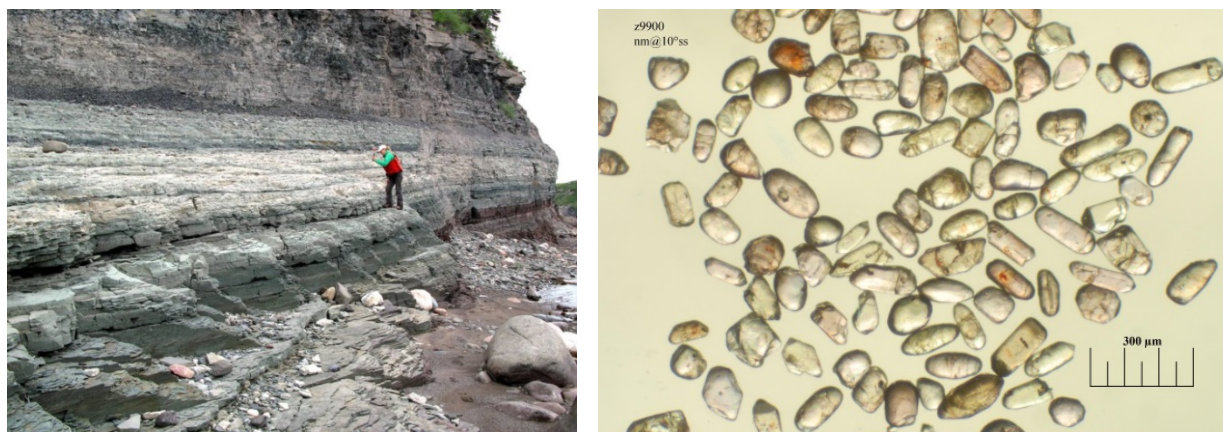


**TABLE DR1****TABLE DR2****APPENDIX I: SAMPLE DESCRIPTIONS AND DETAILED PROVENANCE  
INTERPRETATION OF DETRITAL ZIRCON U-PB AGES****Rae Group-Coppermine Homocline*****Escape Rapids Formation******Sample 08RAT-10a (lower Hihotok member).***

Sample number:	08RAT-10a
Stratigraphic Unit	Escape Rapids Formation, lower Hihotok Member
GSC Laboratory number:	9900
Geographic location:	Coppermine River, NU 67°35'14.49"N 115°31'52.72"W, NAD83
Collection History:	Sampled in 2008 by Rob Rainbird
Lithology:	quartz arenite
Mount ID:	IP528
U-Pb standard and reproducibility:	6266, 1.1% (1 $\sigma$ )
External error in U-Pb:	0.2% (1 $\sigma$ )
207Pb/206Pb Standard:	z1242 (2679.6 $\pm$ 0.2Ma, 95% confidence)
Measured value ( $\pm$ 95% confidence):	2676 $\pm$ 3 Ma
IMF correction applied?	No
Interpreted Age:	1666 $\pm$ 30 Ma (single analysis, concordia age)
Interpretation:	Youngest detrital zircon

*Description.* The analyzed specimen was collected from an outcrop on the Coppermine River, along the southern margin of the Amundsen Basin (see below and sample location map, at end of Appendix 1). It is a light-green, fine-grained, cross-bedded, silty quartzarenite located ~2 m above an erosional unconformity with sandstones of the underlying Husky Creek Formation (Coppermine River Group).



**Left: Cross-bedded marine sandstone 08RAT-10a along the Coppermine River. Unconformity with underlying Husky Creek Formation (Coppermine River Group) is at the interface between the red and green units, approximately 1m below the feet of the geologist. Right: micrograph of detrital zircon grains from 08RAT-10.**

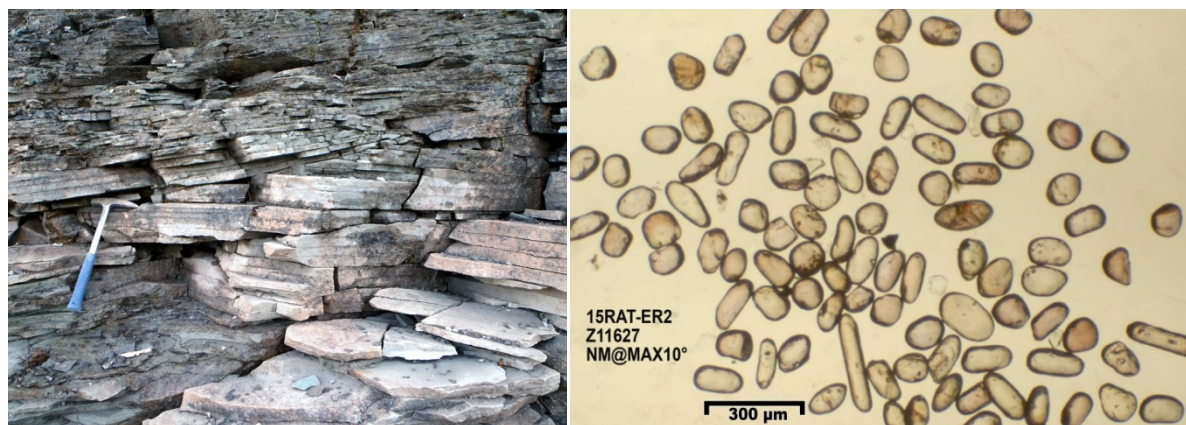
*U-Pb Results and Interpretation.* The detrital zircon grains preserve a minor Slave/Rae province signature (2.6 Ga and older) as well as 15 grains ranging in age from 2.53 to 2.32 Ga (Fig. 4), a component typical of the Queen Maud block and/or western Rae Province (Berman et al., 2013; Hartlaub et al., 2007; Schultz et al., 2007). A probable source for these grains could be sandstones of the Coppermine River and Hornby Bay groups, which directly underlie the Shaler Supergroup and contain high proportions of such grains (Rainbird et al., 2007; Rayner and Rainbird, 2013). This sample is dominated by zircon grains with ages ranging from 1.96 to 1.84 Ga (21 grains), which can be attributed to relatively local sources in volcanic and plutonic rocks from the Hottah terrane and Great Bear magmatic zone (Ootes et al., 2015), a potential proximal source exposed ~100 km to the south of the Amundsen Basin. The distribution and frequency of grain ages closely mimics that of the underlying Husky Creek Formation (Rayner and Rainbird, 2013), suggesting these grains could also have been derived by recycling. The youngest grain in the sample,  $1666 \pm 30$  Ma ( $2\sigma$ ), is older than that of the underlying Husky Creek Formation ( $1232 \pm 15$  Ma; Rayner and Rainbird, 2013) so does not provide a maximum depositional age.

