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Was there SAMBA in Columbia? Paleomagnetic evidence from 1790 Ma Avanavero mafic sills (northern Amazonian Craton)

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ABSTRACT

The Amazonian Craton represents an important piece in the Paleoproterozoic paleogeography of the Earth. This study presents paleomagnetic data obtained on well-dated (U–Pb) 1790 Ma mafic sills from the Avanavero magmatism in northern Amazonian Craton (Guiana Shield). AF and thermal treatments revealed southeastern, low downward/upward inclination, remanent magnetization directions that are carried by moderate to high-H_c and high-T_B Ti-poor titanomagnetite. The site mean directions cluster around the mean $D_m = 138.2°$, $I_m = -3.4°$ ($N = 13$, $\alpha_{95} = 13.0°$), which yields a robust paleomagnetic pole (AV pole) at 27.9°E, 48.4°S ($A_{95} = 9.6°$) with a *Q*-value of 5. The characteristic component disclosed for the Avanavero sill matches that obtained for sediments collected along the baked contact and are distinct from those away from the sill. The Avanavero directions are also significantly different from those obtained for younger units, with ages spanning from 1420 to 520 Ma, suggesting the sills carry a primary remanence. The Avanavero pole helps in constraining the paleogeography of the central pieces of Columbia. It is compatible with the Baltica and Amazonian Cratons SAMBA link in the Columbia Supercontinent at about 1780 Ma, but other configurations are also possible. When compared to other Paleo- to Mesoproterozoic paleomagnetic poles from the southern Amazonian Craton (Central Brazil Shield), our new paleomagnetic pole suggests intracratonic motions within the southern area of the Craton, probably after 1420 Ma ago. We tentatively suggest that these movements are related to the collision of the Paraguá Block with the proto-Amazonian Craton at about 1350–1320 Ma ago.

1. Introduction

The paleogeography of Proterozoic supercontinents is still controversial because of the difficulties and uncertainties that arise when someone compares the geological and geophysical record of continental fragments that once have come together to form them (Pesonen et al., 2003). Nevertheless, it is believed that at least twice in the Proterozoic continents assembled to form supercontinents (Hossain et al., 2007): at ca. 1850 Ma ago with the Columbia Supercontinent (e.g., Rogers, 1996; Rogers and Santosh, 2002; Zhao et al., 2004, 2006, 2008; Meert, 2012; Kusky et al., 2007; Johansson, 2009; Yakubchuk, 2010), and at ca. 1100–1000 Ma with the Rodinia supercontinent (e.g., Hoffman, 1991; Dalziel, 1997; Weil et al., 1998; D'Agrella-Filho et al., 1998; Pesonen et al., 2003; Li et al., 2008; Evans, 2009).

The exact configuration of Columbia is still unknown and a great deal of geological, geochronological and paleomagnetic data is required in order to provide a means of establishing the links between the different continental fragments in the Paleo- and Mesoproterozoic. From the paleomagnetic point of view, only precisely dated Paleoproterozoic geological units of these continental fragments have the potential to provide reliable information to constrain the Columbia paleogeography (Buchan et al., 2000; Pesonen et al., 2003). Gradually, these data are being acquired in several continents and we can now propose some crude quantitative tests on the different Columbia configurations using the paleomagnetic database (e.g., Meert, 2002, 2012; Pesonen et al., 2003, 2012; Salminen and Pesonen, 2007; Bispo-Santos et al., 2008, 2012; Johansson, 2009; Cordani et al., 2009; Lubnina et al., 2010; Piper et al., 2011; Evans and Mitchell, 2011; Zhang et al., 2012; D'Agrella-Filho et al., 2012; Mertanen and Pesonen, 2012).

