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Late Paleozoic to Jurassic chronostratigraphy of coastal southern Peru: Temporal evolution of sedimentation along an active margin

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ABSTRACT

We present an integrated geochronological and sedimentological study that significantly revises the basin and magmatic history associated with lithospheric thinning in southern coastal Peru (15–18°S) since the onset of subduction at ~530 Ma. Until now, estimating the age of the sedimentary and volcanic rocks has heavily relied on paleontologic determinations. Our new geochronological data, combined with numerous field observations, provide the first robust constraints on their chronostratigraphy, which is discussed in the light of biostratigraphical attributions. A detailed review of the existing local units simplifies the current stratigraphic nomenclature and clarifies its absolute chronology using zircon U–Pb ages. We observe that the Late Paleozoic to Jurassic stratigraphy of coastal southern Peru consists of two first-order units, namely (1) the Yamayo Group, a sedimentary succession of variable (0–2 km) thickness, with apparently no nearby volcanic lateral equivalent, and (2) the overlying Yura Group, consisting of a lower, 1–6 km-thick volcanic and volcaniclastic unit, the Chocolate Formation, and an upper, 1–2 km-thick sedimentary succession that are in markedly diachronous contact across the coeval arc and back-arc. We date the local base of the Chocolate Formation, and thus of the Yura Group, to 216 Ma, and show that the underlying Yamayo Group spans a >110 Myr-long time interval, from at least the Late Visean to the Late Triassic, and is apparently devoid of significant internal discontinuities. The age of the top of the Chocolate Formation, i.e. of the volcanic arc pile, varies from ~194 Ma to less than ~135 Ma across the study area. We suggest that this simplified and updated stratigraphic framework can be reliably used as a reference for future studies.

1. Introduction

A well-defined chronostratigraphy is crucial to accurately reconstruct the evolution of an active continental margin and its neighbouring continental mass. This appears particularly relevant for the Late Paleozoic to Jurassic, during which the assembly of Pangaea and its subsequent breakup occurred. Because Pangaea was entirely surrounded by subduction zones (e.g. Collins, 2003), improved temporal constraints on the evolution of the active continental margins should provide original insights into the history of its assembly and breakup.

We address this issue by studying the present day, emerged forearc of southern Peru (Fig. 1). New and reliable chronostratigraphic constraints were acquired for the Late Paleozoic to Jurassic by U–Pb dating of detrital and magmatic zircons using Laser Ablation-Inductively Coupled Plasma-Mass Spectrometry (LA-ICP-MS) and Chemical Abrasion-Isotope Dilution-Thermal Ionization Mass Spectrometry (CA-ID-TIMS).

The stratigraphy of this region remained poorly constrained due to the fragmented preservation of the Late Paleozoic to Jurassic stratigraphic succession and severe alteration of its volcanic rocks. Current chronostratigraphic knowledge of this 3–10 km thick, dominantly sedimentary pile (Fig. 2), which overlies the basement of the Arequipa Massif in discontinuous outcrops, has mainly relied on sparse and sometimes poorly constrained biostratigraphical determinations. Furthermore, initial mapping in the 1960s led to the definition of a plethora of units with little subsequent agreement about their possible correlation and age. The main objectives of this paper are to review all previous biostratigraphical and sedimentological work carried out in southern coastal Peru (15–18°S), and constrain the duration and extent of periods of sedimentation and arc magmatism using our U–Pb zircon age data acquired from the pre-Andean margin of southern Peru, from the Carboniferous to the Jurassic.

