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Upper Cretaceous to Miocene tectonostratigraphy of the Azuero area (Panama) and the discontinuous accretion and subduction erosion along the Middle American margin

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ABSTRACT

The Central American forearc allows insight into the long-term evolution of the Middle American margin and possible shifts between accretionary and erosive periods of subduction. We present a revised tectonostratigraphic subdivision of the Azuero area based on new field observations and biochronologic data, and a synthesis of previous age, geochemical and stratigraphic data. The basement of the area is composed of an autochtonous oceanic plateau, the early Central American arc and accreted seamounts, which are unconformably overlain by forearc sediments. The nature and spatial arrangement of basement units combined with patterns of uplift and subsidence recorded in overlapping sediments allow reconstruction of the local evolution of subduction tectonics between the Upper Cretaceous and Miocene. Comparison of this evolution with that formerly proposed for the south Costa Rican margin based on a similar approach (Buchs et al., 2009, 2010) provides an insight into temporal and along-strike changes of subduction tectonics along a ~500 km-long segment of the Middle American margin. We find that subduction erosion (or non-accretion), punctuated by seamount accretion, was the dominant process along the margin between the late Campanian and Middle Eocene. In the Middle Eocene, uplift of the Central American forearc, initiation of a volcanic front retreat in Panama and a pulse of seamount accretion between south Costa Rica and west Panama are likely to relate to a reorganization of plate tectonics in the Pacific. A contrasted evolution occurred in south Costa Rica and Panama afterwards, with continued subduction erosion in the Azuero area and net accretion of olistostromal and hemipelagic sediments in south Costa Rica at least until the Middle Miocene. Our results show that tectononstratigraphic observations in the forearc may represent a valuable complement to offshore drilling and geophysical studies to understand modern subduction tectonics along the Middle American margin.

1. Introduction

The Middle American margin is one of the most studied around the world and regarded as an archetypical example of a margin undergoing subduction erosion (e.g. Ranero et al., 2007). Subduction erosion is a process by which material is removed from the upper plate in a subduction zone due to: (1) subduction of topographic highs such as seamounts and ridges, which trigger temporary dismemberment of the outer forearc wedge by mass-wasting and cause "tunneling" of the overriding plate; or (2), dehydration of the subducting slab that can enhance hydraulic fracturation and disaggregation of the hanging wall above the subduction channel (von Huene et al., 2004). Subduction erosion is recognized as a widespread mechanism along convergent margins (von Huene and Scholl, 1991). ~57% of modern convergent margins are considered as erosive, with a long-term (>10 Ma) history of erosion (Clift and Vannucchi, 2004). Erosive plate margins are commonly distinguished from accretionary ones by the occurrence of geophysically-identifiable features such as a steep trench slope, normal faulting associated to subsidence in the forearc area and an absence of large volumes of accreted sediments close to the trench (Ranero and von Huene, 2000; von Huene et al., 2004). These are common features along the Middle American margin and support its present-days erosive nature (Ranero and von Huene, 2000; Ranero et al., 2007; Vannucchi et al., 2001; von Huene et al., 1995).

In contrast, oceanic complexes exposed in the south Central American forearc suggest the existence of several events or periods of accretion between the Upper Cretaceous and Miocene (see Denyer et al., 2006, and Denyer and Gazel, 2009 for a general review). Complexes that clearly point toward accretion include: (1) the Osa Mélange that is composed of Late Eocene to Miocene accreted olistostromal deposits and hemipelagic sediments (Buchs and Baumgartner, 2007; Buchs et al., 2009; Di Marco, 1994; Vannucchi et al., 2006, 2007); (2) the Quepos Block that includes Upper Cretaceous–Paleocene accreted ocean island basalts (OIB) (Baumgartner et al., 1984; Hauff et al., 2000); (3) the Osa Igneous Complex that consists of several fragments of Upper Cretaceous to Eocene

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seamounts (Buchs et al., 2009; Hauff et al., 2000); (4) undifferentiated complexes in west Panama that include Upper Cretaceous to Cenozoic accreted OIB (Hoernle and Hauff, 2007; Hoernle et al., 2002); and (5), the Azuero Accretionary Complex that includes two Paleogene oceanic islands (Buchs et al., 2011) (Fig. 1). Other igneous complexes exposed in the forearc have been interpreted as uplifted portions of an Upper Cretaceous oceanic plateau part of the Caribbean Large Igneous Province (CLIP) on the basis of similar radiometric ages and geochemical data (Hauff et al., 2000; Hoernle and Hauff, 2007; Hoernle et al., 2004; Sinton et al., 1997, 1998) (Fig. 1). These igneous complexes are considered to form the basement of the arc in south Central America (e.g. Christeson et al., 1999; Sallarès et al., 2001), but recent tectonostratigraphic contributions suggest that some most likely represent fragments of exotic oceanic plateaus or seamounts, possibly unrelated to the CLIP, which accreted between the Campanian and Paleocene (Bandini et al., 2008; Baumgartner et al. 2008; Buchs et al., 2009). Field and geochemical constraints that clearly support occurrence of a CLIP sequence at the base of the Middle American margin are currently restricted to the Azuero Marginal Complex in west Panama and Golfito Complex in south Costa Rica (Buchs et al., 2010).