***Samples 15RAT-ER1, 2. (middle Hihotok Member).***

Sample number:	15RAT-ER1
Stratigraphic Unit	Escape Rapids Formation, middle Hihotok Member
GSC Laboratory number:	11626
Geographic location:	Coppermine River, NU 67°36'52.38"N; 116° 2'51.61"W, NAD83
Collection History:	Sampled in 2015 by John Prince
Lithology:	quartz arenite
Mount ID:	IP793
U-Pb standard and reproducibility:	6266, 1.31% (1 $\sigma$ )
External error in U-Pb:	n/a
207Pb/206Pb Standard:	z1242 (2679.6 $\pm$ 0.2Ma, 95% confidence)
Measured value ( $\pm$ 95% confidence):	2676 $\pm$ 2 Ma
IMF correction applied?	No
Interpreted Age:	1235 $\pm$ 28 (single analysis, concordia age)
Interpretation:	Youngest detrital zircon

Sample number:	15RAT-ER2
Stratigraphic Unit	Escape Rapids Formation, middle Hihotok Member
GSC Laboratory number:	11627
Geographic location:	Coppermine River, NU 67°40'22.43"N; 116°25'48.55"W, NAD83
Collection History:	Sampled in 2015 by John Prince
Lithology:	quartz arenite
Mount ID:	IP793
U-Pb standard and reproducibility:	6266, 1.31% (1 $\sigma$ )
External error in U-Pb:	n/a
207Pb/206Pb Standard:	z1242 (2679.6 $\pm$ 0.2Ma, 95% confidence)
Measured value ( $\pm$ 95% confidence):	2676 $\pm$ 2 Ma
IMF correction applied?	No
Interpreted Age:	1152 $\pm$ 14 Ma (3 replicates, mean concordia age)
Interpretation:	Maximum age of deposition

*Description.* Both specimens are fine-grained, well-sorted, quartzarenite from ~105 and 70 m, respectively, above the basal unconformity with the Coppermine River Group (Kaizen Discoveries, pers. com., 2015; see below and sample location map). Presence of glauconite, shale partings and rip-ups suggests deposition in very shallow water, perhaps tidal flat environment.



**Left: Hummocky cross-bedded marine sandstone outcrop representing similar stratigraphic level as samples taken from drill core (15RAT-ER1 and 2). Right: Transmitted-light micrograph of detrital zircon grains from 15RAT-ER2.**

*U-Pb Results and Interpretation.* The two samples come from stratigraphically equivalent horizons ~20 km apart and their U-Pb detrital zircon ages are similar, so data were combined for simplicity of description and interpretation. The maximum depositional age for this unit is  $1152 \pm 14$  Ma ( $2\sigma$ ), based on 3 replicate analyses of the youngest grain in 15RAT-ER2. Relative to the lower Hihotok member sandstone sample 08RAT-10a, located ~60 m stratigraphically below, the combined U-Pb concordia age profile from these samples differ significantly in that they record an influx of younger, late Paleoproterozoic to Mesoproterozoic-age, detritus with minor peaks at 1784, 1690, 1616, 1475 and 1238 Ma (Fig. 5). Source rocks of this age are unknown locally but are widely exposed along the southeast margin of Laurentia, in the Yavapai province of the midwest U.S., the Mazatzal province of the southern U.S. and its equivalent, the Labrador subprovince in eastern Quebec and Labrador (Whitmeyer and Karlstrom, 2007). Derivation from these sources requires long-distance transport (>3000 km). This is a possible indication of the “Grenvillian sedimentation episode” that is more substantively represented higher in the section (Rainbird et al., 2012; see below). Like sample 08RAT-10a, these samples display a prominent peak at 1860 Ma and 25% of the analyses range in age from 1960 to 1850 Ma. This age range matches closely the ages of plutonic and volcanic rocks exposed in the Hottah terrane and Great Bear magmatic zone (see Ootes et al., 2015).



***Sample 08RAT-15 (upper Hihotok Member).***

Sample number:	08RAT-15
Stratigraphic Unit	Escape Rapids Formation - upper Hihotok Member
GSC Laboratory number:	9901
Geographic location:	Coppermine River, NU 67° 40' 57.0"N; 115°29'52.0"W, NAD83
Collection History:	Sampled in 2008 by Rob Rainbird
Lithology:	lithic arenite
Mount ID:	IP527
U-Pb standard and reproducibility:	6266, 1.1% (1 $\sigma$ )
External error in U-Pb:	0.3% (1 $\sigma$ )
207Pb/206Pb Standard:	z1242 (2679.6 $\pm$ 0.2Ma, 95% confidence)
Measured value ( $\pm$ 95% confidence):	2682 $\pm$ 6 Ma
IMF correction applied?	No
Interpreted Age:	1151 $\pm$ 13 Ma (3 replicates, mean concordia age)
Interpretation:	Maximum age of deposition

*Description.* This specimen was collected at an outcrop on the Coppermine River from a section of ripple cross-laminated, light-green to buff, fine-grained, lithic arenite probably deposited on a shallow, wave-dominated shelf (see below and sample location map).



