TECTONO-MAGMATIC EVOLUTION AND CRUSTAL GROWTH ALONG THE WEST-CENTRAL AMAZONIA SINCE THE LATE MESO-PROTEROZOIC: EVIDENCE FROM THE EASTERN CORDILLERA OF PERU

ALEKSANDAR MIŠKOVIĆ AND URS SCHALTEGGER

Department of Earth Sciences, University of Geneva, 13 rue des Maraîchers Geneva, Switzerland

INTRODUCTION

Whereas the Cretaceous to recent orogenic cycle is well characterised (Ramos and Aleman; 2000), the knowledge of the early Phanerozoic and Proterozoic evolution of the Andes is increasingly fragmentary with age due to paucity of exposed lithologies. The problem is less pronounced along the Peruvian segment of the orogen: the lacuna in the ubiquitous Cenozoic volcanic cover is interpreted to have resulted from the flat slab subduction of the Nazca ridge (Jaillard et al., 2000). Batholiths of the Eastern Cordillera of Peru which straddle the tectonic boundary between the allochthonous western Amazonian tectonic provinces of San Ignacio (1.57-1.24 Ga) and Sunsás (1.19-0.92 Ga) on one side and comparatively few parautochthonous to allochthonous crustal domains (1.9-1.8 Ga Arequipa-Antofalla; 150 Ma Olmos-Amotape terrane) on the other, thus provide an optimal record of the nature and rate of crustal growth at a long lived, non-accretionary cratonic margin. Despite its fortuitous setting however, the timing of magmatism in the central Andes is relatively poorly understood with most of the geochronological work so far relying heavily upon whole rock Rb-Sr and K-Ar techniques, both of which are known to yield ambiguous dates because of low retention temperatures and isotopic disturbance by subsequent tectono-thermal episodes. This is a particularly acute problem in Peru considering ~150 Ma of uninterrupted compressive tectonism of the last Andean cycle (Benavides, 1999).

We use a combination of *in situ* U-Pb geochronology and Lu-Hf isotopic tracing of plutonic zircons along the strike of the Eastern Cordillera of Peru to construct a detailed geochronological framework and identify sources of consecutive magma pulses in order to define cratonic domains and track crustal evolution of the proto-Andean margin of Amazonia. By relating the secular changes in magma sources to the tectono-magmatic cycles of continental assembly and breakup over the last 1.1 Ga, we can test both the current geodynamic scenarios for the evolution of the western Amazonian shield with particular focus on the poorly understood break up of Rodinia (Meert and Torsvik, 2003; Loewy et al., 2003; Cordani et al., 2003; Fuck et al., 2008; Li et al., 2008) and the models constraining the relative contributions of Phanerozoic and Neoproterozoic arc magmatism in the formation of the continental crust (Condie, 2001; Davidson and Arculus, 2005).

U-Pb AGE DETERMINATIONS

The results of a laser ablation ICPMS U-Pb isotopic study on zircons from 60 Eastern Cordilleran intrusives of Peru reveal 1.15 Ga of magmatic activity along the central western Amazonian margin that is largely dominated by mid-Phanerozoic plutonism related to the assembly and break up of Pangea (Figure 1). A Carboniferous-Permian (340-285 Ma) continental arc is identified along the orogenic trend from the Ecuadorian border (6°S) to the inferred inboard extension of the Arequipa –Antofalla terrane in the southern Peru (14°S). The widespread crustal extension and thinning which affected the western Gondwana throughout Permian and Triassic resulted in the central late to post orogenic La Merced-San Ramón-type anatectites dated between 275 and 220 Ma while the emplacement of the southern Cordillera de Carabaya peraluminous granitoids in the late Triassic to early Jurassic (220-190 Ma) represents, temporally and regionally, a separate tectono-magmatic event likely related to re-suturing of the Arequipa-Antofalla block. Alkaline volcano-plutonic complexes and stocks associated with the onset of the modern

Andean cycle in southeastern Peruvian Andes cluster between 170-180 Ma. A volumetrically minor intrusive pulse of the Oligocene age (~30 Ma) is detected near the southwestern Cordilleran border with Altiplano, and only one remnant of the late Ordovician intrusive belt is recognised in the eastern marginal Macchu Picchu batholith (446.5 ± 9.7 Ma) indicating that the Famatinian arc system previously identified in Peru only along the north-central Cordillera Oriental and the coastal Arequipa terrane had also developed inboard of this para-autochthonous crustal fragment. Both post-Gonwanide and Precambrian plutonism are restricted to isolated occurrences spatially comprising less than 15% of the Eastern Cordillera intrusives. Hitherto unknown occurrences of the late Mesoproterozoic and middle Neoproterozoic granitoids from the south central cordilleran segment define magmatic events at 691 ± 13 Ma, 751 ± 8 Ma, and 985 ± 14 Ma, 1071 to 1123 ± 23 Ma that are broadly coeval with the Braziliano and Grenville-Sunsás orogenies respectively. Our data suggest the existence of a contiguous orogeny in excess of 3800 km along western Amazonia during the formation of Rodinia and its "early" fragmentation prior to 690 Ma.

