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Geochronology and geochemistry of the Parashi granitoid, NE Colombia: Tectonic implication of short-lived Early Eocene plutonism along the SE Caribbean margin

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ABSTRACT

The Parashi granitoid of northeasternmost Colombia intrudes the Upper Cretaceous to Lower Paleocene accretionary complex formed by the collision of the Caribbean arc and the continental margin of South America. This granitoid presently separated of the continental margin includes a major quartzdiorite body with andesite to dacite dikes and mafic enclaves. Zircon U–Pb LA-MC-ICP-MS and K–Ar geochronology on the quartzdiorite and the dikes suggest that crystallization extended from ca. 47 to 51 Ma. Major and trace elements are characterized by a medium-K, immature continental arc signature and high Al_2O_3, Na_2O and Ba–Sr contents. Initial $^{87}Sr/^{86}Sr$ isotopic values range between 0.7050 and 0.7054, with $^{143}Nd/^{144}Nd = 0.51235–0.51253$, εNd and εHf values from −0.81 to −4.40 and −4.4 and −5.2. Major and trace element ratios and isotopic modeling suggest that sedimentary and/or quartz-ofeldspathic crustal sources were mixed with a mafic melt input. The petrotectonic and geological constraints derived from this granitoid suggest that Parashi plutonism records an immature, oblique subduction-zone setting in which the presence of a high-temperature mantle realm and strong plate coupling associated to upper crust subduction caused the partial fusion of a previously tectonically underplated mafic crust and associated metasediments exposed in the continental margin. The limited temporal expression of this magmatism and the transition to a regional magmatic hiatus are related to a subsequent change to strongly and slow oblique tectonics in the Caribbean–South America plate interactions and the underflow of a relatively thick slab of Caribbean oceanic crust.

1. Introduction

Plate tectonic reconstructions have suggested that after the Late Cretaceous to Paleocene collision of the Caribbean arc and oceanic plateau with northwestern South America (Pindell, 1993; Kerr et al., 1997; Spikings et al., 2001; Pindell et al., 2005; Luzieux et al., 2006; Vallejo et al., 2006; Weber et al., 2009, 2010a; Cardona et al., 2010; 2011a; van der Lelij et al., 2010; Villagómez et al., 2011), plate convergence in northwestern South America shifted to an oblique and transcurrent system (Pindell et al., 1998; Müeller et al., 1999; Montes et al., 2005; Pindell and Keenan, 2009), and the convergence between North and South America (Pindell et al., 1998, 2005; Müeller et al., 1999) forced the Caribbean plate to be subducted under the South American continent.

Despite the major effects that such tectonic changes must leave within the upper continental plate, the geological record associated to this transition is not fully constrained (Montes et al., 2010; Bayona et al., 2011, 2012; Cardona et al., 2011a,b; Villagómez et al., 2011).

It's well known that the spatio-temporal and compositional features of magmatic rocks, when integrated with other geological information are sensible recorders of past tectonic setting and provide a robust limit to the timing of successive tectonic events (Pearce et al., 1984, 1996; Barbarin, 1999).

We present field and petrographic relationships together with U–Pb LA-MC-ICP-MS zircon and K–Ar geochronology, whole-rock

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geochemistry, Sr-Nd-Hf isotopes, from the Parashi Stock in the northeasternmost Caribbean region of Colombia (Fig. 1a, b). The temporal and petrotectonic character of this plutonism isolated from the Andean mountain as a consequence of subquent dispersion tectonics, record the early evolution of a new subduction system formed on the northwestern continental margin of South America due to oblique convergence of the Caribbean oceanic plate. The relatively short duration of the Eocene magmatism is also a major consequences of the changing nature of the convergence relation in the continental margin, that shift towards a more oblique subduction that limit magma generation in the arc system, and is responsible for block translation and deformation along the margin (Montes et al., 2005, 2010; Bayona et al., 2012).

2. Geological setting

In northern Colombia the continuous physiography of the Andean chain changes to a series of discontinuous uplifted massifs surrounded by thick Cenozoic basins that extend into the Caribbean Sea (Fig. 1a). Ranges or Serranías, in the northernmost Guajira Peninsula consist of isolated massifs surrounded by broader plains (MacDonald, 1964; Lockwood, 1965; Alvarez, 1967).

Palinspastic restoration suggests that these Serranías remained attached to the northernmost extension of the pre-Andes uplift that included the southwestern Santa Marta Massif and the Central Cordillera of the Andes at least until the Palaeogene when the front of the Caribbean plate collided with the continental margin (Alvarez, 1967; Montes et al., 2005, 2010; Pindell et al., 2005). The post-Eocene dextral strike-slip dominated movement of the Caribbean plate and the northern displacement of the northern Andean block caused the formation of several pull-apart basins in the northern South America plate, and caused the displacement and isolation of different crustal domains in northern Colombia (Pindell, 1993; Macellari, 1995; Trenkamp et al., 2002; Montes et al., 2010; Cardona et al., 2011a,b).

