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Geochemistry and geochronology from Cretaceous magmatic and sedimentary rocks at 6°35′ N, western flank of the Central cordillera (Colombian Andes): Magmatic record of arc growth and collision

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ABSTRACT

The spatio-temporal, compositional and deformational record of magmatic arcs are sensible markers of the long-term evolution of convergent margins including collisional events. In this contribution, field relations, U-Pb LA-ICP-MS zircon geochronology from magmatic and sedimentary rocks, and whole-rock geochemistry from volcanic and plutonic rocks are used to reconstruct the Cretaceous arc growth and collision in the awakening of the Northern Andean orogeny in northwestern Colombia. The Quebrada-grande Complex that includes a sequence of volcanic rocks intercalated with quartz-rich sediments is a tholeiitic arc characterized by an enrichment in LREE and Nb-Ti anomalies that document crustal thickening in an arc system that was already active by ca. 93 Ma. This arc was built associated with thin continental and newly formed oceanic crust, as suggested by the presence of Triassic and older detrital zircons in the associated sandstones. This fringing arc subsequently experienced deformation and a major switch to and enriched calc-alkaline high-k plutonism between 70 and 73 Ma. The deformation record and changes in composition are related to an opposite double-vergence Molucca-sea type arc-arc collision that ended with the accretion to the continental margin of an allochthonous island arc built on an oceanic plateau associated with the Caribbean plate.

The new time-framework suggest that the Late Cretaceous to Paleocene collisional tectonics include various stages before the switching to a subduction-dominated regime in most of the Cenozoic.

1. Introduction

The spatiotemporal and compositional character of magmatic rocks can be used to discriminate major tectonic settings (i.e. magmatic arcs, rift, MORB settings), or may also become a major tracer of the modifications experienced by the continuous evolution of a convergent margin, including changes in the subduction angle, crustal thickening or thinning, or the arrival of a colliding element (Kay and Mpodozis, 2001; Whalen et al., 2006; Bouilhol et al., 2014; Zhu et al., 2015).

Collisional tectonics involve the approach between colliding blocks and the subsequent response and re-arrangement of the crust and the lithosphere to the collisional events (Brown et al., 2011). During these stages, magmatic activity experienced major compositional changes, as sediment and/or crustal subduction and thickness increase, or the mantle flow is modified associated to delamination or slab break-off, that can melt different reservoirs (Von Blanckenburg and Davies, 1995; Elburg and Foden, 1999; Cloos et al., 2005; Bouilhol et al., 2014; Kerr et al., 2015).

To appropriately relate compositional changes in the magmatic activity of convergent margins that experienced collisional events, temporal constraints, composition, and deformational relations must be integrated in order to recognized the different pre, syn and post-collisional stages (Cloos et al., 2005; Whalen et al., 2006; Bouilhol et al., 2014).

The Late Cretaceous tectonic evolution of the Northern Andes in the Central and Western Cordilleras of Colombia is recorded in various Cretaceous continental and oceanic arcs that were juxtaposed between the Late Cretaceous and the Early Paleogene (Fig. 1; Pindell et al., 2005; Vallejo et al., 2006; Pindell and Kennan, 2009;

