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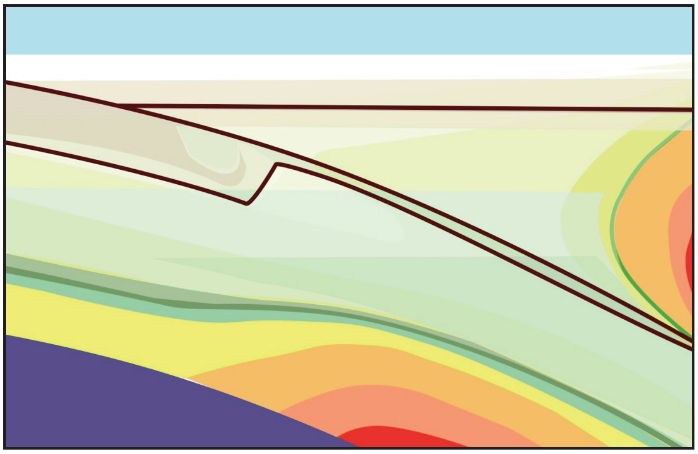

Lithotectonic Framework of the Core Zone, Southeastern Churchill Province, Canada

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SUMMARY

The Core Zone, a broad region located between the Superior and North Atlantic cratons and predominantly underlain by Archean gneiss and granitoid rocks, remained until recently one of the less well known parts of the Canadian Shield. Previously thought to form part of the Archean Rae Craton, and later referred to as the Southeastern Churchill Province, it has been regarded as an ancient continental block trapped between the Paleoproterozoic Torngat and New Quebec orogens, with its relationships to the adjacent Superior and North Atlantic cratons remaining unresolved. The geochronological data presented herein suggest that the Archean evolution of the Core Zone was distinct from that in both the Superior and North Atlantic (Nain) cratons. Moreover, the Core Zone itself consists of at least three distinct lithotectonic entities with different evolutions, referred to herein as the George River, Mistinibi-Raude and Falcoz River blocks, that are separated by steeply-dipping, crustal-scale shear zones interpreted as paleosutures. Specifically, the George River Block consists of ca. 2.70 Ga supracrustal rocks and associated ca. 2.70–2.57 Ga intrusions. The Mistinibi-Raude Block consists of remnants of a ca. 2.37 Ga volcanic arc intruded by a ca. 2.32 Ga arc plutonic suite (Pallatin) and penecontemporaneous alkali plutons (Pelland and Nekuashu suites). It also hosts a coarse clastic cover sequence (the Hutte Sauvage Group) which contains detrital zircons provided from locally-derived, ca. 2.57–2.50 Ga, 2.37–2.32 Ga, and 2.10–2.08 Ga sources, with the youngest concordant grain dated at 1987 ± 7 Ma. The Falcoz River Block consists of ca. 2.89–2.80 Ga orthogneiss intruded by ca. 2.74–2.70 granite, tonalite, and granodiorite. At the western margin of the Core Zone, the George River Block and Kuujjuaq Domain may have been proximal by ca. 1.84 Ga as both appear to have been sutured by the 1.84–1.82 Ga De Pas Batholith, whereas at its eastern margin, the determination of metamorphic ages of ca. 1.85 to 1.80 Ga in the Falcoz River Block suggests protracted interaction with the adjacent Lac Lomier Complex during their amalgamation and suturing, but with a younger, 'New Quebec' overprint as well. The three crustal blocks forming the Core Zone add to a growing list of 'exotic' Archean to earliest Paleoproterozoic microcontinents and crustal slices that extend around the Superior Craton from the Grenville Front through Hudson Strait, across Hudson Bay and into Manitoba and Saskatchewan, in what was the Manikewan Ocean realm, which closed between ca. 1.83–1.80 Ga during the formation of supercontinent Nuna.

RÉSUMÉ

La Zone noyau, une vaste région située entre les cratons du Supérieur et de l'Atlantique Nord et reposant principalement

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sur des gneiss archéens et des roches granitiques, est demeurée jusqu'à récemment l'une des parties les moins bien connues du Bouclier canadien. Considérée auparavant comme faisant partie du craton archéen de Rae, puis comme la portion sud-est de la Province de Churchill, on l'a perçue comme un ancien bloc continental piégé entre les orogènes paléoprotérozoïques des Torngat et du Nouveau-Québec, ses relations avec les cratons supérieurs adjacents et de l'Atlantique Nord demeurant nébuleuses. Les données géochronologiques présentées ici permettent de penser que l'évolution archéenne de la Zone noyau a été différente de celle des cratons du Supérieur et de l'Atlantique Nord (Nain). De plus, la Zone noyau elle-même se compose d'au moins trois entités lithotectoniques distinctes avec des évolutions différentes, appelées ici les blocs de la rivière George, de Mistinibi-Raude et de la rivière Falcoz, lesquels sont séparées par des zones de cisaillement crustales à forte inclinaison, conçues comme des paléosutures. Plus précisément, le bloc de la rivière George est constitué de roches supracrustales d'env. 2,70 Ga, et d'intrusions connexes d'env. 2,70–2,57 Ga. Le bloc Mistinibi-Raude est constitué de vestiges d'un arc volcanique d'env. 2,37 Ga, recoupé par une suite plutonique d'arc d'env. 2,32 Ga (Pallatin) et de plutons alcalins péné-contemporains (suites Pelland et Nekuashu). Il contient également une séquence de couverture clastique grossière (le groupe Hutte Sauvage) renfermant des zircons détritiques de sources locales, âgés d'env. 2,57–2,50 Ga, 2,37–2,32 Ga et 2,10–2,08 Ga, le grain concordant le plus jeune étant âgé de 1987 ± 7 Ma. Le bloc de la rivière Falcoz est formé d'un orthogneiss âgé d'env. 2,89–2,80 Ga, recoupé par des intrusions de granite, tonalite et granodiorite âgées d'env. 2,74–2,70 Ga. À la marge ouest de la Zone noyau, le bloc de la rivière George et du domaine de Kuujjuaq peuvent avoir été proximaux il y a 1,84 Ga env., car les deux semblent avoir été suturés par le batholithe De Pas il y a environ 1,84–1,82 Ga, alors qu'à sa marge est, la détermination des datations métamorphiques de 1,85 à 1,80 Ga dans le bloc de la rivière Falcoz suggère une interaction prolongée avec le complexe adjacent du lac Lomier durant leur amalgamation et leur suture, mais affecté aussi d'une surimpression « Nouveau Québec » plus jeune. Les trois blocs crustaux formant la Zone noyau s'ajoutent à une liste croissante de micro-continents et d'écailles crustales « exotiques » archéennes à paléoprotérozoïques très précoces qui s'étalent autour du craton Supérieur depuis le front de Grenville jusqu'au Manitoba, à travers le détroit d'Hudson, la baie d'Hudson jusque dans le Manitoba et la Saskatchewan, là où s'étendait l'océan Manikewan, lequel s'est refermé il y a environ 1,83–1,80 Ga, pendant la formation du supercontinent Nuna.

Traduit par le Traducteur

INTRODUCTION

Much of the crustal growth of the interior of Laurentia (North American Precambrian continent) occurred by tectonic and magmatic accretion during the Paleoproterozoic, between ca. 2.0 and 1.8 Ga (Fig. 1). The resulting landmass consists of a collage of large, stable Archean cratons (Slave, Superior and North Atlantic), bound together by mobile belts (mostly components of the Churchill Province) that are composed of a mosaic of variably reactivated Archean crustal blocks (also referred to as 'cratons' or 'provinces') and microcontinents as well as juvenile Proterozoic crust, magmatic arcs, and intracratonic sedimentary basins (Hoffman 1988, 1990; Lewry and Collerson 1990; Rainbird 2004; St-Onge et al. 2006; Whitmeyer and Karlstrom 2007; Corrigan et al. 2009). The Churchill Province has been historically separated into a western part (Western Churchill Province) west of Hudson Bay, a central part situated north of Hudson Strait, and a southeastern arm (Southeastern Churchill Province), lying between the Superior and North Atlantic cratons south of Ungava Bay (Hoffman 1990). Earlier syntheses suggested that most of the Churchill Province was underlain by two distinct Archean crustal blocks termed the Rae and Hearne 'provinces' (e.g. Hoffman 1988), whereas subsequent models based on a large geochronological database and an interpretation of regional aeromagnetic lineaments permitted the identification of a collage of other distinct Archean to earliest-Paleoproterozoic crustal blocks confined within the mobile belts, including the Sask 'craton,' Sugluk 'block,' Meta-Incognita 'micro-continent' and Core Zone (Chiarenzelli et al. 1998; James and Dunning 2000; Hajnal et al. 2005; St-Onge et al. 2006; Corrigan et al. 2009). The Churchill Province is interpreted as the more or less contiguous area of the collage described above that was thermally and structurally affected by terminal collision with the Superior Craton during the interval 1.83 to 1.80 Ga (Lewry and Collerson 1990; Corrigan et al. 2009).

This paper presents a new synthesis of the Core Zone (Fig. 2), one of the Archean blocks or microcontinents forming the Churchill Province collage, and provides some speculations on its relationship with the bounding New Quebec and Torngat orogens. The results highlighted herein stem from recent 1:100,000-scale bedrock mapping in the Core Zone, led by the Ministère de l'énergie et des ressources naturelles du Québec (Hammouche et al. 2011; Simard et al. 2013; Lafrance et al. 2014), as well as thematic mapping by the Geological Survey of Canada under the auspices of the Geo-mapping for Energy and Minerals (GEM) program (Corrigan et al. 2015, 2016; Sanborn-Barrie et al. 2015; Sanborn-Barrie 2016). We present a synthesis of previous work and new bedrock geology observations, as well as U–Pb zircon ages that provide constraints on the crustal evolution of the Core Zone and its role in the tectonic evolution of the Churchill Province. Earlier work by Wardle and van Kranendonk (1996), Girard (1990a, b, c), James and Dunning (2000) and Simard et al. (2013), among others, has recognized the existence of a major network of sub-parallel to anastomosing shear zones separating elongate to lens-shaped blocks along the north-south extent of the Core Zone. We provide arguments suggesting that the Core Zone comprises at least three distinct Archean to earliest-Paleoproterozoic crustal blocks that are separated by sutures. We speculate on the crustal evolution of these crustal blocks, the timing of their amalgamation, their relationship with the flanking Superior and North Atlantic cratons, as well as their possible correlatives elsewhere in the Churchill Province.

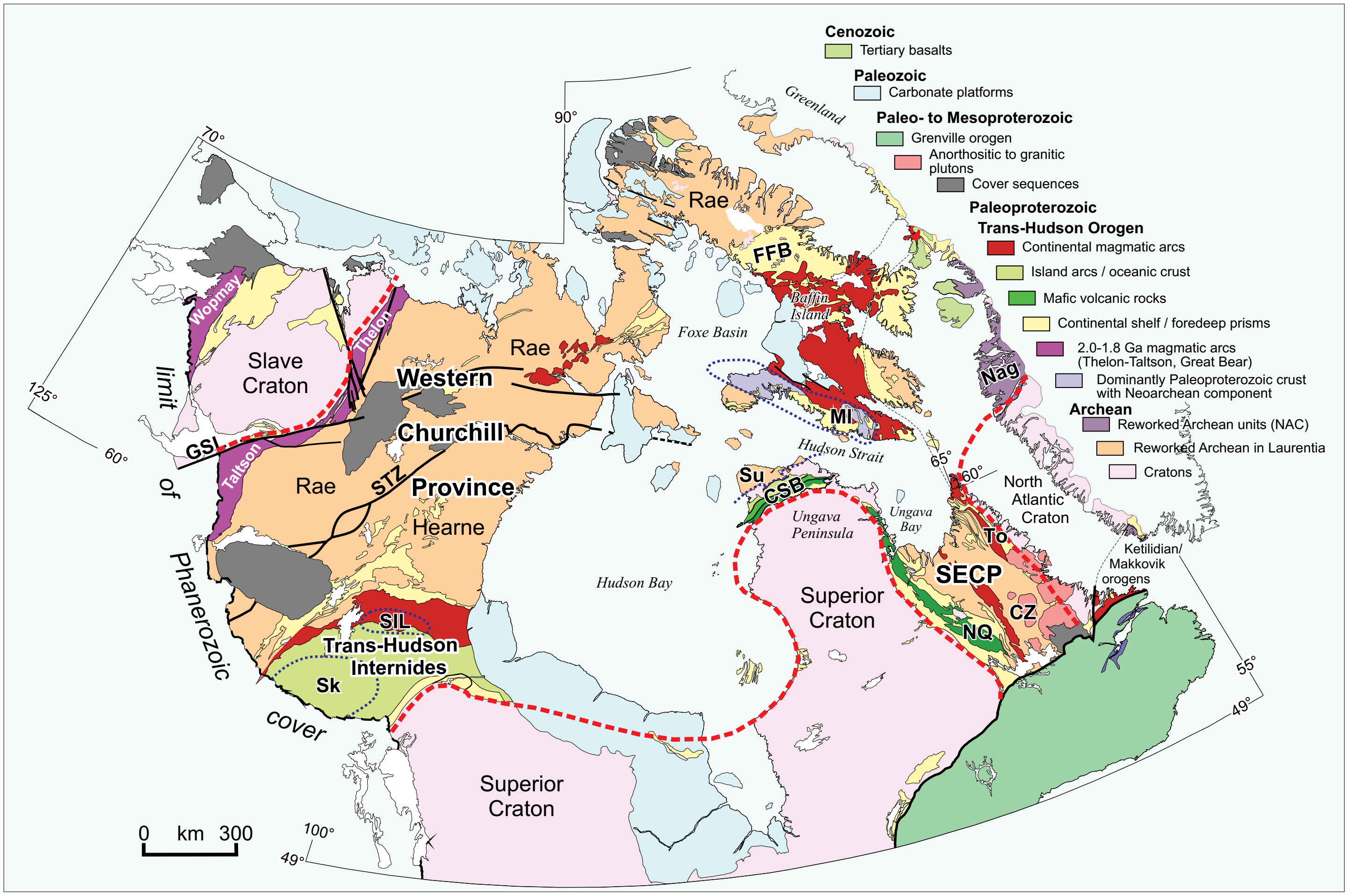

Figure 1. Simplified bedrock geology map of Laurentia. Abbreviations: CSB, Cape Smith Belt; CZ, Core Zone; FFB, Foxe Fold Belt; MI, Meta-Incognita microcontinent; Nag, Nagssugtoqidian Orogeny; NQ, New Quebec Orogen; SECP, Southeastern Churchill Province; SIL, Southern Indian Lake; Sk, Sask Craton (showing interpreted outline at MOHO); Su, Sugluk Block; To, Torngats Orogen. Map modified after Hoffman (1990).