Baltica and Laurentia are the central pieces of Columbia. There are basically two models for the Laurentia-Baltica connection in this supercontinent: the first one juxtaposes western Baltica to the southeastern Greenland in Laurentia (Zhao et al., 2004; Hou

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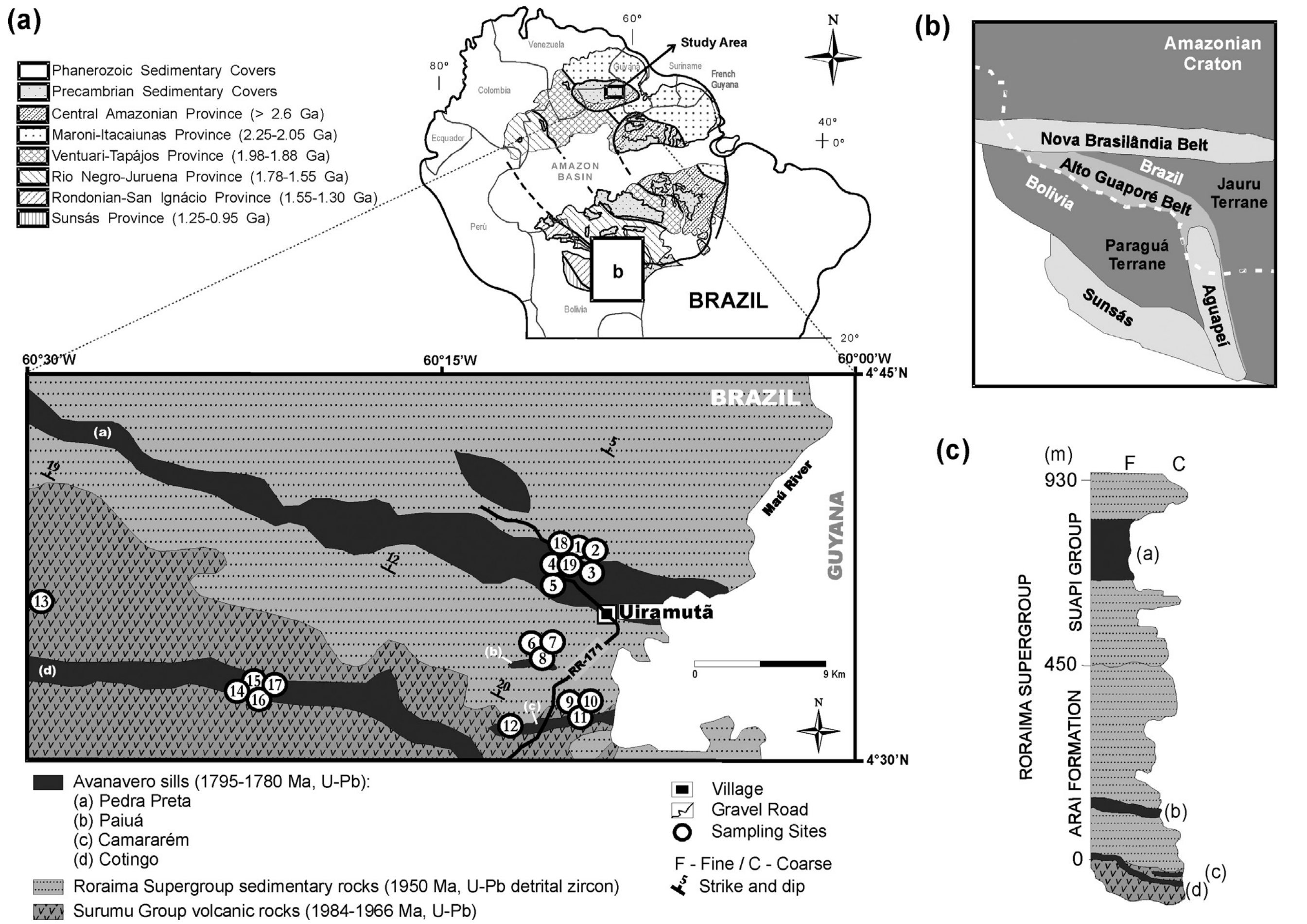