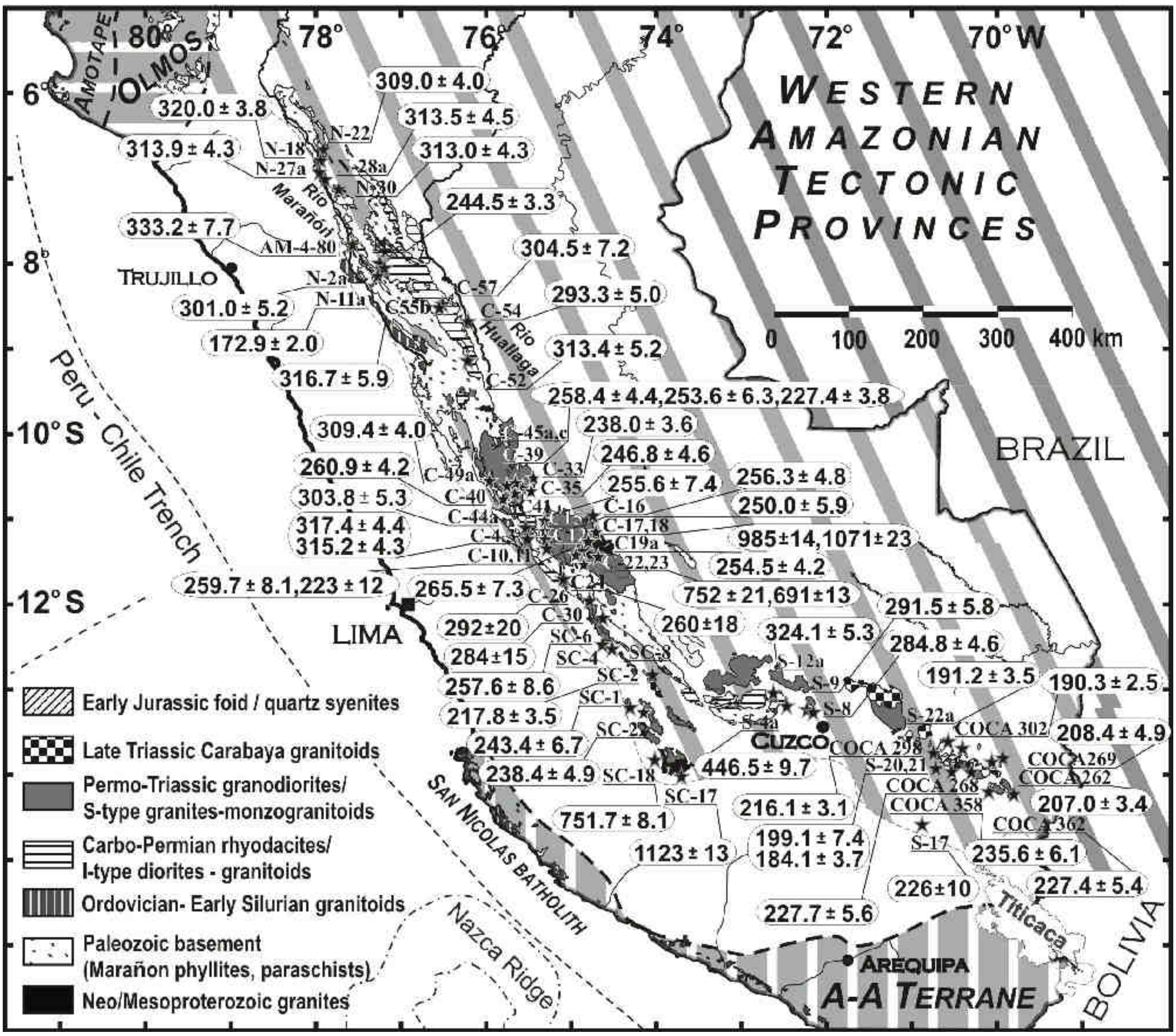

Figure 1. Geochronological framework of the Eastern Peruvian Cordillera plutonism

Hf ISOTOPE ANALYSES

In addition to dating the emplacement of plutonic rocks, we performed an *in situ* LA MC-ICPMS survey of Hf isotope composition of magmatic zircons from the Eastern Cordillera batholiths. These are invariably characterised by a range in the initial $^{176}Hf/^{177}Hf$ compositions for a given intrusive event suggesting mixing of material derived from the Paleoproterozoic crustal substrate and variable Neoproterozoic to recent juvenile sources. The periods of well documented compressive tectonics correspond to negative mean εHf_i values of -6.73, -2.43, -1.57 for the Ordovician Famatinian, Carboniferous-Permian and late Triassic respectively, suggesting the minimum crustal contribution between 74% and 44% by mass (Figure 2). The average initial Hf systematics from granitoids associated with intervals of regional extension such as the middle Neoproterozoic, Permian-Triassic and Cenozoic Andean back arc plutonism are consistently shifted toward the positive values (mean εHf_i = -0.7 to +8.0) indicating systematically larger inputs of juvenile magma (22% to 49%).

