Precambrian Research 244 (2014) 156–169

Contents lists available at ScienceDirect

Precambrian Research

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

Paleomagnetism of Mesoproterozoic Satakunta sandstone, Western Finland

R. Klein[a,*], L.J. Pesonen[a], J. Salminen[a,c], S. Mertanen[b]

[a] Division of Geophysics and Astronomy, Department of Physics, University of Helsinki, FI-00014 Helsinki, Finland
[b] Geological Survey of Finland, FI-02151 Espoo, Finland
[c] Division of Geology, Department of Geosciences and Geography, University of Helsinki, FI-00014 Helsinki, Finland

ARTICLE INFO

Article history:
Received 20 February 2013
Received in revised form 30 August 2013
Accepted 3 September 2013
Available online 12 September 2013

Keywords:
Paleomagnetism
Mesopoterozoic
Baltica
Satakunta sandstone
NENA

ABSTRACT

A paleomagnetic study of the Mesoproterozoic Satakunta sandstone formation, Western Finland is presented here. Two components of natural remanent magnetization (NRM) were isolated in the sandstone with alternating field (AF) and thermal demagnetization treatments. The first is a high coercivity/unblocking temperature component which, after tilt and inclination shallowing corrections, yields a remanent magnetization of $D = 25.2^\circ$, $I = 3.9^\circ$ with $\alpha_{95} = 9.1^\circ$ (10 sites), corresponding to a paleomagnetic pole of Plat = 27.8° N, Plon = 173.2° E, with $A_{95} = 6.5^\circ$. Positive reversal and tilt tests, an inverse baked contact test, as well as a stratigraphic order of the site mean poles, indicates a primary remanence. The relative age of the sandstone is estimated at ca. 1600 based on the proximity to other well defined poles of 1540–1770 Ma from Baltica. However, because the pole also overlaps with poles with the ages of 1452–1630 Ma, the age of the sandstone cannot be accurately defined. The second component is a lower coercivity/unblocking temperature component with a remanent magnetization direction $D = 34.0^\circ$, $I = -40.7^\circ$ with $\alpha_{95} = 8.1^\circ$ (13 sites) similar to that of the Postjotnian Satakunta diabase intrusions, which are widespread in the area. Comparing APWPs of Baltica and Laurentia during 1.77–1.27 Ga gives strong support to the Mesoproterozoic NENA configuration at 1.6 Ga.

1. Introduction

The paleographic position of Baltica and its relationship to other continental blocks during the Proterozoic are based on little data, and are often of limited reliability (Pesonen et al., 2003, 2012). Most cratonic blocks show evidence of either collision or accretion between 1.9 and 1.8 Ga, which lead researchers to propose the Mesoproterozoic supercontinent Columbia (Hudsonland, Nuna) (Meert, 2002; Pesonen et al., 2003; Zhao et al., 2002, 2004). According to several authors (e.g. Gower et al., 1990; Salminen and Pesonen, 2007; Evans and Pisarevsky, 2008; Lubnina et al., 2010; Evans and Mitchell, 2011; Salminen et al., 2014) Baltica and Laurentia were connected in the NENA (North Europe-North America) configuration forming the core of the Columbia supercontinent between 1.8 and 1.2 Ga. However there are not only significant gaps in the apparent polar wander paths (APWP's) of Baltica and Laurentia between 1.78 Ga and 1.27 Ga, but also controversies in attempts to match the APWP's (Salminen et al., 2014).

Although there are numerous paleomagnetic poles from the Mesoproterozoic for Baltica, many of them fulfil very few of the reliability criteria set out by Van der Voo (1990). A case in point is the earlier study on the Mesoproterozoic Satakunta sandstone (Neuvonen, 1973). Old-fashioned demagnetization methods ("blanket cleaning") were used, which are insufficient to isolate the characteristic natural remanence (ChRM). Furthermore, an insufficient number of samples ($N = 10$) were used for the study, no reversals were observed from the four study sites, and no tilt- or inclination-corrections were applied. Moreover, the results are doubted since it closely resembles the results of Postjotnian diabases (Neuvonen, 1965).

In this study we revisited the Mesoproterozoic Satakunta sandstone, systematically sampling all the known sandstone outcrops, and using modern demagnetization techniques coupled with rock magnetic measurements. The objective is to identify the ChRM of the Satakunta sandstone, to estimate the relative paleomagnetic age of deposition, and to use the new paleomagnetic pole for Baltica to check the validity of NENA at the estimated age of the sandstone.

2. Geological background

Satakunta sandstone is a fluvial formation situated in the Satakunta region in Western Finland (Fig. 1). This unmetamorphosed sandstone was deposited in a deltaic environment and has been preserved in a SE-NW trending graben within the

* Corresponding author. Tel.: +358 449701210.
E-mail address: robert.klein@helsinki.fi (R. Klein).

