Precambrian Research 184 (2011) 24–42

Contents lists available at ScienceDirect

Precambrian Research

journal homepage: www.elsevier.com/locate/precamres

Field and geochemical characteristics of Mesoarchean to Neoarchean volcanic rocks in the Storø greenstone belt, SW Greenland: Evidence for accretion of intra-oceanic volcanic arcs

J.C. Ordóñez-Calderón[a,b,*], A. Polat[a,c], B.J. Fryer[a,c], J.E. Gagnon[a,c]

[a] Department of Earth and Environmental Sciences, University of Windsor, Windsor, ON, Canada N9B 3P4
[b] Mineral Exploration Research Centre, Department of Earth Sciences, Laurentian University, Sudbury, ON, Canada P3E 2C6
[c] Great Lakes Institute for Environmental Research, University of Windsor, Windsor, ON, Canada N9B 3P4

ARTICLE INFO

Article history:
Received 8 July 2008
Received in revised form 28 October 2010
Accepted 28 October 2010

Keywords:
Archean
Greenstone belt
Amphibolites
Island arc tholeiites
Supra-subduction zone

ABSTRACT

The Storø greenstone belt, southern West Greenland, consists of thrust-imbricated slices of Mesoarchean (>3060 Ma) and Neoarchean (ca. 2800 Ma) mafic to ultramafic volcanic rocks, volcaniclastic sediments, and gabbro–anorthosite associations. The belt underwent polyphase metamorphism at upper amphibolite facies conditions between 2650 and 2600 Ma. The contacts between the Mesoarchean and Neoarchean volcanic rocks, and surrounding Eoarchean to Neoarchean tonalite–trondhjemite–granodiorite (TTG) gneisses are tectonic and typically bounded by high-grade mylonites. Regardless of age, the volcanic rocks are dominated by mafic amphibolites with a tholeiitic basalt composition, near-flat to slightly enriched light rare earth element (LREE) patterns (La/Sm_{cn} = 0.91–1.48), relatively flat to slightly depleted heavy-REE (HREE) (Gd/Yb_{cn} = 1.0–1.28), and pronounced negative Nb–Ta anomalies (Nb/Nb^* = 0.34–0.73) on chondrite- and primitive mantle-normalized diagrams. These geochemical characteristics are consistent with subduction zone geochemical signatures and partial melting of a shallow (<80 km) mantle source free of residual garnet. There is no geochemical evidence for contamination by older continental crust. The overall field and geochemical characteristics suggest that the thrust-imbricated basaltic rocks were erupted in intra-oceanic subduction zone settings. Sedimentary rocks are represented by garnet–biotite and quartzitic gneisses. They are characterized by relatively high contents of transition metal (Ni = 10–154 ppm; Cr = 7–166 ppm) and enriched LREE patterns (La/Sm_{cn} = 1.38–3.79). These geochemical characteristics suggest that the sedimentary rocks were derived from erosion of felsic to mafic igneous source rocks. Collectively, the structural and lithogeochemical characteristics of the Storø greenstone belt are consistent with collision (accretion) of unrelated Archean volcanic rocks formed in supra-subduction zone geodynamic settings. Accordingly, the Mesoarchean and Neoarchean rock record of the Storø greenstone belt may well be explained in terms of modern-style plate tectonic processes.

1. Introduction

The Nuuk region in southern West Greenland (Fig. 1) comprises several Eo- to Neoarchean (3850–2800 Ma) tectono–stratigraphic terranes assembled into a single super-terrane during prolonged continent–continent collisional events taking place between 2960 and 2600 Ma (Friend et al., 1988, 1996; Nutman et al., 1989; McGregor et al., 1991; Friend and Nutman, 2005; Nutman and Friend, 2007; Windley and Garde, 2009). Terrane amalgamation resulted in polyphase regional amphibolite–granulite facies metamorphism and multi-stage ductile deformation (Nutman and Friend, 2007). The allochtonous terranes are dominated by Archean tonalite–trondhjemite–granodiorite (TTG) associations and include small fragments of greenstone belts <5 km in width. The accretion of allochtonous terranes in the Nuuk region has been considered as one of the best-documented examples of Archean collisional orogeny (Nutman and Friend, 2007). The collisional orogenic model proposed for the Nuuk region has important implications for the geodynamic origin of Archean greenstone belts (cf., Nutman and Friend, 2007). In Phanerozoic collisional orogens, supra-subduction zone ophiolites have been emplaced onto continents during the progressive closure of ocean basins (Dilek and Flower, 2003; Flower and Dilek, 2003; Pearce, 2003; Şengör and Natal'in, 2004). Therefore, the tectonic terrane model suggests that some greenstone belts from the Nuuk region may represent the Archean analogues of Phanerozoic oceanic crust (cf., De Wit, 2004). Or alternatively, they may also represent remnants of continental flood and rift volcanic sequences deformed during collisional tec-

* Corresponding author. Present address: Laurentian University, Department of Earth Sciences, Mineral Exploration Research Centre, 933 Ramsey Lake Road, 7th Floor, Sudbury, Ontario, Canada P3E 6B5. Tel.: +1 519 253 3000x2498.
E-mail address: ordonez.jc@gmail.com (J.C. Ordóñez-Calderón).

0301-9268/$ – see front matter © 2010 Elsevier B.V. All rights reserved.
doi:10.1016/j.precamres.2010.10.003

tonics (cf., Bickle et al., 1994; Hunter et al., 1998; Bleeker, 2002; Thurston, 2002; Hartlaub et al., 2004; Shimizu et al., 2005).