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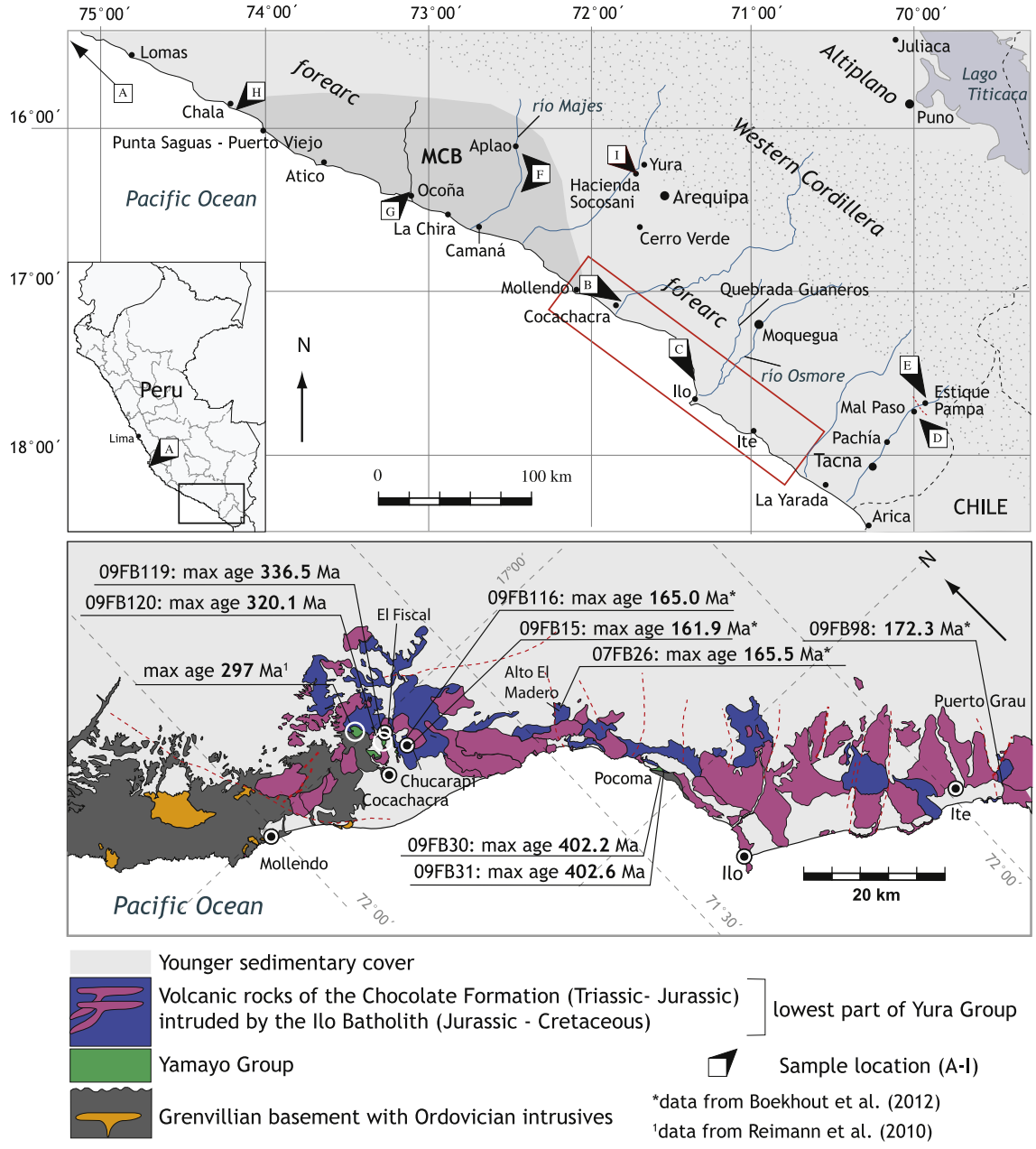

Fig. 1. Map of southern Peru indicating the studied sedimentary successions (a–i). The local basement coincides with the 'Arequipa Massif' underlying the present day forearc and Western Cordillera. The Mollendo–Camaná Block (MCB) forms a major part of the forearc and is intruded by Ordovician plutonic rocks. The following locations were studied: (a) Paracas area, La Mina; (b) El Fiscal and Cocachacra area (c) Pocoma area; (d) Mal Paso area; (e) Estique Pampa area; (f) Majes area; (g) Ocoña valley; (h) Chala; (i) Yura.

We find that the Late Paleozoic to Jurassic stratigraphy of coastal southern Peru consists of two first-order units, which are the Yamayo Group and the overlying Yura Group (Fig. 2). The Yamayo Group consists of a sedimentary succession of variable (0–2 km) thickness, with apparently no nearby volcanic lateral equivalent. In contrast, the Yura Group consists of a lower, 1–6 km thick volcanic and volcaniclastic unit, the Chocolate Formation, and an upper, 1–2 km thick sedimentary succession, that are in diachronous contact across the coeval arc and back-arc. The ages of these previously relied on paleontologic analyses, and we present geochronological data that provide the first robust constraints on their chronostratigraphy.

Strata in the Yamayo Group were thought to have accumulated during the Late Paleozoic to Triassic (Bellido and Guevara, 1963; Pino et al., 2004; Wilson and García, 1962), but lack volcanic rocks, precluding direct isotopic geochronological analyses. Although ash layers were reported in Carboniferous units from other locations in Peru (Mégard, 1978), they are apparently missing from possibly coeval sequences in southern Peru. Permo–Triassic stratigraphic successions have not been indisputably identified in this region. Sedimentary detritus may offer a more widely representative record of events along an ancient active margin in this case where only limited outcrops of magmatic rocks are preserved. We investigated the erosional products of these ancient arc systems using U–Pb zircon (detrital and magmatic) geochronology, (Dickinson and Gehrels, 2009) thus deciphering the geochronological history of this part of the Andean margin.

The lowest part of the overlying Yura Group is the Chocolate Formation, which was previously considered to be Late Triassic to Jurassic in age (Sempere et al., 2002), and consists of a volcanic and