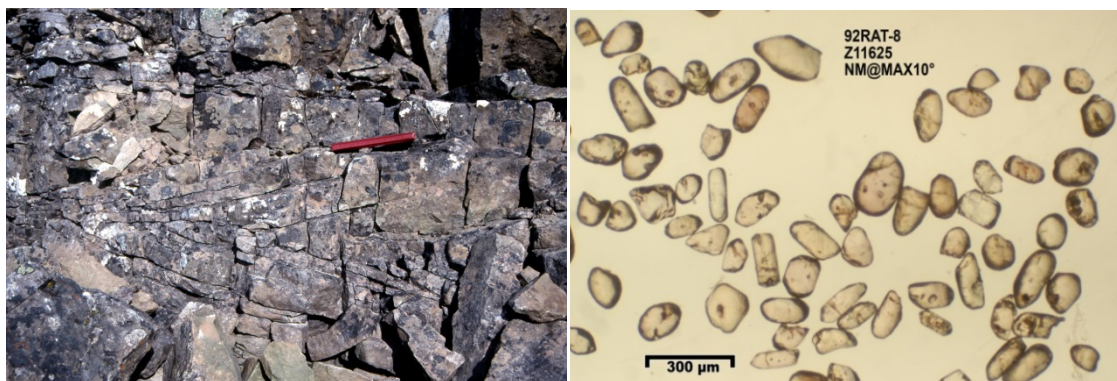
**Left: Discontinuous, fine-grained sandstone layers in outcrop along the Coppermine River. Right: micrograph of detrital zircon grains from 08RAT-15.**

*U-Pb Results and Interpretation.* This specimen displays a comprehensive change in provenance to mainly Mesoproterozoic sources with peaks at 1428 Ma, 1498 Ma, 1527 Ma and 1622 Ma (Fig. 5). A subset of 6 grains defines a younger peak at 1150 Ma. Paleoproterozoic and Archean zircon grains, common in underlying samples, were not recognized, although this sample set is relatively small ( $n = 37$ ), owing to low yield. Many of the early Mesoproterozoic grains are relatively euhedral (see above) indicating limited abrasion, which suggests local provenance, but zircon-bearing rocks of this age are unknown in this region suggesting a non-Laurentian source (e.g., Siberia; (Ernst et al., 2016). Potential sources to the north of Amundsen basin cannot be evaluated because they are covered by Phanerozoic rocks. In other samples from this and previous studies, grains with early Mesoproterozoic ages are inferred to be sourced from the eastern Grenville Province and Labrador orogen. Replicate analyses on the youngest detrital zircon constrain the maximum age of deposition to 1151  $\pm$  13 Ma.

**Rae Group-Minto Inlier*****Escape Rapids Formation******Sample 92RAT-008, (middle Hihotok Member).***

Sample number:	92RAT-008
Stratigraphic Unit	Escape Rapids Formation - middle Hihotok Member
GSC Laboratory number:	Z11625
Geographic location:	Minto Inlier, NU, 72° 0'60.00"N 108°25'0.00"W, NAD83
Collection History:	Sampled in 1992 by Rob Rainbird
Lithology:	quartz arenite
Mount ID:	IP793
U-Pb standard and reproducibility:	6266, 1.31% (1 $\sigma$ )
External error in U-Pb:	n/a
207Pb/206Pb Standard:	z1242 (2679.6 $\pm$ 0.2Ma, 95% confidence)
Measured value ( $\pm$ 95% confidence):	2676 $\pm$ 2 Ma
IMF correction applied?	No
Interpreted Age:	1137 $\pm$ 12 Ma (3 replicates, mean concordia age)
Interpretation:	Maximum age of deposition

*Description.* This specimen is from a section near the base (not exposed) of the Escape Rapids Formation (Hihotok Member), located on the west side of Hadley Bay on northern Victoria Island, nearly 600 km northeast of the Coppermine River sampling area (see below and sample location figure). The section is similar to that preserved along the Coppermine River, demonstrating the broad lateral continuity of facies within the Amundsen Basin (see Rainbird et al. 1994). The host rock is a texturally mature, fine-medium grained quartz arenite from a single, large-scale cross-bedded layer, in an otherwise wavy to lenticular-bedded section of drab siltstone and white to pink quartz arenite. Paleocurrents indicate dominant transport to the northwest with some reversals, possibly indicating tidal influence.



**Left:** Large-scale crossbedded quartz arenite from northeastern Minto Inlier (notebook, for scale, is 20cm long). **Right:** Transmitted light micrograph of detrital zircon grains from 92RAT-8.

*U-Pb Results and Interpretation.* This specimen presents a broad spectrum of detrital zircon U-Pb ages with a prominent peak near 2700 Ma defined by 10 grains varying in age between 2670 and 2730 Ma and characteristic of granites from the Slave Province, which are exposed in a small inlier nearby to the south, along Hadley Bay (Fig. 5; Campbell, 1981). At the other end of the age spectrum, peaks at 1214 and 1163 Ma are defined by 13 grains ranging in age from 1240 – 1130 Ma. Replicate analyses on the youngest detrital zircon constrain the maximum age of deposition to  $1137 \pm 12$  Ma.

These ages match the age of major plutonism of AMCG- and A-type granitic rocks in the southeastern part of the Grenville Province, northeast of the Composite Arc Belt (see summary in (Davidson, 2008). These intrusions are associated with the Shawinigan phase of the Grenvillian orogeny (Hynes and Rivers, 2010). In between are a scattering of early Mesoproterozoic zircon ages similar to those described from the other Escape Rapids Formation samples. The young grains are notable for they represent the first significant influx of detritus that can be fingerprinted as coming from the Grenvillian orogeny and such ages continue to be important component of the detrital zircon inventories of samples higher in the stratigraphic succession of the Amundsen Basin (Fig. 5; see also Rayner and Rainbird, 2013).