REGIONAL SETTING

The Core Zone (Fig. 2) forms an ~ 500-km-long by ~ 200-km-wide crustal domain that is situated in the central part of the Southeastern Churchill Province. It has been interpreted as an elongate sliver of Archean continental crust (ribbon continent) that was accreted between the colliding Superior and North Atlantic cratons during the Paleoproterozoic (James et al. 1996; James and Dunning 2000; Wardle et al. 2002). It is flanked on its western side by the ca. 1.83–1.80 Ga New Quebec Orogen (Hoffman 1988; Perreault and Hynes 1990; Moorhead and Hynes 1990), and on its eastern side by the ca. 1.87–1.86 Ga Torngat Orogen (Wardle et al. 2002 and references therein). The extent to which it is affected by tectonism related to either of these orogens remains unclear, although the 'New Quebec' overprint appears to be more widespread. The earliest systematic mapping of the Core Zone was performed during 'Operation Torngat,' a helicopter-supported survey conducted by the Geological Survey of Canada that was completed in the late 1960s and resulted in the publication of a series of 1:250,000-scale bedrock maps (Taylor 1979). Lithological units on these maps consist mostly of Archean orthogneiss with minor paragneiss and plutonic rocks. Detailed mapping in the south-central part of the Core Zone by Girard (1990a, b) and van der Leeden (1994) highlighted the presence of supracrustal and plutonic rocks of low- to medium-metamorphic grade in the central part of the Core Zone (Mistinibi-Raude Block), with the supracrustal rocks hosting a plutonic unit that yielded a U–Pb zircon age of ca. 2.33 Ga (Girard 1990a). In addition, throughout the Core Zone, Girard (1990b) recognized the presence and significance of major, orogen-parallel ductile shear zones that separated distinct crustal blocks. Subsequently, James et al. (2003) and Hammouche et al. (2011) completed regional mapping and U–Pb geochronology on key protoliths in the southern part of the Core Zone north of Smallwood Reservoir. In the same area, Nunn et al. (1990) had previously recognized the presence of ca. 2.68–2.67 Ga tonalite and mafic volcanic rocks having minimal Proterozoic overprint, collectively suggesting variable degrees of tectonothermal overprint throughout the Core Zone, ranging from granulite to sub-greenschist facies. Bedrock geological mapping along the northern extents of the Core Zone was performed by Verpaelst et al. (2000) and Simard et al. (2013).

The Core Zone has historically been interpreted to encompass the entire span of Archean rocks exposed between Pale-

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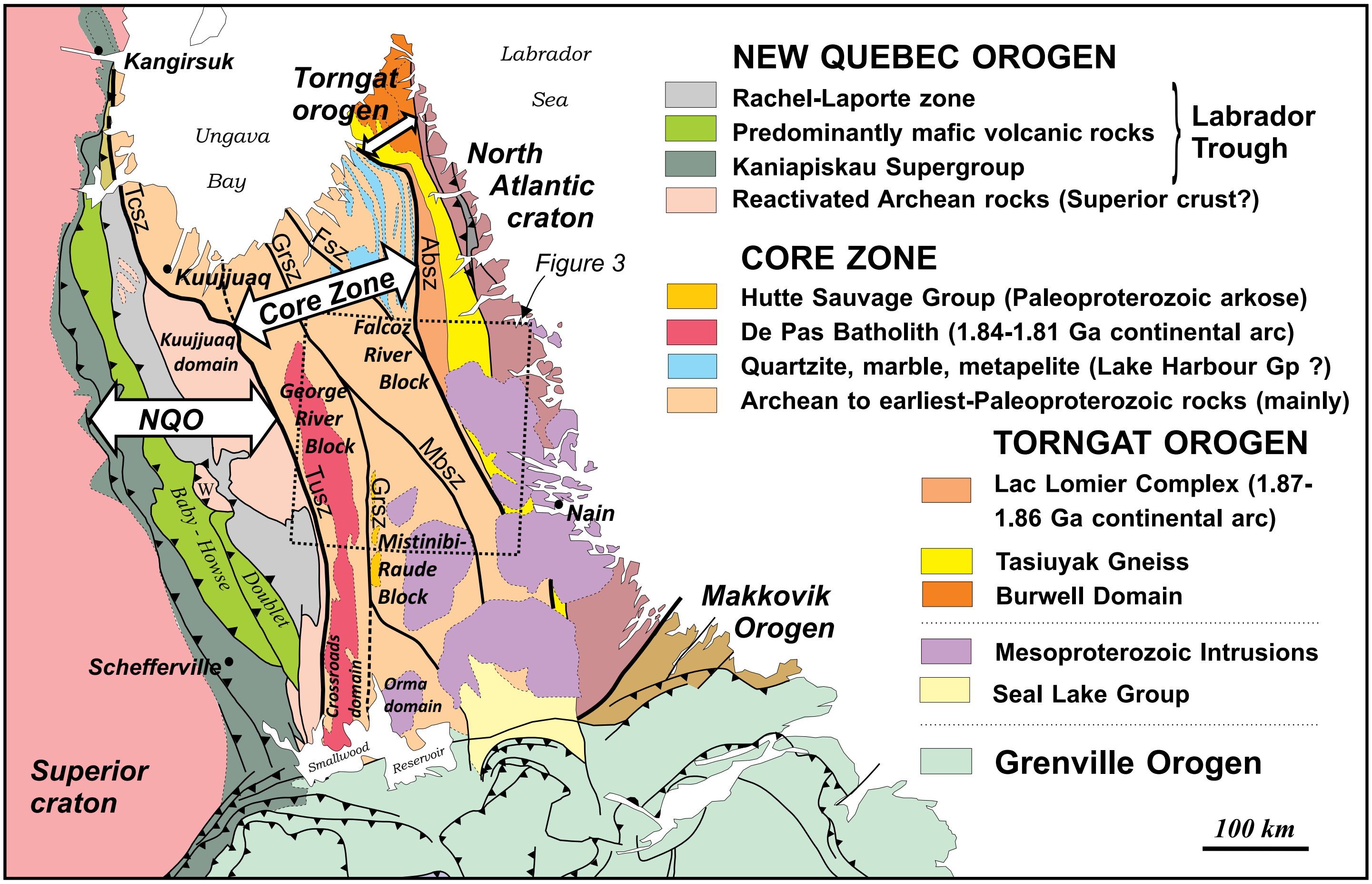

Figure 2. Simplified geological map of the Southeastern Churchill Province (SECP). Abbreviations as follows: Absz, Abloviak shear zone; Fsz, Falcoz shear zone; Grsz, George River shear zone; Mbsz, Moonbase shear zone; Tcsz, Lac Turcotte shear zone; Tusz, Lac Tudor shear zone; NQO, New Quebec Orogen; W, Wheeler dome. Location of Figure 3 shown in box. Modified after James and Dunning (2000).

oproterozoic rocks of the Labrador Trough to the west and the Lac Lomier domain to the east (Wardle and Van Kranendonk 1996). However, there are inherent uncertainties regarding this approach. Specifically, these concern the origin of Archean rocks exposed between the eastern edge of the Labrador Trough and the Lac Tudor shear zone (Fig. 2), and their potential affinity with the Superior Craton. That area, often referred to in the literature as "undivided Core Zone," has been interpreted by Poirier et al. (1990), Wardle et al. (2002) and Simard et al. (2013), based primarily on lithology and apparent continuity of aeromagnetic lineaments, as belonging to the Superior Craton. This interpretation is also supported by U–Pb ages recently obtained on various intrusions that suggest an affinity with the adjacent Superior Craton (Rayner et al. 2017). In addition, the Superior Craton can be traced around the northernmost lobe of the Labrador Trough north of Kangirsuq (Fig. 2), suggesting that it forms the direct basement beneath at least that part of the Trough. Moreover, basement domes and nappes with Superior crust affinities occur west of Kuujjuaq (Machado et al. 1989), and in a tectonic window in the central part of the Trough (Wheeler Dome). In this paper, we focus our attention on the geological framework of that part of the Core Zone situated between the Lac Tudor shear zone and the western edge of the Lac Lomier Complex, which we define herein as Core Zone *sensu stricto* (e.g. Wardle et al. 2002).

GEOLOGY OF THE CORE ZONE

For the most part, the Core Zone consists of variably transposed metaplutonic rocks, gneiss and migmatite that form North-South elongated crustal lenses, up to 500 km long and 100 km wide, separated by steeply dipping, ductile shear zones (Girard 1990b; Wardle and Van Kranendonk 1996). The metaplutonic rocks have yielded U–Pb ages ranging from 2.6 to 3.0 Ga (Nunn et al. 1990; Ryan et al. 1991; Isnard et al. 1998, 1999; James and Dunning 2000), with one of the crustal blocks (Mistinibi-Raude) hosting predominantly supracrustal and plutonic rocks with the latter yielding a significantly younger and from a global perspective, relatively unusual age of 2.33 Ga (Girard 1990a, c). Infolded remnants of a Paleoproterozoic cover sequence containing quartzite, marble, metapelite and rare ultramafic sills occur in the northeast part of the Core Zone and have been tentatively correlated with the Lake Harbour Group on Southern Baffin Island (Jackson and Taylor 1972; Scott and St-Onge 1998; Bourlon et al. 2002).

A ca. 1.84–1.82 Ga continental magmatic arc suite, the De Pas Batholith, occurs close to the western edge of the Core Zone and appears to be mostly confined to the George River Block (van der Leeden et al. 1990; Dunphy and Skulski 1996; James and Dunning 2000). Wardle et al. (2002) pointed out that negative ε_{Nd} values ranging from -7 to -3 obtained for the De Pas Batholith (Kerr et al. 1994; Dunphy and Skulski 1996) indicate significant contamination by Archean crust and suggested that parts of the batholith may be syn-collisional. The Core Zone is also host to a significant portion of the Mesoproterozoic Nain Plutonic Complex (Emslie and Hunt 1990). In the following sections we describe the various crustal blocks forming the Core Zone, which we define as the George River, Mistinibi-Raude and Falcoz River blocks. The George River Block correlates with the Crossroads and Orma domains identified farther south by James and Dunning (2000), and the Falcoz River Block amalgamates the Ford River, Henrietta, Anaktalik and Konrad Brook domains previously defined by Wardle et al. (2002) and references therein.

George River Block

The George River Block (Figs. 3 and 4), situated between the Lac Tudor and George River shear zones, is underlain by a distinct assemblage of metaplutonic and supracrustal rocks and is the main host to the ca. 1.84–1.82 Ga De Pas Batholith (Fig. 5A). Other than the batholith, its main lithology is the Archean (see below) Tunulik Belt (Lafrance et al. 2015), a supracrustal assemblage of mainly mafic to intermediate metavolcanic (Fig. 5B) and volcanogenic sedimentary rocks with rare felsic components. It also comprises a sub-volcanic plutonic root, composed of mixed, medium-grained, dioritic to granitic intrusions and quartz-feldspar porphyry (Fig. 5C), all intruded by megacrystic granite (Fig. 5D). The latter can be distinguished from the De Pas Batholith by its higher degree of recrystallization and migmatization. In contrast, the ca. 1.84–1.81 Ga De Pas Batholith is in general non-migmatitic, commonly preserving K-feldspar megacrysts in a weakly to moderately foliated matrix. Metamorphic assemblages are indicative of mid-amphibolite facies throughout the George River Block, and structural fabrics are generally oriented north-south, becoming more intense and progressively steeper towards the bounding shear zones. Some of the De Pas plutons contain orthopyroxene, but it is an igneous phase.

Falcoz River Block

Between the George River/Moonbase and Abloviak shear zones (Fig. 3) lies an area dominated by Archean rocks. This area has historically been divided into several domains based on dominant rock composition, metamorphic grade and/or presence of Paleoproterozoic-age cover sequences. These were named the Ford River, Henrietta Lake, Anaktalik and Konrad Brook domains by Wardle et al. (1990) and Wardle and Van Kranendonk (1996). Considering their similar age ranges and apparent continuity on aeromagnetic maps (see sections below) we group them all into the larger Falcoz River Block. The most common lithologies are meta-plutonic rocks, orthogneiss and migmatite (Fig. 5E) metamorphosed at upper-amphibolite facies. In its northern extents, the Falcoz River Block hosts distinct charnockite and enderbite plutons that retain most of their original igneous feldspars (only partially recrystallized) and are interpreted as Proterozoic-age intrusions, possibly related to the Cumberland Batholith on Baffin Island (Bourlon et al. 2002). Throughout this block, strain is variable, displaying fabrics becoming progressively more transposed near bounding shear zones. In its eastern part, the Falcoz River Block contains a greater abundance of late-Archean (see below) granite intrusions, as well as a widespread cover sequence that comprises quartzite, metapelite and marble, with mafic and ultramafic sills near their base. This supracrustal sequence has been tentatively correlated with the Lake Harbour Group on Southern Baffin Island (Jackson and Taylor 1972; Scott and St-Onge 1998). The metamorphic facies in the eastern part of the domain is uppermost-amphibolite to incipient granulite facies. The fact that biotite-out reactions have occurred in metapelites of potential Lake Harbour Group affinity, as well as evidence for orthopyroxene-in reactions in mafic rocks, suggests that > 800°C temperatures have been reached during the Paleoproterozoic, at least locally. However, the possibility that granulite facies conditions may have also occurred during the Archean cannot be ruled out. Fabrics in the eastern half of the Falcoz River Block are relatively flat to shallow-dipping, forming dome and basin structures that are slightly elongated along a north-south axis. These structures progressively steepen towards the Falcoz and Abloviak shear zones, as well as towards their contact with the Lac Lomier Complex.

Mistinibi-Raude Block

The Mistinibi-Raude Block (Fig. 3) is situated between the Moonbase and George River shear zones and is compositionally and metamorphically distinct from the George River and Falcoz River blocks. It consists of a supracrustal belt (Ntshuku Belt) composed mainly of mafic metavolcanic rocks (Fig. 5F), with minor meta-andesite and rhyolite, associated with staurolite-garnet-cordierite-bearing metapelite, psammite and calc-silicate gneiss (Fig. 6A). The supracrustal rocks are intruded by a distinct suite of calc-alkaline sub-volcanic metaplutonic rocks that includes feldspar- and hornblende-phyric diorite, granodiorite and monzogranite (Pallatin suite), for which a preliminary U–Pb zircon age of ca. 2.33 Ga has been reported (Girard 1990a). The existence of a second, slightly more alkaline plutonic suite is suggested by the presence of large composite intrusions that consist of gabbro, monzogabbro, diorite, monzodiorite, quartz syenite, and augite syenite. Silica-saturated rocks of that suite commonly contains blue, rutilated quartz, as well as rare orthopyroxene- and blue quartz-bearing pegmatite, suggestive of emplacement at very high temperatures under locally anhydrous conditions. That more alkaline suite coincides with two strong magnetic anomalies on regional airborne aeromagnetic surveys (Fig. 4) that have been referred to as the Nekuashu and Pelland plutons (Lafrance et al. 2015, 2016). The Mistinibi-Raude Block also hosts a fluvial clastic sedimentary sequence, the Hutte Sauvage Group (van der Leeden 1994), which comprises meta-conglomerate and