Geologically, the Guajira Serranías are composed of three lithostratigraphic belts that can be correlated with the adjacent Santa Marta region and the Colombian Andean Cordilleras (Alvarez, 1967, Fig. 1b). From southeast to northwest they include: (1) A weakly deformed Mesozoic volcano-sedimentary units correlatable with coeval units exposed in the southeastern Santa Marta massif foothills and the Perija range (MacDonald, 1964; Villamil, 1999). (2) A composite Grenvillian and Late Palaeozoic to Triassic metamorphic domain (Alvarez, 1967; Cordani et al., 2005; Cardona-Molina et al., 2006; Weber et al., 2010) which is intruded by Upper Jurassic plutons similar to the parautochthonous basement of the Andes (Aspden et al., 1987; Cardona-Molina et al., 2006). (3) Upper Cretaceous greenschist facies metamorphosed volcano-sedimentary units with intercalated mafic-ultramafic plutonic rocks (Alvarez, 1967; Weber et al., 2007, 2010), together with supra-subduction-zone mafic and ultramafic rocks that crop out as an isolated remnant in the coastal region, and represent a remnant of the colliding Caribbean intra-oceanic arc (Alvarez, 1967; Weber et al., 2009). This belt represents a collage of mixed intra-oceanic arc and passive margin sediments, metamorphosed due to the collision of the Caribbean plate with the South American continent after ca. 76 Ma and before the intrusion of the Eocene igneous rocks (Weber et al., 2009, 2010).

A quartzdiorite stock (Parashi Stock) and a series of andesite to dacite dikes, which are the object of this contribution, intrude the Upper Cretaceous to Palaeocene collision-related greenschist facies rocks of the northern Guajira region (Lockwood, 1965; Weber et al., 2010). Previous K–Ar hornblende ages presented by Lockwood (1965) indicate that this magmatism is Early Eocene in age. However due to the nature of this geochronological method, which may record cooling after magmatic crystallization or may not allow to discriminate between Ar in excess or the presence of scarce radiogenic Ar – therefore this granitoid deserve a more appropriate geochronological constraints such as the new U–Pb age single crystal ages which are presented here.

Continental plutonic rocks of similar age have also been found in the adjacent Santa Marta Massif and the Central Cordillera of Colombia and record a margin scale convergent margin for the Eocene (Tschanz et al., 1974; Aspden et al., 1987; Cardona et al., 2011a; Bayona et al., 2012).

2.1. Geology and petrography of the Parashi Stock

The Parashi Stock (Lockwood, 1965) is exposed in the Jarara Serranía of the Guajira Peninsula (Fig. 2). The plutonic body covers an

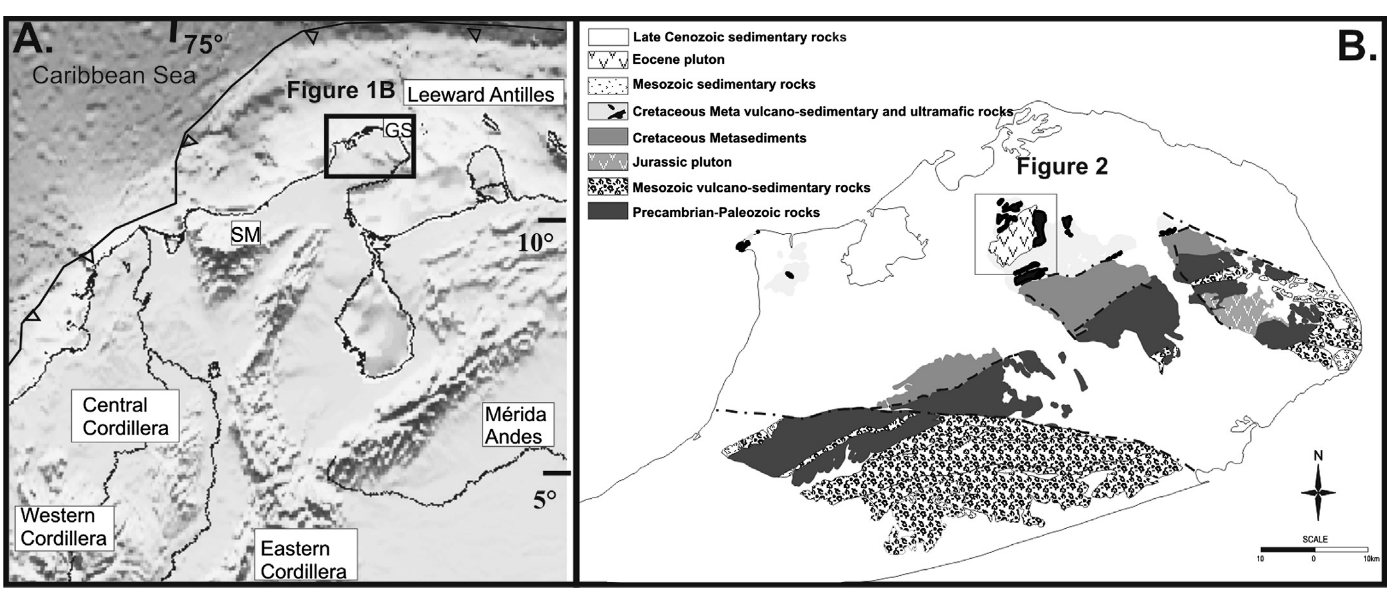

Fig. 1. A. Digital elevation model of northern Colombia, Caribbean region. SM = Santa Marta Massif, GS = Guajira Serranías. B. Geological map of the Guajira Peninsula, northern Colombia, including the Parashi granitoid (modified from Lockwood (1965) and Gómez et al. (2007)).