Recent field and geochemical investigations in the region have shown that the Mesoarchean (3070–3075 Ma) Ivisaartoq, Ujarassuit, and Qussuk greenstone belts display lithological and geochemical characteristics that are reminiscent of Phanerozoic intra-oceanic subduction zone geodynamic settings (Garde, 2007; Polat et al., 2007, 2008, 2009b; Ordóñez-Calderón et al., 2008, 2009). These characteristics include: (1) pyroclastic andesites in the Qussuk belt (Garde, 2007); (2) epidosites in pillow basalts in the Ivisaartoq belt (Polat et al., 2007) resembling those recovered from modern sea-floor hydrothermal systems in the Tonga-Kermadec forearc (cf., Banerjee et al., 2000); (3) basaltic amphibolites with negative Nb–Ta anomalies in primitive mantle-normalized diagrams (Polat et al., 2007, 2008; Ordóñez-Calderón et al., 2008, 2009); (4) ultramafic rocks with geochemical composition sim-

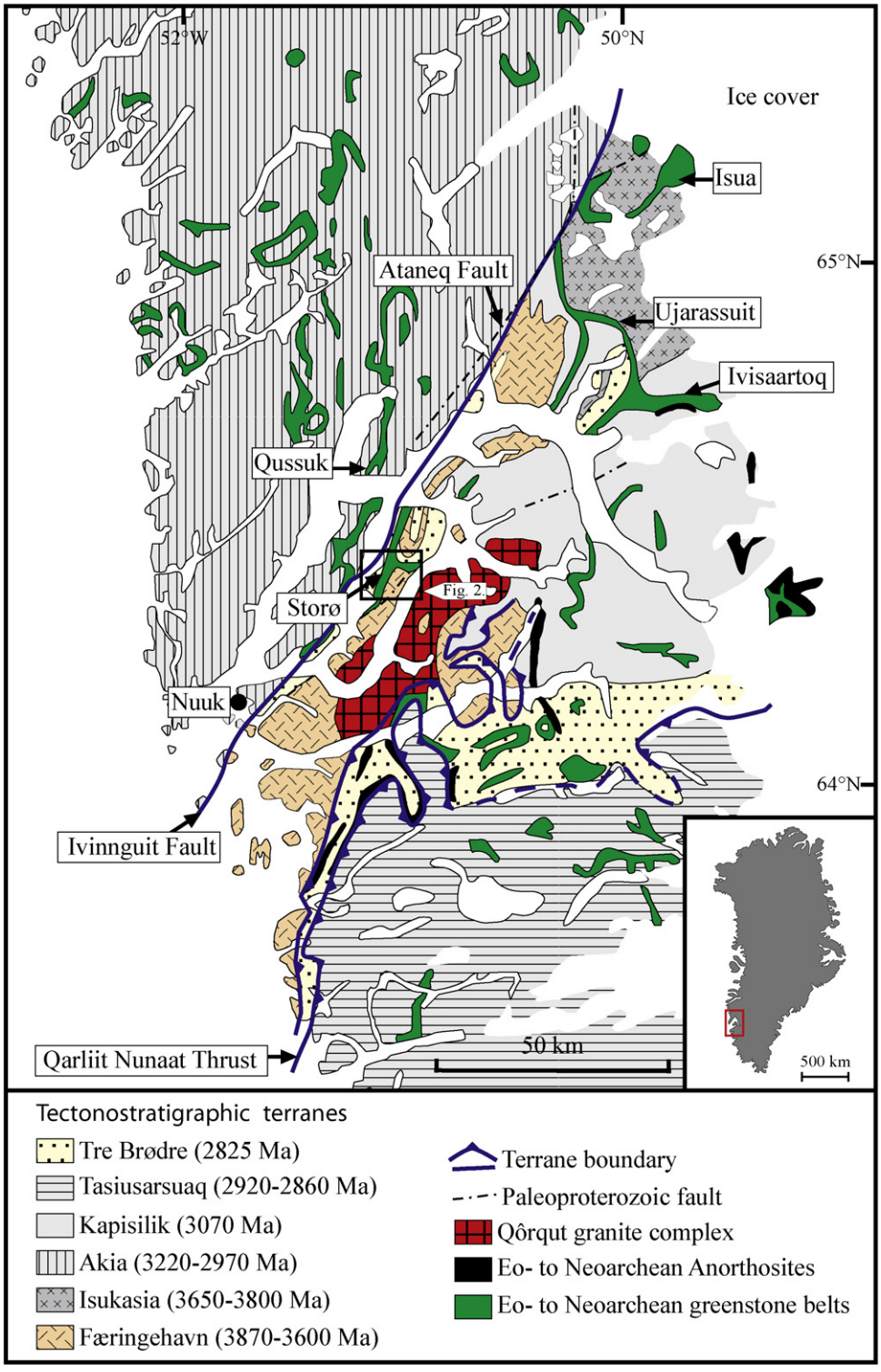

Fig. 1. Geological map showing the Eoarchean to Neoarchean tectono–stratigraphic terranes of the Nuuk Region. The locations of Isua, Ujarassuit, Ivisaartoq, Qussuk, and Storø (inset, Fig. 2) greenstone belts are also shown. The map is adapted from Friend and Nutman (2005), and Nutman and Friend (2007).