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THE LOST “CHIVATEROS PLATEAU” AND THE NEOCOMIAN FLAT SLAB ALONG THE WESTERN MARGIN OF GONDWANA: EVIDENCE AT THE JURASSIC-CRETACEOUS CONTACT IN THE LIMA AREA

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In the Lima area, there is a unique, well-known and hitherto unexplained abrupt provenance and source difference occurs at the contact between the Puente Piedra and Morro Solar groups that imply an important collapse and drowning of the Jurassic Volcanic Arc contemporaneous with the uplift of quartz-rich basement rocks (Fig. 1, 2 and 3). Regional analysis strongly supports a switch from steep to shallow subduction angle to explain the sudden change from volcanic-arc derived, quartz-absent Puente Piedra Group to the basement derived quartz rich Morro Solar Group (Figs. 1, 2 and 3). This novel interpretation of a Neocomian (post Berriasian) shallow subduction explains 1) the regional volcanic lull, 2) the timing of uplifting of the Marañon Block and the Arequipa Terrain, 3) the synchronous basin development and subsidence between these basement uplifts, 4) deposition of a Neocomian thick clastic wedge west of the Marañon Block, and 5) perhaps explains the poorly documented and dated Viru Orogenic Event (Jaillard, 1994).

This long lasting Neocomian flat slab along the western margin of Gondwana can be explained by the subduction of an alleged oceanic plateau here named “Chivateros Plateau” (after the oldest Pre-Inca culture). An oceanic plateau is more liable than subduction of and aseismic ridge because of the concurrent volcanism termination, the length and duration of this shallow subduction (20 Ma), which is similar to the processes that gave rise to the Laramide Flat Slab in the western U.S.A (Liu et al, 2008, 2010). Indeed, the well documented Jurassic arc-trench system that stretched from Chile to northwest Peru was relayed northward of the latitude of Olmos by a collisional suture associated with the accretion of Paleozoic terranes in northern Peru and Ecuador (fig. 4 and 5). Furthermore, the subduction of the Chivateros Oceanic Plateau associated to oblique convergence between the Farallon and South America Plates enhanced the initiation of crustal shortening and exhumation of basement blocks concurrent with regional cessation of arc volcanism and localized inversion of the Jurassic arc edifice