Fig. 1. (a) Geological sketch of the studied area with location of sampling sites (circled numbers) (adapted from Reis et al., 2004), inset: Amazonian Craton and their geochronological Provinces (after Tassinari et al., 2000); (b) general geometry of SW Amazonian Craton showing the ca. 1.47–1.35 Ga Alto Guaporé belt (Rizzotto and Hartmann, 2012), and the ca. 1.2–1.0 Ga Sunsás, Aguapeí and Nova Brasilândia belts (adapted from D'Agrella-Filho et al., 2012); (c) schematic stratigraphic section of Roraima Supergroup in the studied area (after Reis and Yánez, 2001).

et al., 2008; Johansson, 2009; Halls et al., 2011), the second one juxtaposes northern Baltica to eastern Greenland (Karlstrom et al., 2001; Buchan et al., 2000; Pesonen et al., 2003; Zhao et al., 2006; Salminen and Pesonen, 2007; Lubnina et al., 2010; Pisarevsky and Bylund, 2010; Evans and Mitchell, 2011; D'Agrella-Filho et al., 2012; Bispo-Santos et al., 2008, 2012). Paleomagnetic evidence favors the last link (Buchan et al., 2000; Salminen and Pesonen, 2007; Lubnina et al., 2010; Pisarevsky and Bylund, 2010). Also at the heart of Columbia, a link between northern South America (SAM) (Amazonian Craton) and southwestern Baltica (BA), dubbed SAMBA, was proposed on the basis of Archaean to Paleo-Mesoproterozoic geological evidence (e.g., Johansson, 2009). However, until recently the available Paleo- to Mesoproterozoic paleomagnetic data implied a gap between these two blocks (Pesonen et al., 2003; Bispo-Santos et al., 2008; D'Agrella-Filho et al., 2012). Based on 1790–1770 Ma paleomagnetic data from Baltica (Ropruchey sills and Shoksha Formation), Amazonian Craton (Colíder Group) and North China (Tahiang dykes), Bispo-Santos et al. (2008) suggested that North China could fill the gap between Baltica and the Amazonian Craton. Recent paleomagnetic data from 1420 Ma mafic dykes from Nova Guarita swarm and gabbros from the Indiavaí Intrusive (southern Amazonian Craton) seemed to corroborate this interpretation (D'Agrella-Filho et al., 2012). Here we present a paleomagnetic study of well-dated 1789 Ma mafic sills from the Avanavero magmatic event located at the northern Roraima State (Central Amazonian Province of the Amazonian Craton) and its implications for the paleogeography of Columbia.

2. Geological setting

The Amazonian Craton (Fig. 1a) is one of the largest stable cratonic areas in the world (430,000 km^2). It is exposed in two large areas separated by the Phanerozoic Amazonian sedimentary basin comprising the northern Guiana Shield and the southern Central-Brazil or Guaporé Shield (Lacerda-Filho et al., 2004; Schobbenhaus et al., 1984; Santos et al., 2000). Its northeastern part consists of two Archean nuclei (>2600 Ma – Central Amazonian Province in Fig. 1a) encircled by a predominantly accretionary Paleoproterozoic belt (2250–2050 Ma) which form the Maroni-Itacaiúnas Province (Tassinari and Macambira, 1999; Tassinari et al., 2000). The southwestern part of this Archean nucleus was accreted by subduction-related juvenile magmatic arcs forming the 1980–1810 Ma Ventuari-Tapajós, and the 1780–1600 Ma Rio Negro-Juruena Provinces (Tassinari et al., 2000; Pinho et al., 2003; Schobbenhaus and Brito-Neves, 2003; Cordani and Teixeira, 2007). In the Mesoproterozoic, subduction-related magmatic arcs of the 1600–1300 Ma Jauru Terrane in the Central-Brazil Shield (Rondonian-San Ignacio Province) developed until the final collision of the Paraguá Terrane at ca. 1320 Ma (Bettencourt et al., 2010). This collisional model was recently extended to the northwest with the recognition of the Trincheira ophiolite by Rizzotto and Hartmann (2012). These authors interpret these rocks as a record of oceanic crust relics associated with the collision of the Paraguá Block with the proto-Amazonian Craton along the Alto Guaporé Belt at the Middle Mesoproterozoic (Fig. 1b). In this geotectonic