

The Paracas Terrane (central-northern Perú): A Grenville-age sialic basement accreted to the western Gondwana margin during the Famatinian orogeny

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Abstract. The northern segment of the Central Andes of Perú has limited exposures of a pre-Andean basement along the forearc region. Recent studies performed in the Isla de Las Hormigas de Afuera, located in the outer shelf along the continental slope, show a high grade basement of Grenville age. This basement was correlated with a series of basement highs along the forearc region where industrial drillings tested a continuous occurrence of similar gneisses. This confirmed the cratonic nature of the forearc basement, and the existence of a cratonic terrane, named Paracas, as an allochthonous-paraautochthonous terrane accreted to the Gondwana margin. Ophiolites, high pressure-low temperature and low pressure-high temperature paired metamorphic belts, as well as the related structural deformation confirmed the collision during middle-late Ordovician times of this terrane against the Gondwana margin.

Keywords: Collision, Ordovician, high-grade metamorphism, Marañón Massif, ophiolites, paired metamorphic belt.

1 Introduction

The ages of the metamorphic basement of the Las Hormigas de Afuera Island (Fig. 1) allow for the first time to assess the existence of a pre-Jurassic sialic crust in the forearc of central and northern Peru (Romero et al., 2011). The new data show that the Paracas terrane basement has a Grenville-age of $1,001 \pm 10$ Ma, values common in the Arequipa Massif (Wasteneys et al., 1995; Loewy et al., 2003, 2004) and elsewhere from Colombia to Patagonia in the proto-continental margin of South America (Ramos, 2010). The metamorphic high grade is the same as the Arequipa gneisses, and it has also a magmatic episode of 467.9 ± 4.5 Ma, an age almost identical to the San Nicolas Batholith crystallization ages obtained by Lowey et al. (2003, 2004). These facts confirm the correlation between the outer-shelf high in the Peruvian forearc and the Arequipa Massif, as early proposed by Atherton et al. (1983), based on the comparison of the gravity sections along the coast. These authors emphasized the important crustal change north and south of the Abancay deflection, which represent for them a change in the pre-Mesozoic crust.

Since the early work of Atherton et al. (1983), most of the authors accepted the continental crustal nature for the Western Cordillera to explain the large volume of granitic

juvenile magmas, as emplaced in an aborted back-arc basin developed in attenuated continental crust (Aguirre et al., 1989; Atherton and Aguirre, 1992).

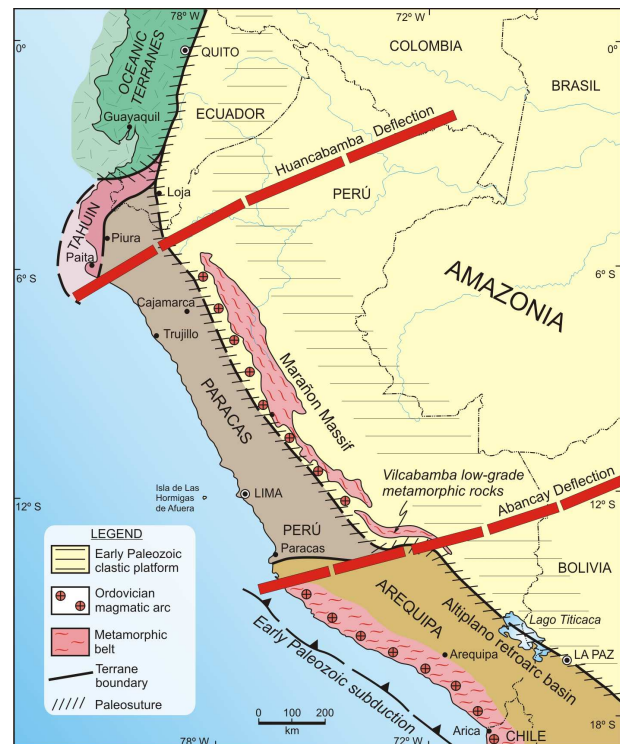


Figure 1: Main tectonic elements of the early Paleozoic of Perú showing the extent of the Paracas terrane, the Ordovician magmatic arc, and the location of the suture where ophiolites have been reported as well as high pressure metamorphic conditions (modified from Ramos, 2009).

