

Geochronology and provenance analysis of basement and clastic cover sequences within the northern Western Cordillera, Ecuador

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INTRODUCTION

The Western Cordillera of Ecuador consists of allochthonous terranes, which accreted to the South American margin during the late Cretaceous and early Tertiary. Each allochthonous terrane is composed of a mafic oceanic basement, overlain by pre-, syn- and post-accretionary late Cretaceous and Tertiary sedimentary rocks. Transcurrent displacements along mainly N-S trending faults, resulting in variable clockwise rotations, have produced a complex juxtaposition of tectono-stratigraphic units. We present both provenance analyses of the sediments, which overlie the mafic basement, as well as U/Pb zircon (SHRIMP) and ⁴⁰Ar/³⁹Ar data from the basement rocks of the Western Cordillera between 0° 20' N to 2° S. Based on this data we propose a tentative geological history.

The Pallatanga Terrane is exposed along the eastern border of the Cordillera and is separated from the continental margin by a deformed suture zone (the Pujilí fault zone). Mafic basement rocks (Pallatanga Unit) yield oceanic plateau geochemical signatures and probably form part of the Caribbean Oceanic Plateau, implying a late Cretaceous age (Spikings et al., 2001; Kerr et al., 2002). The Pallatanga Terrane includes an ultramafic complex, the San Juan Unit, dated by Lapierre et al. (2000) as 123±13 Ma. The Macuchi Terrane is located along the western border of the Cordillera, and is separated from the Pallatanga Terrane by the regional-scale Chimbo-Toachi dextral shear zone (Fig. 1). The basaltic-andesitic basement of the Macuchi Terrane (Macuchi Unit) was deposited in an island arc system that has not been dated, although it is intercalated with Eocene sediments (Hughes and Pilatasig, 2002).

PRELIMINARY RADIOMETRIC DATINGS

The San Juan Unit hosts ultramafic and gabbroic mafic cumulates, which yield an oceanic plateau geochemical signature, similar to the Pallatanga Unit (Mamberti et al., 2004). U/Pb (SHRIMP) analyses of homogeneous zircons extracted from a gabbro in the San Juan Unit yielded an age of 87.1 ± 0.8 Ma. This age is significantly younger than the Sm/Nd internal isochron age of 123 ± 13 Ma derived by Lapierre et al. (2000) from gabbros along the same outcrop. The U/Pb age is interpreted as the crystallisation age of the gabbros. Zircons from a fractionated juvenile pegmatite, which forms part of the Pallatanga Unit, yielded a U/Pb (SHRIMP) zircon age of 85.5 ± 0.6, which we interpret to be the time of crystallisation of late, fractionated melts that gave rise to the Pallatanga Unit. The San Juan and Pallatanga units have very similar ages, suggesting that they probably represent a single plateau sequence that hosts both ultramafic cumulates and younger fractionated sequences, similar to what is observed in the Caribbean Colombian Oceanic Plateau sequence in Colombia (Kerr et al., 2002).

