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Magnetic fabric (AMS, AAR) of the Santa Marta batholith (northern Colombia) and the shear deformation along the Caribbean Plate margin

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ABSTRACT

Anisotropy of low-field magnetic susceptibility (AMS) and anhysteretic remanence (AAR) were measured in the Santa Marta Batholith formed by subduction of the Caribbean Plate beneath the northern South America. The batholith, elongated in the N-S direction, records multiple pulses of quartzdiorite to tonalite and granodiorite magmas between 58 and 49 Ma. The high mean magnetic susceptibility (4×10^{-3} SI) combined with thermomagnetic and partial magnetic remanence measurements indicate that the magnetic susceptibility depends on Ti-poor magnetite. AMS is defined by ellipsoids that are dominantly oblate. The foliation was used to distinguish a narrow band of E-trending magnetic structures that separate the batholith in two lobes. The southern lobe is characterized by foliations that are broadly parallel to the contact with the wall rocks, while the northern lobe by foliations oblique to the batholith elongation. Late tonalitic magmas dated at c. 50 Ma record, in turn, a fabric apparently controlled by E-trending tectonic events. Partial AAR indicates that the subfabrics of magnetite with different grain sizes are nearly parallel to AMS, therefore discarding the possibility of superposed fabrics with different orientations. The magnetic fabric pattern is consistent with a magma emplaced in an arc setting deformed by a dextral shear. Synthetic extensional shear bands localize the magmatic deformation along East-trending corridors that probably were exploited to emplace the late magmatic pulses. Accretion of the Eocene batholith and the Late Cretaceous metasedimentary host-rocks to the South American continent defines a major strike-slip shear suture that resulted from the oblique convergence of the Caribbean Plate.

1. Introduction

Anisotropy of magnetic susceptibility (AMS) in granitic rocks is a reliable recorder of the kinematics of regions in which plutons are emplaced (Archanjo et al., 1994; Neves et al., 1996; Wilson and Groccott, 1999; Moyen et al., 2003; Stevenson et al., 2007; Wei et al., 2014; among many others), being used for plate tectonic analysis of orogenic belts (Benn et al., 2001). AMS studies of granite plutons from magmatic arc settings, such as in Chilean Central Andes or in western North America Cordillera, have shown that magnetic fabrics are either strongly coupled with the arc deformation (Tikoff and Saint-Blanquat, 1997; Wilson, 1998; Fawcett et al., 2003; Titus et al., 2005) or record structures formed by body (ascent, convection) forces and tectonic-related fabrics (Saint-Blanquat et al., 2001; Parada et al., 2005). Magnetic fabrics orientations controlled by the deformation in magmatic arcs have been documented in Jurassic to Middle Cretaceous plutons emplaced in the Central Andean Belt (Wilson, 1998) when the arc was submitted to extension (Ramos, 2009). According to Grocott and Taylor (2002), the granitic complexes were accommodated in the crust by a mechanism of floor-depression and/or roof uplift that allowed a vertical transfer of magma without important horizontal displacement of the wall rocks. In contrast AMS of the Mid-Cretaceous Las Tazas batholith evidence finite strains when the arc was deforming by transtension (Wilson and Groccot, 1999). AMS, therefore, was interpreted as recording a tectonic overprint in the final stages of the magmatic crystallization due to the lateral movement of the Atacama Fault (Grocott and Taylor, 2002).

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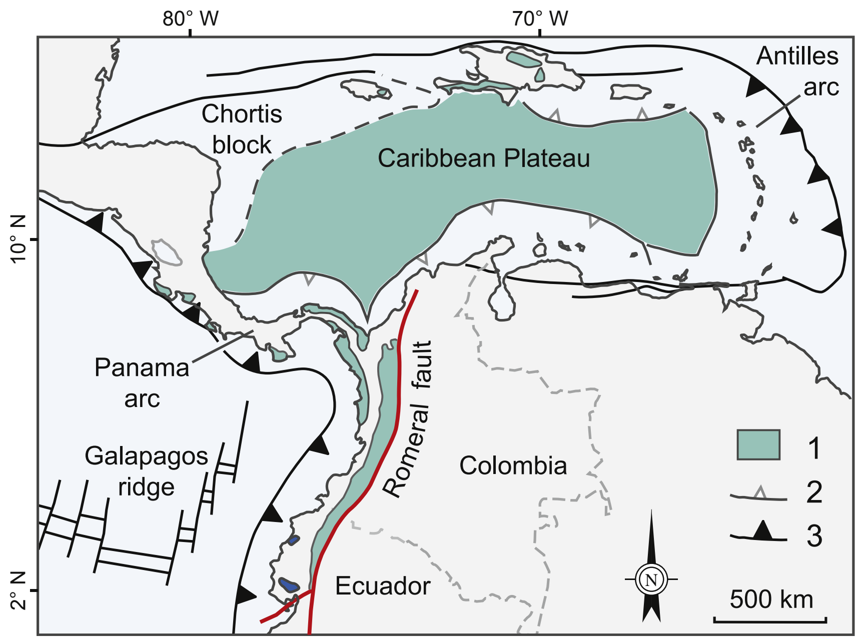

Fig. 1. Caribbean oceanic plateau bounded by the subduction zones of Antilles and Panamá, and strike-slip (transform) faults. Accreted oceanic terranes related to the oblique subduction of the Caribbean plate beneath South America are shown to the Ecuador, Colombia and Panama to the west of the Romeral fault system. 1. Cretaceous oceanic rocks; 2, thrust; 3, subduction zone (modified from Kerr, 2014).

