Precambrian Research 170 (2009) 43–60

Contents lists available at ScienceDirect

Precambrian Research

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

Provenance record from Mesoproterozoic-Cambrian sediments of Peary Land, North Greenland: Implications for the ice-covered Greenland Shield and Laurentian palaeogeography

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ARTICLE INFO

Article history:
Received 17 December 2007
Received in revised form
24 November 2008
Accepted 30 November 2008

Keywords:
Greenland
Zircon
Provenance
Grenville
Peary Land
Elzevirian

ABSTRACT

In North Greenland, Precambrian crystalline basement forms restricted outcrops bordering the Inland Ice. The coverage and nature of this basement is of key importance in understanding the evolution of the Greenland Shield and its palaeogeography. Specifically, the extent of the Grenville Orogen within Greenland is difficult to resolve due to overprinting deformation and ice cover. In an effort to remove some of this uncertainty, we have examined autochthonous sedimentary deposits in Peary Land.

Detrital zircon crystals in siliciclastic units of the Mesoproterozoic Independence Fjord Group (Inuiteq Sø Formation) yield ages from 1814 to 3299 Ma. The detrital population in these samples contains significant Palaeoproterozoic peaks at c. 1900 and 1990 Ma and a subordinate Neoarchaean peak at c. 2700 Ma. Detrital zircon grains from the overlying Neoproterozoic (?Marinoan) Morænesø Formation, range from 970 to 3970 Ma and include a substantial 1000–1400 Ma population that peaks at c. 1020 Ma. The (?Neoproterozoic-Lower Cambrian) Portfjeld Formation, higher in the stratigraphy, also contains late Palaeoproterozoic and late Mesoproterozoic peaks. The Palaeoproterozoic and older populations in the Morænesø and Portfjeld formations are comparable to those in the Inuiteq Sø Formation. Within these formations, the similarity of both the detrital ages and palaeocurrent directions, predominantly to the NE, suggests a consistent provenance area sourced throughout the Proterozoic. This source region was, however, affected by Grenville events after the deposition of the Inuiteq Sø Formation.

Granitoid clasts within diamictites of the Morænesø Formation contain high uranium metamict zircon grains but yield best age estimates for unfoliated clasts of c. 2700 Ma. However, foliated clasts suggest c. 1250 Ma crystallization or overprinting.

The age range of detritus and palaeocurrent directions is consistent with a dominant provenance from the Greenland Shield to the south-west. Potential sources include the Committee-Melville Orogen (Archaean), the Ellesmere-Inglefield Mobile Belt (Palaeoproterozoic) and the sub ice continuation of the Victoria Fjord complex (Archaean). A proximal source of late Mesoproterozoic detritus is unknown in North Greenland. It is conceivable that some of the sand-grade material may have been transported across the shield from a Grenville foreland basin, but the presence of cobble-sized clasts with indications of an Elzevirian history, strongly implies that the North Greenland basement was near to a zone of c. 1250 Ma reworking.

1. Introduction

The crystalline shield of Greenland crops out along much of the eastern and western coast bordering the central icecap, the Inland Ice, which accounts for 85% of the island's surface (Fig. 1). In contrast, in North Greenland an extensive sedimentary cover hides the shield apart from local outcrops at the ice margin. Exposed rocks throughout Greenland document a predominantly Archaean crust which was intruded and reworked during the Proterozoic (Kalsbeek, 1982). In the north and south, Proterozoic juvenile crust is also preserved (e.g. Dawes, 1988; Garde et al., 2002). Due to the similarity of this basement architecture Greenland is traditionally considered to conjoin North America and Baltica in Neoproterozoic supercontinent reconstructions (Bridgwater et al., 1991; Hoffman, 1991; Moores, 1991; Dawes, in press; Nutman et al., 2008). However, due to the extent of the Inland Ice, tracing of orogenic belts and intracratonic structures, that define a

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doi:10.1016/j.precamres.2008.11.006