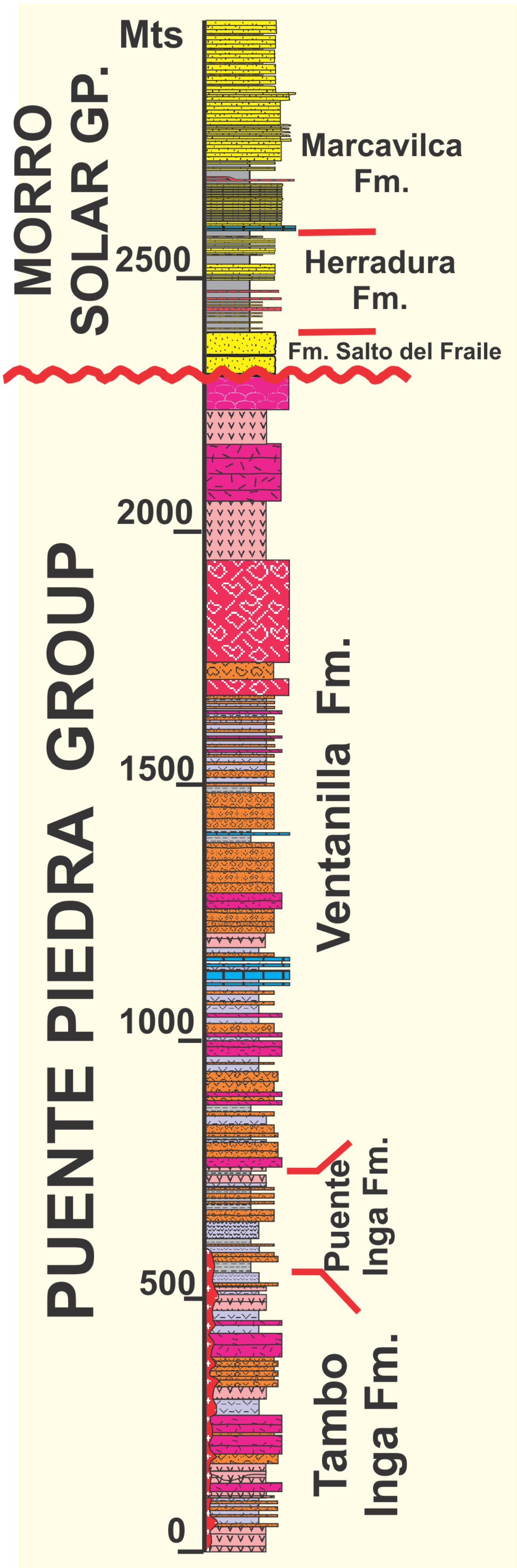

Fig. 1. Stratigraphic column of the Puente Piedra and Morro Solar groups (after Aleman et al, 2004)

While most of the Mesozoic western margin of Gondwana was characterized by subduction erosion and almost continuous arc-trench system, a Neocomian flat slab has been documented and occurred along the Peruvian Coastal Ranges (PCR) from near the latitude of Olmos in the north (Fisher,1956, Pardo and Sanz,197), to near Arica in northern Chile (Oliveros et al, 2007). The abrupt switch from arc-derived to quartz-rich siliciclastic took place near the Jurassic-Cretaceous boundary and heralded the change from normal to shallow subduction (fig. 2). Indeed, protracted Jurassic arc volcanism characterized most of the Peruvian and Chile margins which, terminated in northwest Peru where it was replaced northward by a suture zone associated to the accretion of Paleozoic terranes as documented along the Cordillera Real and the Tahuin Mountain of Ecuador (Litherland et al, 1994).

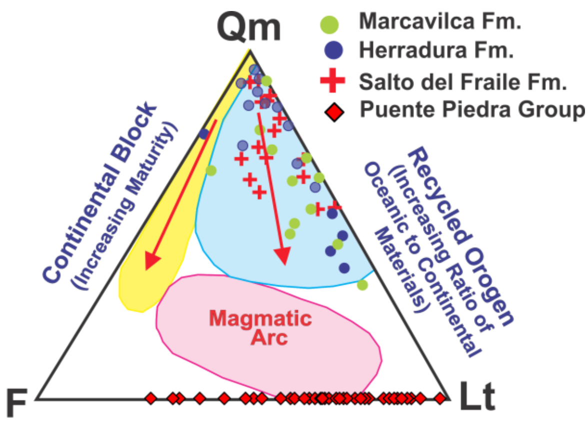

Fig. 2. Modal analysis of the Puente Piedra and Morro Solar groups.

The northernmost outcrop along the coast is in the La Leche River (Lambayeque), where the Neocomian, quartz rich Chimu Formation has been documented to be overlying the Middle Jurassic volcaniclastics of the Colan Formation (Pardo and Sanz, 1979). Unfortunately, the Coastal Batholith and the Albian/Cenomanian Casma Group have reduced and covered most of the Lower Cretaceous outcrops. However, several localities in the Lima area such as the Manzano Hills and the Chapeconde Beach have been reported to have the Neocomian quartz rich Morro Solar Group overlain the volcanic arc sequence of the Tithonian Puente Piedra Group (Aleman et al, 2006). Further south, the last contact documented is located along the Rio Grande River (Ica) where the Neocomian quartz-rich Hualhuani Formation is overlain the Guaneros Formation (Aleman et al, 2008, Leon et al, 2008). Further south, along the coast between Punta de Bombon and Tacna, the lower to upper Jurassic arc sequence of the Chocolate and Guaneros formations where exhumed during this postulated shallow subduction and most if not all the Yura Group is absent (Bellido and Guevara, 1963; Martinez and Cervantes, 2003). Indeed, along the coast, they have mapped the Chocolate and Guaneros formations to be overlying by the uppermost Cretaceous to lower Paleocene volcanic arc sequence of the Toquepala Formation. However, at almost the same latitude but further east in Arequipa, the Liassic Chocolate Formation was described to be overlain by a Bajocian to Toarcian limestones of the Socosani Formation which in turn is overlain by Callovian to Neocomian Yura Group that contains several formations of quartz rich sandstones including the Neocomian Hualhuani Formation (Benavides, 1962).