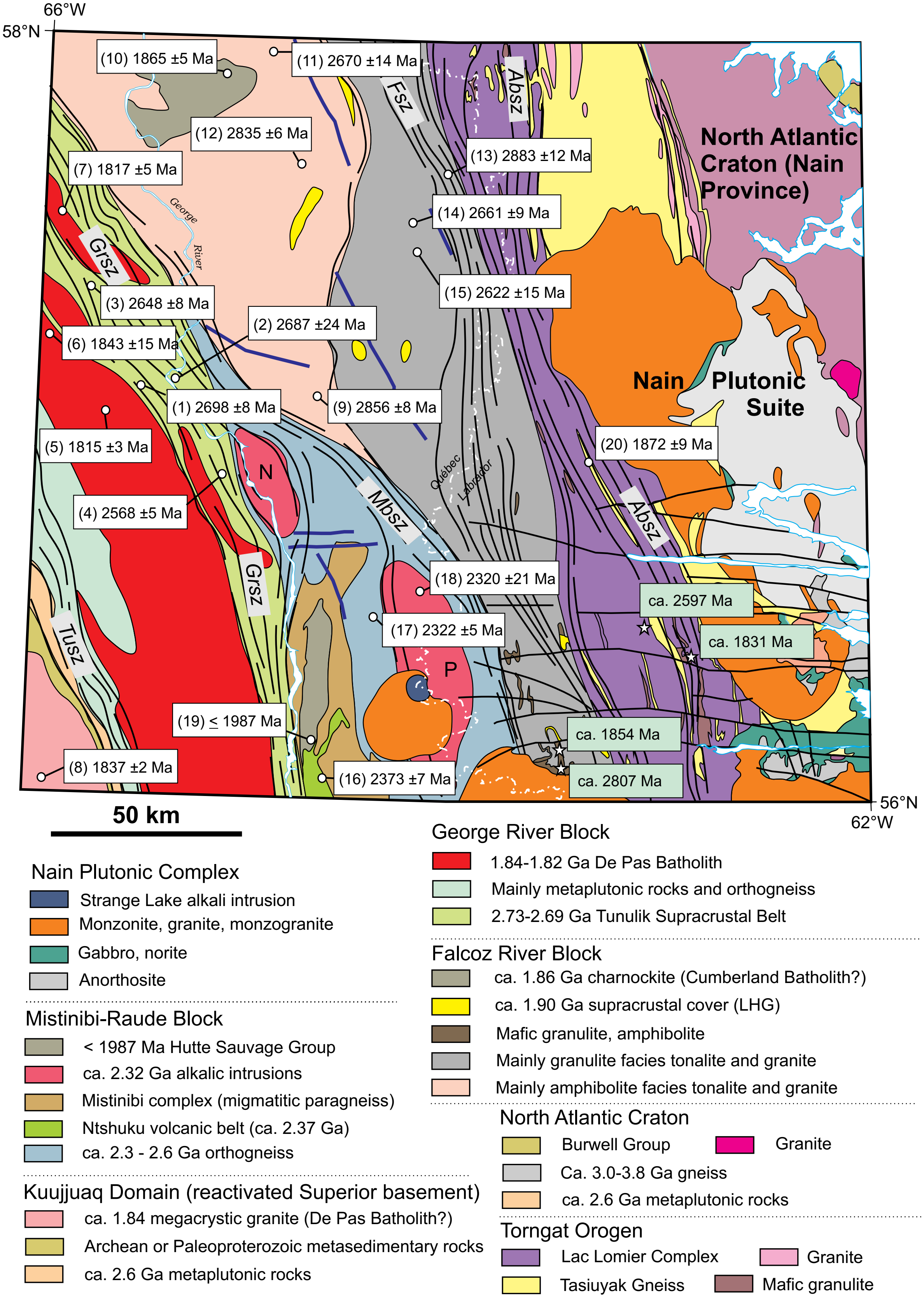

Figure 3. Bedrock geology map of the central part of the Core Zone and adjacent areas. Discontinuous black form lines show the location of high strain zones. U–Pb ages in white boxes are keyed to sample numbers in the text. Ages shown in the light blue boxes in the southeastern area are from Ryan et al. (1991). Absz, Abloviak shear zone; Fsz, Falcoz shear zone; Grsz, George River shear zone; Mbsz, Moonbase shear zone; Tusz, Lac Tudor shear zone.

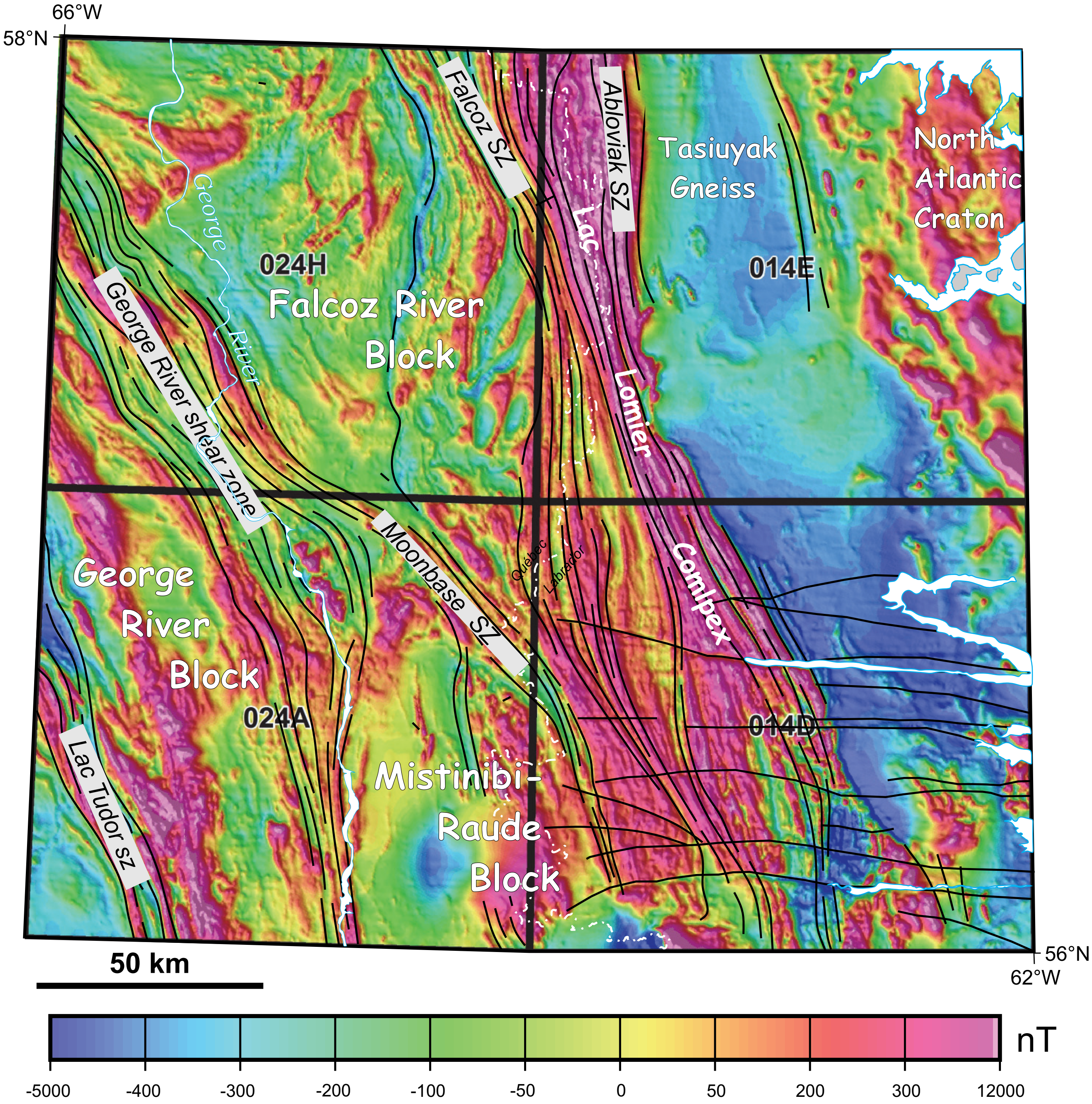

Figure 4. Coloured total-field aeromagnetic map of the central part of the Core Zone. Brittle E–W faults and ductile shear zones are highlighted with black form lines. Geological Survey of Canada database. 1:250,000-scale NTS map areas 014D, 014E, 024A and 024H are shown.

locally cross-bedded meta-arkose and quartzite (Fig. 6B). It was interpreted by Girard (1990a) as a post-1820 Ma sedimentary sequence based on the presence of clasts of K-feldspar megacrystic granite inferred to have been derived from the De Pas Batholith. Metamorphism within the Mistinibi-Raude Block ranges from lower to upper amphibolite facies.

Lac Lomier Complex

The Lac Lomier Complex bounds the Core Zone on its eastern side. It consists of metaplutonic rocks and orthogneiss of predominantly intermediate composition, but ranging overall from mafic to felsic in composition that is banded at the centimetre to metre scale. These rocks are metamorphosed at granulite facies, giving them a waxy green to light brown colour, and characteristically have orthopyroxene and hornblende as the main mafic phases (Fig. 6C).

The Lac Lomier Complex has been interpreted by Wardle et al. (1990) as a ca. 1.87 to 1.86 Ga continental arc emplaced

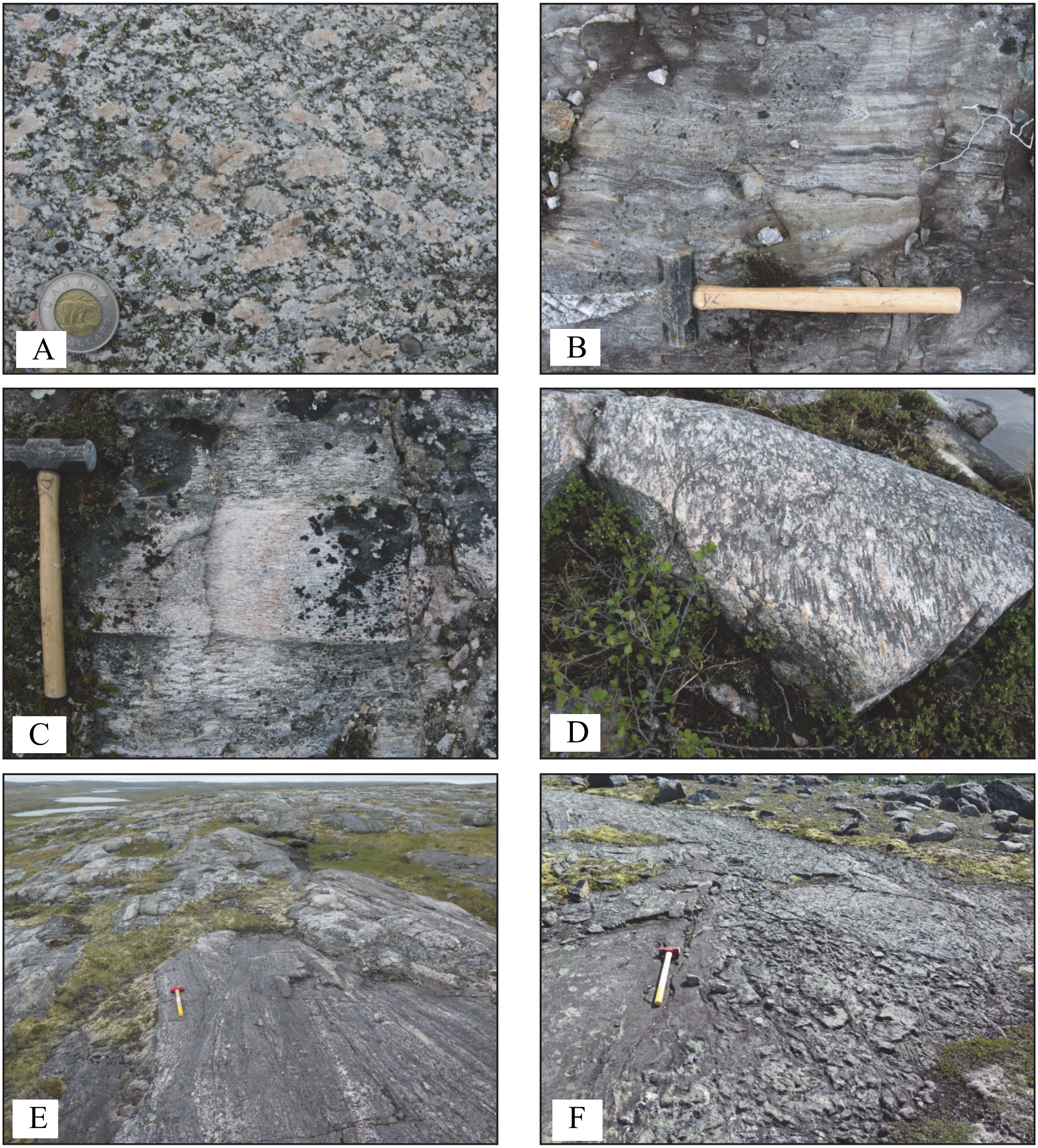

Figure 5. Field photographs from the Core Zone. A) K-feldspar megacrystic, hornblende-biotite granite from the De Pas Batholith. Coin for scale is 28 mm in diameter. B) Intermediate to felsic volcaniclastic rock outcrop from the Tunuliq Belt. Hammer for scale is 38 cm long. C) Sub-volcanic quartz-feldspar porphyry phase of the Tunuliq Belt (center of the photograph) intruding a coarser-grained granodioritic intrusion of likely similar age. Hammer for scale is 38 cm long. D) Metamorphosed and recrystallized K-feldspar megacrystic granite that intrudes metavolcanic rocks of the Tunuliq Belt (geochronology Sample 4). Base of photograph is 1.5 m across. E) Field photograph of a typical outcrop in the Falcoz River Block, showing variably transposed orthogneiss. Hammer for scale is 38 cm long. F) Outcrop photograph of flow breccia (right side of photo) in Ntshuku Belt basaltic rock. Hammer for scale is 38 cm long.