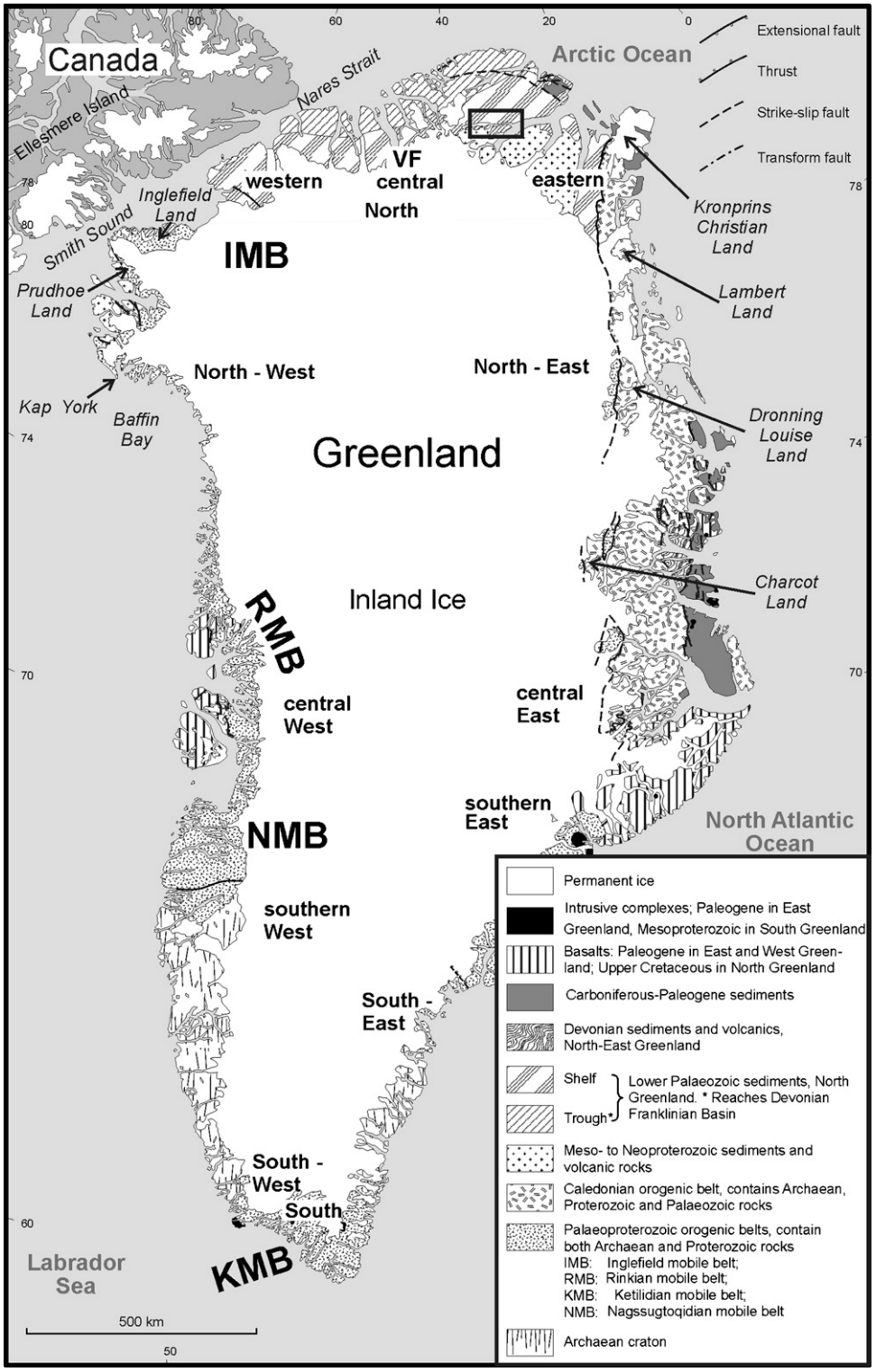

Fig. 1. Geological map of Greenland based on Escher and Pulvertaft (1995) with geographic subdivisions from Henriksen et al. (2000). The study area in Peary Land is enclosed in a box.

coherent supercontinent, is problematic. Hence, other methods are needed to investigate the palaeogeography of Greenland with respect to Rodinia (McMenamin and McMenamin, 1990; Piper, 2007; Bogdanova et al., 2008; Li et al., 2008). Detrital zircon geochronology offers the ability to independently test stratigraphic correlations and depositional frameworks. Moreover, and critically in a palaeogeographic context, age signatures when combined with palaeocurrent observations allows hypotheses for the past locations of specific crustal units to be evaluated.

The concept of Rodinia is based on petrological, geochemical and tectonic evidence for Proterozoic continentality (Ronov, 1968; McLennan and Taylor, 1983; Piper, 1987) which includes correlation of orogenic belts (Dalziel, 1991) and Neoproterozoic sedimentary sequences (Eisbacher, 1985). Rodinia is generally thought to