

Avanavero mafic magmatism, a late Paleoproterozoic LIP in the Guiana Shield, Amazonian Craton: U–Pb ID-TIMS baddeleyite, geochemical and paleomagnetic evidence

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ABSTRACT

The Avanavero Large Igneous Province (LIP) constitutes the most important Paleoproterozoic mafic magmatism event in the Guiana Shield, northern Amazonian Craton. It comprises voluminous dykes and sills, the latter intruded into regional sedimentary cover successions such as the Roraima Supergroup and Urupi Formation. Roughly contemporary mafic magmatism such as the Crepori Dolerite occurs in the southern part of the Amazonian Craton (Central Brazil Shield). This study reports new geochemical data for samples from the Avanavero Dolerite and the coeval Quarenta Ilhas Dolerite, as well as reassessing published information on roughly contemporaneous mafic dykes in the shield to address issues related with the tectonic significance of such an intraplate igneous event and paleogeographic reconstructions. The Avanavero magmatism is tholeiitic and is geochemically similar to E-MORB and subcontinental lithospheric mantle basalts. New U–Pb baddeleyite ages of 1795 ± 2 Ma and 1793 ± 1 Ma, respectively, from occurrences in both the Pakaraima and Urupi Blocks at the north and south portions of the Guiana Shield confirm that they belong to the Avanavero LIP. These two ages are within error of a U–Pb age of 1794 ± 4 Ma for an Avanavero dyke in Guyana. Slightly younger published U–Pb ages range from about 1780–1787 Ma, including the Crepori Dolerite in Central Brazil Shield (southern Amazonian Craton). This may indicate that two pulses of magmatism could be associated with the Avanavero event. The paleomagnetic data favour a Laurentia/Baltica/Amazonia link at 1.79 Ga, and this large landmass may have constituted the core of the Columbia supercontinent during Late Proterozoic times.

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1. Introduction

This paper summarises several decades of investigation of Avanavero intraplate magmatism in the northern Guiana Shield, mainly in Brazil (Pinheiro et al., 1990; Santos et al., 2003a). Our main purpose here is to review the available information on the geology of the Avanavero dykes and sills, supported by new precise ID-TIMS (Isotope Dilution-Thermal Ionisation Mass Spectrometry) U–Pb baddeleyite analyses on two key samples and geochemical data on additional related samples. These data provide new insights on the origin and tectonics of such intraplate igneous activity affecting large parts of the northern Amazonian

Craton during late Paleoproterozoic times. Also, new paleomagnetic data from the Avanavero sills and dykes from northern Roraima State are used to test the paleogeography of the Amazonian Craton in the hypothesised Columbia supercontinent.

2. Review of the geology of the Amazonian Craton

The Amazonian Craton, one of the largest of South America, is bounded to the east by a Neoproterozoic province (Tocantins) while the western portion is obscured by the foreland basin strata of the Andean Chain (Cordani et al., 2009) – Fig. 1a. Phanerozoic sedimentary rocks of the Amazonas basin crop out over the central part the Craton leading to characterization of two Precambrian shields: namely the Guiana and Central Brazil shields, located at the northern and southern cratonic portions, respectively.

Two geotectonic models have been proposed for the Amazonian Craton dealing with its Archean and Proterozoic evolution, allowing characterization of six to seven geochronological provinces (Cordani

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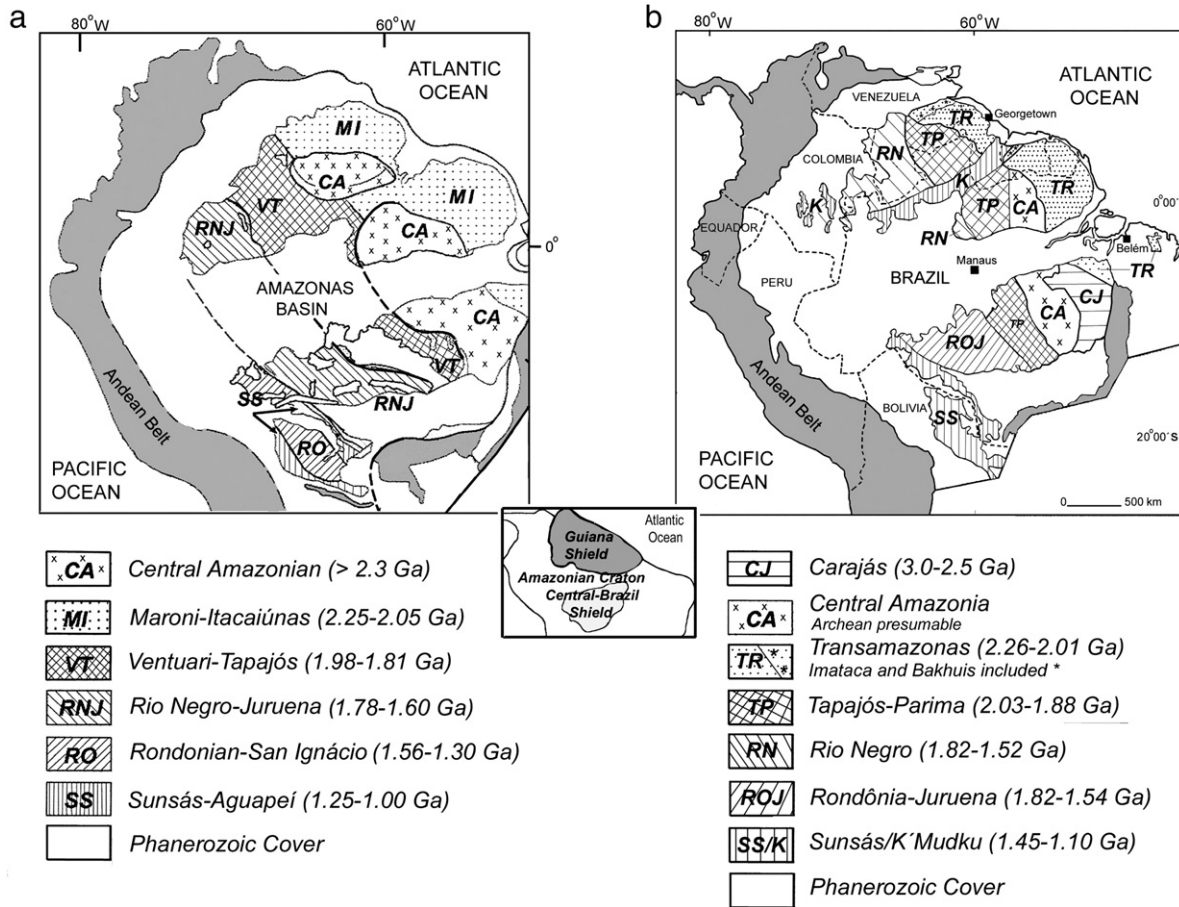