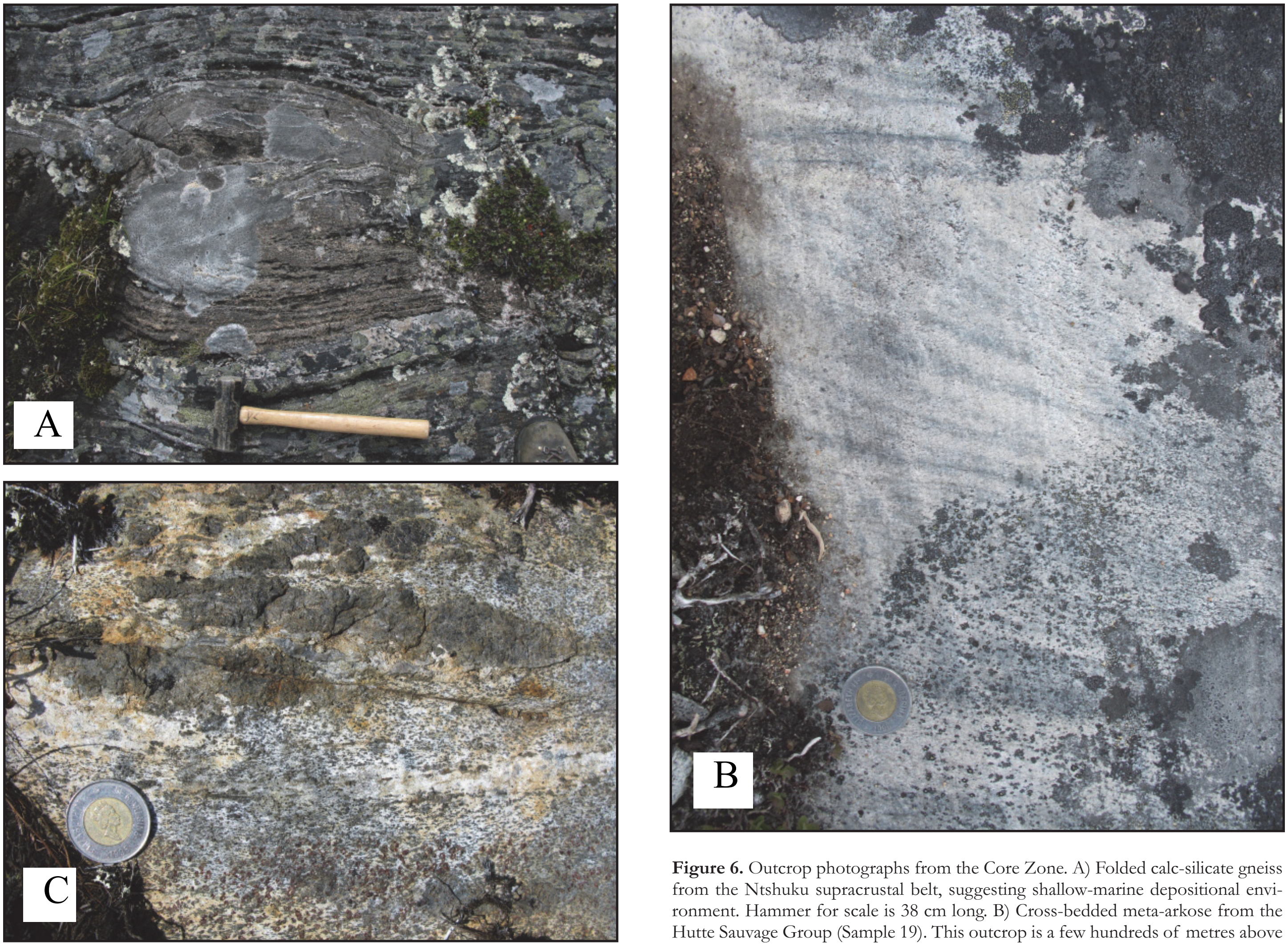

Figure 6. Outcrop photographs from the Core Zone. A) Folded calc-silicate gneiss from the Ntshuku supracrustal belt, suggesting shallow-marine depositional environment. Hammer for scale is 38 cm long. B) Cross-bedded meta-arkose from the Hutte Sauvage Group (Sample 19). This outcrop is a few hundreds of metres above a conglomerate horizon. Coin for scale is 28 mm in diameter. C) Very large orthopyroxene crystals (brown colour, top of photograph) in mafic to intermediate granulite of the Lac Lomier Complex. Coin for scale is 28 mm in diameter.

on the western margin of the North Atlantic Craton. The presence of map-scale screens of metapelitic rocks, likely derived from the Tasiuyak Gneiss, lends support to that interpretation. Overall, the Lac Lomier Complex is highly strained, with the very strong transposition of lithological layers forming a steeply-dipping gneiss with a pervasive, sub-horizontal mineral and stretching lineation. Kinematic indicators show a consistent dextral strike-slip sense of shear. Its contact with the Falcoz River Block is relatively sharp and appears to be structural.

ANALYTICAL PROCEDURES

Two different analytical techniques, performed in separate laboratories, were used to generate U–Pb ages. Eleven samples were analyzed using the sensitive high-resolution ion microprobe (SHRIMP) at the Geological Survey of Canada (GSC), and nine samples were analyzed by laser ablation, inductively coupled plasma mass spectrometry (LA-ICPMS) at the Department of Earth Sciences, University of New Brunswick. Four samples from the George River Block (samples 1, 3, 4 and 5), one from the Falcoz River Block (Sample 9), four from the Mistinibi-Raude Block (samples 16 to 19), and one from the Lac Lomier Complex (Sample 20) were analyzed using SHRIMP. The zircon separates were prepared using standard crushing, grinding, Wilfley™ table, and heavy liquid techniques, followed by magnetic susceptibility sorting using a Frantz™ isodynamic separator. SHRIMP analytical procedures followed those described by Stern (1997), utilizing standards and U–Pb calibration methods following 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 a ^{206}Pb/^{238}U age of 559 Ma). The mid-sections of the zircon grains were exposed and polished using 9, 6, and 1 µm diamond compound, and the internal features of the grains (such as zoning, structures, alteration, etc.) were imaged in back-scattered electron mode (BSE) or in cathodoluminescence (CL) utilizing a Zeiss Evo 50 scanning electron microscope. Mount surfaces were evaporatively coated with 10 nm of high-purity Au. Analyses were conducted using a ^{16}O- primary beam, projected onto the zircon at 10 kV. 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 SQUID 2.50.11.10.15, rev. 15 Oct. 2011) software written by Ludwig (2003). The 1σ external errors of ^{206}Pb/^{238}U ratios reported in supplementary data Table S-1 incorporate the error in calibrating the standard. The common Pb correction utilized Pb composition of the surface blank (Stern 1997). Yb and Hf concentration data were calculated using sensitivity factors derived from standard z6266 with values of 69 and 8200 ppm, respectively. Analyses of a secondary internal zircon standard (z1242, with an accepted age of 2679.7 ± 0.2 Ma (B. Davis, personnel communication)) were interspersed between the sample analyses to monitor Pb isotopic fractionation. Isoplot v. 4.15 (Ludwig 2003) was used to generate Concordia plots and the probability density diagram for detrital Sample 19, and to calculate weighted means. The error ellipses on the Concordia diagrams and the weighted mean errors are reported at 2σ.

U–Pb analyses for samples 2, 6, and 7 from the George River Block, and samples 10 to 15 from the Falcoz River Block were processed at the Department of Earth Sciences geochronology laboratory, University of New Brunswick. Zircon U–Pb dating was carried out using a Resonetics RESOlution M-50 series 193 nm excimer laser ablation system equipped with a Laurin Technic Pty S-155 ablation cell. Ablation was conducted in a mixed He (325 mL/min) and Ar (930 mL/min) carrier gas and mixed with N_2 (2 mL/min) downstream of the cell. Contamination at mass 204 from Hg in the carrier gases was < 150 cps. Data listed in supplementary Table S-2 were collected using either 17 or 24 μm diameter laser crater depending on the size of the grains, a repetition rate of 4.5 Hz, and laser fluence of ~ 4 J/cm^2. The data were standardized against FC1 zircon (1099 ± 2 Ma) which was distributed evenly throughout the sequence and analyzed at least 16 times per run. Each ablation was 35 seconds in duration and was preceded by 40 sec of background collection. Ablated aerosol was transferred to the ICP-MS using nylon tubing with an in-line 'squid' smoothing device connected immediately before the junction with the ICP-MS torch. Isotope intensities were measured using an Agilent 7700x quadrupole-ICP-MS operated in 'auto' detector mode: sensitivity and P/A factors were tuned by rastering across NIST610 glass before the start of each run. A second external rotary pump was used to enhance sensitivity. The ICP-MS method measured ^{90}Zr, ^{202}Hg, ^{204}Pb, ^{206}Pb, ^{207}Pb, ^{208}Pb, ^{232}Th and ^{238}U with a total quadrupole sweep time of 0.23 seconds. The background corrected ^{202}Hg ion beam measured during ablation was used to peak strip any small excess ^{204}Hg from the ^{204}Pb signal using the ^{202}Hg/^{204}Hg measured on the gas background. The magnitude of this correction was typically insignificant. The data were reduced offline using VizualAge (Petrus and Kamber 2012) and Iolite v2.5 (Paton et al. 2011) running as plugins in Wavemetrics Igor Pro 6.23. Concentration data were calculated relative to NIST610 (distributed throughout the sequence) and using the Iolite trace-elements "internal standardization" data reduction scheme. An estimated value of 44 wt% Zr in zircon was used as the internal standard composition. Common Pb was corrected using the background-corrected and Hg-interference corrected ^{204}Pb intensity, a common-Pb composition based on the Pb–Pb evolution curve of Stacey and Kramers (1975) and an estimate of the age of the zircon based on the uncorrected ^{206}Pb/^{238}U age. This correction method is suitable for grains with modest common-Pb content and minor Pb-loss. The %Pb* estimate reported in supplementary data Table S-2 was taken from the Andersen (2002) routine implemented in VizualAge. A summary of U–Pb ages is presented in Table 1.

RESULTS

Samples for dating were principally collected from the George River, Mistinibi-Raude and Falcoz River blocks of the Core Zone *sensu stricto*, with one each coming from the adjacent Kuujjuaq Block and Lac Lomier Complex to the west and east, respectively.

George River Block

Seven rock units were sampled from the George River Block, providing age constraints on the Tunulik volcanic belt, gneiss and migmatite associated with this belt, as well as late plutonism interpreted to be associated with the De Pas Batholith. Results are as follows:

Sample 1: Tunulik Meta-Rhyolite (14CXA-D90A1; SHRIMP)

The Tunulik meta-rhyolite is medium-grained, well-foliated and metamorphosed at mid- to upper amphibolite facies. It yielded numerous, clear, colourless, short prismatic zircon grains with internal oscillatory growth zoning and thick to thin unzoned rims likely of metamorphic origin (Fig. 7A). Thirty of the 32 U–Pb SHRIMP analyses fall into two main groupings with oscillatory zoned material yielding a weighted mean ^{207}Pb/^{206}Pb age of 2698 ± 8 Ma (n = 20/23; MSWD = 1.20, probability of fit (POF) = 0.25), interpreted as the timing of volcanism, and unzoned rims giving a weighted mean age of 2543 ± 20 Ma (MSWD = 0.28, POF = 0.92), interpreted as the time of metamorphic zircon crystallization or recrystallization. The two oldest analyses from this sample, with low U contents (17–19 ppm) and strongly discordant ages of 2855 and 2807 Ma, are interpreted to represent xenocrystic material.

Sample 2: Migmatitic Granodiorite (14CXA-D92A1; LA-ICPMS)

Sample 2 is from a complex outcrop that includes gneissic and migmatitic orthogneiss of predominantly felsic to intermediate composition. Field relationships suggest that it may comprise the oldest component of the George River Block and a granodiorite paleosome was sampled for dating. This sample contained small (10–150 μm long and approximately 50 μm wide) colourless to pale brown to dark brown zircons. Numerous grains are murky and turbid and moderately cracked. High-U cores surrounded by reddish-brown damage zones are locally visible in the transmitted light image. The cathode luminescence (CL) response is strongly quenched (high U content) and a combination of faint planar and locally oscillatory zoning is visible. The U–Pb data for this sample displays a combination

Table 1. Summary of U–Pb ages from the Core Zone, Southeastern Churchill Province, Canada.

								NAD 83		
Sample #	**Field number**	**Rock type**	**Belt/Suite**	**Crustal block**	**Age (Ma)***	**Method**	**Lab**	**Easting**	**Northing**	**Zone**
1	14CXA-D90A1	Meta-rhyolite	Tunulik	George River	2698 ± 8 p 2543 ± 20 m	SHRIMP	Ottawa	346644	6330719	20
2	14CXA-D92A1	Migmatitic granodiorite		George River	2687 ± 24 p 1731 ± 24 m	LA-ICP-MS	UNB	358780	6330859	20
3	14CXA-D75A1	Quartz-feldspar Porphyry	Tunulik	Greoge River	2648 ± 8 p 1831 ± 12 m	SHRIMP	Ottawa	333598	6357440	20
4	14CXA-D46A1	Megacrystic granite		George River	2568 ± 5 p	SHRIMP	Ottawa	372193	6302686	20
5	14CXA-D42A1	Ultrapotassic intrusion	De Pas Batholith	George River	1815 ± 3 p	SHRIMP	Ottawa	338374	6321438	20
6	SB-4053-A13	Megacrystic granodiorite	De Pas Batholith	George River	1843 ± 15 p? 1773 ± 7 m	LA-ICP-MS	UNB	321570	6354669	20
7	LP-2108-A13	Massive granite, med. gr.	De Pas Batholith	George River	1817 ± 5 p	LA-ICP-MS	UNB	344254	6375188	20
8	14CXA-D6A1	Megacrystic granite	De Pas Batholith?	Kuujjuaq Domain	1837 ± 2 p	SHRIMP	Ottawa	318992	6213758	20
9	14CXA-D97B1	Tonalite gneiss		Falcoz River	2856 ± 8 p 1845 ± 3 m	SHRIMP	Ottawa	399834	6325559	20
10	DB-1057-A13	Tonalite	Simitalik	Falcoz River	1865 ± 5 p	LA-ICP-MS	UNB	374480	6416931	20
11	LP-2049-A13	Granodiorite	Simitalik	Falcoz River	2841 ± 13 i? 2670 ± 14 p 1844 ± 15 m	LA-ICP-MS	UNB	386899	6423346	20
12	CB-5063-A13	Foliated granodiorite	Simitalik	Falcoz River	2835 ± 6 p	LA-ICP-MS	UNB	387578	6395018	20
13	IL-3157-A13	Enderbitic gneiss	Sukaliuk	Falcoz River	2883 ± 12 p 1768 ± 52 m	LA-ICP-MS	UNB	439232	6392190	20
14	BC-6179-A13	Massive enderbite	Innuluttalik	Falcoz River	2832 ± 21 i? 2661 ± 9 p 1808 ± 86 m	LA-ICP-MS	UNB	427923	6377552	20
15	SB-4161-A13	Tonalitic gneiss	Sukaliuk	Falcoz River	2622 ± 15 p 1718 ± 98 m	LA-ICP-MS	UNB	429457	6368209	20
16	14CXA-D94A1	Plagioclase-hornblende porphyry	Ntshuku	Mistinibi-Raude	2373 ± 7 p 2317 ± 8 m	SHRIMP	Ottawa	401577	6213626	20
17	14CXA-D72A1	K-feldspar megacrystic monzogranite	Pelland	Mistinibi-Raude	2322 ± 5 p 2093 ± 17 m	SHRIMP	Ottawa	416187	6260623	20
18	14CXA-D68B1	Granophyric gabbro	Pelland	Mistinibi-Raude	2320 ± 21 p 2053 ± 13 m	SHRIMP	Ottawa	429482	6267957	20
19	14CXA-D18A1	Meta-arkose	Hutte Sauvage	Mistinibi-Raude	< 1987 ± 7 d	SHRIMP	Ottawa	398026	6224724	20
20	14CXA-D30C2	Monzogranite dyke	Lac Lomier	Torngat Orogen	1872 ± 9 p	SHRIMP	Ottawa	479855	6305985	20

*Letters in the 'Age (Ma)' column are: i = inheritance age; m = metamorphic age; p = protolith age.