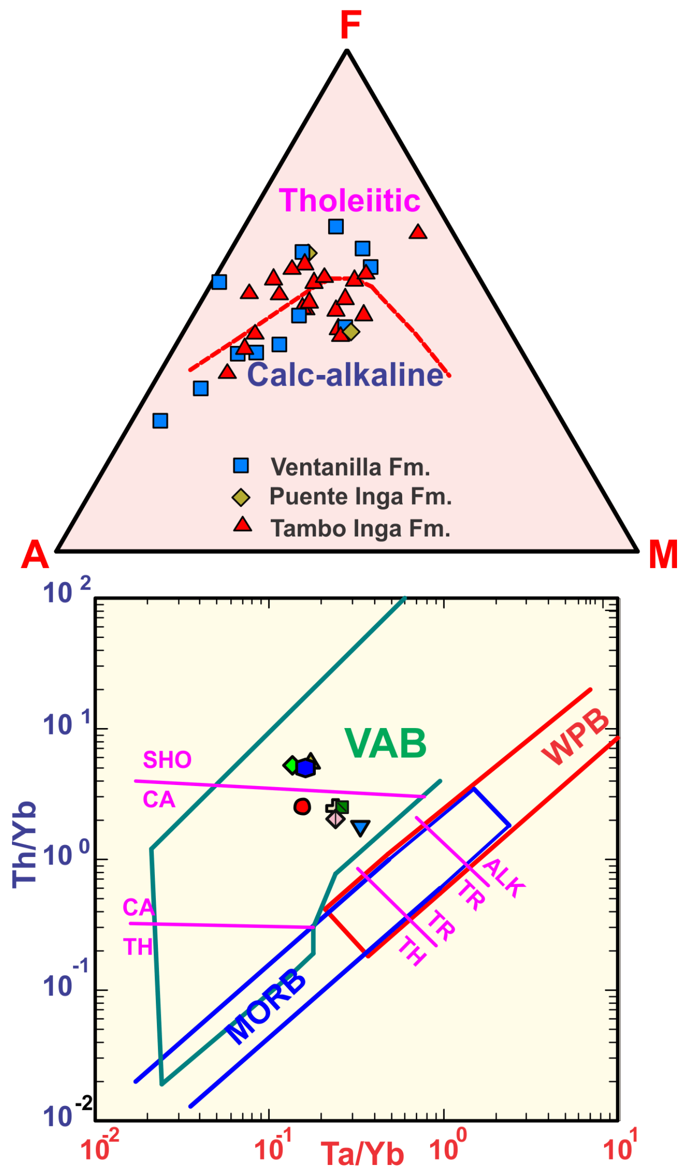

Fig. 3. AFM (after Irvine and Baragar, 1971) and discrimination diagram of the lavas (after Pearce, 1982) for the Puente Piedra Group.

Subduction flattening at the Jurassic-Cretaceous boundary associated to subduction of the buoyant “Chivateros Plateau” was concomitant with oblique convergence (Maloney et al, 2013; Müller et al, 2016). This paired tectonic events caused widespread shortening and exhumation of the upper plate due to inboard propagation of the strong plate contact. Thus, the compressional stress at the plate boundary was magnified by the almost absence of asthenospheric wedge which in turn was boosted by strain partitioning associated to the oblique convergence (Maloney et al, 2013; Müller et al, 2006). This strong intraplate coupling yield deformation hundreds of kilometers inboard and because of the buoyancy lost during basalt-eclogite transformation as described by Liu et al, (2008. 2010), the uplift continued throughout the subduction of this anomalous oceanic crust. Indeed, the Neocomian flat slab triggered the uplift of the Marañon block and the Arequipa Terrain, as occurs in many old and modern flat subductions (Haeusher, 2008). In our opinion, the absence of lower Cretaceous units along the coast of the Arequipa Terrain is perhaps related to long-term uplift from Neocomian to lower Campanian. The sediment source were the uplifted areas and in between was the site of subsidence and deposition of a thick Neocomian clastic wedge that extended to the western edge of the Maranon Block (Fig. 4).