However, Haeberlin et al. (2004) proposed an alternative explanation for the lack of evidence of sialic cratonic material below western Perú: the high density basement is thought to correspond to a piece of oceanic crust formed during the Paleozoic through the removal and northward migration of the northern part of the Arequipa Massif. Polliand et al. (2005) present interpretations based on U-Pb, Hf, and geologic data at the latitude of Lima that are in agreement with the intra-arc extensional model of Soler (1991), but support the lack of sialic basement underlying this part of the Peruvian coast.

2 Ordovician paleogeography

Based on the new data presented in the Las Hormigas de Afuera Island by Romero et al. (2011), the proposal of removal and northern migration of the northern part of the Arequipa Massif should be discarded. However, the lack of evidence of a continental crust based on U-Pb, Hf, and other geologic data, is easy to reconcile with an extensional regime as the one proposed by Soler (1991). Most of the continental margin of South America has been affected by extension during Late Jurassic and Early Cretaceous times, and as result of that, poorly evolved igneous rocks of juvenile nature were erupted in these intra-arc settings.

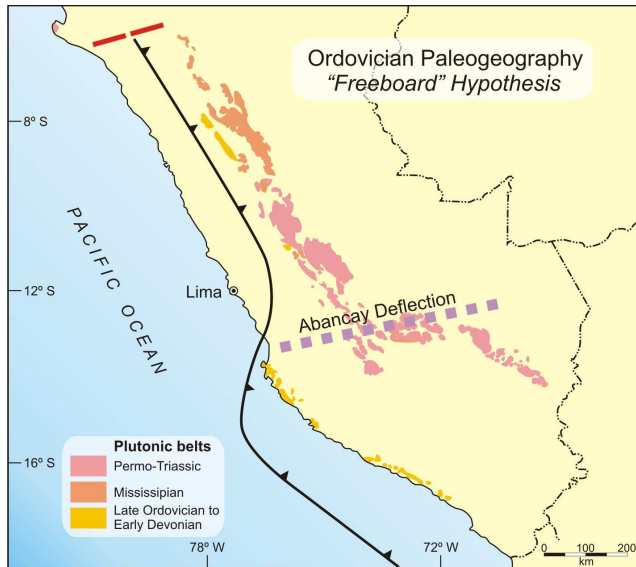


Figure 2. Free board hypothesis with indication of the paleosubduction zone proposed during the Ordovician to explain the magmatic arc recognized in the Marañón Massif (based on Chew et al., 2007).

The existence of an early Paleozoic magmatic arc along the Marañón Massif, more than 600 km away from the present trench (Cardona et al., 2005; Chew et al., 2007) requires that the Paracas terrane was not in its present position during Ordovician times. To avoid this problem several authors proposed a freeboard hypothesis (see Fig. 2), which requires only oceanic crust west of the Marañón Massif, and postulated an oceanic embayment north of the Abancay deflection (Chew et al., 2007). The alternative hypothesis considered the collision of a Paracas sialic terrane in Ordovician times (Ramos, 2008).

New research conducted by Castroviejo et al. (2009, 2010) along the western margin of the Marañón Massif recognized a suture with a NMORB to EMORB ophiolitic assemblage. New studies on this belt by Willner et al. (2010) identified high pressure metamorphic conditions with garnet amphibolites along this collisional shear zone, which also favor the hypothesis of a collision. This high pressure belt together with the metamorphism of low to middle pressure and high temperature above the magmatic

arc of Marañón described by Chew et al. (2007) will constitute a typical metamorphic pair as described in other subduction zones.

These ophiolites represent oceanic crust formed during the break-up of Rodinia (~ 720 Ma) and tectonically emplaced at some stage in the Late Ordovician (~ 450 Ma) according to Tassinari et al. (2011).

3 Discussion and Conclusions

The new data indicate that the accretion of the Paracas terrane took place after 467 Ma and prior to 450 Ma along the continental protomargin of Gondwana. The main geological characteristics and the age of the magmatic arc show that this collision was coeval with the Famatinian orogeny recognized all along the Sierras Pampeanas of Argentina, and even further north. The Grenvillian age of this basement suggests that Paracas, as well as Arequipa, was part of the Rodinia supercontinent. This implies a previous accretion in Mesoproterozoic times, a detachment in the Neoproterozoic with formation of oceanic crust, and a new accretion in middle to late Ordovician times. These processes affected the whole western margin (present coordinates) of Western Gondwana between middle Proterozoic and the Ordovician times.

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