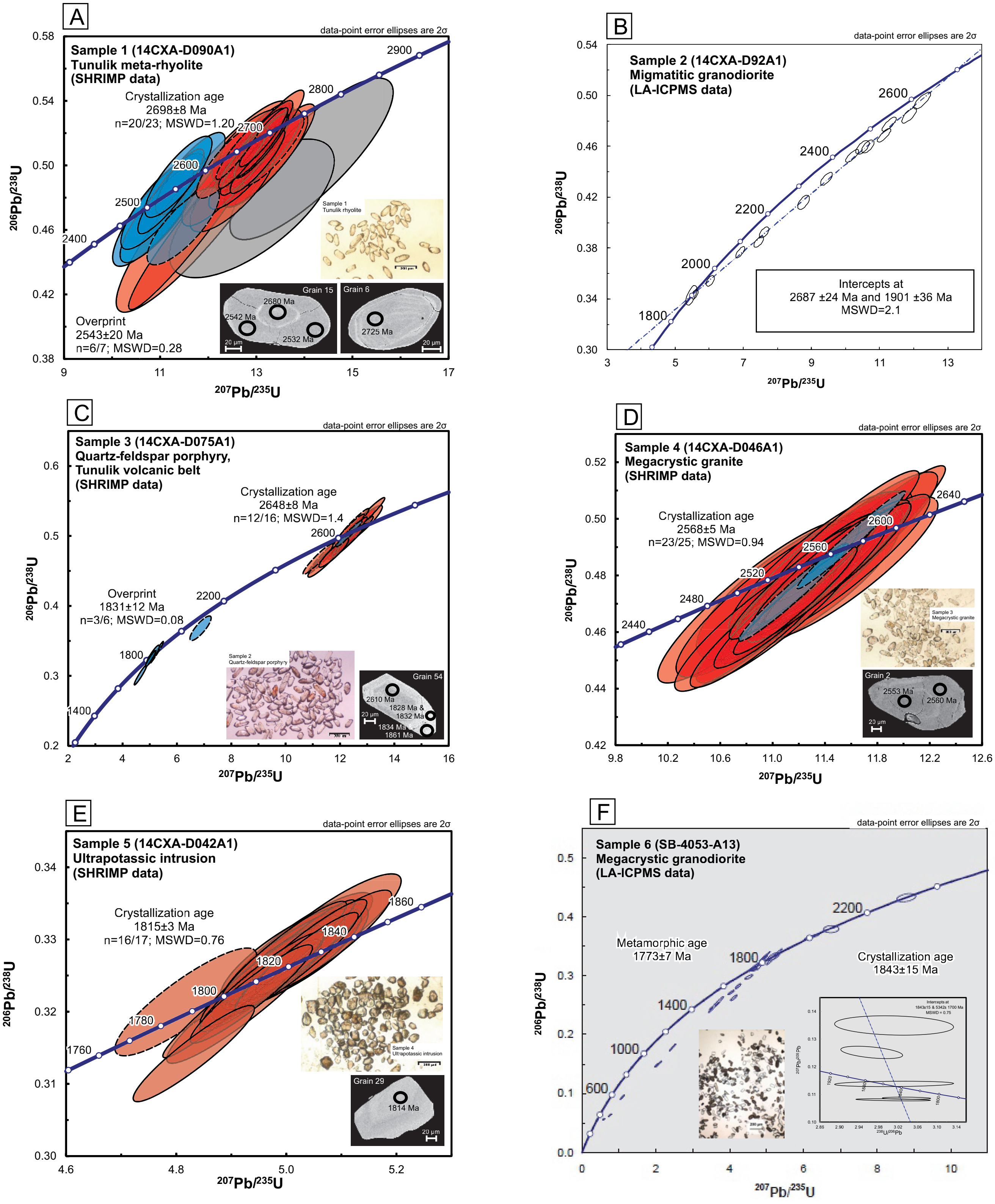

Figure 7. Concordia diagrams (2σ errors), transmitted light images of zircon, and/or BSE SEM images of representative zircon crystals for rock units from the George River Block. A) SHRIMP data for Tunulik meta-rhyolite Sample 1; B) LA-ICP-MS data for Sample 2, a granodiorite paleosome; C) SHRIMP data for quartz-feldspar porphyry Sample 3; D) SHRIMP data for megacrystic granite Sample 4; E) SHRIMP data for ultrapotassic intrusion Sample 5; F) LA-ICP-MS data for Sample 6, a megacrystic granodiorite from the De Pas Batholith. In SHRIMP Concordia diagrams, red ellipses correspond to analyses from magmatic zircon, blue ellipses to recrystallized or newly grown zircon, and grey ellipses to xenocrystic zircon or inherited components within zircon. Dashed ellipses not included in weighted mean age calculations. In BSE SEM images, circles indicate approximate locations of analyses with corresponding ^{207}Pb/^{206}Pb ages.

of recent and ancient Pb-loss as well as the effects of small and variable common-Pb incorporation (Fig 7B). To avoid effects of common-Pb incorporation, the data were filtered to consider only analyses that encountered > 98% Pb* (as estimated using the Andersen (2002) routine in VizualAge) as well as ^{206}Pbcps/^{204}Pbcps > 1000. This yielded a subset of data that defines a discordia with an upper intercept of ~ 2700 Ma and a lower intercept of ~ 1800 Ma. The Isoplot 'residuals' technique was used to refine this discordia to a statistically meaningful (MSWD = 2.1) regression line with an upper intercept of 2687 ± 24 Ma and a lower intercept 1901 ± 36 Ma.

Sample 3: Sub-volcanic Quartz-Feldspar Porphyry (14CXA-D75A1; SHRIMP)

Supracrustal rocks of the Tunulik Belt are intruded by sheets and dykes of mostly felsic quartz-feldspar porphyry that were interpreted in the field as sub-volcanic intrusions (Fig. 5C). They are mostly recrystallized except for the up to 5–10 mm-sized phenocrysts which locally preserve unrecrystallized cores. Sample 3 was taken near the George River shear zone, where different rocks of the Tunulik Belt are transposed into sub-parallelism and have been metamorphosed at mid- to upper-amphibolite facies during deformation. Zircon crystals form euhedral, short to elongate prisms with well-developed internal oscillatory zoning. Several grains have bright, thin to thick rims (see Fig. 7C). The twelve oldest SHRIMP U–Pb analyses of oscillatory zoned zircon yield a weighted mean age of 2648 ± 8 Ma (n = 12/16; MSWD = 1.4, POF = 0.16) interpreted as the crystallization age of the porphyry. Analyses of the bright rims yield a range of concordant to discordant ages between 2613 and 1828 Ma. The three youngest analyses from this population give a weighted mean age of 1831 ± 12 Ma (MSWD = 0.083, POF = 0.92) interpreted as the time of deformation and amphibolite facies metamorphism along the George River shear zone. The other three rim analyses with ages > 1861 Ma were excluded from the weighted mean as they may reflect incomplete resetting of the U–Pb system during metamorphic recrystallization.

Sample 4: Recrystallized Megacrystic Granite (14CXA-D46A1; SHRIMP)

Sample 4 is from a megacrystic granite that intrudes the Tunulik Belt and associated metaplutonic and gneissic rocks. It compositionally resembles the K-feldspar megacrystic rocks of the De Pas Batholith but, in contrast to the latter, contains totally recrystallized K-feldspar megacrysts (Fig. 5D) and appears to have been affected by a more complex metamorphic and deformation history. Zircons from this rock occur as euhedral to subhedral, short to elongate prisms that exhibit mostly diffuse oscillatory zoning. A subset of grains has bright rims. All U–Pb SHRIMP analyses, from both oscillatory zoned interior regions and bright rims, define a relatively tight grouping (Fig.7D) indicating that the observed internal structure reflects compositional zonation. Excluding the two high-U, precise rim analyses, the remaining 23 analyses yield a weighted mean age of 2568 ± 5 Ma (MSWD = 0.94; POF = 0.54), interpreted as the crystallization age of the megacrystic granite. This age is slightly older than, but within error of, the age of metamorphic rims from the Tunulik meta-rhyolite (Sample 1), indicating a potential link between emplacement of the Archean megacrystic granite and regional metamorphism in the George River Block.

Sample 5: Ultrapotassic Intrusion, De Pas Batholith (14CXA-D042A1; SHRIMP)

This very weakly deformed, biotite and K-feldspar rich, locally riebeckite- and epidote-bearing plutonic rock is spatially associated with the De Pas Batholith but its temporal relationship with it remains obscure. Zircon from this rock occurs as glassy, colourless to light brown, subrounded, anhedral to subhedral fragments. A number of grains exhibit faint broad zoning. U–Pb SHRIMP analyses on 16 of 17 zircon fragments yielded a weighted mean age of 1815 ± 3 Ma (MSWD = 0.76, POF = 0.72), interpreted as the age of crystallization (Fig. 7E). This age is distinctly younger than the mostly 1840–1830 Ma age range reported for the De Pas Batholith (e.g. Wardle et al. 2002; this paper), and could indicate the presence of a later, more metasomatized phase of the intrusion.

Sample 6: Megacrystic Granodiorite, De Pas Batholith (SB-4053-A13; LA-ICPMS)

This sample is from a moderately foliated K-feldspar megacrystic granodiorite from the northern part of the De Pas Batholith (Fig. 3). It contains murky-brown to pale brown zircons that form prisms with slightly rounded edges. Analyses show abundant Pb-loss in the majority of grains (Fig. 7F), but the five spots shown in the inset on the figure define an inverse isochron lower-intercept age of ~ 1843 ± 15 Ma, interpreted as age of emplacement. A younger array of normally-discordant spots defines an upper intercept age of 1773 ± 7 Ma, interpreted as the age of metamorphism. This crystallization age, together with the previous sample (Sample 5) corroborates with the known age range of the De Pas Batholith, which is generally accepted as ca. 1.84–1.82 Ga (Wardle et al. 2002).

Sample 7: Massive Granite, De Pas Batholith (LP-2108-A13; LA-ICPMS)

Sample 7 is a homogeneous, medium-grained, weakly foliated granite that represents a late phase of the De Pas Batholith. The zircons are long prismatic grains with rounded edges and are murky to light brown. LA-ICP-MS analyses have yielded a set of near-concordant points lying along an array between 1900 and 1750 Ma (Fig. 8A), with a cluster of five overlapping concordant points at 1817 ± 5 Ma, interpreted as the age of the intrusion. Another subset of points shows an inheritance at about 2.6 Ga. Data points trailing to older ages may represent inadvertent incorporation of older inherited components, whereas data points trailing down towards younger ages could represent either ancient Pb-loss or placement of spots astride narrow younger overgrowths.

Sample 8: K-feldspar Megacrystic Granite (14CXA-D6A1; SHRIMP)

Sample 8 is from a K-feldspar-megacrystic granite that has

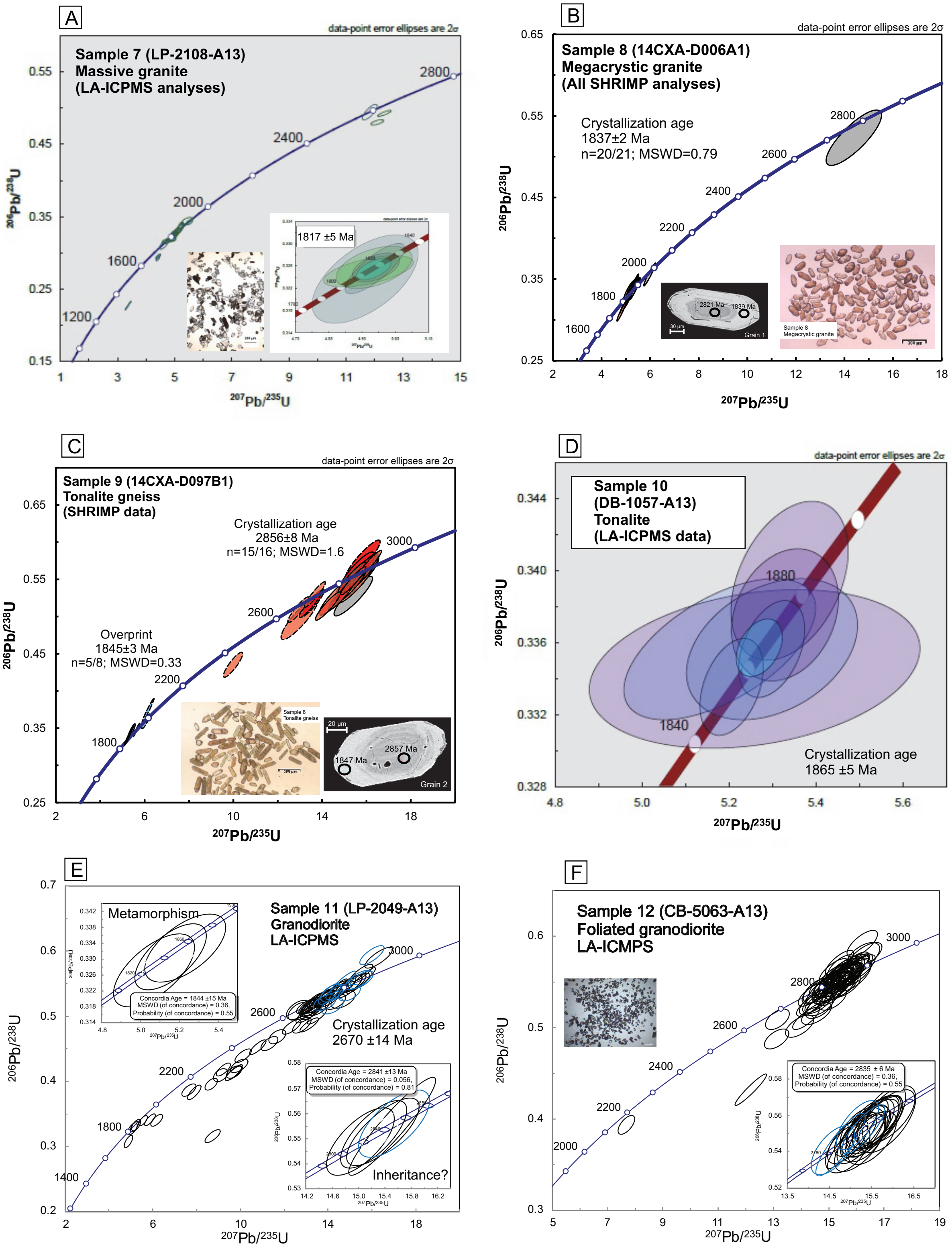

Figure 8. Concordia diagrams (2σ errors), transmitted light images of zircon, and/or BSE SEM images of representative zircon crystals for rock units from the George River and Falcoz River blocks, as well as Kuujjuaq Domain. A) LA-ICP-MS data for Sample 7, a late, massive granite phase of the De Pas Batholith, George River Block; B) SHRIMP data for K-feldspar megacrystic granite Sample 8, Kuujjuaq Domain; C) SHRIMP data for Sample 9, a tonalite gneiss from the Falcoz River Block; D) LA-ICP-MS data from Sample 10, a tonalite from the Simitalik Suite in the Falcoz River Block; E) LA-ICP-MS data from Sample 11, a foliated granodiorite from the Falcoz River Block; F) LA-ICP-MS data from Sample 12, a foliated granodiorite from the Falcoz River Block. In SHRIMP Concordia diagrams, red ellipses correspond to analyses from magmatic zircon, blue ellipses to recrystallized or newly grown zircon, and grey ellipses to xenocrystic zircon or inherited components within zircon. Dashed ellipses not included in weighted mean age calculations. In BSE SEM images, circles indicate approximate location of analyses with corresponding ^{207}Pb/^{206}Pb ages.

intruded strongly deformed Archean gneiss of the Kuujjuak Domain, located a few kilometres west of the Lac Tudor shear zone, and therefore lies outside of the George River Block. From a compositional and textural perspective, it is indistinguishable from rocks of the De Pas Batholith. This unit was sampled to test if it could potentially belong to the De Pas Batholith, or from a different, possibly Archean suite emplaced in the Kuujjuaq Domain, hence on the reactivated and tectonically uplifted margin of the Superior Craton. It contains abundant, colourless to brown prismatic zircon. The majority of the grains are fractured and contain inclusions. Twenty SHRIMP analyses from fine-scale, oscillatory-zoned zircon (Fig. 8B) with a wide range of uranium concentrations (184–1961 ppm) yield a weighted mean ^{207}Pb/^{206}Pb age of 1837 ± 2 Ma (MSWD = 0.79, POF = 0.71), interpreted as the crystallization age of the granite. The youngest analysis (11305-053.2) was excluded from the weighted mean calculation as it overlapped the edge of the grain. The five oldest analyses from faintly zoned, relatively low-U cores with ages between 2821 and 1847 Ma are interpreted to be inherited from surrounding plutonic rocks. This new age demonstrates that satellite intrusions related to the De Pas Batholith do in fact occur on either side of the Lac Tudor Shear Zone, and implications are discussed further down in the text.