***Nelson Head Formation******Sample 94RAT-001.***

Sample number:	94RAT-001
Stratigraphic Unit	Nelson Head Formation
GSC Laboratory number:	6814
Geographic location:	Victoria Island, Wynnatt Bay, NWT 72°19'6.9"N 111°53'6.1"W, NAD83
Collection History:	Sampled in 1994 by Rob Rainbird
Lithology:	Quartz arenite
Mount ID:	IP528
U-Pb standard and reproducibility:	6266, 1.1% (1 $\sigma$ )
External error in U-Pb:	0.2% (1 $\sigma$ )
207Pb/206Pb Standard:	1242 (2679.6 $\pm$ 0.2Ma, 95% confidence)
Measured value ( $\pm$ 95% confidence):	2676 $\pm$ 3 Ma
IMF correction applied?	No
Age Peaks:	1080 Ma, 1150 Ma, 1360 Ma, 1450 Ma,
Interpreted Age:	1013 $\pm$ 25 Ma (single analysis, concordia age)
Interpretation:	Maximum age of deposition

**Description.** The specimen we analyzed was collected from a cliff-face outcrop in Wynnatt Bay, northern Minto Inlier (see below and sample location map). The rock is a white to tan crossbedded feldspathic arenite. Crossbeds indicating consistent northwesterly transport were deposited by a broad, braided river system (Ielpi and Rainbird, 2016).



**Left: Nelson Head Formation exposure in Wynnatt Bay, northern Victoria Island. Right: Transmitted-light micrograph of detrital zircon grains from 94RAT-1.**

**U-Pb Results and Interpretation.** There is a scattering of late Archean ( $n = 3$ ) and late Paleoproterozoic ( $n = 5$ ) grains but the majority of the detrital zircon grains in this sample yield U-Pb ages between 1.5 and 1.0 Ga, with separate groupings between 1500 and 1280 Ma and between 1230 and 1000 Ma (Fig. 5). The older grouping has a significant peak at 1460 Ma, but the entire range of detrital zircon ages can be matched with ages from the U.S. mid-continent granite-rhyolite province (Bickford and Anderson, 1993; Van Schmus et al., 1996; Whitmeyer



Rainbird, R.H., Rayner, N.M., Hadlari, T., Heaman, L.M., Ielpi, A., Turner, E.C., and MacNaughton, R.B., 2017, Zircon provenance data record lateral extent of pan-continental, early Neoproterozoic rivers and erosional unroofing history of the Grenville orogen: *GSA Bulletin*, doi:10.1130/B31695.1.

and Karlstrom, 2007). 1450–1500 Ma rocks also occur in the Grenville Province (e.g., (Rivers and Corrigan, 2000; Slagstad et al., 2004a). The younger grouping has a peak at 1140 Ma, and matches the age of the voluminous AMCG suites that occur across the Grenville Province, most notably in the Adirondack Highlands of the northern New York (Hamilton et al., 2004; Hebert and van Breemen, 2004; Hynes and Rivers, 2010; McLelland et al., 1996). Significantly, it contains 4 grains younger than 1100 Ma, which typify the Ottawan phase of the Grenvillian orogeny (ca. 1090–1050 Ma; (Gower et al., 2008; Hynes and Rivers, 2010; Rivers, 1997; Rivers et al., 2002). The maximum age of deposition ( $1013 \pm 25$  Ma) is based on a single analysis of the youngest concordant zircon from this group. The Mesoproterozoic grains are all considered to be first-cycle and thus delivered by rivers directly from the source regions described above. There is no obvious correlation between degree of roundness, grain size and age.

**Rae Group-Brock Inlier*****Nelson Head Formation******Sample 14RAT-518.***

Sample number:	14RAT-518
Stratigraphic Unit	basal Nelson Head Formation
GSC Laboratory number:	11454
Geographic location:	Brock River, Brock Inlier, NWT 69°20'53.63"N; 122°55'4.65"W, NAD83
Collection History:	Sampled in 2014 by Rob Rainbird
Lithology:	Quartz arenite
Mount ID:	IP769
U-Pb standard and reproducibility:	6266, 1.1% (1 $\sigma$ )
External error in U-Pb:	0.2% (1 $\sigma$ )
207Pb/206Pb Standard:	1242 (2679.6 $\pm$ 0.2Ma, 95% confidence)
Measured value ( $\pm$ 95% confidence):	2680 $\pm$ 4 Ma
IMF correction applied?	No
Age Peaks:	1163 Ma, 1321 Ma, 1427 Ma, 1501 Ma, 1628 Ma
Interpreted Age:	1071 $\pm$ 36 Ma (single analysis, concordia age)
Interpretation:	Maximum age of deposition

*Description.* This sample is from a fluvial sandstone of the basal Nelson Head Formation at a section on the north side of the Brock River (see below and sample location map), one meter above a sharp but conformable contact with carbonate-rich shallow marine – lagoonal strata of the Mikkelsen Islands Formation (see Rainbird et al. 2015). The rock, from a 4-m thick unit of compounded cross-bedded sandstone, is a fine- to medium-grained, relatively well-sorted quartzarenite. Grains are well- to very well-rounded and cemented by syntaxial quartz overgrowths.

Left: Fluvial quartz arenite of the basal Nelson Head Formation, sampled near contact with Mikkelsen Island Formation (just above geologist's head). Right: Transmitted-light micrograph of detrital zircon grains from 14RAT-518.



