6th International Symposium on Andean Geodynamics (ISAG 2005, Barcelona), Extended Abstracts: 787-790

Geochemical, geochronological and isotopic characterisation of the mafic basement and cover sequences within the Interandean depression, Ecuador

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Distinct N-S trending topographic ridges of the Eastern Cordillera and the Western Cordillera in Ecuador are separated by the Interandean Depression (IAD) between 1°N and 2°S. The IAD separates continental rocks in the east from accreted oceanic rocks in the west. However, the origin and composition of its basement is unknown because it is mainly overlain by post-Oligocene volcanic and volcanoclastic rocks. We present preliminary data that characterise the composition, age and origin of the basement of the IAD. We also present a detailed sedimentological, chronological and structural study of post-late Miocene intra-arc basins that reside in, and constrain the history of the IAD. Work is currently in progress and will be completed at the time of presentation (geochemical and isotopic analysis, $^{40}Ar/^{39}Ar$, Sm/Nd radiometric dating and fission-track analysis) although previous results and geological mapping lead us to propose a model for the IAD.

GEOLOGICAL SETTING

The crystalline, mafic basement of the Western Cordillera partly comprises the Pallatanga Terrane (Boland, 2000; Hughes and Pilatasig, 2002), which consists of Late Cretaceous oceanic plateau basalts and ultramafic rocks of the Pallatanga and San Juan Units (e.g. Mamberti et al., 1999), in tectonic contact with a late Cretaceous, tholeiitic island arc sequence (Mamberti, 2002; Boland, 2000; Vallejo, this volume). All these units and their respective sedimentary covers were accreted against the continental margin during the late Cretaceous (Hughes and Pilatasig, 2002; Spikings et al., in press), forming the Calacalí-Pujilí-Pallatanga Fault (CPF), which defines the western border of the IAD (Fig. 1). Paleozoic-lower Cretaceous metamorphosed continental rocks are exposed in the Eastern Cordillera, which is juxtaposed against the IAD via the Peltetec Fault. Undated ultramafic and mafic igneous rocks are exposed along the Peltetec Fault and form the Peltetec Unit.

Published hypotheses generally propose that the IAD basement is either composed of individual microplates (e.g. Litherland et al., 1994) or that the valley is floored by a regional scale, tectonised zone, defined by a mélange, which has captured rocks from both the continental and oceanic domains (Spikings et al., in press).

RESULTS: Composition of the basement

We present data from basaltic crystalline basement of the IAD that crops out close to Ambato (Mamberti et al., 2003) and Quito. These data (Fig. 2) show that the basement of the IAD can be geochemically correlated with mafic rocks of the Western Cordillera, and therefore we postulate that the CPF does not define the late Cretaceous suture between continental and oceanic terranes. Basaltic rocks close to Ambato exhibit a similar, normalised trace element pattern to the Pallatanga Unit (Fig. 2), and plot in the same intraplate, tectonic

discriminating field based on Ti, Zr and Y content (Pearce and Cann, 1973) as the Pallatanga Unit. However, the trace element content of basaltic rocks proximal to Quito reveal an oceanic island arc affinity. These rocks may form part of the Río Cala arc, although geochronological confirmation is required.