Falcoz River Block

Sample 9: Tonalite Gneiss (14CXA-D97B1; SHRIMP)

Sample 9 is from a tonalite gneiss that forms a large part of the Falcoz River Block. It is medium to light grey in colour and typically migmatitic. Zircon grains, extracted from a non-migmatitic portion of the unit, occur mostly as brown to colourless, oscillatory zoned prisms to faintly zoned or unzoned equant grains. Many grains are highly turbid and show extensive alteration in SEM BSE images. U–Pb SHRIMP analysis of oscillatory zoned interior regions show a distinct grouping of analyses at 2856 ± 8 Ma (n = 15/16; MSWD = 1.6, POF = 0.084), interpreted as the crystallization age of the tonalitic protolith (Fig. 8C). The single oldest analysis at 2920 Ma is interpreted to be inherited. It is unclear whether the cluster at ca. 2.73 Ga, which included faintly zoned to unzoned equant crystals, reflects new growth of zircon or Pb loss from ca. 2.856 Ga zircon. Analyses from bright, recrystallized domains (rims or interiors of grains) with distinctly high uranium concentrations (1363–2468 ppm) and low Th/U ratios (< 0.09) yield a weighted mean age of 1845 ± 3 Ma (MSWD = 0.33, POF = 0.86), interpreted as the age of peak metamorphism that led to regional anatexis. Three high-U analyses with older ^{207}Pb/^{206}Pb ages (1989–1918 Ma) were excluded from this mean age calculation since they show incomplete resetting as a result of this recrystallization event.

Sample 10: Tonalite (DB-1057-A13; LA-ICPMS)

Sample 10 is from a massive to weakly foliated, biotite-hornblende tonalite from the Simitalik Suite in the Falcoz River Block. Plagioclase crystals are mostly light grey to purplish in colour and not recrystallized. It contains abundant pale-brown elongate zircon crystals with rounded terminations and obvious core-overgrowth relationships, as well as abundant apatite. The U–Pb data displays a combination of Pb-loss as well as the effects of high common-Pb content. A variety of inherited ages were encountered ranging from 2720 Ma to 2100 Ma. There is a more coherent cluster of near-concordant data with ^{207}Pb/^{206}Pb ages of ca. 1860 Ma (Fig. 8D). Within this cluster a set of 6 concordant analyses define a Concordia age of 1865 ± 5 Ma, which is taken as the best estimate of the zircon crystallization age. This age is similar to those reported from the Cumberland Batholith on Southern Baffin Island (Scott and St-Onge 1998), suggesting a possible link. Alternatively, it could indicate an earlier age of formation for the De Pas Batholith, but its petrology and texture is sufficiently different from other De Pas Batholith units to cast doubts on an unambiguous association.

Sample 11: Granodiorite (LP-2049-A13; LA-ICPMS)

Sample 11 is from a massive, homogeneous granodiorite of the Simitalik Suite that has intruded tonalitic to granitic orthogneisses and migmatites in the Falcoz River Block. It contains abundant colourless to brown zircon prisms ranging from 20–250 μm in length and 10–100 μm in width. Single crystals and broken fragments display terminations ranging from sharp pyramidal to subrounded shapes. Concentric oscillatory zoning is locally visible in larger brown grains. Optical CL imaging revealed pale yellow to grey oscillatory-zoned cores surrounded by blue-grey luminescent domains also containing combinations of faint oscillatory and rare convoluted or sector zoning. Zircon data for Archean components from a continuous array between 2841 ± 13 Ma and 2670 ± 14 Ma that is best interpreted as a mixing line between older inherited components and magmatic zircon overgrowths. Thus, 2670 ± 14 Ma (Fig. 8E) is interpreted as the age of emplacement. A younger cluster of concordant data points at 1844 ± 15 Ma is interpreted as the age of metamorphic overprint.

Sample 12: Foliated granodiorite (CB-5063-A13; LA-ICPMS)

Sample 12 is from a magnetite-bearing, foliated granodioritic layer in a generally felsic to intermediate orthogneiss that is part of the Simitalik Suite in the Falcoz River Block. It contains abundant colourless to dark brown equant to elongate zircon prisms with predominantly rounded to subrounded terminations. Crystals range in length from 10–150 μm and 10–100 μm in width. CL zoning in shades of blue, grey, and pale yellow is mostly planar with local patchy zoning with a subset of crystals exhibiting oscillatory zoned blue-grey cores with featureless overgrowths. Most analyses define a single cluster on a Concordia diagram (Fig. 8F), yielding a calculated age of 2835 ± 6 Ma, interpreted as the age of emplacement.

Sample 13: Enderbitic Gneiss (IL-3157-A13; LA-ICPMS)

Sample 13 is from an enderbitic gneiss from the eastern part of the Falcoz River Block. It contains abundant colourless to pale brown zircon ranging from 50–200 μm in length and 50–70 μm wide. Optical CL imaging revealed a combination of simple concentric oscillatory zoning with colours ranging from blue to grey to pale yellow. A few grains display oscillatory-zoned cores that are truncated by thin (10–20 µm) discontinuous overgrowths typically with pale yellow CL. Domains of more nebulous transgressive recrystallization that partially obscure oscillatory-zoned cores are also locally visible. The 24 µm laser craters were located wherever possible on subdomains where primary oscillatory zoning features were preserved, although some analyses were placed completely within overgrowth domains that yielded younger concordant ages. The U–Pb data for this sample (LA-ICPMS) display a combination of recent and ancient Pb loss as well as the effects of small and variable common-Pb incorporation (Fig. 9A). In order to avoid effects of common-Pb incorporation, the data were filtered to consider only analyses that encountered > 98% Pb* (as estimated using the Andersen (2002) routine in VizualAge) as well as ^{206}Pbcps/^{204}Pbcps > 1000. This yielded a subset of data that defines a statistically robust (MSWD = 1.7) discordia with an upper intercept of 2883 ± 12 Ma and a lower intercept of 1768 ± 52 Ma. The existence of a single concordant 2040 ± 13 Ma overgrowth (^{207}Pb/^{235}U age) hints at possible older reworking of this sample.

Sample 14: Massive Enderbite (BC-6179-A13: LA-ICPMS)

Sample 14 from massive enderbite contains sparse colourless to pale-brown stubby to elongate zircon prisms with rounded terminations. The grains are typically 40–60 µm wide and 100–200 µm long. A large number of the grains are fractured and a few contain small cores observable in transmitted light. Optical CL imaging revealed a diversity of CL intensities and internal zoning features with primarily dark-blue (higher U), pale-blue, grey, and pale-yellow colours. Zoning is primarily planar with rare concentric oscillatory zoning. Patchy transgressive zoning that truncates planar and oscillatory zones is also locally present.

The U–Pb data for this sample display evidence for ancient Pb-loss and possibly physical mixing between two older end-members. The evidence for mixing comes from a continuous array of near-concordant data points between ~2832 ± 21 Ma and 2661 ± 9 Ma and that for Pb-loss from the series of discordant analyses trending towards a lower intercept of 1808 ± 86 Ma (see Fig. 9B). These patterns are best interpreted as caused by mixed sampling, with the laser crater straddling ca. 2830 Ma domains representing inherited cores, and ca. 2660 Ma domains representing zones of crystallization.

Sample 15: Tonalitic Gneiss (SB-4161-A13; LA-ICPMS)

Sample 15 from tonalitic gneiss contains abundant elongate (~60 µm × ~200 µm), colourless to pale brown zircons with subrounded terminations. The majority of grains produced minimal CL response in shades of dark blue. A few colourless grains produced CL that revealed a combination of simple planar zoning and concentric oscillatory zoning. A few of the grains display small high-U cores marked by more severe radiation damage (reddish-brown zones) in the neighbouring overgrowths.

The U–Pb data for these highly radiogenic zircon grains form a discordant array between ~2650 Ma and ~1800 Ma (Fig. 9C). Data points with > 99% Pb* define a line (as a result of either physical mixing or ancient Pb-loss) with an upper intercept of 2622 ± 15 Ma (Fig. 9D), interpreted as the age of emplacement, and a lower intercept of 1718 ± 98 Ma interpreted as the approximate timing of metamorphism.

Mistinibi-Raude Block

Apart from the ca. 2.33 Ga age reported from Girard (1990a), there are no other U–Pb geochronological data reported in the literature for this block. Furthermore, the data for the above-mentioned age are not published, with only the interpreted age reported. In order to test that age, as well as provide information on the age and evolution of the Mistinibi-Raude Block in general, four rocks were sampled for U–Pb dating including: i) a plagioclase-hornblende porphyry sub-volcanic rock of intermediate composition that intrudes the Ntshuku supracrustal rocks (Sample 16), ii) a K-feldspar megacrystic monzogranite from a suite that intrudes the Ntshuku supracrustal rocks (Sample 17), iii) a granophyre from the Pelland alkaline intrusion (Sample 18), and iv) meta-arkose from the Hutte Sauvage Group (Sample 19).

Sample 16: Plagioclase-Hornblende Porphyry Intrusion, Ntshuku Suite (14CXA-D94A1; SHRIMP)

Sample 16 is from a 2-m-thick, hornblende-bearing, feldspar porphyry sill intruding mafic volcanic and meta-sedimentary rocks of the Ntshuku volcanic belt. It is interpreted as a sub-volcanic intrusion, hence its age should provide a minimum (and also approximate) age for the evolution of the volcanic belt. Zircons from this rock consist mostly of clear, colourless, mildly fractured stubby to elongate prisms with diffuse igneous zoning and subordinate, clear, subrounded, faintly zoned to unzoned grains. Many zircon grains have thin to thick overgrowths, most of which are devoid of zoning. Fifteen U–Pb SHRIMP analyses from oscillatory-zoned prisms (Fig. 9E, inset, grain 118) give a weighted mean age of 2373 ± 7 Ma (MSWD = 2.1; POF = 0.011), interpreted as the crystallization age of the porphyry. The two youngest analyses from oscillatory-zoned prisms (11306-56.1 and -61.1) are interpreted to have experienced Pb-loss and were excluded from the weighted mean calculation. Faintly zoned rims and subrounded grains yield distinctly younger ages with a weighted mean age of 2317 ± 8 Ma (n = 9; MSWD = 0.74; POF = 0.66), which is interpreted as the time of metamorphic recrystallization. The oldest analysis from this zircon rim population (11306-26.2), not included in the mean age calculation, may reflect incomplete recrystallization as a result of the younger overprint event. There are no hints of inheritance or zircon cores, suggesting that the Ntshuku supracrustal belt may be juvenile. Interestingly, there are no hints of New Quebec or Torngat Orogen (i.e. ca. 1.87–1.80 Ga) metamorphic rims either, despite the rock having a moderately strong foliation parallel to the regional N–S fabrics.

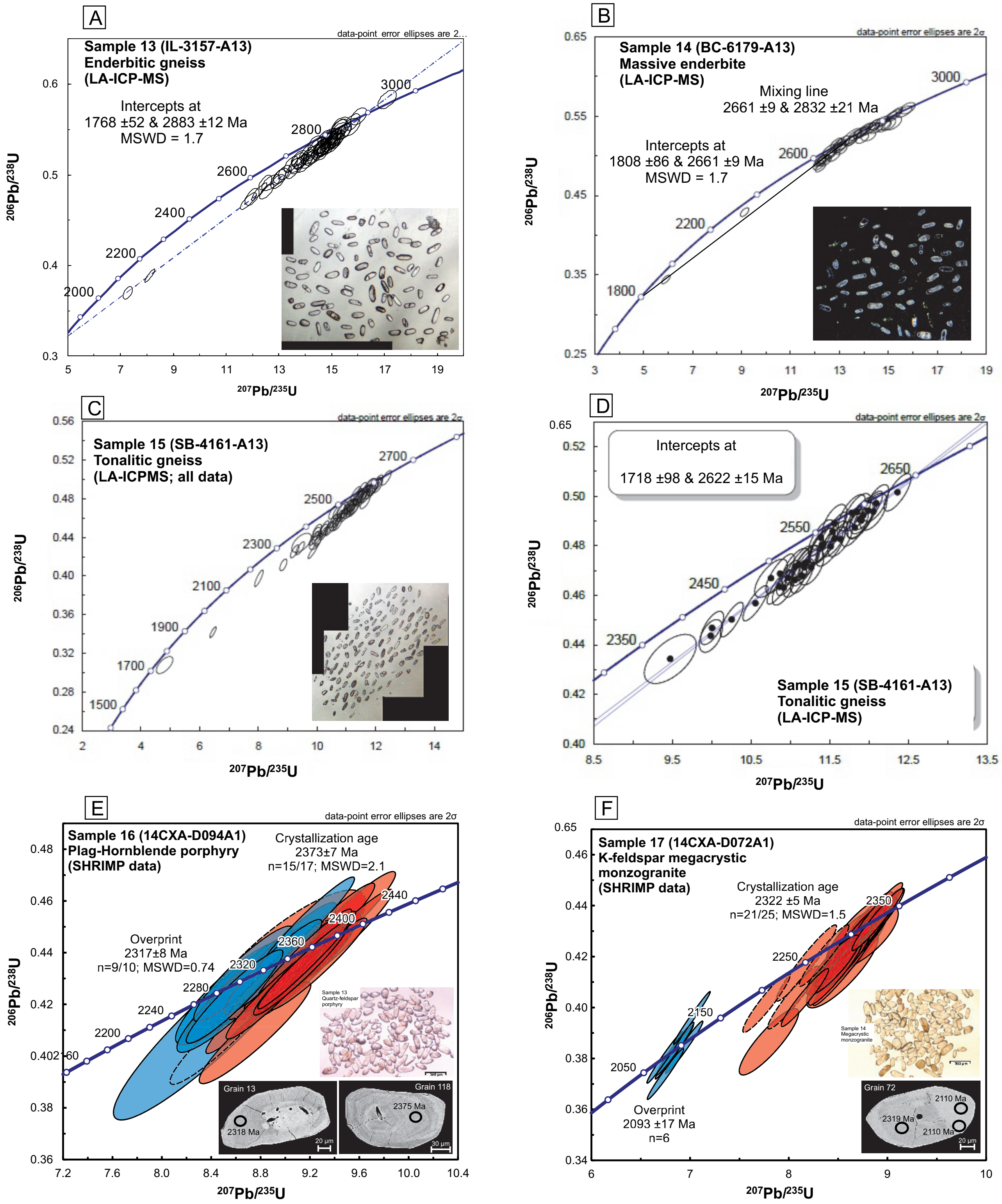

Figure 9. Concordia diagrams (2σ errors), transmitted light images of zircon, and/or BSE SEM images of representative zircon crystals for rock units from the Falcoz River and Mistinibi-Raude blocks. A) LA-ICP-MS data for Sample 13, an enderbitic gneiss from the Falcoz River Block; B) LA-ICP-MS data for Sample 14, a massive enderbite from the Falcoz River Block. Cathodo-luminescence image of zircons in inset; C) LA-ICP-MS data for granite Sample 15, a tonalitic gneiss from the Falcoz River Block; D) more detailed view of the upper data grouping on the Concordia plot for Sample 15; E) SHRIMP data for Sample 16, a sub-volcanic plagioclase-hornblende porphyry intrusion in the Ntshuku volcanic belt of the Mistinibi-Raude Block; F) SHRIMP data for Sample 17, a K-feldspar megacrystic monzogranite intruding orthogneiss in the Mistinibi-Raude Block. In the SHRIMP Concordia diagram, red ellipses correspond to analyses from magmatic zircon and blue ellipses to recrystallized or newly grown zircon. Dashed ellipses not included in weighted mean age calculations. In the BSE SEM image, circles indicate approximate location of analyses with corresponding ^{207}Pb/^{206}Pb ages.

