperture	70 um
Spot size	~15 um
Primary Beam Intensity	2.3-2.5 nA
Raster time	1.5 minutes
Scans per analysis	5
Secondary Standard	1242
Mass Fractionation value	1.0029

Results and Age Interpretation

Zircon were of extremely poor quality and only a small number of analyses were accomplished. The majority of the analyses have Neoarchean ages ranging from 2.46 to 2.695 Ga (Figure 10660-3). Two grains have Paleoproterozoic ages for which three analyses yield a weighted

mean $^{207}Pb/^{206}Pb$ age of 1845 ± 18 Ma (MSWD = 0.49, probability = 0.69). The Archean zircon yield an ambiguous age interpretation. One analyses has a discordant $^{207}Pb/^{206}Pb$ age of 2695 Ma that is 100 Ma older than the next oldest analyses and is considered to be an inherited crystal. A group of five analyses, less than 4% discordant, yield a weighted mean $^{207}Pb/^{206}Pb$ age 2565 ± 13 Ma (MSWD = 2.9, probability = 0.022). A sixth, discordant analyses has an age that falls within this group but demonstrates recent Pb-loss. The low probability of fit indicates excess scatter in the data which may indicate small amounts of Pb-loss in one or more of these grains. Paleoproterozoic Pb-loss is indicated by analyses 15.1 with a discordant age of 2461 Ma. Regression of the data excluding the inherited and discordant analyses yields an upper intercept age of 2611 ± 35 Ma (MSWD = 1.16; grains 6.2 and 18.1 excluded) with a lower intercept anchored at 1845 ± 18 Ma (Figure 3). The 2565 ± 13 Ma age is considered a minimum estimate of the crystallization of the rock, whereas the 2611 ± 35 Ma age represents a maximum age estimate. The 1845 ± 18 Ma age is interpreted as a time of metamorphism of the rock

Figure 10660-3 U-Pb Concordia diagram for sample 10660. Blue ellipses demonstrate recent Pb-loss and were excluded from the regression analyses.

Acknowledgements

Ann Thériault, Angelique Magee and Michele Coyne are thanked for their help discovering the samples within the GSC sample archive facility. Beth Hillary provided support in managing information relating to original data and notes. John Percival spearheaded the effort to organize the archive samples and provided support as project leader. Sally Pehrsson provided considerable input on sample selection and geological discussion. Ray Chung and Ron Christie expertly prepared zircon separates. Julie Peressini guided the sample grain selection and generally moved things through the process. Pat Hunt is thanked for her skill in acquiring the SEM images and Tom Pestaj and Nicole Rayner for their support preparing ion probe mounts as well as SHRIMP lab operations. A review of this report by Nicole Rayner greatly improved the clarity of this manuscript.

References

Berman, R.G., Sanborn-Barrie, M., Stern, R.A., and Carson, C.J. 2005. Tectonometamorphism at ca. 2.35 and 1.85 ga in the Rae domain, western Churchill province, Nunavut, Canada: Insights from structural, metamorphic and in situ geochronological analysis of the southwestern committee bay belt. Canadian Mineralogist, **43**: 409-442.

Berman, R.G., Pehrsson, S., Davis, W.J., Ryan, J.J., Qui, H., and Ashton, K.E. 2012. The Arrowsmith orogeny: Geochronological and thermobarometric constraints on its extent and tectonic setting in the Rae craton, with implications for pre-Nuna supercontinent reconstruction. Precambrian Research, (dx.doi.org/10.1016/j.precamres.2012.10.015).

Chacko, T., De, S.K., Creaser, R.A., and Muehlenbachs, K. 2000. Tectonic setting of the Taltson magmatic zone at 1.9-2.0 Ga: A granitoid-based perspective. Canadian Journal of Earth Sciences, **37**: 1597-1609.

Fraser, J.A. 1988. Geology of the Woodburn lake map area, District of Keewatin. Geological Survey of Canada, Paper, **87-11**: 1-12.

Fraser, J.A. 1964. Geological notes on northeastern District of Mackenzie, Northwest Territories. Geological Survey of Canada, Paper, **63-40**.

Frisch, T. 2000. Precambrian geology of Ian Calder lake, Cape Barclay, and part of Darby lake map areas, south-central Nunavut. Geological Survey of Canada, Bulletin, **542**: 1-51.

Frisch, T. 1983. Precambrian geology of the Prince Albert hills, western Melville peninsula, Northwest Territories. Geological Survey of Canada, Bulletin, **346**: 1-70.

Frith, R.A. and van Breemen, O. 1990. U-Pb zircon age from the himag plutonic suite, Thelon tectonic zone, Churchill structural province, Northwest Territories. Geological Survey of Canada, Paper, **89-2**: 49-54.

Henderson, J.B. and Thériault, R.J. 1994. U-Pb zircon evidence for circa 3.1 ga crust south of the McDonald fault, northwestern Canadian Shield, Northwest Territories. Geological Survey of Canada, Current Research, **1994-F**: 43-47.

Henderson, J.B. and van Breemen, O. 1992. U - Pb zircon ages from an Archean orthogneiss and a Proterozoic metasedimentary gneiss of the Thelon tectonic zone, District of Mackenzie, Northwest Territories. Geological Survey of Canada, Paper, **91-2**: 25-33.

Henderson, J.B., McGrath, P.H., Theriault, R.J., and Van Breemen, O. 1990. Intracratonic indentation of the B Slave province into the early Proterozoic Thelon tectonic zone of the Churchill province, northwestern Canadian Shield. Canadian Journal of Earth Sciences, **27**: 1699-1713.

