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GEOLOGY AND GEOCHRONOLOGY OF THE ILO BATHOLITH OF SOUTHERN COASTAL PERU

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INTRODUCTION

The western margin of the South American plate is one of the Earth's longest-lived active continental margins, and hence serves as a prime observatory for active margin orogenic processes. The Cenozoic evolution of the Andean margin has attracted much attention (e.g., Dewey and Lamb, 1992; review in Sempere et al., 2008), whereas the Mesozoic and older history is still poorly constrained. Our study aims at reconstructing the late Triassic(?) - Jurassic evolution of the southern Peruvian margin by constraining the age, chemistry, and palaeogeographic setting of its volcanic-sedimentary arc sequences in the Arequipa Terrane.

In southern Peru the Triassic-Jurassic transition is characterized by a cessation of continental extension along the Mitu rift (Reitsma et al., 2010) and, south of 12°S, by renewed subduction-related magmatism along the present-day coastline and inland region of the Arequipa massif. Several continuous rock sections proximal to the coast of the Arequipa Terrane are interpreted to have originated in a continental arc setting, which possibly commenced in the late Triassic (?) to Jurassic (Sempere et al., 2002). We speculate that the extensional geodynamic scenario which formed the Mitu rift may have terminated during renewed orthogonal subduction, enhancing active margin magmatism.

In southern coastal Peru the Ilo batholith (17°00' - 18°30' S) was emplaced into the Chocolate (s.l.) Formation, of Early to Middle Jurassic age. This unit consists of more than 1000 m of basaltic and andesitic flows, agglomerates and breccias that grade upward into volcaniclastic marine sediments. Early workers have assigned the dioritic to granodioritic rocks of this Ilo batholith to the 'Coastal Batholith' of dominantly Cretaceous to Paleogene age. However, K-Ar and ^{40}Ar-^{39}Ar geochronology of plutonic rocks in the Ilo area indicates Jurassic ages, as well as middle Cretaceous intrusives (McBride et al., 1983; Sánchez, 1983; Clark et al., 1990). The oldest part of this plutonic assemblage was thus emplaced prior to the initiation of the main 'Coastal Batholith' emplacement, and can therefore be considered as a significant plutonic segment of the rarely exposed Jurassic arc in Peru. It is however doubtful that these large volumes of Jurassic plutonic rocks represent the first stages of Andean subduction (as suggested by Oliveros et al., 2006), as the Andean margin is likely to have been an active one since the late Neoproterozoic (~650 Ma; Chew et al., 2008).

Our aim is to describe and interpret the history of the Ilo batholith, and to discuss how the magmatic history of this batholith fits into the framework of magma genesis and modes of emplacement along the coeval active Andean margin. A combination of field observations, zircon U-Pb (LA-ICP-MS and CA-ID-TIMS) data, and element geochemistry of the batholith is used to distinguish between different magmatic pulses and their duration. Additional Sr, Nd, Pb, Hf isotope studies specify the magmatic source of the different plutonic pulses.

FIELD RELATIONSHIPS AND SAMPLING

Field observations reveal that most of the Ilo batholith is a tabular body that has been tilted down to the NE by 20-30°. Cross-sections of the batholith are thus exposed, their top being located to the NE in map view. We were therefore able to study the intrusive contact with the Chocolate Formation above and below the batholith, and to sample it along several cross-sections for geochronology and geochemistry. In addition, clastic sedimentary rocks above and below the batholith were sampled in order to determine their maximum depositional age by dating detrital zircons using LA-ICP-MS. It is expected that similar detrital zircon populations will be found both below and above the tabular plutonic body, as they were originally juxtaposed.

Mafic and felsic granitoid magmas are intimately associated in the Ilo batholith, as reflected by the emplacement of mixed diorite-granodiorite units. Furthermore, mafic and felsic magma mingling is observed north of Ilo (e.g., globular enclaves of diorite in granodiorite, elongated inclusions, derived from both basaltic and composite basaltic/dacitic synplutonic dikes). Thus no simple mafic to felsic intrusive sequence prevailed during construction of this batholith.

RESULTS

Twenty new U–Pb zircon ages (LA-ICP-MS and CA-ID-TIMS) accompanied by geochemical data suggests the Ilo batholith formed via the amalgamation of subduction-related melts of Middle Jurassic and late Early Cretaceous age (Fig. 1). The dominance of late Middle Jurassic ages (~170-163 Ma) has to be stressed, as it reflects that large magmatic volumes were emplaced at this time, which coincides with major slumping in the backarc as well as initiation of clastic progradation from the NE (Sempere et al., 2002). The late Early Cretaceous ages are early Albian, as in the Coastal Batholith of central Peru (Pitcher et al., 1985), coinciding with the time when a major transgression was initiated in the nearby backarc (Robert et al., 2002).

