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Baltica, Amazonia and the SAMBA connection—1000 million years of neighbourhood during the Proterozoic?

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ABSTRACT

Possible large-scale geological correlation between Baltica (East European Craton) and Amazonia (central South America) is discussed using compilations of recent data and regional geological models. A fit with northwest Amazonia attached to southwest Baltica – the SAMBA (South America–Baltica) connection – produces a closely matching pattern of westward younging Proterozoic growth zones and is suggested to have existed from at least 1.8 Ga to at least 0.8 Ga. West Africa was probably attached to northeast Amazonia and southeast Baltica during the same time period. As in most plate tectonic reconstructions, northwest Baltica was attached to eastern Laurentia (Greenland) from 1.9 Ga to at least 1.3 Ga, and western Amazonia thus formed a continuation of the southeast Laurentia–western Baltica active margin, being characterized by intermittent crustal growth and orogenic deformation during the late Palaeoproterozoic and Mesoproterozoic, as well as periods with more inboard intraplate magmatism. In order to reach the "standard" Rodinia configuration, Baltica must have separated from Laurentia and, together with Amazonia and West Africa, rotated c. 75° clockwise relative to Laurentia. During the 1.1–0.9 Ga Grenvillian – Sveconorwegian – Sunsas orogeny, the western margin of Baltica and Amazonia collided with the southeast margin of Laurentia, as part of the formation of the Neoproterozoic supercontinent Rodinia. Final break-up of Rodinia occurred around 0.6 Ga, although separation of Amazonia and West Africa from Baltica may have occurred earlier. With ocean opening along the southwest (Tornquist) and northwest (Iapetus) margins of Baltica, and the formation of the Timanian orogen along the leading northeastern edge at 0.6–0.55 Ga, Baltica moved to the (present-day) northeast, into a 200 million year period of solitude, the only period during its history when Baltica existed as a continent of its own, before reuniting with Laurentia during the Caledonian orogeny and then merging with the rest of Eurasia.

1. Introduction

In Precambrian plate tectonic reconstructions, a close connection between North America (Laurentia) and Northeast Europe (the East European Craton or Baltica) is often assumed, based on geological correlation between the two continents (e.g. Gower et al., 1990; Karlstrom et al., 2001). The detailed configuration often differs between different authors, and depending on whether an early, middle or late Proterozoic configuration is discussed. Based on palaeomagnetic evidence, Baltica is often assumed to have made a c. 90° clockwise rotation from its Mesoproterozoic position relative to Laurentia to its Neoproterozoic position, in connection with the Grenvillian—Sveconorwegian orogeny and the formation of the Neoproterozoic supercontinent Rodinia. In Rodinia reconstructions, Amazonia (the core of South America) is often placed somewhat loosely southeast (in present-day coordinates) of Laurentia and southwest of Baltica, and is assumed to have been involved in the Grenville collisions leading to the formation of Rodinia (e.g. Rogers, 1996; Torsvik et al., 1996; Dalziel, 1997; Geraldes et al., 2001; Tohver et al., 2002, 2004; Li et al., 2008). In this paper, a more tight fit with northern Amazonia attached to southwest Baltica – the SAMBA (South America–Baltica) connection – from at least 1.8 Ga to at least 0.8 Ga is proposed, and its implications both for early and late Proterozoic plate tectonic reconstructions are discussed.

2. Overview of Baltica

Baltica is the Precambrian part of Europe, located west of the Ural mountains and northeast of the Trans-European Suture Zone. Its Precambrian basement is exposed in the Baltic or Fennoscandian Shield in the northwest, and in the smaller Ukrainian Shield in the southeast. Otherwise, it is overlain by Phanerozoic sedimentary rocks and only known through geophysical investigations and deep drill holes. The northwestern margin of Baltica is overlain by Caledonian nappes.