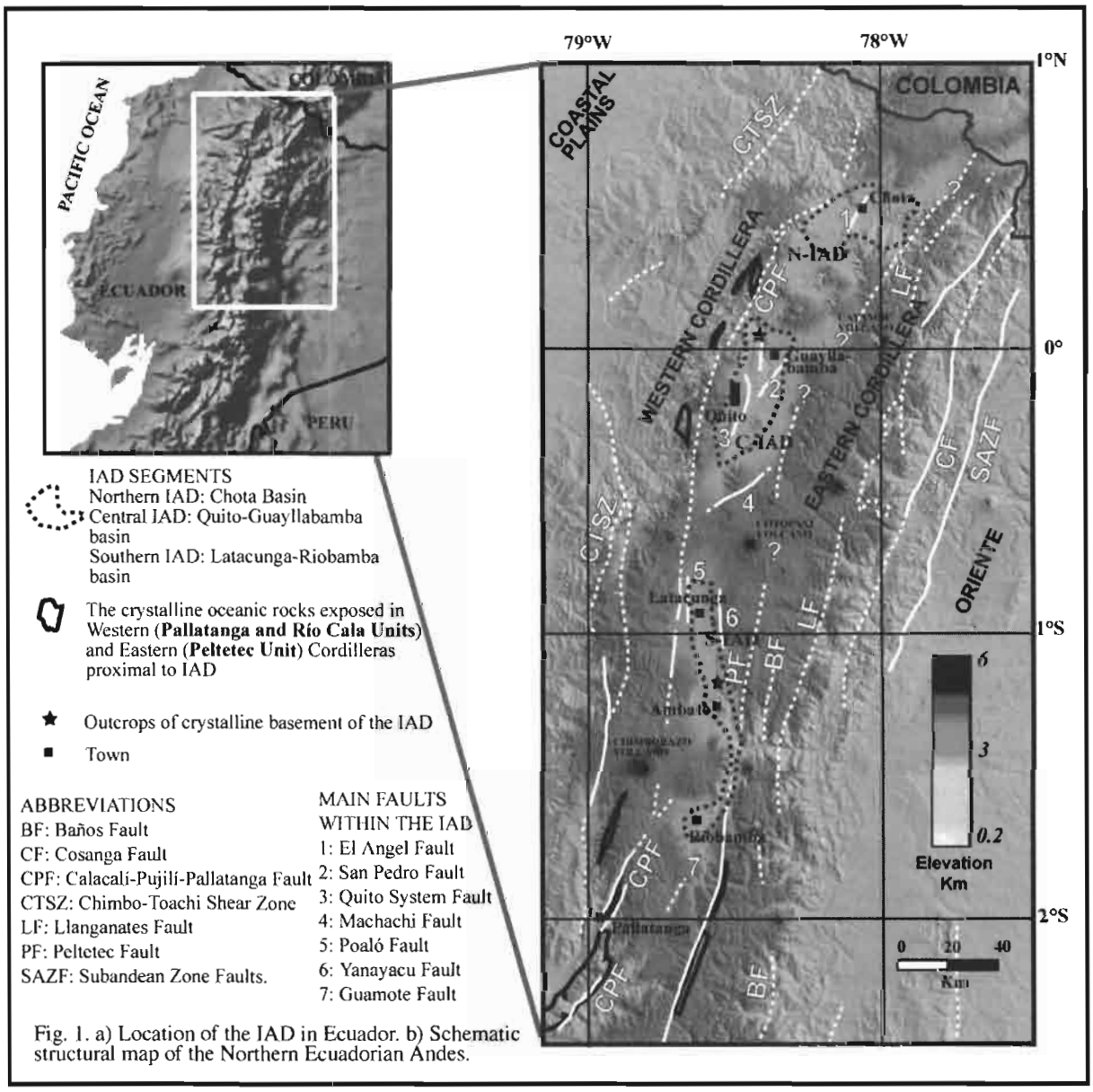

Fig. 1. a) Location of the IAD in Ecuador. b) Schematic structural map of the Northern Ecuadorian Andes.

RESULTS: Structure and sedimentary history

The juxtaposition of oceanic plateau and arc elements within the basement of the IAD is similar to the complexity present in the Western Cordillera, where faulted contacts are widespread. The segmented basement is clearly expressed in the morphology of the IAD and corresponds with the locations of Plio-Quaternary volcanoes. Several faults have been identified (Egüez et al., 2004; Villagómez et al., 2003), which segment the IAD (Fig. 1), with trends both parallel to the bounding cordilleras (N-S to NNE-SSW; e.g Quito, Poaló, Yanayacu Faults) and slightly oblique to them (NE-SW; El Angel, Machachi, San Pedro, Guamote faults, Southern CPF). These faults may define the boundaries of plateau and arc elements within the IAD.

Morphologically, the valley of the IAD can be divided into three segments, each with a different orientation (Northern IAD, Central IAD, Southern IAD, Fig. 1) and separated from each by volcanogenic regions. Variations in post-Miocene sedimentation between these regions suggest they experienced different tectonic histories (e.g. Winkler et al., in press).

