Available online at www.sciencedirect.com

SCIENCE DIRECT®

Earth and Planetary Science Letters 236 (2005) 670–690

EPSL

www.elsevier.com/locate/epsl

Cretaceous alkaline intra-plate magmatism in the Ecuadorian Oriente Basin: Geochemical, geochronological and tectonic evidence

Roberto Barragán[a,*], Patrice Baby[a], Robert Duncan[b]

[a]*Institut de Recherche pour le Développement (ex-ORSTOM), Unité de Recherche 104, Université Paul Sabatier, Toulouse III, 38 rue des Trente-Six Ponts, 31400 Toulouse, France*

[b]*College of Oceanic and Atmospheric Sciences, Oregon State University, Corvallis, Or 97331, USA*

Received 27 September 2004; received in revised form 15 March 2005; accepted 31 March 2005

Editor: E. Bard

Abstract

Small volumes of Cretaceous alkaline basaltic magmas have been identified in the sedimentary infill of the Ecuadorian Oriente foreland basin. They are characterized by a restricted range of compositional variation, low LILE/HFSE ratios and Sr–Nd isotope values within the range of oceanic island basalts (OIB). Reflection seismic data show that a pre-existing NNE–SSW Triassic and Jurassic rift controls the location and occurrence of these alkaline eruptive sites. Radiometric ages (^{40}Ar–^{39}Ar, incremental heating method) and the biostratigraphic record of their surrounding sediments indicate a NNE–SSW systematic age variation for the emplacement of this alkaline volcanism: from Albian (110 ± 5.2 Ma) in the northern part of the Oriente Basin, to Campanian (82.2 ± 2.0 Ma) in the west-central part. The geochemical, geochronological and tectonic evidences suggest that asthenospheric mantle has upwelled and migrated to the SSW, into the region underlying the pre-existing Triassic and Jurassic rift (thin-spot?). We propose that subduction was abandoned, subsequent to the accretion of allochthonous terranes onto the Ecuadorian and Colombian margin in the latest Jurassic–earliest Cretaceous, causing the relict slab material, corresponding to the eastwards-directed leading plate, to roll-back. Unmodified asthenospheric mantle migrated into the region previously occupied by the slab. This resulted in partial melting and the release of magmatic material to the surface in the northern part of the Oriente Basin since at least Aptian times. Then, magmatism migrated along the SSW-trending Central Wrench Corridor of the Oriente Basin during the Upper Cretaceous, probably as a consequence of the lateral propagation of the transpressive inversion of the Triassic–Jurassic rift. Eventually, the Late Cretaceous east-dipping Andean subduction system was renewed farther west, and the development of the compressional retro-foreland Oriente Basin system halted the Cretaceous alkaline magmatic activity.

Keywords: Northern Andes; Ecuador; Oriente Basin; alkaline magmatism; Cretaceous; roll-back; transpressive inversion

* Corresponding author. OXY Ecuador, Ave. Naciones Unidas E7-95 y Shyris, Edificio Banco del Pacífico, Quito-Ecuador. Tel.: +593 2 299 3700; fax: +593 2 299 3701.

E-mail address: roberto_barragan@oxy.com (R. Barragán).

0012-821X/$ - see front matter © 2005 Elsevier B.V. All rights reserved.
doi:10.1016/j.epsl.2005.03.016

1. Introduction

Intra-continental plate alkaline magmatism is reported from numerous locations in Mesozoic and Cenozoic strata along the Pacific margin of the Americas and the Antarctic Peninsula [1–11]. Different models, each related to a tectonic setting, have been proposed to explain the generation and occurrence of alkaline magma. Possible mechanisms include: (a) mantle plumes with abnormally high asthenospheric temperatures beneath continental crust [12–14] (e.g., Columbia River Basalts in the NW United States [15]); (b) upwelling and decompressional melting due to lithospheric extension [16] and rift propagation (e.g., Andean Jurassic back-arc basin between 25° S and 0° [1–3]); (c) development of slab windows associated with the ending of subduction processes along active continental margins following ridge crest–trench collision [17–19] (e.g., Baja California [4]; Southern Patagonia [5–7]; Antarctic Peninsula [8 9]; British Columbia [10]); and (d) a combination of slab roll-back associated with lateral and vertical asthenospheric migration into the locus of a pre-existing area of lithospheric thinning or "thin-spots" (e.g., The Antarctic James Ross Islands [11]).

