

Multiple generations of TTG gneisses host Eoarchean supracrustal belts in the Innukjuak domain (Québec, Canada)

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Introduction

The ca. 3750-3780 Ma Nuvvuagittuq supracrustal belt (NSB) in northern Québec is the best known of a dozen or so km-scale supracrustal enclaves which are part of the Innukjuak domain of the northwest Superior province in Canada. These supracrustal bodies are intruded and surrounded by several generations of tonalite-trondhjemite-granodiorite (TTG) gneisses. New geochemical and U-Pb zircon geochronological data are presented for these gneisses coupled with data from previously undated but locally significant gneisses enveloping the NSB; the Voizel suite (Simard et al. 2003).

Geologic Setting

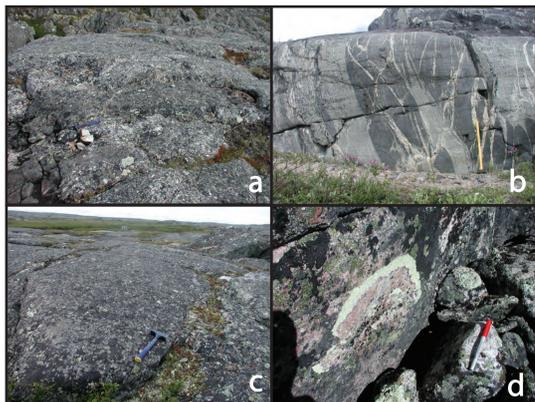


Figure 2. Field photographs of main lithologies: a. Voizel (sample 050), b. enclaves in Voizel (042), c. CTG (012), d. Boizard (054)

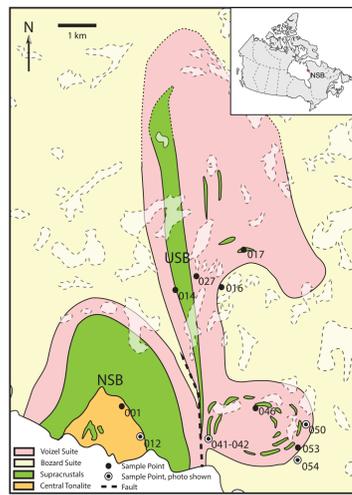


Figure 1. Geologic map of main lithologies showing sample locations, field photo locations indicated with bulls-eye

Located in northern Québec (Fig. 1) The NSB and Ukalik supracrustal belt (USB; informal name given to this enclave) are surrounded and intruded by younger gray gneisses of the Voizel suite (Fig. 2a). Unlike the NSB, which is a large cohesive supracrustal enclave, the USB is comprised of smaller (1-20 m), mostly mafic pods surrounded by Voizel suite gneisses (Fig. 2b). Previously thought to be part of the Voizel, the Central tonalitic gneiss (CTG) only occurs at the core of the NSB (Fig. 2c). The enclave-hosting Voizel suite is itself surrounded by the much younger, granitic Boizard suite (Fig. 2d) (Simard et al. 2003).

Geochronology

The maximum age for the CTG is ca. 3650 Ma (Fig. 3a), 100 Ma older than the Voizel, which is now dated to 3550 Ma. Zircons with younger ages observed in CTG sample IN05001 are likely metamorphic in origin (see zircon trace-element geochemistry). Boizard suite gneisses are younger at ca. 2700 Ma (Fig. 3c) but do preserve some zircon inheritance up to 3704 Ma. Zircons from the tonalite to granodiorite gneisses within the USB enclaves (Purple, Table 1) are largely metamorphic (geochronology not shown here). The oldest, most concordant grains are ca. 3650 Ma and may date the USB as contemporaneous with the CTG.