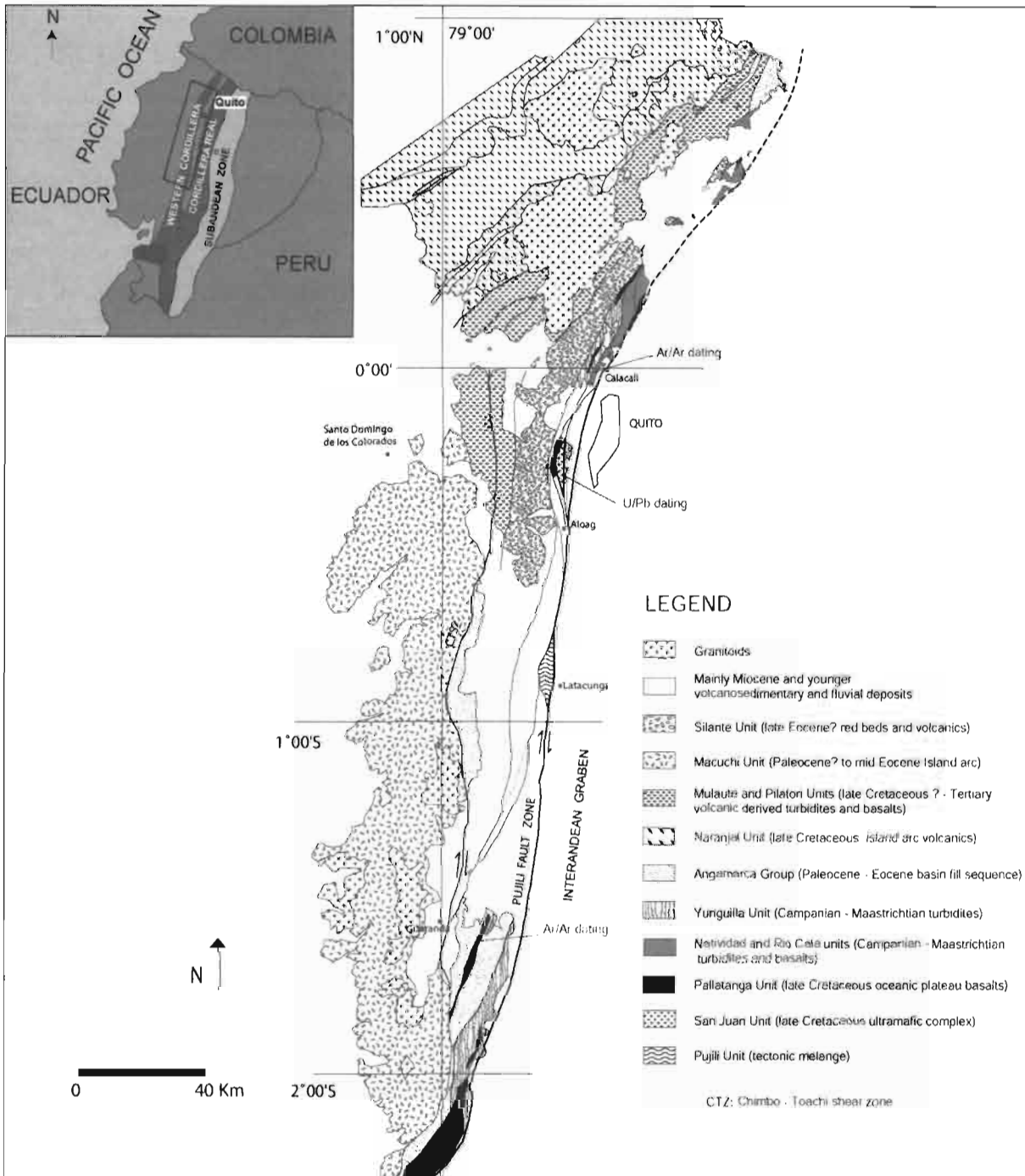


Figure 1. Location of study area and geological map (modified from Hughes and Pilatasig, 2002).

$^{40}\text{Ar}/^{39}\text{Ar}$ data from plagioclase crystals extracted from basalts of the Pallatanga Unit, west of Riobamba, yield a plateau age of 73 ± 4 Ma, which we tentatively interpret as a cooling age, possibly driven by the accretion of the Pallatanga Terrane with the South American Plate. $^{40}\text{Ar}/^{39}\text{Ar}$ analyses of plagioclase crystals extracted from basalts of the Natividad Unit yield a plateau age of 64.3 ± 0.4 Ma, interpreted as the time of crystallization subsequent to eruption.

HEAVY MINERAL ASSEMBLAGES AND SINGLE GRAIN GEOCHEMISTRY

Heavy mineral (HM) assemblages of volcanic rich sandstones of the late Cretaceous – Tertiary Mulaute and Pilatón units (Boland et al., 2000) are characterized by high percentages (90 - 95%) of volcanic derived minerals, suggesting that they were derived from a volcanic source, distant from the continent. However, a significant quantity of material derived from continental crust occurs in the upper Mulaute Unit. Single grain geochemistry of clinopyroxenes (CPX) extracted from these units indicate that their mafic sources were tholeiitic and formed in a subduction zone, suggesting an oceanic island arc origin. The juxtaposing Campanian - Maastrichtian Natividad Unit is dominated by volcanic derived minerals. The composition of CPX extracted from basalts and sandstones in this unit indicates a tholeiitic, island arc setting. Finally, the late Eocene Silante Unit is characterized by a high abundance of volcanic derived minerals (80 - 95%). CPX geochemistry indicates a subduction related, calc-alkaline volcanic source.

DISCUSSION

Similar U/Pb crystallization ages from the San Juan and Pallatanga Units suggests that they represent ultramafic and fractionated components of a single oceanic plateau sequence, which crystallized during 88 – 85 Ma. These ages partly overlap with those determined for the Caribbean plateau (e.g. 91 - 88 Ma; Sinton et al., 1998). Heavy minerals, single grain geochemistry and sedimentary facies indicate that the Natividad, Pilatón and Mulaute units were derived from an island arc volcanic source, which was separated from continental detrital input until deposition of the youngest strata in the Mulaute Unit. $^{40}\text{Ar}/^{39}\text{Ar}$ dating indicates this island arc was active during the Maastrichtian-Danian and microfossil data suggests it may be as old as the Campanian (Boland et al., 2000). The timing of exposure of the arc to the continental margin is not well constrained due to the unknown age of the Mulaute Unit. Unfortunately, faulted contacts render it difficult to assess whether or not the Pallatanga Unit represents the basement of the arc, although Kerr et al. (2002) present geochemical arguments that the arc erupted through thickened oceanic crust.

The relationship between the island arc exposed in the northeastern part of the cordillera with the Macuchi island arc is not clear due to the unknown age of the volcanic rocks of the Macuchi Unit. The overlying late Eocene Silante Unit corresponds to deposits of a volcanic arc built on continental crust subsequent to the accretion of the island arcs.

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