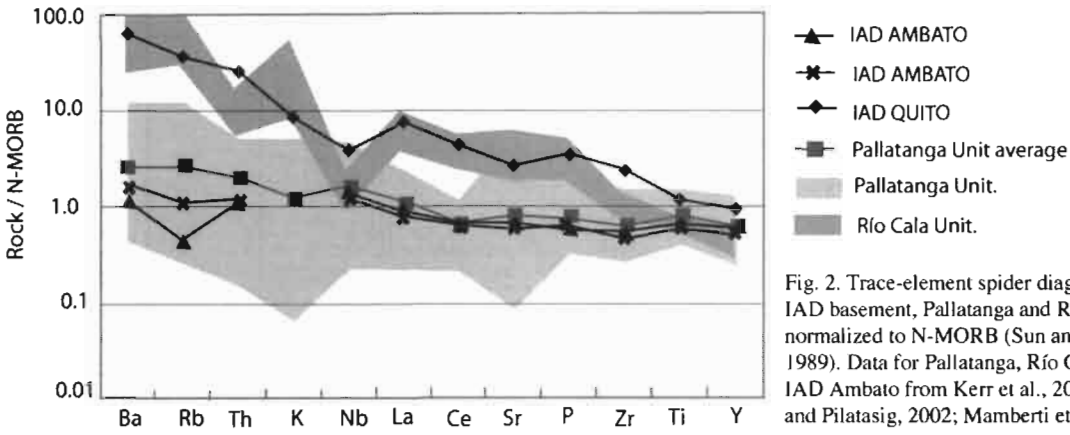

Fig. 2. Trace-element spider diagram for the IAD basement, Pallatanga and Río Cala Units, normalized to N-MORB (Sun and McDonough, 1989). Data for Pallatanga, Río Cala Units and IAD Ambato from Kerr et al., 2002; Hughes and Pilatasig, 2002; Mamberti et al., 2003.

Mapping and tentative sedimentary correlations between basins of the IAD reveals two compressive events that occurred during 6-4 Ma and 1-0 Ma, separated by a period of extension (Villagómez et al., 2003; Fig. 3). The first compressive event may have been responsible for the inception of the IAD (constrained by the oldest sedimentary rocks in the Chota Basin; Fig. 3), which initially opened in the north and progressively migrated southwards (Winkler et al., in press). The subsequent compressive phase commenced at ~1 Ma, which folded and overthrusted all the sedimentary sequences in the IAD basins.

The IAD formed by displacement along a major transcurrent fault system, which accommodates the northward displacement of the North Andean Block with respect to the South American plate (Ego and Sebrier, 1996). Localised fault reactivation within the bounding cordilleras suggests the transcurrent system may be 120 km wide, including segments of the CPF, Peltetec, Chingual-La Sofía, Llanganates, Cosanga, Sub-Andean and Chimbo-Toachi faults (e.g. Spikings et al., 2000, 2004, in press; Ruiz, 2002).

CONCLUSIONS

The basement of the IAD may be an extension of accreted oceanic fragments currently exposed in the Western Cordillera. The dense fault array, which is reflected in the morphology and location of volcanic edifices, may simply separate distinct accreted terranes, or alternatively be a result of the formation of a tectonic mélange, which contains continental and oceanic rocks. These hypotheses will be tested by geochronology and the distribution of Sr, Nd and Pb isotopic analyses of basement rocks. The IAD basement may also contain fragments of the undated Peltetec Unit, which raises the possibility that the Peltetec Unit can be correlated with late Cretaceous-Tertiary accreted oceanic terranes that are currently exposed in the Western Cordillera. The CPF may not represent a fundamental terrane boundary and may be a young feature related to the opening of the IAD.

The IAD began to open at c.a. 6-5 Ma and propagated from the north (Chota Basin), southward into the Quito-Guallabamba and Latacunga- Riobamba basins. The basins were filled with alluvial fan, fluvial, lacustrian and contemporaneous volcanic deposits. Syn-sedimentary deformation prevailed during most of the life-span of the IAD.