**Left: Fluvial quartz arenite of the basal Nelson Head Formation, sampled near contact with Mikkelsen Island Formation (just above geologist's head). Right: Transmitted-light micrograph of detrital zircon grains from 14RAT-518.**

*U-Pb Results and Interpretation.* Results from this sample are almost indistinguishable from the Nelson Head Formation sample 94RAT-1 from northern Minto Inlier, displaying the same older and younger Mesoproterozoic groupings with prominent peaks at 1430 Ma, 1320 Ma and 1160 Ma and matching the U.S. mid-continent granite-rhyolite and Grenville Province sources described above (Fig. 5). In both samples, there are minima in the probability density distributions between 1200 and 1300 Ma and there is even a matching number and scattering of older grains, some of which are the same age. There are two younger grains with ages at ca. 1070–1080 Ma.

***Sample 14RAT-514.***

Sample number:	14RAT-514
Stratigraphic Unit	upper Nelson Head Formation
GSC Laboratory number:	11452
Geographic location:	Hornaday River, Brock Inlier, NWT 69° 0'20.60"N; 122°39'47.05"W, NAD83
Collection History:	Sampled in 2014 by Rob Rainbird
Lithology:	Quartz arenite
Mount ID:	IP763
U-Pb standard and reproducibility:	6266, 1.3% (1 $\sigma$ )
External error in U-Pb:	0.3% (1 $\sigma$ )
207Pb/206Pb Standard:	1242 (2679.6 $\pm$ 0.2Ma, 95% confidence)
Measured value ( $\pm$ 95% confidence):	2677 $\pm$ 7 Ma
IMF correction applied?	No
Age Peaks:	1078 Ma, 1287 Ma, 1227 Ma, 1453 Ma
Interpreted Age:	1028 $\pm$ 31 Ma (single analysis, concordia age)
Interpretation:	Youngest detrital zircon

*Description.* Our sample comes from uppermost (shallow marine) strata of the Nelson Head Formation in the Hornaday River canyon (see below and sample location map). Rock is from a 10m+ thick unit of tabular to swaley cross-bedded sandstone and is a fine- to medium-grained, very well-sorted, glauconitic quartz arenite. Grains are very well-rounded and cemented by syntaxial quartz overgrowths.



**Left: Marine quartz arenite of the upper Nelson Head Formation, at outcrop on east side of Hornaday River. Geologist in white rectangle, for scale. Right: Transmitted-light micrograph of detrital zircon grains from 14RAT-514.**

*U-Pb Results and Interpretation.* Detrital zircon U-Pb ages from this sample are quite similar to the lower Nelson Head Formation sample from Brock Inlier (Fig. 5), the main difference being at the younger end of the age spectrum where there is a prominent peak at 1080 Ma, which is centered on a grouping of 15 grains with ages between 1105 and 1050 Ma. The youngest detrital zircon yields an age of 1028  $\pm$  31 Ma, although the maximum age of deposition is better constrained by the cluster of analyses at ca. 1080. These ages are associated with



Rainbird, R.H., Rayner, N.M., Hadlari, T., Heaman, L.M., Ielpi, A., Turner, E.C., and MacNaughton, R.B., 2017, Zircon provenance data record lateral extent of pan-continental, early Neoproterozoic rivers and erosional unroofing history of the Grenville orogen: GSA Bulletin, doi:10.1130/B31695.1.

regional high-grade metamorphism and related partial melting during the Ottawan phase of the Grenvillian orogeny (e.g., (Tollo et al., 2004) and references therein; (Gower et al., 2008; McLelland et al., 2001; McLelland et al., 2010; Slagstad et al., 2004b; Walsh et al., 2004). There are only two concordant analyses older than 1500 Ma emphasizing the overwhelming influence of the Mesoproterozoic provenance in this extensive fluvial sandstone.

### **Mackenzie Mountains Supergroup-Mackenzie Mountains**

Samples from the Mackenzie Mountains Supergroup were collected from a section along an unnamed creek located 50 km WSW of the town of Norman Wells, Northwest Territories, along the outer range of the Eastern Mackenzie Mountains (Hamel and MacNaughton, 2013; sample location figure).

***Tsezotene Formation******Sample 11-MWB-128.***

Sample number:	<b>11-MWB-128</b>
Stratigraphic Unit	Tsezotene Fm.
Geographic location:	Cliff beside an unnamed creek, 55km southwest of Norman Wells, N.W.T. 65° 01' 15.77" N; 127° 48' 27.90" W, NAD83
Collection History:	Sampled in 2011 by Rob MacNaughton
Lithology:	Quartz arenite
U-Pb standard and reproducibility:	LH94-15, 0.3% (2 $\sigma$ )
External error in U-Pb:	1.0% (2 $\sigma$ )
207Pb/206Pb Standard:	OG1 (3465.4 $\pm$ 0.6 Ma, 2 $\sigma$ )
Measured value ( $\pm$ 95% confidence):	3454.8 $\pm$ 3.6 Ma; 95% confidence
IMF correction applied?	No
Age Peaks:	1430, 1220, 1180, 1080 Ma
Interpreted Age:	1052 $\pm$ 32 Ma (2 $\sigma$ , single analysis, concordia age)
Interpretation:	Maximum age of deposition

*Description.* The sample is a very fine- to fine-grained, trough cross-bedded quartzarenite from the uppermost part of Tsezotene Formation, just below its transition to the overlying, sandstone-dominated Eduni Formation. The rock is light gray on fresh surface, weathers beige and is thin- to thick-bedded.