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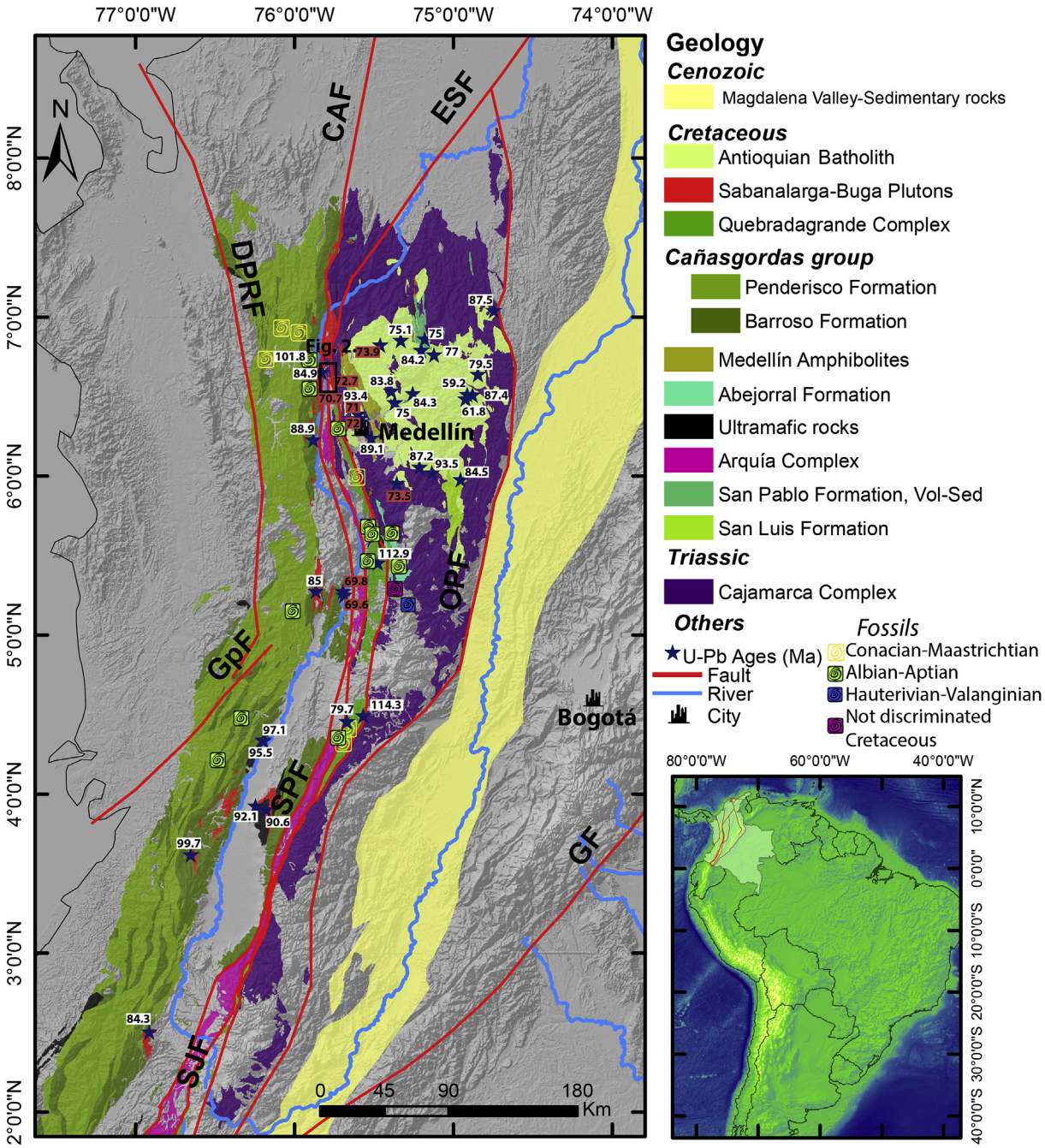

Fig. 1. Geology of the Central and Western Cordillera of the Colombian Andes including published U-Pb zircon ages from magmatic rocks (Cochrane, 2013; Gómez et al., 2015; Maya and González, 1995; Restrepo et al., 2011; Spikings et al., 2015; Villagómez et al., 2011). The study area and the new geochronological results (red squares) are also highlighted. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

Cardona et al., 2011; Villagómez et al., 2011; Cochrane et al., 2014a; Spikings et al., 2015).

The existence of a Late Cretaceous to Paleocene oblique oceanic-continent collisional event in the Colombian Andes have been inferred from the presence of magmatic rocks with oceanic plateau and arc affinity in the Western Cordillera (Toussaint, 1996; Kerr et al., 1997; Villagómez et al., 2011; Weber et al., 2015; Zapata et al., 2017).

This event caused a major environmental and basin filling change in the eastern Middle and Upper Magdalena Valley basins, in which thermally controlled shallow to deep marine platform changes to unstable and transitional continental environments (Pindell et al., 1998; Villamil, 1999; Moreno-Sanchez and Pardo-Trujillo, 2003; Gómez et al., 2005; Bayona et al., 2008; Reyes-Harker et al., 2015).

Fast cooling events in the Cretaceous and older rocks exposed in the Central and Western Cordilleras are related to tectonically controlled exhumation (Villagómez and Spikings, 2013; Spikings et al., 2015), whereas the Late Cretaceous mylonitic units (Vinasco et al., 2013) and the apparent existence of magmatic gaps in the Late Cretaceous continental arc from the Central Cordillera are also major expressions of the Collisional event (Villagómez et al., 2011;