Sample 17: K-feldspar Megacrystic Monzogranite, Pelland Pluton (14CXA-D72A1: SHRIMP)

Sample 17 is from one of a series of K-feldspar megacrystic granitoid bodies that have intruded the Ntshuku supracrustal belt, but are for the most part foliated and recrystallized. The monzogranite contains clear, light brown, faintly zoned, stubby to elongate zircon prisms. Medium-brown rims and subequant grains, characterized by a bright BSE response, are also present. The zoned prisms yield a grouping of concordant to near-concordant data points between 2339 and 2231 Ma. The 21 oldest analyses from this population define a weighted mean age of 2322 ± 5 Ma (n = 21/25; MSWD = 1.5, POF = 0.063), interpreted as the age of crystallization (Fig. 9F). Analyses from bright unzoned rims have high U concentrations (857–1855 ppm) and their individual dates are very precise. Thus, a robust Tukey's biweight mean calculation was used to minimize the effects of any outliers. The resulting age, 2093 ± 17 Ma, is interpreted as the age of a metamorphic overprint. It is noteworthy that the age of emplacement of this plutonic suite is within error of the metamorphic age obtained for the Ntshuku Belt (see Sample 16), suggesting that plutonism was accompanied by regional deformation and metamorphism within the Mistinibi-Raude Block.

Sample 18: Granophyric Gabbro from the Pelland Pluton (14CXA-D68B1; SHRIMP)

The Pelland pluton is a composite body consisting of metagabbro, monzodiorite, monzonite, and syenite, and is distinguished by the presence of blue rutilated quartz, rapakivi feldspar, and orthopyroxene-bearing pegmatite, all suggestive of high-temperature, and at least partially anhydrous, conditions during emplacement. The sample dated is from a marginal, granophyric phase of a gabbro containing rare K-feldspar megacrysts and blue quartz. Zircon grains from this sample form stubby to elongated prisms, many with rounded edges and terminations. Core–rim relationships are visible in a number of grains in transmitted light. The distribution of ages from unzoned and oscillatory-zoned zircon between ~2050 and 2370 Ma does not permit an unambiguous age interpretation (Fig. 10A). Nonetheless, the four youngest analyses from homogeneous rims and grains yield a weighted mean ^{207}Pb/^{206}Pb age of 2053 ± 13 Ma (MSWD = 1.16, POF = 0.32), interpreted as the age of metamorphism of the gabbro. Oscillatory-zoned zircons plot along Concordia from the metamorphic age to 2.37 Ga. The nine oldest analyses exhibit excess scatter with a weighted mean age of 2339 ± 22 Ma and MSWD of 6.5. The Tukey biweight mean age for these analyses, 2320 ± 21 Ma, overlaps with the weighted mean age and is taken as a more robust estimate of the age of the rock. However, given evidence for extensive Pb-loss in this zircon population as a result of the younger metamorphic event, this age should be regarded as a minimum estimate of the crystallization of the granophyric gabbro. The oldest analyses are from faintly zoned cores or grains that are interpreted as inherited. Their ^{207}Pb/^{206}Pb ages, which range from ~ 2350 to 2500 Ma, are interpreted as representing the approximate or minimum age of crust assimilated into the granophyric, marginal phase of the gabbro, again suggesting that the Mistinibi-Raude Block is principally juvenile as is the case with samples 16 and 17 above.

Sample 19: Meta-Arkose, Hutte Sauvage Group (14CXA-D18A1; SHRIMP)

The Hutte Sauvage Group unconformably overlies the Ntshuku and Mistinibi belts. It consists of matrix-supported pebble to cobble conglomerate at the base, grading upwards to meta-arkosic sandstone. The sample dated is from the upper part of the section, within a meta-arkosic layer containing trough crossbeds outlined by heavy mineral layers. Zircon from the meta-arkose consist of colourless to pale brown prisms or subequant crystals. Many grains preserve facets and terminations, but a small number show evidence for mechanical abrasion. Sixty five SHRIMP analyses were carried out on 61separate zircon grains, yielding dates between 2570 and 1978 Ma (Figs. 10B and 10C). All results are within ± 5% discordance and therefore considered to approximate the true crystallization ages of the zircon grains. The detrital provenance profile is characterized by three dominant modes at ca. 2510 Ma, ca. 2320 Ma, and ca. 2080 Ma. Replicate analyses on the youngest detrital zircon (grain 10) yield a weighted mean age of 1987 ± 7 Ma (n = 5/5; MSWD = 1.01, POF = 0.40), interpreted as the maximum age of deposition. Based on the three dominant modes, it is noteworthy that all detrital zircon grains appear to have been derived solely from the Mistinibi-Raude Block and have not sourced adjacent Archean domains. This dataset also provides constraints that do not support incorporation of detritus from the De Pas Batholith into the Hutte Sauvage Group, an interpretation made earlier based on the presence of K-feldspar megacrystic granite cobbles (Girard 1990a).

Lac Lomier Complex

The Lac Lomier Complex consists mainly of banded, granulite-facies orthogneiss ranging from mafic to felsic but of predominantly intermediate (enderbitic) composition. The complex locally hosts elongate map-scale ribbons or screens of metapelitic rock interpreted as fragments of the Tasiuyak accretionary wedge incorporated into the Lac Lomier continental magmatic arc during its emplacement (Wardle et al. 2002). U–Pb zircon data from the Lac Lomier Complex has been proven difficult to interpret, since its lower crustal emplacement under granulite-facies metamorphism have brought into question whether the dated zircon are igneous or metamorphic. An age of ca. 1.86 Ga has been generally attributed to emplacement (Wardle and van Kranendonk 1996). We have collected a sample to try to clarify that issue by analysing cores and rims with the SHRIMP method.

Sample 20: Monzogranite (14CXA-D30C2; SHRIMP)

The dated Sample 20 is from a highly strained, monzogranite dyke emplaced in ultra-high P-T metapelite assumed to belong to the Tasiuyak gneiss. The dyke is transposed into sub-parallelism with the metapelite, but has clearly intruded it. Zircon from this sample occurs mostly as clear, colourless to pale brown rounded crystals or anhedral fragments. Prismatic

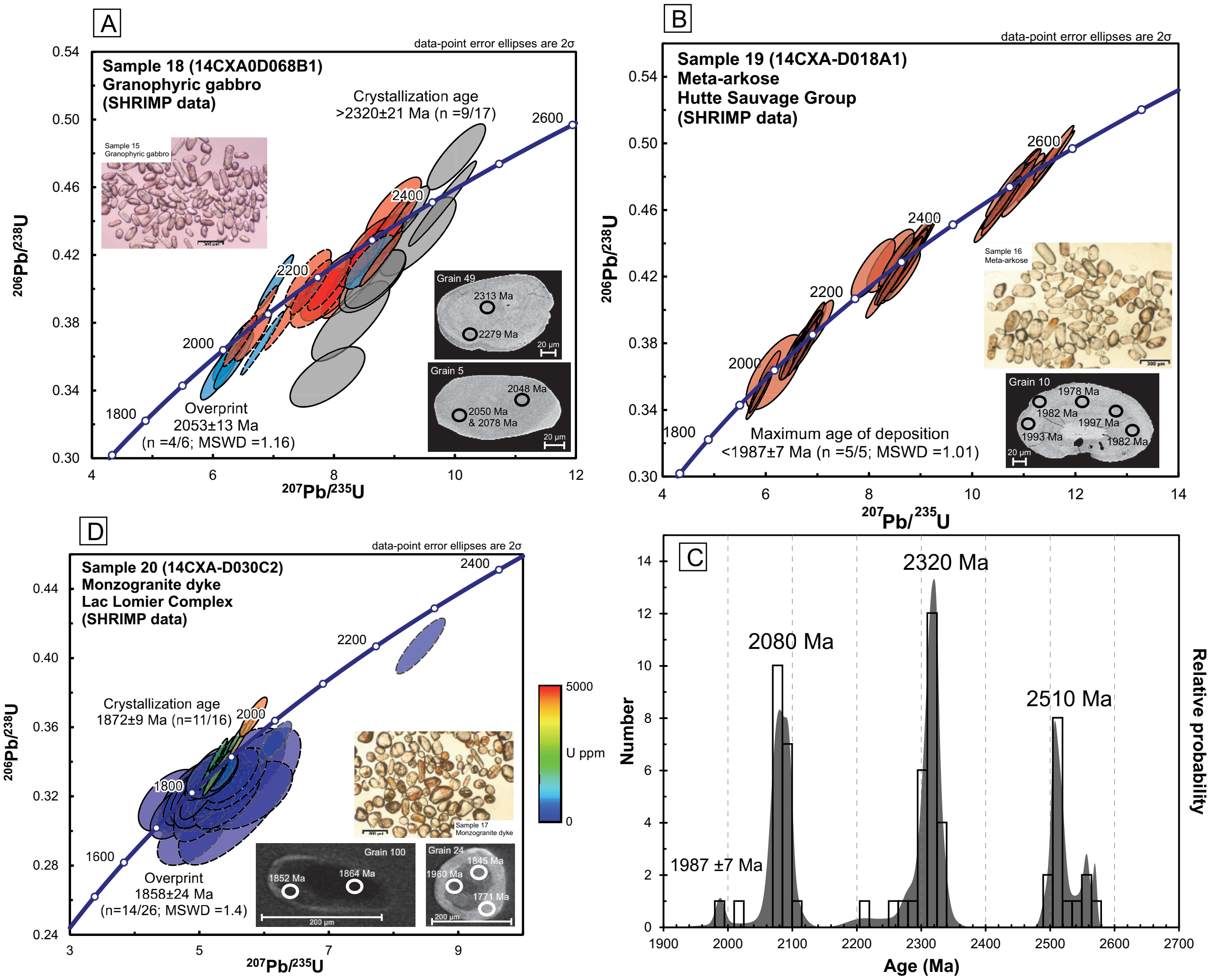

Figure 10. Concordia diagrams (2σ errors), transmitted light images of zircon, and BSE SEM images of representative zircon crystals for rock units from the Mistinibi-Raude Block (A, B) and Lac Lomier Complex (D). A) SHRIMP data for granophyric gabbro Sample 18; B) SHRIMP data of detrital zircons from a meta-arkose from the Hutte Sauvage Group (Sample 19); C) combined probability density plot and histogram for Sample 19 (bin width is 15 Ma); D) SHRIMP data for monzogranite Sample 20 from the Lac Lomier Complex. Ellipses in the concordia diagram are colour-scaled according to uranium concentrations. Dashed ellipses were not included in weighted mean age calculations. The blue ellipses with grey dashed lines represent analyses from core material from grain 69. In the CL images, circles indicate approximate location of analyses with corresponding $^{207}Pb/^{206}Pb$ ages.

grains are also present, but are strongly resorbed with no preserved facets, crystal edges or terminations. Rounded crystals and anhedral fragments predominantly display medium to high CL response with sector or irregular zoning, whereas most prisms are characterized by very low CL response (dark) with rare broad zoning. Bright CL rims surrounding darker cores are present in all morphological types. The SHRIMP data define two compositionally distinct groupings (Fig. 10D), which broadly correlate with grain morphology. The 11 oldest analyses from dominantly prismatic grains with high U concentrations (526–4742 ppm) and generally low but variable Th/U ratios (0.01–0.70) yield a Tukey's biweight mean age of 1872 ± 9 Ma (n = 11/16). The very low Th/U ratios from this population are consistent with metamorphic growth; however, the prismatic shape of the grains is more consistent with magmatic growth. Thus, based on this morphological evidence, we interpret the 1872 ± 9 Ma as the age of crystallization of the monzogranite dyke. Analyses derived from rounded crystals, anhedral fragments, and rims with a medium to high CL response are characterized by distinctly lower U concentrations (26–293 ppm), higher Th/U ratios (1.02–2.70), and highly variable $^{207}Pb/^{206}Pb$ ages ranging from 2110 to 1691 Ma. Fourteen of the fifteen youngest analyses from this population give a weighted mean age of 1858 ± 24 Ma (1 of 15 rejected; MSWD = 1.4, POF = 0.16). The rejected analysis is the youngest in the group at 1691 ± 68 Ma. Based on morphology, zoning characteristics, and chemistry, this age is assigned as the time of metamorphism. The older analyses from this grouping (1922–2110 Ma) are highly discordant (> 6%) and may include an inherited component. Two low-U analyses from the core of prismatic grain 69 with non-reproducible $^{207}Pb/^{206}Pb$ ages of 2345 and 2058 Ma also likely reflect inheritance. The host metapelite could be the source of the 1922–2345 Ma zircon, but these dates should be taken as minimum ages of inheritance given the strong discordancy of the data.

DISCUSSION

The data presented here as well as reported in the literature, together with field observations and recent mapping, suggest that the Core Zone consists of at least three distinct crustal blocks separated by ductile, sub-vertical shear zones that could potentially represent ancient sutures. We define them here as the George River Block, the Mistinibi-Raude Block, and the Falcoz River Block. Also, we exclude the Kuujjuaq Domain and Lac Lomier Complex from the Core Zone *sensu stricto*. The Kuujjuaq Domain has been interpreted as the uplifted and tectonically reactivated margin of the Superior Craton (Wardle et al. 2002; Rayner et al. 2017). The Lac Lomier Complex is the root of a 1.87–1.86 Ga continental magmatic arc emplaced along the western accretionary margin of the Nain Craton and it is in structural relationship with the Core Zone. While acknowledging the previous domain nomenclature, we introduce some new nomenclature in an attempt to bring uniformity and consistency throughout the region. In addressing this issue, we have generally considered priority and opted for the first published use of names for a particular crustal block or domain, or by grouping previous sub-domains if warranted by the U–Pb zircon data presented herein.

The George River Block consists of remnants of a Neoarchean terrane that comprises juvenile ca. 2.73 to 2.70 Ga supracrustal rocks (Tunulik Belt) and their plutonic root, with the latter including mainly felsic and intermediate composition intrusions that have yielded ages as young as 2568 ± 5 Ma. It is bounded to the west by the Lac Tudor shear zone, and to the east by the George River shear zone. The George River Block is the primary host of the ca. 1.84–1.82 Ga De Pas Batholith, although it is clear that K-feldspar megacrystic intrusions of similar age and composition also occur within the Kuujjuaq Domain to the west (i.e. Sample 8). There has been some debate as to whether the De Pas Batholith represents a continental magmatic arc, as suggested by Dunphy and Skulski (1996), or a syn-collisional magmatic suite (i.e. Wardle et al. 2002). We consider the common presence of hornblende and titanite as well as the absence of any significant volume of contemporaneous S-type magmas to be more suggestive of an arc derivation. The Lac Tudor shear zone has traditionally been interpreted as the ancient suture, where presumably east-dipping subduction of oceanic lithosphere would have generated the De Pas batholith (e.g. Wardle et al. 2002). However, our identification of rocks of similar composition and age to the De Pas suite in the Kuujjuaq Domain, west of the Lac Tudor shear zone, challenges that interpretation. Our current understanding of the distribution of De Pas age plutons would require either a single, west-directed subduction along the eastern margin of the George River Block (suture situated along the George River shear zone), or a divergent double subduction (e.g. Soesoo et al. 1997) situated along the Lac Tudor shear zone. We note that the divergent double subduction model is attractive inasmuch as it potentially involves slab floundering, which could account for the large volume of mantle-derived melt, a large portion of it having been emplaced at high temperatures under anhydrous conditions.