**Cross-bedded quartz arenite in uppermost part of Tsezotene Formation, sampled for this study. Outcrop is a small cliff along a tributary stream to the main canyon from which Katherine Group samples were collected.**

*U-Pb Results and Interpretation.* About 85% of the detrital zircon grains in this sample range in age between 1520 Ma and 1050 Ma with 10% Archean grains and 5% Paleoproterozoic grains (Fig. 5). A prominent peak at 1430 Ma, matches ages reported for the U.S. mid-continent eastern Granite-Rhyolite Province (Van Schmus et al., 1996) and equivalents in the Grenville foreland of the U.S. and Canada (e.g., Montauban terrane; (Corrigan and van Breemen, 1997). A large grouping of ages between 1220 and 1150 Ma can be attributed to calc-alkaline tonalitic bodies in the Frontenac-Adirondack belt (McLelland et al., 1996) and AMCG and MDGS suites widespread within the Grenville orogen (Hynes and Rivers, 2010).

***Katherine Group—Grafe River Formation***

***Sample 11-MWB-129.***

Sample number:	<b>11-MWB-129</b>
Stratigraphic Unit	Grafe River Fm.
Geographic location:	Cliff beside an unnamed creek, 3.9 km north of <b>11-MWB-128</b> 65° 03' 17.88" N; 127° 48' 11.62" W, NAD83
Collection History:	Sampled in 2011 by Rob MacNaughton
Lithology:	Quartz arenite
U-Pb standard and reproducibility:	LH94-15, 0.3% (2 $\sigma$ )
External error in U-Pb:	1.0% (2 $\sigma$ )
207Pb/206Pb Standard:	OG1 (3465.4 $\pm$ 0.6 Ma, 2 $\sigma$ )
Measured value ( $\pm$ 95% confidence):	3460.7 $\pm$ 3.6 Ma; 95% confidence
IMF correction applied?	No
Age Peaks:	1630 Ma, 1440 Ma, 1350 Ma, 1090 Ma
Interpreted Age:	1065 $\pm$ 22 Ma (2 $\sigma$ , single analysis, concordia age)
Interpretation:	Maximum age of deposition

*Description.* The sample is a very fine- to fine-grained, trough cross-bedded subarkose from the uppermost Grafe River Formation (Sample location map; from interval 1 in measured section 0901S of (Hamel and MacNaughton, 2013). White on fresh surface, weathers pale pinkish tan; thin to thick-bedded. Subrounded to subangular monocrystalline quartz dominates the framework with subordinate K-feldspar, plagioclase, polycrystalline quartz, plus rare argillic lithoclasts and glauconite.



**Trough cross-bedded quartz arenite in the (fluvial?) Grafe River Formation, exposed in a cliff face along an unnamed stream in the eastern Mackenzie Mountains. Geologist is pointing to the stratigraphic level at which sample was collected.**

*U-Pb Results and Interpretation.* U-Pb ages for detrital zircon grains from this sample are strikingly similar to 11MWB-128 with ~80% of the zircon grains ranging in age between 1500 Ma and 1050 Ma, 10% Archean grains and 5% Paleoproterozoic grains (Fig. 5). Prominent peaks occur at 1440 Ma, 1350 Ma and 1090 Ma with secondary peaks at 1630 Ma and 1220 Ma. There is a significant grouping of grains ( $n = 10$ ) between 1100 and 1070 Ma, which is only weakly represented in the Tsezotene Fm. sample. Rocks of such age are characteristic of the Ottawa phase of the Grenvillian orogeny (for summary, see McLelland et al. 2010).



***Katherine Group—Shattered Range Formation***

***Sample 11-MWB-130.***

Sample number:	<b>11-MWB-130</b>
Stratigraphic Unit	Shattered Range Fm.
Geographic location:	Cliff beside an unnamed creek, 650m north of <b>11-MWB-129</b> 65° 03' 36.81" N; 127° 48' 02.77" W, NAD83
Collection History:	Sampled in 2011 by Rob MacNaughton
Lithology:	Quartz arenite
U-Pb standard and reproducibility:	LH94-15, 0.3% (2σ)
External error in U-Pb:	1.0% (2σ)
207Pb/206Pb Standard:	OG1 (3465.4±0.6 Ma, 2σ)
Measured value (±95% confidence):	3461.2 ± 4.5 Ma, 95% confidence
IMF correction applied?	No
Age Peaks:	1460 Ma, 1430 Ma, 1380 Ma, 1220 Ma
Interpreted Age:	990±15 Ma (2σ; single analysis, 207Pb/206Pb date)
Interpretation:	Maximum age of deposition

*Description.* The sample is a fine-grained, well cemented, trough cross-bedded subarkose from the Shattered Range Formation (interval 7 in measured section 0901S of Hamel and MacNaughton, 2013). The rock is pale pink on fresh surface, weathers pale tan to pale pinkish tan and is thick-bedded. Framework is dominated by subrounded to subangular monocrystalline quartz with subordinate K-feldspar, plagioclase and polycrystalline quartz. Accessory framework grains include glauconite, clay-rich sedimentary grains and heavy minerals.



**Quartz arenite of the Shattered Range Formation, exposed in a cliff face along an unnamed stream in the eastern Mackenzie Mountains. Geologist is collecting the sample used in the present study.**

*U-Pb Results and Interpretation.* Similar to underlying units with ~80% of the detrital zircon grains ranging in age between 1500 Ma and 1000 Ma, with 10% Archean grains and 10% Paleoproterozoic grains. The PDD indicates prominent peaks at 1460 Ma, 1430 Ma, 1380 Ma and 1220 Ma (Fig. 5). Two grains, 1003  $\pm$  15 Ma ( $2\sigma$ ) and 990  $\pm$  15 Ma ( $2\sigma$ ), are the youngest detrital zircon grains ever recovered from the Katherine Group and thus provide a new maximum age for its deposition. The largest age grouping is between 1500 and 1420 Ma (30% of analyses), ages that can be found in the eastern granite-rhyolite province of the U.S. midcontinent (Van Schmus et al., 1996).