Table 1. Upper discordia or weighted average (*) ages for different lithologies. Red=CTG; Green=Voizel; Blue=Boizard; Purple=enclaves

Sample	Age	n	MSWD
IN05001*	3451 ± 72	26	4.6
IN12012*	3652 ± 14	11	8.8
IN12014	3550 + 52/-44	14	1.7
IN12027*	3519 ± 16	4	2.1
IN12041	3550 ± 120	14	4.3
IN12046	3483 ± 140	25	11.6
IN12050	3437 ± 170	12	14
IN12016*	2706 ± 19	6	4.6
IN12054*	2720 ± 27	17	1.1
IN12017	3598 + 44/-37	8	2.0
IN12042	3492 ± 190	6	8.0
IN12053	3412 ± 160	12	7.1

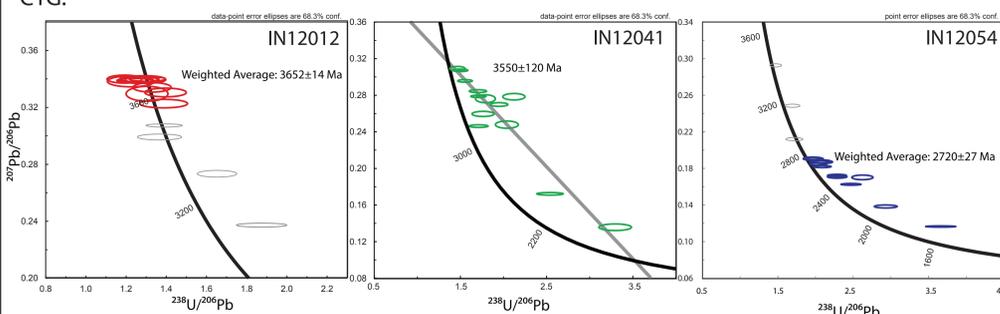


Figure 3. Tera-Wasserberg plots for selected samples; a=CTG, b=Voizel, c=Boizard

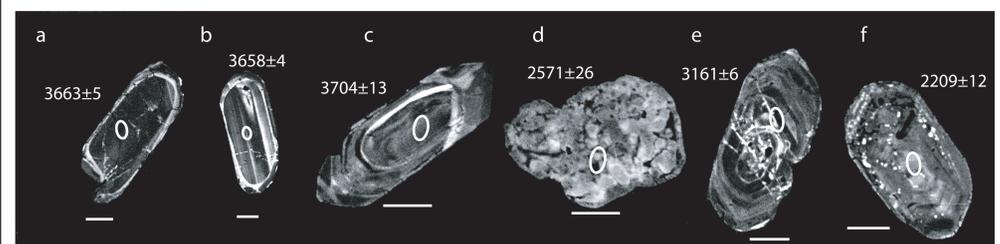


Figure 4. CL images of zircons showing the variety of observed textures. a-c: zircons with concordant cores surrounded by either (a,b) metamorphic or (c) igneous rims. d-f: discordant zircons with (d) textures typical of hydrothermal growth, (e) geochronology spots that overlapped cracks, or (f) metamictization (scale bars = 50 µm).

Whole-rock Geochemistry

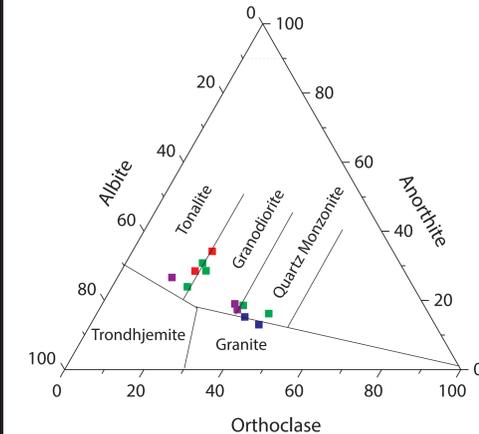


Figure 5. Classification of samples based on normative An-Ab-Or composition. Fields from Barker (1979); CTG = red, Voizel = green, Boizard = blue, enclaves = purple

Most gneisses have typical TTG compositions, but Boizard suite rocks are granitic (s.s.).

Two of the Voizel gneiss samples fall in the quartz-monzonite field (Fig. 5). These rocks also have large Eu/Eu* (~2) and relatively low concentrations of REE overall (fig. 6) (<100x chondrite LREE, <10x chondrite HREE), consistent with plagioclase enrichment during migmatization. Trace element plots are also typical for TTGs, with slight enrichments in Zr consistent with zircon inheritance.