Between Late Cretaceous and Eocene the Central and Northern Andes were submitted to contraction (Ramos, 2009). While in the Central Andes the contraction would be linked to the shallowing of the subduction zone, convergence between the oceanic Caribbean Plate and the Northern South America Plate would account for the accretion of terranes and magmatic activity along the margin of Ecuador and Colombia (Pindell and Kennan, 2009; Cardona et al., 2011a; Boschman et al., 2014). Likewise, the northward migration of the triple junction between the Farallon and Caribbean plates relative to the South American Plate would indicate that the collage of terranes was accompanied by large dextral shearing (Kennan and Pindell, 2009). The Caribbean Plate is, in present day, bordered by the magmatic arcs of the Panama and Antilles (Fig. 1). A considerable proportion of the plate consists of a thick (up to 20 km) oceanic crust referred to as Caribbean-Colombian Oceanic Plateau (Kerr, 2014). The plateau would have been formed over the Galapagos hot-spot and gradually moved to its present position over the past 90 Ma (Duncan and Hargraves, 1984; Kerr and Tarney, 2005; Pindell and Kennan, 2009). Subduction of the Caribbean Plate between 60 and 40 Ma resulted in the emplacement of calc-alkaline tonalites, granodiorites and quartz diorites in the Central Cordillera, Sierra Nevada de Santa Marta and Guajira Peninsula in Colombia (Fig. 2) (Bayona et al., 2012; Cardona et al., 2014). The relatively short period (<15 Ma), wide areal distribution of the igneous bodies and the abrupt interruption of the magmatism in Middle Eocene are attributed to the difficulty of the thick oceanic crust to subduct (Bayona et al., 2012).

Our study is focused on the Santa Marta batholith, one of the largest Eocene pluton of Colombia that intruded subduction complexes of the leading-edge of the Caribbean plate accreted to the northern margin of the South America (Cardona et al., 2011a; Escalona and Mann, 2011). We use anisotropy of magnetic susceptibility to define the batholith magmatic fabric and anisotropy of anhysteretic remanence to investigate the possible contribution of superposed fabrics (Trindade et al., 1999; Usui et al., 2006) in an actively deforming arc setting. This study also documents the tectonic record in the pluton emplacement fabrics when the

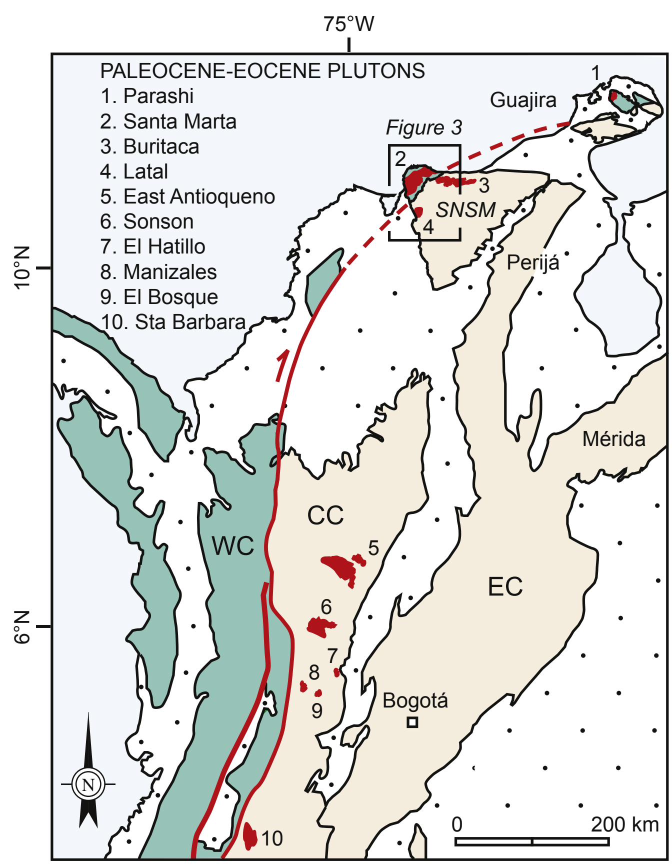

Fig. 2. Simplified physiographic map of the northern Andes showing the Cretaceous oceanic rocks of the West Cordillera (WC) in contact with the Central Cordillera (CC) along the Romeral fault system. The Eastern Cordillera (EC) is separated from the Sierra Nevada de Santa Marta (SNSM) block and Central Cordillera by sedimentary deposits of the César-Rancheria and Magdalena basins. Plutonic rocks corresponding to the Paleocene-Eocene magmatic arc are shown in red (modified from Bayona et al., 2012). (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)