Heywood, W.W. 1961. Geological notes, northern District of Keewatin. Geological Survey of Canada, Paper, **61-18**.

Heywood, W.W. and Schau, M. 1978. A subdivision of the northern Churchill structural province. Geological Survey of Canada, Paper, **78-1A**: 139-143.

Hinchey, A.M., Davis, W.J., Ryan, J.J., and Nadeau, L. 2011. NeoArchean high-potassium granites of the Boothia mainland area, Rae domain, Churchill Province: U-Pb zircon and Sm-Nd whole rock isotopic constraints. Canadian Journal of Earth Sciences, **48**: 247-279.

Hoffman, P.F. 1989. Precambrian geology and tectonic history of North America. The Decade of North American Geology Project, Volume **A**: 447-512.

Hoffman, P.F. 1988. United plates of America, the birth of a craton: Early Proterozoic assembly and growth of Laurentia. Annual Review of Earth and Planetary Sciences, **16**: 543-603.

James, D.T., van Breemen, O., and Loveridge, W.D. 1988. Early Proterozoic U-Pb zircon ages for granitoid rocks from the Moraine lake transect, Thelon tectonic zone, District of Mackenzie. Geological Survey of Canada, Paper, **88-2**: 67-72.

Ludwig, K.R., 2003. Using Isoplot/Ex, version 3, A geochronological toolkit for Microsoft Excel: Berkeley Geochronology Center. Special Publications, **4**, 70 p.

Rainbird, R.H., Davis, W.J., Pehrsson, S.J., 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. Precambrian Research, **181**: 167-186.

Roddick, J.C. and van Breemen, O. 1994. U-Pb zircon dating: A comparison of ion microprobe and single grain conventional analyses. Geological Survey of Canada, Current Research, **1994-F**: 1-9.

Schultz, M.E.J. 2007, The Queen Maud block, Nunavut – Genesis of a large felsic igneous province in the earliest Paleoproterozoic and implications for Laurentian geotectonic models, Unpublished M.Sc. Thesis, University of Alberta, 71 p.

Schultz, M.E.J., Chacko, T., Heaman, L.M., Sandeman, H.A., Simonetti, A., and Creaser, R.A. 2007. Queen Maud block: A newly recognizedPpaleoproterozoic (2.4-2.5 Ga) terrane in northwest Laurentia. Geology, **35**: 707-710

Skulski, T., Sandeman, H., Sanborn-Barrie, M., MacHattie, T., Young, M., Carson, C., Berman, R.G., Brown, J., Rayner, N., Panagapko, D., Byrne, D., and Deyell, C. 2003. Bedrock

geology of the Ellice Hills map area and new constraints on the regional geology of the Committee Bay area, Nunavut. Geological Survey of Canada, Current Research (Online), **2003-C22**: 1-11.

Stern, R.A. 1997. The GSC sensitive high resolution ion microprobe (SHRIMP): Analytical techniques of zircon U-Th-Pb age determinations and performance evaluation. Geological Survey of Canada, Current Research, **1997-F**: 1-31.

Stern, R.A. and Amelin, Y. 2003. Assessment of errors in SIMS zircon U-Pb geochronology using a natural zircon standard and NIST SRM 610 glass. Chemical Geology, **197**: 111-142.

Tella, S. 1994. Geology, Amer Lake (66H), Deep Rose Lake (66G) and parts of Pelly Lake (66F); Geological Survey of Canada, Report Number 2969. scale 1:250000

Thériault, R.J., Henderson, J.B., and Roscoe, S.M. 1994. Nd isotopic evidence for early to mid-Archean crust from high grade gneisses in the Queen Maud block and south of the McDonald fault, western Churchill province, Northwest Territories. Geological Survey of Canada, Current Research, **1994-F**: 37-42.

Tersmette, D.B. 2012. Geology, geochronology, thermobarometry, and tectonic evolution of the Queen Maud block, Churchill craton, Nunavut, Canada. MSc., University of Alberta.

van Breemen, O. and Henderson, J.B. 1988. U-Pb zircon and monazite ages from the eastern Slave province and Thelon tectonic zone, artillery lake area, N.W.T. Geological Survey of Canada, Paper, **88-2**: 73-83.

van Breemen, O., Henderson, J.B., Loveridge, W.D., and Thompson, P.H. 1987a. U - pb zircon and monazite geochronology and zircon morphology of granulites and granite from the Thelon tectonic zone, Healey lake and Artillery lake map areas, N.W.T. Geological Survey of Canada, Paper, **87-1A**: 783-801.

van Breemen, O., Thompson, P.H., Hunt, P.A., and Culshaw, N. 1987b. U - Pb zircon monazite geochronology from the northern Thelon tectonic zone, District of Mackenzie. Geological Survey of Canada, Paper, **87-2**: 81-93.

Wodicka, N., Corrigan, D., Nadeau, L. and Erdmann, S., 2011. New U-Pb geochronological results from Melville Peninsula: unravelling the Archean and Early Paleoproterozoic magmatic history of the north-central Rae craton. Geol. Assn. Canada - Mineral. Assn. Canada Abst. 36.

Zaleski, E., Pehrsson, S., Duke, N., Davis, W.J., L'Heureux, R., Greiner, E., and Kerswill, J.A. 2000. Quartzite sequences and their relationships, Woodburn lake group, western Churchill province, Nunavut. Geological Survey of Canada, Current Research (Online), **2000-C7**: 1-10.