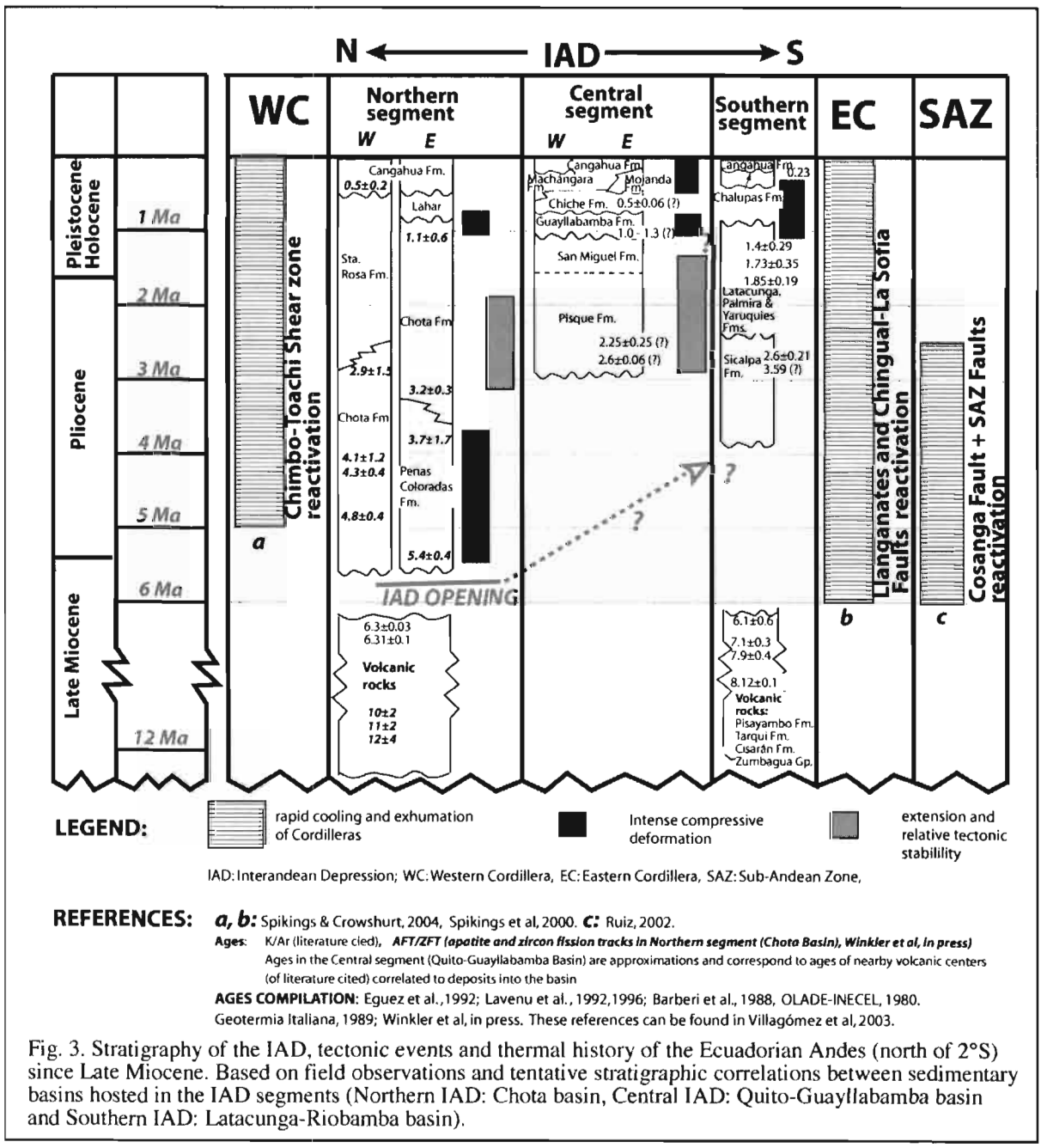

Fig. 3. Stratigraphy of the IAD, tectonic events and thermal history of the Ecuadorian Andes (north of 2°S) since Late Miocene. Based on field observations and tentative stratigraphic correlations between sedimentary basins hosted in the IAD segments (Northern IAD: Chota basin, Central IAD: Quito-Guayllabamba basin and Southern IAD: Latacunga-Riobamba basin).

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