In the absence of evidence for lateral accretion of exotic crust, the time integrated Hf record from the central proto-Andean margin of western Amazonia suggests crustal reworking as the dominant process during episodes of arc magmatism and implies that most of continental growth took place vertically via crustal underplating of isotopically juvenile, mantle derived magma during intervals of crustal attenuation.

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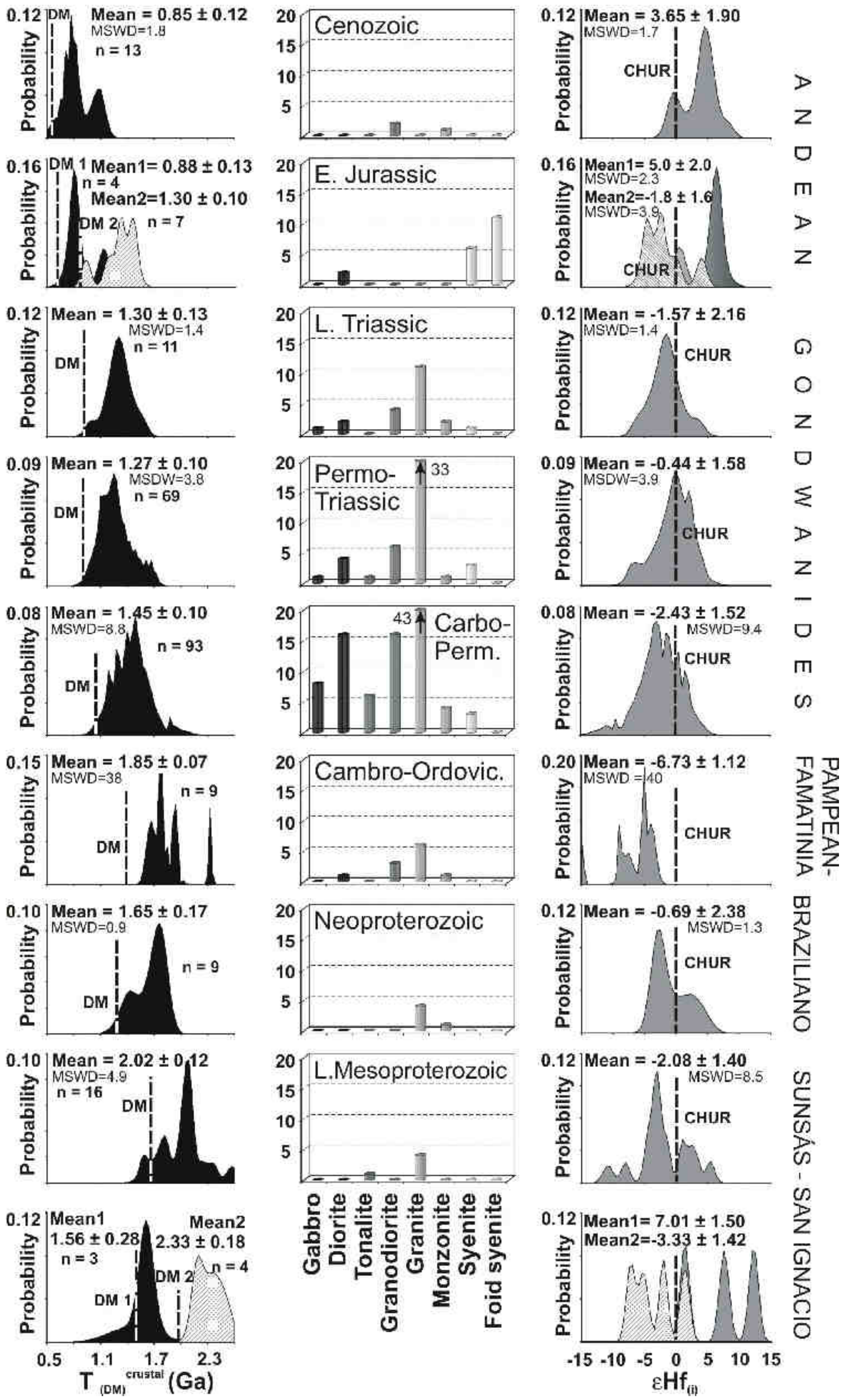

Figure 2. $^{176}Hf/^{177}Hf$ systematics from the Eastern Peruvian Cordillera granitoids.