0301-9268/$ – see front matter © 2013 Elsevier B.V. All rights reserved.
http://dx.doi.org/10.1016/j.precamres.2013.09.003

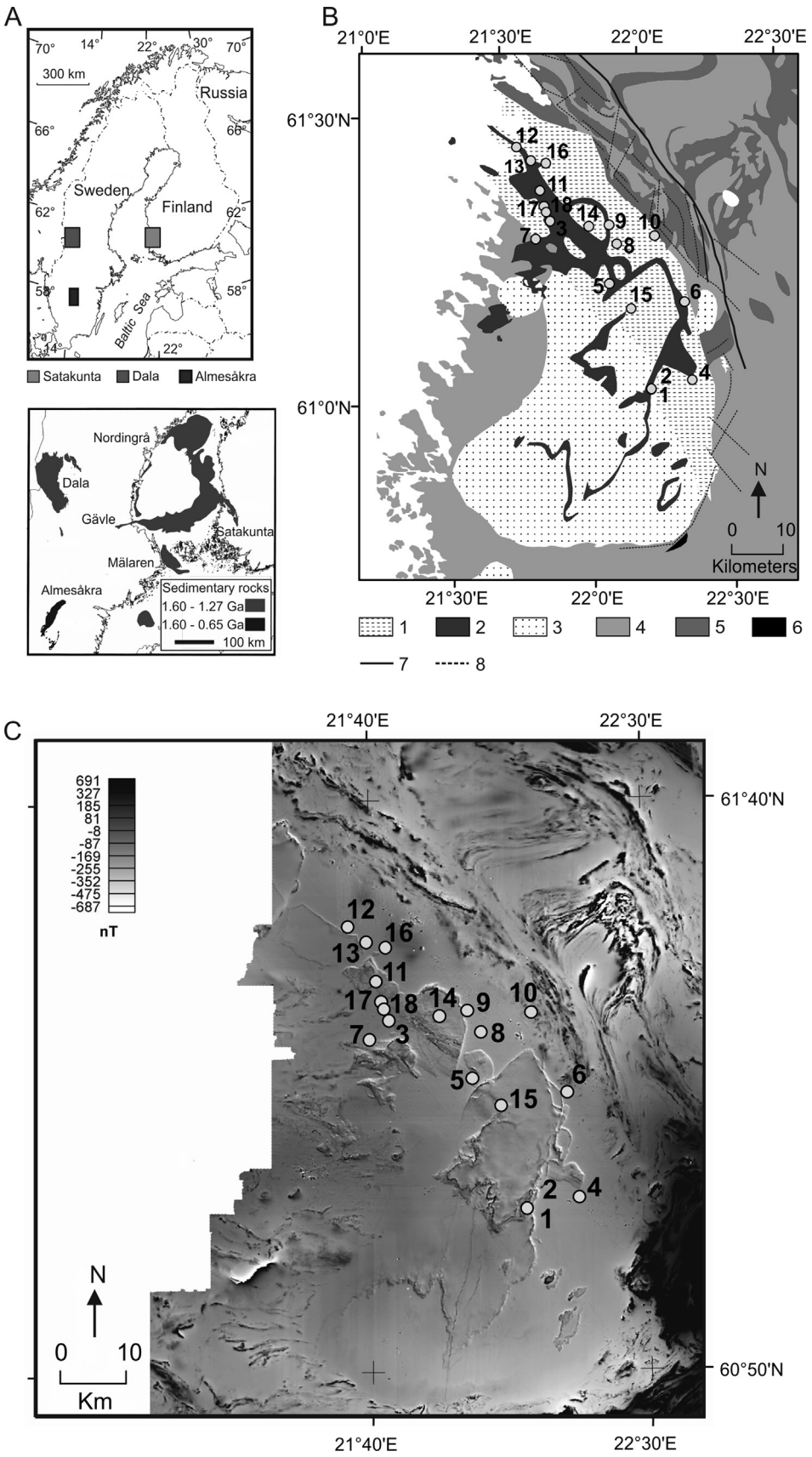

Fig. 1. (A) Satakunta sandstone and other Fennoscandian sedimentary formation. (B) Bedrock of Satakunta: 1. Sandstone, 2. Postjotnian Diabase, 3. Rapakivi granite, 4. Svecofennian bedrock (Southern Finland arc complex), 5. Svecofennian bedrock (Central Finland arc complex), 6. Gabbro, 7. Kynsikangas shear/fault zone, 8. Faults/shears (modified from Pajunen and Wennerström (2010)). Studied sandstone sites (and sample codes used in this study). 1. Kiperi (80-KP, KT), 2. Kiperoja (80-KO, KJ), 3. Sahankoski (SK), 4. Karhusuo (MU, SS, SY), 5. Panelia (PA), 6. Koomankallio (KK), 7. Naskalinkallio (NK), 8. Leistilänjärvi (LJ), 9. Leistilä (LE, LS), 10. Harjavalta (HA, HC, HV), 11. Knapernummi (KM, KN), 12. Makholm (MH), 13. Kalliopää (KP), 14. Pössi (PS), 15. Kiukainen (KI), 16. Metsäkulma (MK), 17. Murro-oja (MO), and 18. Kotkajärvenoja (KR). All sites marked on the map are sandstone outcrop sites; diabase was collected from outcrops in contact with or in close proximity to the sandstone outcrops. (C) Aeromagnetic anomaly map of Satakunta (copyright: GTK airborne geophysical database). Nominal terrain clearance is 30 m and line spacing is 200 m. Flight line direction mainly E–W, partly N–S.