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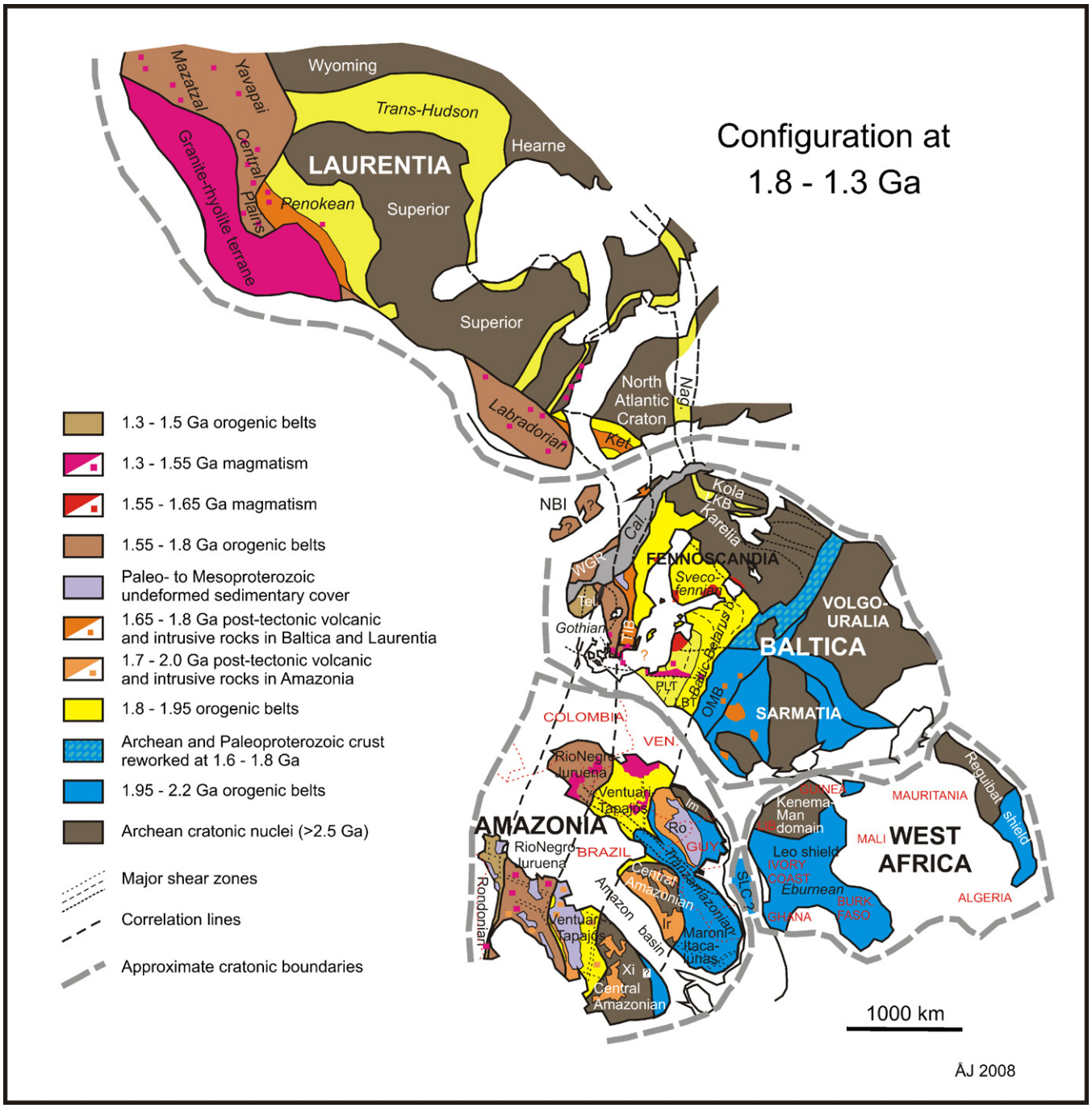

Fig. 1. Proposed fit of Laurentia, Baltica, Amazonia and West Africa during the 1.8–1.3 Ga time period. Laurentia map based on Bleeker (2005) (with modifications from Gower et al., 1990, and Karlstrom et al., 2001), Baltica map based on Bogdanova et al. (2005) (with modifications from Bogdanova et al., 2006), Amazonia map based on Tassinari and Macambira (1999, 2004) (with modifications from Santos et al., 2000), and West Africa map based on Feybesse et al. (2006). Names of orogenic belts in italics, names of proto-cratons and other geological provinces in normal letters, names of major cratons and cratonic segments in capitals. Abbreviations: Nag, Nagssugtoqidian belt; Ket, Ketilidian belt; NBI, Northern British Isles; LKB, Lapland-Kola Belt; WGR, Western Gneiss Region; Tel, Telemarkia; TIB, Transscandinavian Igneous Belt; PLT, Polish-Lithuanian Terrane; LBT, Lithuanian-Belarus Terrane; OMB, Osnitsk-Mikashevichi Belt; SLC, São Luis Craton; Ro, Roraima Block; Xi, Xingu Block; Ir, Iricoumé Block; Im, Imataca belt.

Baltica is divided into three crustal segments, Fennoscandia, Sarmatia and Volgo-Uralia (Fig. 1), each containing Archaean cratonic nuclei (Gorbatschev and Bogdanova, 1993; Bogdanova et al., 2005, 2008). Volgo-Uralia is totally unexposed, but appears to consist predominantly of Archaean crust (Bogdanova et al., 2005, 2008). Sarmatia, which is exposed within the Ukrainian Shield, consists of several blocks of 3.7–2.8 Ga old Archaean crust, with intervening belts of juvenile early Palaeoproterozoic (2.2–2.1 Ga) crust, and bound to the north and west by 2.0–1.9 Ga tectonic belts forming its boundaries towards Volgo-Uralia and Fennoscandia, respectively (Bogdanova et al., 2005, 2006, 2008; Claesson et al., 2006). Sarmatia is also intruded by several large 1.80–1.74 Ga post-tectonic gabbro-anorthosite-granite plutons, the largest being the Korosten pluton (Bogdanova et al., 2005, 2006).

Fennoscandia consists of the 3.5–2.7 Ga old Archaean crust of the Kola and Karelian proto-cratons (Bogdanova et al., 2005), welded together at c. 1.9 Ga along the Palaeoproterozoic Lapland-Kola collisional belt (LKB; Daly et al., 2006). The Archaean basement of the Karelian proto-craton is partly overlain by 2.5–2.0 Ga rift-related metavolcanic and metasedimentary rocks. To the southwest of the