Here we present evidence of active intra-plate alkaline magmatism from the Oriente Basin of Ecuador associated with the evolution of the northwestern margin of the South American plate during Cretaceous

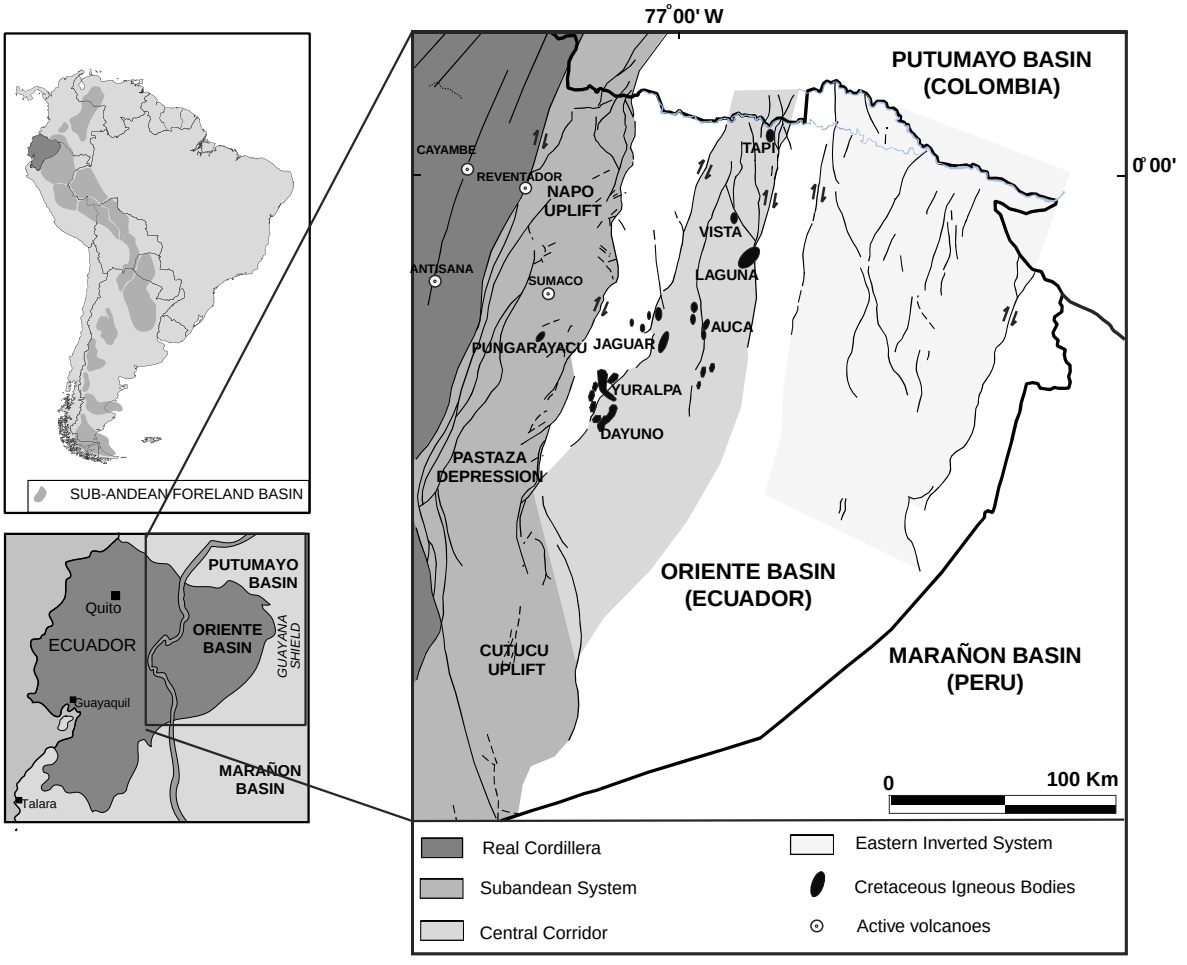

Fig. 1. Regional location map. Synthetic tectonic map of the Ecuadorian Oriente Basin (modified from [20]).