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Using zircon U–Pb ages and trace element chemistry to constrain the timing of metamorphic events, pegmatite dike emplacement, and shearing in the southern Parry Sound domain, Grenville Province, Canada

Jeffrey H. Marsh[a,*], Christopher C. Gerbi[a], Nicholas G. Culshaw[b], Scott E. Johnson[a], Joseph L. Wooden[c], Christopher Clark[d]

[a] Department of Earth Sciences, University of Maine, Orono, ME 04473, USA
[b] Department of Earth Sciences, Dalhousie University, Halifax, NS B3H 3J5, Canada
[c] School of Earth Sciences, Stanford University, Palo Alto, CA 94305, USA
[d] Department of Applied Geology, Curtin University, Perth, WA 6845, Australia

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ABSTRACT

The integration of zircon U–Pb ages and trace element chemistry with structural and petrologic relations from a range of sample types provides important temporal constraints on the tectono-metamorphic evolution of the southern Parry Sound domain (PSD), Ontario, Canada, and the processes attending development of the underlying Twelve Mile Bay shear zone (TMBSZ). Intact granulites preserve *ca.* 1145 Ma ages, slightly younger than those farther to the north in the interior PSD, but similar to that of the underlying granulite-to-amphibolite facies Parry Sound shear zone. Weaker zircon HREE enrichment in sheared and retrogressed samples with partially resorbed garnet porphyroblasts (containing abundant zircon inclusions) suggests that the 1128–1143 Ma ages common to sheared rocks in the southern PSD record an earlier phase of metamorphism and deformation, and not the timing of shear zone development. Deformed pegmatite dikes bounded by sheared and retrogressed wall rocks from across the southern interior PSD consistently record *ca.* 1100 Ma ages, indicating synchronous pegmatite emplacement across the transect and constraining the bounding amphibolite-facies shear zones to ≤1100 Ma. TMBSZ samples retain evidence for (1) the older (*ca.* 1145 Ma) high-grade metamorphic event, (2) pegmatite emplacement and shear deformation at *ca.* 1100 Ma, and (3) a later (*ca.* 1070 Ma) shearing event. Combined with published structural and petrologic data, these ages indicate that pegmatite emplacement and shearing in the TMBSZ was synchronous with that in the southern interior PSD; further confirming published models for TMBSZ development. Additionally, the data suggest that the Twelve Mile Bay assemblage (within the TMBSZ) experienced high-grade metamorphism synchronously with the interior PSD, and may therefore be correlative with the basal PSD to the north.

1. Introduction

Reconstructing the evolution of poly-deformed, high-grade metamorphic terranes requires synthesis of detailed field, petrologic, and geochronological data. Zircon is among the most commonly used geochronometers in high-grade rocks due to its presence over a range of bulk-rock compositions and high closure temperature for chemical diffusion (e.g. Cherniak et al., 1997; Cherniak and Watson, 2000; Hoskin and Schaltegger, 2003), which enables retention of distinct chemical domains through multiple tectono-metamorphic events (e.g. Wayne and Sinha, 1992; Vavra et al., 1996; Hoskin and Black, 2000; Möller et al., 2002; Kelly and Harley, 2005). These qualities, however, can also lead to uncertainty in the interpretation of zircon ages, even when collected from specific growth domains by in situ analytical methods. In recent decades many studies have used trace-element concentration and zoning in zircon as a tool for interpreting U–Pb ages in terms of igneous or metamorphic crystallization events, or even specific reactions (e.g. Heaman et al., 1990; Fraser et al., 1997; Schaltegger et al., 1999; Hoskin and Black, 2000; Rubatto, 2002; Kelly and Harley, 2005; Harley and Kelly, 2007; Baldwin and Brown, 2008). The rapidly expanding datasets for rare earth element (REE) fractionation between zircon and major rock-forming minerals, especially garnet, have enabled more precise interpretations to

* Corresponding author. Current address: Department of Geological Sciences, University of Texas, 1 University Station C1100, Austin, TX 78712-0254, USA.
E-mail addresses: jhmarsh@jsg.utexas.edu (J.H. Marsh), christopher.gerbi@umit.maine.edu (C.C. Gerbi), nicholas.culshaw@dal.ca (N.G. Culshaw), johnsons@maine.edu (S.E. Johnson), jwooden@stanford.edu (J.L. Wooden), c.clark@curtin.edu.au (C. Clark).