## ***Abraham Plains Formation***

### ***Sample 11-MWB-131.***

Sample number:	<b>11-MWB-131</b>
Stratigraphic Unit	Abraham Plains Fm.
Geographic location:	Cliff beside an unnamed creek, 600m northeast of <b>11-MWB-130</b> 65° 03' 53.79" N; 127° 47' 40.21" W, NAD83
Collection History:	Sampled in 2011 by Rob MacNaughton
Lithology:	Quartz arenite
U-Pb standard and reproducibility:	LH94-15, 0.3% (2σ)
External error in U-Pb:	1.0% (2σ)
207Pb/206Pb Standard:	OG1 (3465.4±0.6 Ma, 2σ)
Measured value (±95% confidence):	3459.4 ± 4.2 Ma, 95% confidence
IMF correction applied?	No
Age Peaks:	1625 Ma, 1440 Ma, 1360 Ma, 1200 Ma
Interpreted Age:	1007±24 Ma (2σ, single analysis, 207Pb/206Pb date)
Interpretation:	Maximum age of deposition

*Description.* The sample is a fine to coarse-grained, trough cross-bedded quartzarenite. The rock is light gray on fresh surface, weathers pale pinkish tan and is medium to thick-bedded.



**Trough cross-bedded (fluvial?) quartz arenite of the Abraham Plains Formation, overlain disconformably (dashed white line) by marine quartz arenite of the Mount Clark Formation (Cambrian). Note contrast in bedding style and intensity of joint development between the two units. Sample was collected from low in exposure of Abraham Plains Formation. Locality is along an unnamed stream in the eastern Mackenzie Mountains. Geologist, for scale, at lower left.**

*U-Pb Results and Interpretation.* In sample 11MWB-131, ~60% of the detrital zircon grains range in age between 1500 Ma and 1000 Ma, with 30% Paleoproterozoic grains and 10% Archean grains. The PDD indicates prominent peaks at 1625 Ma, 1440 Ma, 1360 Ma, and 1200 Ma (Fig. 5). The 1440 Ma peak is the strongest and is defined by a grouping of 20 grains ranging in age from 1490 to 1430 Ma. This peak is consistently the strongest in all of the Mackenzie Mountains, Katherine Group samples that we analyzed, indicating a long-lived source that matches a range of ages documented within the eastern granite-rhyolite province of the U.S. midcontinent (Van Schmus et al., 1996). The 1625 Ma peak is defined by a grouping of grains that range in age between 1680 and 1600 Ma. Such ages could represent syn-orogenic plutons and associated rocks from the Mazatzal orogen (1680–1620 Ma) of the southwest U. S. (Amato et al., 2008; Karlstrom and Bowring, 1988), or its equivalents, the Central Plains orogen (Sims and Peterman, 1986) and Labrador orogen (e.g., Trans-Labrador Batholith; (Gower and Krogh, 2002) to the northeast. Like the mid-continent granite-rhyolite source described above, these rocks would have been uplifted during the Elsevirian, Shawinigan and Ottawan collisional accretion events that occurred along the southwest margin of Laurentia during the mid-late Mesoproterozoic.