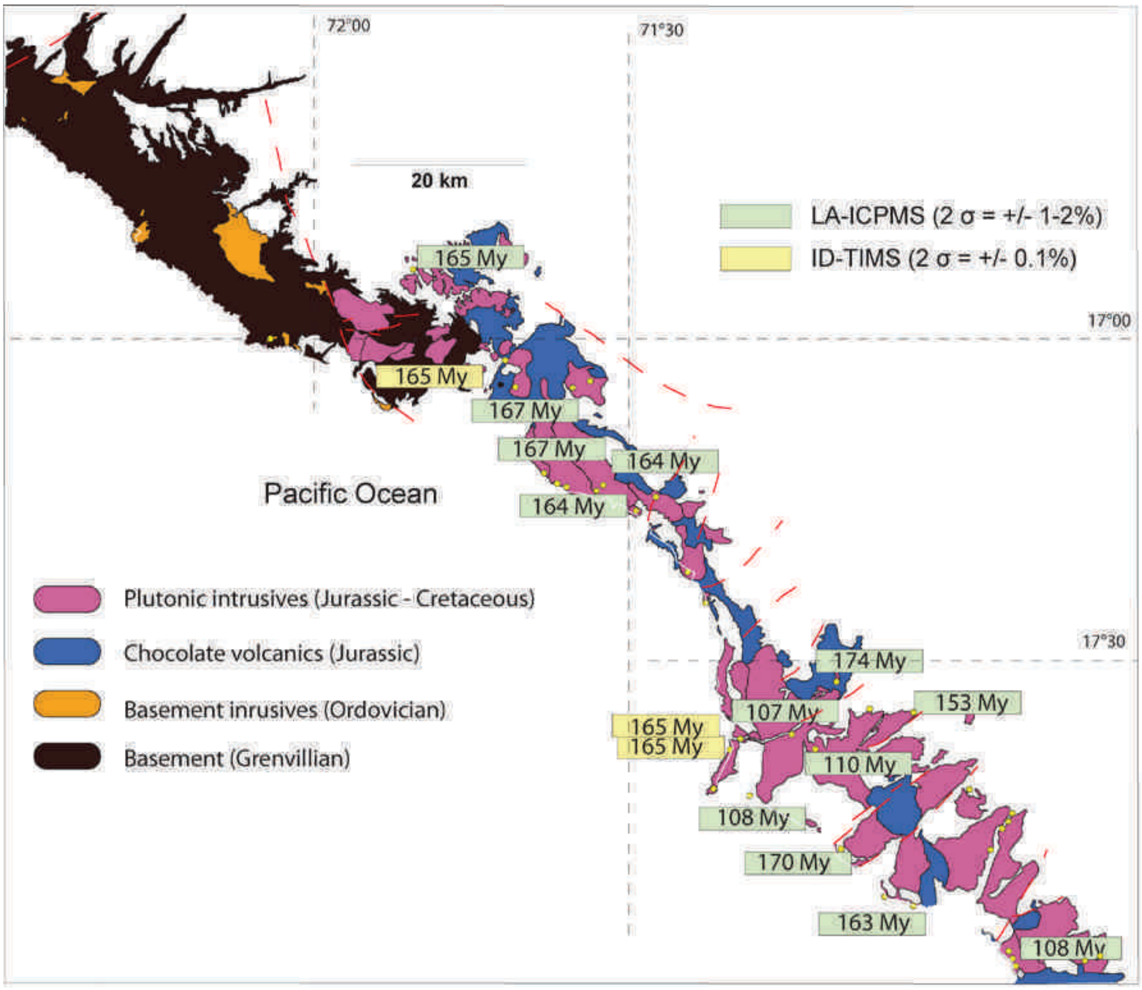

Figure 1. Zircon U-Pb ages obtained in the Ilo batholith

Preliminary Hf isotope analyses of 3 samples dated by U-Pb TIMS show a voluminous pulse of magmatism at ~165 Ma. Values of epsilon-Hf range from +4 to +6.9, indicating a depleted mantle source typical of continental margin settings. Additional Sr, Nd and Hf isotope analyses are planned to further resolve the source regions of different pulses of plutonic activity.

We suggest that batholith emplacement was at least partly coeval with the accumulation of the Late Permian to Middle Jurassic Chocolate s.l. Formation, which is likely to have occurred in an extensional tectonic regime. Our age results and geochemical signatures suggest episodic emplacement of huge amounts of subduction-related magmatism, as observed at several times during the Andean evolution. Although the exact geodynamic setting remains to be precised in each case, it is likely that the voluminous magmatic episode here identified in the late Middle Jurassic was linked to extensional conditions that developed during the breakup of Pangea, which commenced ~230-220 Ma ago along the western margin of South America.

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