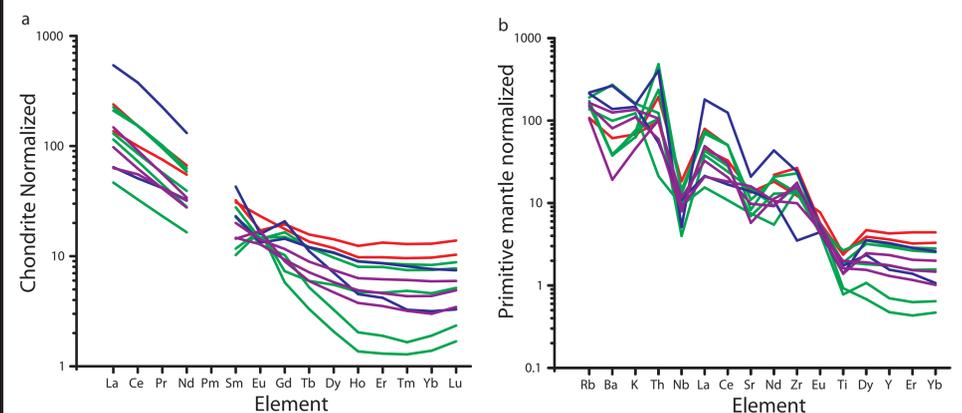
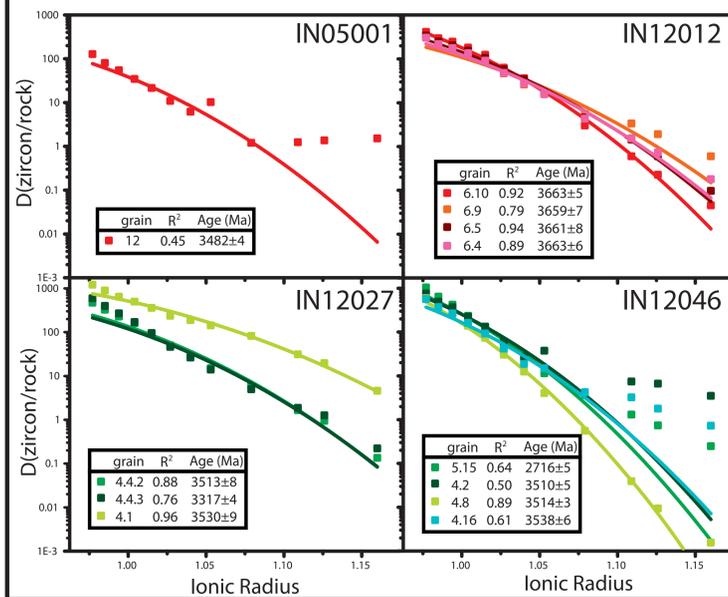


Figure 6. a. Chondrite normalized (Anders and Grevesse, 1989) REE plot and b. Primitive mantle normalized (McDonough, 1992) multi-element plot

Zircon Trace-element Geochemistry



Onuma diagrams with lattice strain partition modeling (e.g. Blundy and Wood, 1994) of zircon/host rock shows that the ca. 3650 Ma zircons are the best fit for CTG gneisses (red). Ca. 3550 zircons are the best fit for dating the Voizel suite (green).

Figure 7. Onuma plots of selected zircons showing the R² values of fitted zircons/host rock partitioning. Different colors indicate individual geochronology spots on zircon grains extracted from sample indicated in the upper right-hand corner. CTG=red, Voizel=green

Conclusions

- Matching zircon REE to whole-rock compositions using the Onuma diagrams coupled with lattice strain partition modeling successfully distinguishes igneous zircons from metamorphic growth and confirms the ages of Innukjuak gneissic suites
- The previously undated Voizel suite is ca. 3550 Ma, 100 Myr younger than the CTG
- Boizard suite (2700 Ma) carries inherited zircons from all older suites, including the NSB
- USB enclave may be contemporaneous to the CTG and a genetic link to the ca 3750-3780 Ma Nuvvuagittuq supracrustal belt (Cates and Mojzsis, 2007; Cates et al., 2013) remains to be established

References

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