Farther south, the George River Block continues into the Crossroads and Orma domains (Fig. 1) identified by James et al. (2003). The Orma Domain hosts supracrustal rocks (Zeni Complex) that can be traced northwards on aeromagnetic maps and appear to merge with the Tunulik Belt. It also hosts metaplutonic rocks ranging in age from 2628 to 2581 Ma, similar in range to the 2648–2568 Ma intrusive rocks in the George River Block as determined herein. We therefore include the Crossroads and Orma domains in the George River Block, which thus extends from the Grenville Front north to Ungava Bay (Fig. 2).

The Mistinibi-Raude Block, which is separated from the George River Block by the George River shear zone and from the Falcoz River Block by the Moonbase shear zone, comprises crust formed at ca. 2.37–2.32 Ga and thus represents a unique component of the Core Zone. Moreover, from a global crustal growth perspective (e.g. Condie et al. 2009) it also forms a relatively rare fragment of arc-derived volcanic and plutonic rocks of earliest-Paleoproterozoic age, a period not well represented in the geological record. The oldest recognized component of the block, the predominantly mafic volcanic Ntshuku Belt, has not been directly dated as we have not been successful at finding zircon-bearing volcanic protoliths. However, a plagioclase-hornblende porphyry sill of intermediate composition that we interpret as a sub-volcanic intrusion, provides a minimum age for volcanism of 2373 ± 7 Ma. The supracrustal rocks of the Ntshuku Belt are intruded by a suite of mafic to felsic plutonic rocks of arc affinity, previously dated at ca. 2.33 Ga (Pallatin suite; age cited in Girard 1990a). We provide two new ages for plutonic units that confirm the existence of a substantial volume of plutonic rocks of that age-range. These are the Pelland pluton, for which a poorly defined age of ca. 2320 ± 21 Ma provides an approximate emplacement age (Sample 18), and a K-feldspar megacrystic monzogranite dated at 2322 ± 5 Ma (Sample 17). The Pelland pluton is composed of quartz-poor, mafic to alkaline intrusions that crystallized at very high temperatures, as suggested by the presence of rutilated quartz, hypersolvus feldspars and locally, orthopyroxene. A similar but yet undated suite (Nekuashu pluton) occurs about 25 km to the northwest of the Pelland intrusion. Zircons from the ca. 2.37 Ga subvolcanic intrusion (Sample 16) show evidence for metamorphism at ca. 2.32 Ga that can be broadly correlated to emplacement of the Pallatin and Pelland intrusions. The latter two, in turn, show evidence for metamorphic zircon growth at ca. 2.09–2.05 Ga, a feature that appears to be unique to the Mistinibi-Raude Block. The Hutte Sauvage meta-arkose, which appears to have sourced zircon uniquely from the Mistinibi-Raude Block, does not contain zircon derived from the ≥ 2.73 Ga Ntshuku volcanic rocks, but contains abundant zircon from the ca. 2.32 Ga intrusions. Interestingly, it contains an older population of detrital zircon as well, with a peak age of ca. 2.50 Ga and for which no local equivalents have yet been found in outcrop, either in the Mistinibi-Raude or adjacent blocks. We assume that zircon of that age represent older crust onto which the Ntshuku supercrustal rocks were erupted and deposited, and provide an upper age limit for the Mistinibi-Raude Block. Based on geochemical studies, Girard (1990b, c) suggested an immature arc setting for the Ntshuku volcanic rocks and related intrusions.

The large expanse of crust situated east and northeast of the George River and Mistinibi-Raude blocks, previously subdivided into four domains, is herein amalgamated into the Falcoz River Block. Along its western flank, the Falcoz River Block is separated from the George River and Mistinibi-Raude blocks by the George River and Moonbase shear zones. Along its eastern flank it is separated from the 1.87–1.86 Ga Lac Lomier Complex by the Abloviak and Falcoz shear zones (Fig. 2), two features that appear to anastomose with one another, and also enclose lenses of less strained crust. In the northern reaches of the map area, the Falcoz shear zone eventually splays from the Abloviak shear zone and can be traced some distance northwestwards towards Ungava Bay, where it loses definition. A feature common to the four former domains now amalgamated into the Falcoz River Block is the widespread presence of tonalitic to granitic gneiss and migmatite (tonalite-trondjemite-granite association), the oldest of which have yielded U–Pb crystallization ages of ca. 2856 ± 8 Ma and 2883 ± 12 Ma (samples 9 and 13, respectively). However, other dated protoliths are distinctively younger, yielding U–Pb zircon ages of 2835 ±6 Ma, 2670 ±14 Ma, 2661 ±9 Ma and 2622 ±15 Ma (samples 12, 11, 14 and 15, respectively), suggesting successively younger pulses of felsic to intermediate magmatism. The 2796 ± 29 Ma age is within error of a 2807 + 45/-27 Ma age obtained by Ryan et al. (1991) for a tonalitic gneiss from the southeastern part of the Falcoz River Block. Moreover, Ryan et al. (1991) also dated granitoid rocks ranging in age from ca. 2657 ± 18 to 2574 ± 8 Ma from the same area, suggesting an increase in the proportion of Neoarchean igneous rocks towards the southeast. Along its western flank, the Falcoz River Block is separated from the George River and Mistinibi-Raude blocks by the George River shear zone and Moonbase shear zone, respectively (Fig. 3). From a metamorphic perspective, the Falcoz River Block comprises granulite-facies assemblages along its eastern half, adjacent to the Lac Lomier Complex, and mainly upper-amphibolite facies assemblages in its northwestern part (see Fig. 2). It also preserves more Paleoproterozoic supracrustal cover rocks in its northern extents. There is definitely a Proterozoic-age granulite facies event, as is implied from metamorphic assemblages present in the cover rocks. However, it is also possible that Archean-age metamorphism also reached granulite facies, at least locally.

The Tasiuyak gneiss has historically been interpreted as a thick accretionary complex formed during the Torngat Orogeny and is intruded by the 1.87–1.86 Ga Lac Lomier continental arc (Wardle et al. 1990; Wardle and van Kranendonk 1996). At the location of Sample 20, a large enclave of granulite-facies metapelite, interpreted as a raft of Tasiuyak gneiss within the Lac Lomier Complex, is intruded by a 2-m-thick monzogranite dyke, dated herein at 1872 ± 9 Ma. The monzogranite dyke is presumably an offshoot of the main Lac Lomier Complex and both it and its host metapelite were strongly transposed within the Abloviak shear zone and, hence, the 1858 ± 24 Ma metamorphic age obtained from this sample (Fig. 10D) provides an estimate for the timing of shearing. However, in detail, the actual metamorphic history appears to be relatively more complex as suggested by the spread of metamorphic age data (i.e. see grain 24, Fig. 10D inset, with spots as young as ca. 1.77 Ga), suggesting that the Abloviak shear zone may have been a long-lived feature. Other small map units of Paleoproterozoic cover sequences composed of high-grade metapelite that occur throughout the mid- to northern Falcoz River Block are more likely related to the Lake Harbour Group than to the Tasiuyak gneiss (Scott et al. 2002, but see discussion below). East of the Tasiuyak gneiss lies the Nain Province, an ancient crustal block that forms part of the North Atlantic Craton. It is composed of two main blocks, the ca. 3.0–3.2 Ga Hopedale Block to the south, and the 3.0–3.8 Ga Saglek Block to the north (James et al. 2002). Both these blocks are significantly older than the Falcoz River Block, suggesting that there is no obvious relation between it and the Nain Province.

"Exotic" Core Zone and Speculations on its Northern Extension

In light of the previous discussions it is clear that: i) the Core Zone is composed of three distinct Archean to early Paleoproterozoic crustal fragments (shear-zone bounded blocks) with contrasting geologic histories, implying that they developed separately prior to their tectonic juxtaposition in the Core Zone in the Paleoproterozoic, and ii) that all three blocks comprising the Core Zone are apparently exotic with respect to the adjacent Superior and North Atlantic cratons. These relationships cast doubts on (but do not preclude) the former interpretation that the Archean rocks in the Core Zone formed a ribbon continent (James and Dunning 2000). They also provide context for a discussion about the possible correlatives of either George River, Mistinibi-Raude or Falcoz River blocks farther north in the Trans-Hudson Orogen, and more speculatively about their linkages to other cratons that comprised parts of the Nuna supercontinent between ca. 1.90 and 1.80 Ga (Stauffer 1984; Hoffman 1990; Corrigan et al. 2009; Pehrsson et al. 2015). A proposed correlation of the Falcoz River Block with parts of the Meta-Incognita microcontinent (Fig. 1), exposed on the peninsula of the same name on southern Baffin Island (see Jackson and Taylor 1972; Scott and St-Onge 1998; St-Onge et al. 2000; Bourlon et al. 2002) is primarily based on the similarity between Paleoproterozoic quartzite-pelite-marble (QPM) associations at both localities. However, the correlation is not entirely unambiguous. In the Falzoz River Block, QPM rocks unconformably sit on ca. 2.9–2.7 Ga Archean basement gneisses and are intruded by minor Paleoproterozoic plutonic rocks of ca. 1.86 Ga age, for which a correlation with the Cumberland Batholith remains to be proven. Both the lack of *bona fide* Archean basement to the Paleoproterozoic QPM lithologies in the Meta-Incognita microcontinent and their occurrence there in detached slices in a thrust stack, suggest the proposed correlation should be considered tentative at best. On the other hand, although not exposed at surface, evidence of Archean crust-forming events of ca. 2.68 Ga and 2.63–2.60 Ga with a minor contribution from Mesoarchean crust (ca. 3.00 and 2.85 Ga) is found in detrital and xenocrystic zircons in QPM and metaplutonic rocks from the Meta-Incognita microcontinent (Wodicka et al. 2010), making a correlation with the Falcoz River Block permissible. In light of the robust confirmation of distinctive, ca. 2.38 and 2.32 Ga plutonic units in the Mistinibi-Raude Block in this study and their rarity in the geological record of the Canadian Shield, perhaps the most compelling evidence that the Core Zone rocks may link with the Meta-Incognita microcontinent is the presence there of detrital and xenocrystic zircon of ca. 2.34–2.31 Ga age, also reported in Wodicka et al. (2010), as well as a 2310 ± 3 Ma cobble from a deformed and metamorphosed conglomerate reported by Partin et al. (2014). These ages fall within the range determined from the Mistinibi-Raude Block and suggest a possible correlation. Although it could be argued that these Baffin Island zircon ages could represent detrital grains with a Core Zone provenance and not a local basement source, the presence of cobble suggests a proximal source.

Correlation of the George River Block northwards into the Trans-Hudson Orogen is a bit more problematic as there are no known crustal slices of that specific and relatively 'tight' Neoarchean age range (2.70–2.57 Ga) identified in the immediate area north and west of Ungava Bay. Along Hudson Strait, the Superior Craton, or at least its reactivated margin (Kovik antiform), is flanked by the Sugluk Block (Fig. 1) which hosts predominantly 3.2–2.8 Ga Archean crust with Paleoproterozoic intrusions (see Corrigan et al. 2009 and references therein). If any correlation would be proposed for the Sugluk Block, it would more likely involve the Falcoz River Block, which comprises ca. 2.9–2.8 Ga crust that overlaps in age with the latter. However, correlations at this point would be speculative at best due to limited geochronological data available from the Sugluk Block.

Following the same line of investigation farther afield to the southwest across Hudson Bay, reveals other possible correlations. Within the former tract of the ancient Manikewan Ocean that was closed during the Trans-Hudson Orogeny (Stauffer 1984), ca. 2.4–2.5 Ga plutonism has been identified in the Sask Craton (see Bickford et al. 2005 and references therein), located in the Trans-Hudson orogeny internides in what is now central Manitoba and Saskatchewan (Fig. 1). Moreover, ca. 2.3–2.5 Ga detrital zircons have been identified in metagreywacke and as xenocrysts in plutonic rocks within the Trans-Hudson Orogen internides between the Sask and Hearne cratons (Southern Indian Lake area; see Rayner and Corrigan (2004) and Partin et al. (2014)), suggesting the presence of crust of the same age as the Mistinibi-Raude Block in that portion of the orogeny ('SIL' in Figure 1). Hence, there is evidence for the presence of earliest-Paleoproetrozoic crust of ca. 2.5–2.3 Ga age now isolated in distinct crustal slices within a closed paleo-ocean realm west, north and east (present day coordinates) of the Superior Craton. Whether these represent vestiges of a tectonically dismembered, single continental mass remains to be determined. To the northeast towards Greenland, on the other hand, there is no hint of ca. 2.5–2.3 Ga protoliths in the Nagssugtoqidian Orogen (Fig. 1), which is the site of ocean closure and ca. 1.86–1.82 Ga continent-continent collision north of the North Atlantic Craton (van Gool et al. 2002).

Paleoproterozoic Tectonic Evolution and Metamorphism

In this paper we have presented evidence for the presence of at least three lithologically distinct crustal blocks forming the Core Zone. The ductile shear zones that bound these blocks are steep and locally form an anastomosing array that accommodated bulk dextral transpressional shear via mainly sub-horizontal, transcurrent motion. Wardle and van Kranendonk (1996) and Wardle et al. (2002) speculated that this bulk regional deformation was a result of oblique convergence between the North Atlantic and Superior cratons during the Paleoproterozoic. The distinct chronological and lithological character of the three Core Zone blocks with respect to the bounding Superior and North Atlantic cratons suggests that: i) they formed at different times in completely different environments and are exotic to both the North Atlantic and Superior cratons, and ii) the Lac Tudor, George River, Moonbase and Abloviak shear zones represent paleo-sutures. From a tectonothermal perspective, the George River and Falcoz River blocks bear similar metamorphic age ranges, between ca. 1831 and 1773 Ma for the former and 1845 and 1768 Ma for the latter (excluding metamorphic ages for samples 14 and 15, which show very large analytical errors), suggesting that they were structurally and metamorphically reactivated during the Paleoproterozoic, particularly during the New Quebec Orogen phase. However, the interior of the Mistinibi-Raude Block, as well as the southeastern extents of the George River Block (Orma Domain of James and Dunning (2000)) appear to have mainly escaped ca. 1.85–1.76 Ga Paleoproterozoic metamorphism. This might be the result of south-directed crustal extrusion and resulting north-to-south extension, a hypothesis that will be discussed in a subsequent publication.

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*For access to the Corrigan et al. (2018) supplementary data, Table S-1 SHRIMP U–Pb data and Table S-2 LA-ICP-MS U–Pb data, please visit the GAC's open source GC Data Repository link Andrew Hynes Series: Tectonic Processes at: https://www.gac.ca/wp/?page_id=306.