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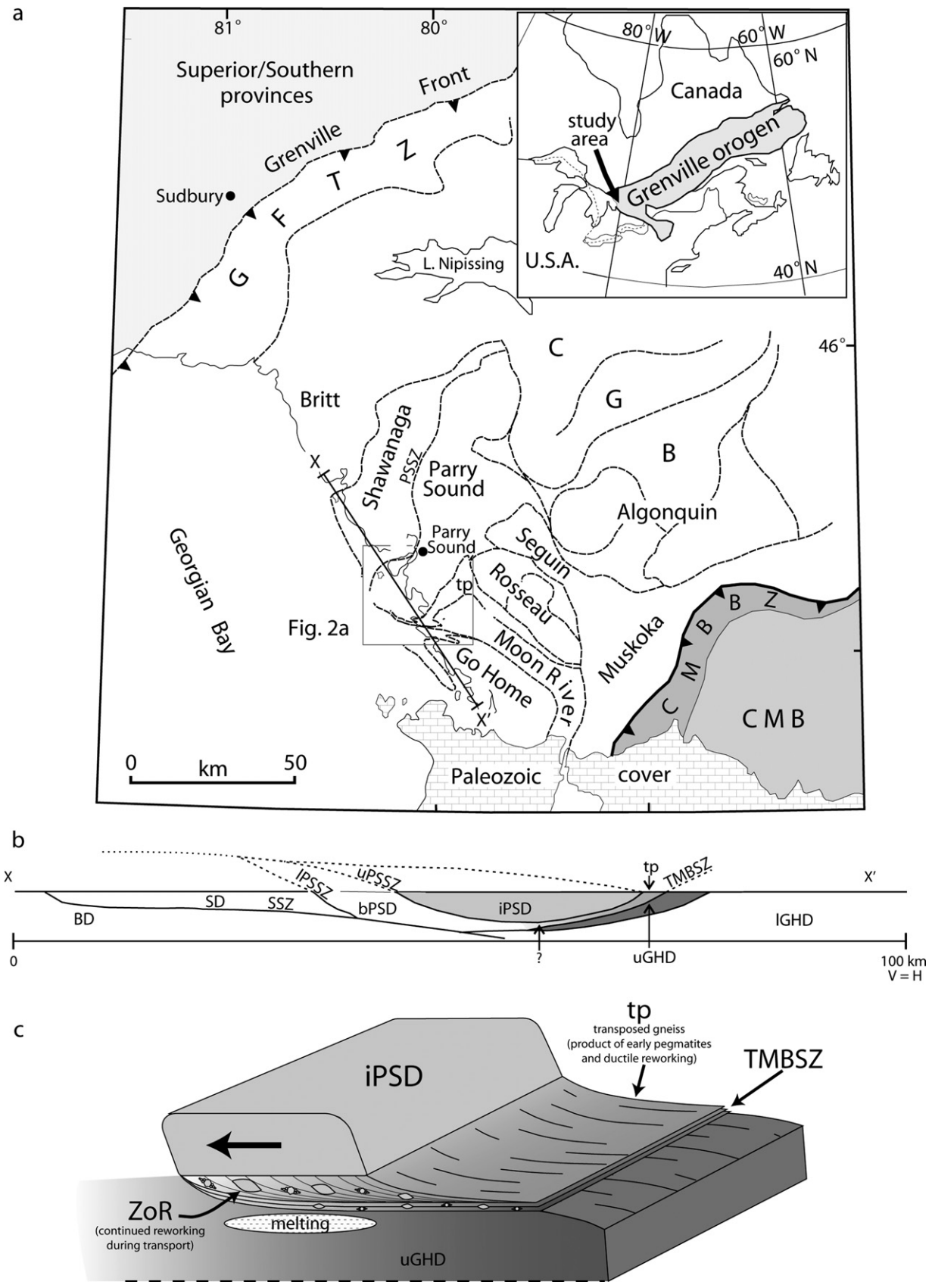

Fig. 1. (a) Location of study area and surrounding litho-tectonic domains within the southwestern Central Gneiss Belt (CGB), Grenville Province, Ontario, Canada (modified after Culshaw et al., 1997). (b) Generalized cross-section with domains and relevant shear zones (modified after Culshaw et al., 1997). GFTZ: Grenville Front Tectonic Zone; CGB: Central Gneiss Belt; CMB: Central Metasedimentary Belt; BD: Britt domain; SD: Shawanaga domain; bPSD: basal Parry Sound domain; iPSD: interior Parry Sound domain; tp: transposed gneiss; uGHD: upper Go Home domain; lGHD: lower Go Home domain; SSZ: Shawanaga shear zone; lPSSZ: lower Parry Sound shear zone; uPSSZ: upper Parry Sound shear zone; TMBSZ: Twelve Mile Bay shear zone. (c) Schematic diagram showing model for ductile sheath development (TMBSZ) involving pegmatite emplacement and hydration-related weakening during northward transport of the interior PSD over peri-Laurentian domains (uGHD; modified after Marsh et al., 2011).