Understanding the origins and tectonostratigraphic relationships of autochtnous and accreted sequences exposed along the forearc in Costa Rica and Panama is fundamental to characterize the long-term development of the Middle American margin. We present here a revised tectonostratigraphic subdivision of the Azuero Peninsula, Soná Peninsula and Coiba Island, which include autochthonous and accreted complexes exposed in the west Panamanian forearc. The revised subdivision is supported by new biochronological data and field observations, as well as a synthesis of previously published geochemical data, radiometric data, seismic data and field observations. The studied sequences document the development of the west Panamanian margin between the Upper Cretaceous and Miocene. Comparison of this development with that proposed for the south Costa Rican forearc (Buchs et al., 2009) allows us to show that events of accretion and periods of subduction erosion or non-accretion occurred at different times and places along the Middle American margin between the Upper Cretaceous and Miocene.

2. Geological background of the Azuero area

The Azuero area is defined as the area including the Azuero Peninsula, Soná Peninsula and Coiba Island. It is located in the Panamanian forearc along the SW edge of the Caribbean Plate, above the subducting Nazca Plate (Fig. 1). Similarly to the Costa Rican forearc, the Azuero area may have experienced recent uplift in response to on-going subduction of topographic highs under the Caribbean Plate (e.g. Sak et al., 2009).

In the most simple terms, the Azuero area can be described as an igneous basement overlain by forearc sediments. Five distinct rock associations have been recognized in the basement on the basis of field observations, geochemical data, $^{40}Ar/^{39}Ar$ radiometric ages, and biochronologic data: (1) Upper Cretaceous basaltic sequences with CLIP geochemical affinities, which are locally covered by Campanian–Maastrichtian hemipelagic limestones (Buchs et al., 2010; Corral et al., 2011; del Giudice and Recchi, 1969; Kolarsky et al., 1995a; Lissinna, 2005); (2) proto-arc-related igneous rocks locally interbedded with late Campanian–Maastrichtian hemipelagic limestones (Buchs et al., 2010); (3) ~71 to 40 Ma arc-related igneous rocks (Buchs et al., 2010; Lissinna, 2005; Lissinna et al., 2002; Wegner

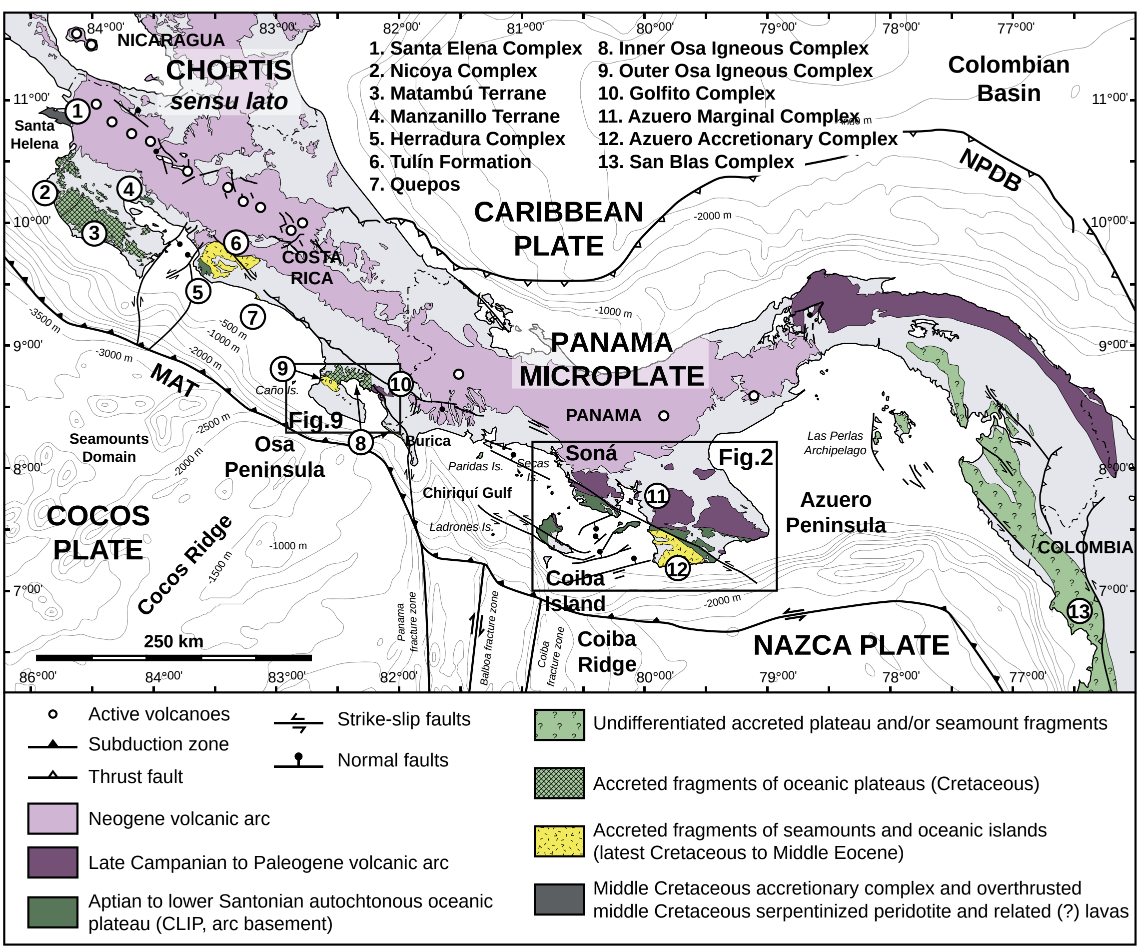

Fig. 1. General setting of the Azuero Marginal Complex and Azuero Accretionary Complex (after Buchs et al., 2010).