Precambrian Research 300 (2017) 223–245

Contents lists available at ScienceDirect

Precambrian Research

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

Tectonic switches and the exhumation of deep-crustal granulites during Neoarchean terrane accretion in the area around Grædefjord, SW Greenland

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ARTICLE INFO

Keywords:
Archean tectonics
Terrane accretion
Granulite exhumation
Pseudosection modelling

ABSTRACT

Terrane accretion in the Nuuk region in the North Atlantic Craton in Greenland shares many characteristics with modern accretionary systems, including compelling evidence for regional-scale crustal thickening as well as the presence of terranes with distinct PT histories. The Nuuk region is therefore interpreted to contain a paired metamorphic belt, formed during the convergence and collision of the Færingehavn terrane with the structurally overlying Tre Brødre and Tasiusarsuaq terranes between ca. 2720 and 2700 Ma. The Tasiusarsuaq terrane exposes a deeply eroded section through the upper plate of the orogen, dominated by granulite and amphibolite facies TTG gneiss and mafic supracrustal rocks. In its centre, nappes of deep crustal granulites (800–950 °C, 9–12 kbar) were exhumed to mid crustal levels at conditions of 660–810 °C and 7–8 kbar. Nappe emplacement occurred during NW-vergent thrusting and the steepening of fabrics between ca. 2760 and 2720 Ma, coeval with the underthrusting of the Færingehavn beneath the Tasiusarsuaq terrane. Pervasive ductile fabrics and the presence of abundant leucosomes and syntectonic pegmatites suggest that mid-crustal nappe emplacement was melt-assisted. The final collisional event between 2720 and 2700 Ma was associated with a switch from convergence-related thrusting and non-coaxial shearing to co-axial shortening, leading to the development of the subvertical, linear Grædefjord gneiss belt that records the vertical extrusion of material. The Grædefjord gneiss belt is the most prominent of these late-stage ca. 2700 Ma extrusion zones that was previously interpreted to be located at or near a boundary between two tectonic blocks.

1. Introduction

The geodynamic processes that formed the Archean crust are highly controversial (e.g., de Wit, 1998; Hamilton, 1998; Stern, 2005; Moyen et al., 2006; Van Kranendonk, 2011; Bédard, 2006, 2017; Bédard et al., 2013; Johnson et al., 2014, 2017), mainly because of the uncertainty related to the effects of higher mantle temperatures during the early stages of Earth's history, but also because of the typically strong reworking of the Archean crust by subsequent tectono-thermal events. A third and commonly underestimated reason is that metamorphic studies are still comparatively rare, with the result that the thermal evolution and structure of Archean cratons are generally not well understood. The Nuuk region of SW Greenland represents a well-preserved section through Archean mid- to lower continental crust and is one of the type localities to study the mechanisms of crust formation and terrane accretion in Archean high-grade gneiss terrains. The region is dominated by tonalite-trondhjemite-granodiorite (TTG) gneisses, and numerous enclaves of mafic to ultramafic, mainly metavolcanic rocks and anorthosites (Fig. 1; Friend et al., 1996; Friend and Nutman, 2005). Previous studies subdivided the area into several distinct terranes (Friend et al., 1987, 1988; McGregor et al., 1991), each of which are characterized by distinct protolith ages and different metamorphic histories that were amalgamated during the Neoarchaean at ca. 2720–2710 Ma (Fig. 1; Nutman et al., 1989; Friend et al., 1996; Crowley, 2002; Friend and Nutman, 2005; Nutman and Friend, 2007; Dziggel et al., 2014). Based on the strong structural evidence for regional-scale crustal shortening, as well as the identification of a paired metamorphic belt defined by the relatively low-T, high-P Færingehavn terrane that is structurally overlain by the high-T, low-P Tre Brødre and Tasiusarsuaq terranes (Fig. 1), Dziggel et al. (2014) presented a new tectonic model proposing the southwards subduction of the Færingehavn terrane underneath the Tre Brødre and Tasiusarsuaq terranes. Prior to final

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http://dx.doi.org/10.1016/j.precamres.2017.07.027
Received 21 March 2017; Received in revised form 8 July 2017; Accepted 18 July 2017
Available online 19 July 2017