## APPENDIX II

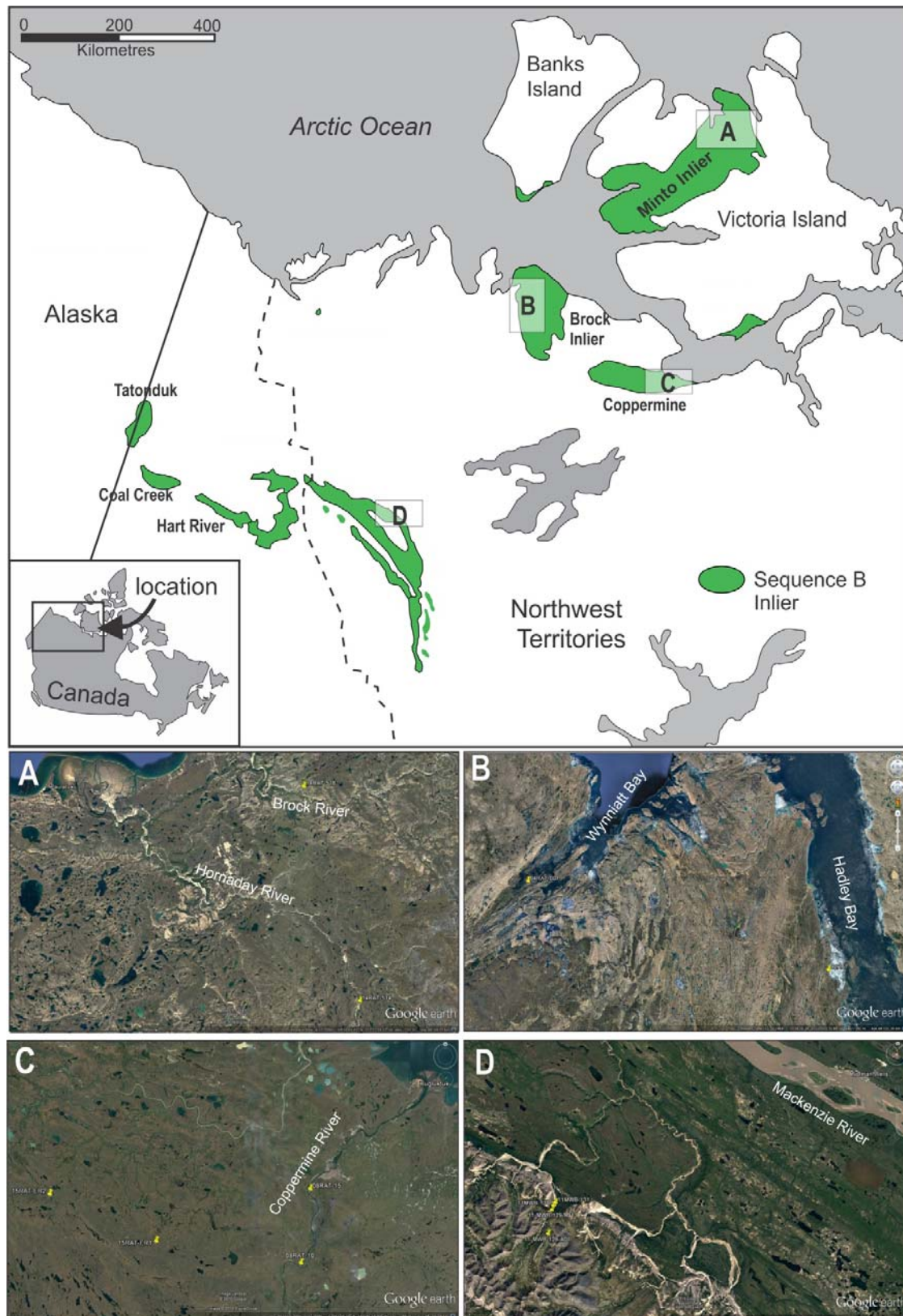
### SHRIMP Analytical Procedures

Most samples were disaggregated using standard crushing/pulverizing techniques followed by density separation using the Wilfley table and heavy liquids. A magnetic separator was used to isolate a zircon separate. Details regarding the procedure, and any deviations from it, are described in (Rayner and Rainbird, 2013). SHRIMP analytical procedures followed those described by Stern (Stern, 1997), with standards and U-Pb calibration methods following Stern and Amelin (Stern and Amelin, 2003). Briefly, zircons were cast in 2.5 cm diameter epoxy mounts (along with fragments of the GSC laboratory standard zircon (z6266, with  $^{206}\text{Pb}/^{238}\text{U}$  age = 559 Ma). The mid-sections of the zircons were exposed using 9, 6, and 1  $\mu\text{m}$  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  $1\sigma$  external errors of  $^{206}\text{Pb}/^{238}\text{U}$  ratios reported in the data table incorporate the error in calibrating the standard. Common Pb correction used the Pb composition of the surface blank (Stern, 1997). Details of the analytical session, including spot size, number of scans, calibration error and the applications of any intraelement fractionation corrections are given in Table DR1. Isoplot v. 3.00 (Ludwig, 2008) was used to generate concordia plots and calculate concordia ages and weighted means. The error ellipses on the concordia diagrams and the weighted mean errors are reported at  $2\sigma$ . AgeDisplay (Sircombe, 2004) was used to generate probability density diagrams.

### LA-ICP-MS Analytical Procedures

Detrital zircon grains were extracted from four sandstone samples for LA-ICP-MS U-Pb age determination using standard pulverizing (jaw crusher, disk mill) and mineral separation (gravimetric, magnetic) techniques. Zircon crystals were individually selected using a stereomicroscope and included the range of zircon morphologies and habits present. The selected grains were secured in an epoxy mount, polished and imaged using a Zeiss Axioskop 40 cathodoluminescence microscope. The U-Pb analyses were performed with a Nu Plasma I multi-collector inductively coupled plasma mass spectrometer following closely the protocol originally established by (Simonetti et al., 2005). Each zircon spot analysis (20  $\mu\text{m}$  diameter) consisted of a 60 second ablation period using a 213 nm New Wave laser (4 Hz;  $1.13 \text{ J}/\text{cm}^3$ ). Pb fractionation was monitored by simultaneously aspirating a Tl solution. Two reference zircon standards were analyzed repeatedly during each analytical session, typically after each 10 unknown analyses. The  $1831 \pm 1 \text{ Ma}$  LH94–15 zircon (Ashton et al., 1999) was used to monitor U/Pb fractionation and the  $3465.4 \pm 0.6 \text{ Ma}$  OG-1 zircon (Stern et al., 2009) was analyzed to verify the age accuracy of the measurement protocol. The OG-1 average  $^{207}\text{Pb}/^{206}\text{Pb}$  age results obtained for each analytical session (one unknown sample per session analyzed in the following sequence 11MWB128–131) are  $3454.8 \pm 3.6 \text{ Ma}$  (MSWD = 0.23; 30/33),  $3460.7 \pm 3.6 \text{ Ma}$  (MSWD = 0.44; 17/19),  $3462.8 \pm 3.2 \text{ Ma}$  (MSWD = 0.56; 9/10) and  $3459.4 \pm 4.2 \text{ Ma}$  (MSWD = 0.45; 13/13); generally overlapping with the accepted age for this standard. The exception is session 1

(sample 11MWB128–128) where the OG1 zircon measured age is slightly younger than the accepted age. The signal at mass 204 during zircon ablation (50–200 cps) was similar for both standard and unknown zircon. The OG1 IDTIMS high measured  $^{206}\text{Pb}/^{204}\text{Pb}$  results (most are 20,000–50,000; Stern et al., 2009) indicate that single crystals of this zircon standard have negligible common Pb; the majority of the mass 204 signal in our ICPMS data is isobaric interference. A common Pb correction was therefore not performed on these standard and unknown zircon analyses. Zircon age uncertainties in the data tables are reported at  $2\sigma$  and include propagating both the ICPMS individual spot analysis measurement error and the uncertainty in the LH94–15 standard zircon results obtained per session. U decay constants and the  $^{238}\text{U}/^{235}\text{U}$  ratio used in the age calculations are from (Jaffey et al., 1971). Probability density plots of the  $^{207}\text{Pb}/^{206}\text{Pb}$  dates were generated using Isoplot v.4.15 (Ludwig, 2008); analyses >10% discordant or with >1000 cps 204 signal were not included in these plots.



Map location of detrital zircon samples collected for this study.

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