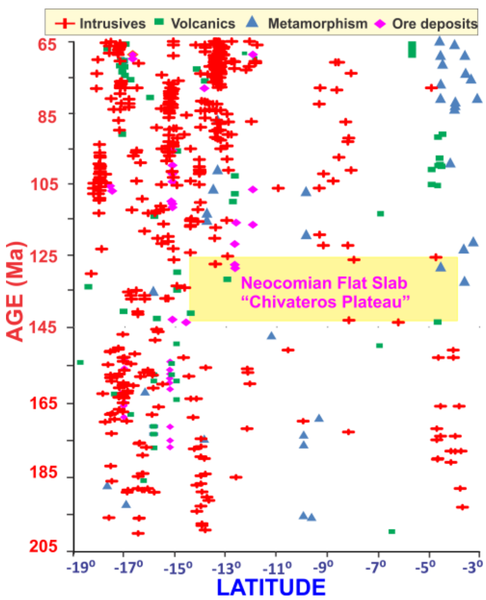

Fig. 4. Jurassic and Cretaceous isotopic ages versus latitude showing the volcanic lull during significant part of the Neocomian. Ages are from INGEMMET database updatted for this study.

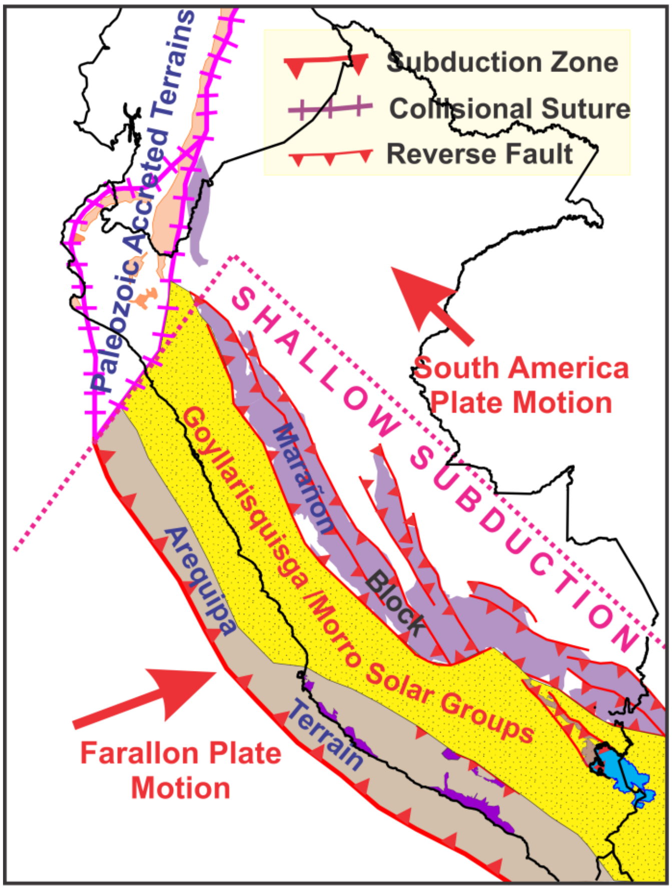

Fig.5. Proposed reconstruction during the Neocomian Flat slab. Relative plate motion is after Müller et al (2016).

CONCLUSIONS

A Neocomian flat subduction initiated during Berriasian times has been suggested to explain the collapse and drowning of the long-lived Jurassic Volcanic Arc concomitant with the uplift of the quartz-rich Maranon and the Arequipa Terrain in the east and west respectively. The thick skinned basement uplift was very similar to the Laramide basement uplifts in the U.S.A which has been also ascribed to a flat subduction associated to the encroaching of an oceanic plateau (Liu et al, 2008, 2010). Indeed, the arrival of the lost "Chivateros Plateau" caused the sudden flattening of the subduction slab was coeval with a regional volcanic lull, pervasive

Laramide-type block uplifting and contemporaneous subsidence between the major uplifted blocks, that was the site of deposition of a thick clastic wedge described by Benavides (1956) in his seminal paper. As an outcome, this shallow subduction may explain the poorly documented and dated Viru Orogeny (Jaillard, 1994).

Fig. 5. Outcrop at the Chapeconde Beach showing an slight ungular unconformity at the contact between the Puente Piedra (JrPp) and Morro Solar (KiMs) groups

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