Fig. 1. Geochronological provinces of northern South America, adapted from (a) Cordani et al. (2010) and (b) Santos et al. (2006).

and Teixeira, 2007; Santos, 2003; Santos et al., 2006; Tassinari and Macambira, 1999, 2004). According to Cordani and Teixeira (2007) four provinces are prominent in the Guiana Shield (through their extension in Central Brazil Shield), namely: Central Amazonian, Maroni-Itacaiúnas, Ventuari-Tapajós, and Rio Negro-Juruena, whereas Santos et al. (2006) distinguish the following alternative framework, namely: Central Amazonia, Transamazonas, Tapajós-Parima, Rio Negro and K'Mudku provinces (Fig. 1b).

Both of the geotectonic models show differences in Precambrian geodynamic evolution in terms of the geometry, ages, and terminology of the provinces – particularly for the Guiana Shield (see Fig. 1). Nevertheless, all workers argue in favour of a prominent regime of Paleoproterozoic magmatic arcs accreting to an Archean core through time and space, although the bulk nature of some of the provinces are still debatable, as summarised below:

1) Tassinari and Macambira (1999, 2004) and Cordani and Teixeira (2007) consider the Central Amazonian province as a supposed Archean nucleus formed by a gneissic-granitoid terrain and greenstone belts where the Paleoproterozoic cratonic cover of the Roraima Supergroup occurs (namely Roraima block). This province occupies extensive areas in the southeast of Roraima, northeast of Amazonas and northwest of Pará states, extending to the south in the Central Brazil shield. According to Santos et al. (2006), however, the Central Amazonian province (Guiana shield portion) in which the age of the crust was inferred to be older than 2.5 Ga (Tassinari and Macambira, 1999) does not yield either Archean nor Transamazonian ages on the country rocks, although the published Sm-Nd T_{DM} -model ages are between 2.5 and 2.3 Ga. As such, this domain assigned to the

northern portion of the Central Amazonian province, would represent the Tapajós-Parima province (2.03–1.88 Ga) of Santos et al. (2006).

2) The extensive portion in the Guiana shield with country rocks with ages in the 2.26–2.01 Ga interval were assigned by Santos et al. (2006) to the Transamazonas province, and includes both the Imataca (Venezuela) and Bakhuis Mountain (Suriname) high grade terrains. This model shows broad similarities to the Maroni-Itacaiúnas province (Cordani and Teixeira, 2007; Tassinari and Macambira, 2004). Following these authors the Maroni-Itacaiúnas province stretches over 1500 km in the Guiana shield, and includes the Bakhuis Mountains. It is bounded to the west by the Imataca allochthonous block, comprising a high grade metamorphic complex (with a ≥ 3.2 Ga continental protolith) which underwent considerable isotopic disturbance plus juvenile accretion at ca. 2.8 Ga. According to Tassinari et al. (2004) the Imataca block was further intruded by Paleoproterozoic plutons during its tectonic juxtaposition to the Maroni-Itacaiúnas province along the Guri fault. From a tectonic perspective, much of the Maroni-Itacaiúnas province is composed of low grade granite-greenstone associations, making up subparallel belts in the northern and eastern parts of the shield. Significantly older rocks have also been described within the province such as the Meso-Neoproterozoic Amapá block (eastern portion), which was partly reworked during the 2.25–2.05 Ga Transamazonian Orogen (Avelar et al., 2003; Rosa-Costa et al., 2003, 2008). The Maroni-Itacaiúnas province is contemporary with the Birimian System in West Africa (Eburnean Orogen), thereby making up a large cratonic mass resulting from amalgamation of independent fragments of the proto-Amazonian and West African cratons, as

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