TECTONIC ROTATIONS IN CENTRAL PERU

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ABSTRACT

The deformation of the Central Andes during the Cenozoic is characterized by tectonic rotations that define the Bolivian Orocline. Rotations are clockwise along the Chilean margin and counter-clockwise along the Peruvian margin (Arriagada *et al*. 2008). Previous results (Roperch, Carlier 1992; Roperch *et al*. 2006, 2011) have shown particularly strong counter-clockwise rotations in southern Peru. The Abancay deflection is an important tectonic structure limiting Central Peru to the south and whose formation is probably associated with the rotations of southern Peru.

To verify this hypothesis, we carried out a paleomagnetic sampling at 87 sites between along a transect of Ica and Ayacucho. We obtained results at 61 sites. The mid-Cretaceous coastal batholith and the Late Cretaceous volcanic rocks, record both counter clockwise rotations of 11°± 6 and 10°± 19 respectively. Oligocene and early Miocene rocks from the Altiplano record counter-clockwise rotations between 5 and 10°. These low magnitude rotations contrast with those previously observed within Southern Peru.

Keywords: Paleomagnetism, Oroclinal bending, Central Andes, Peru

RESUMEN

La deformación de los Andes Centrales durante el Cenozoico se caracteriza por rotaciones tectónicas que definen el Oroclino boliviano. Las rotaciones se encuentran en sentido horario a lo largo del margen chileno y en sentido antihorario a lo largo del margen peruano (Arriagada et al, 2008). Resultados previos (Roperch and Carlier, 1992; Roperch *et al*, 2006, 2011) mostraron en particular rotaciones antihorarias significativas en el sur de Perú. La Deflexión de Abancay es una estructura tectónica importante que limita la zona central de Perú al sur y cuya formación está probablemente asociada a las rotaciones en el sur de Perú.

Para verificar esta hipótesis, hemos realizado un muestreo paleomagnético en 87 sitios a lo largo de la transecta entre Ica y Ayacucho. Obtuvimos resultados en 61 sitios. El batolito de la costa del Cretácico Medio y las rocas volcánicas del Cretácico Superior registran rotaciones antihorarias de 11°± 6 y 10°± 19, respectivamente. Las rocas del Oligoceno y del Mioceno Inferior del Altiplano registran rotaciones antihorarias entre 5° y 10°. Estas rotaciones de baja magnitud contrastan con las rotaciones observadas en el sur de Perú

Palabras claves: Paleomagnetismo, Plegamiento Oroclinal, Andes Centrales, Perú

1. Introduction

The Andes of central and southern Peru are separated by a major E-W discontinuity (the Abancay deflection, Figure 1) (Carlotto, 2013) with several differences in the paleogeographic evolution of during the Mesozoic and the Tertiary. The Abancay deflection is especially well recognized in the abrupt change in the width of the Andean chain. A wide magmatic arc was emplaced during the middle-late Eocene – early Oligocene (~48-30 Ma) as a consequence of flat-slab subduction below southern Peru (James, Sacks 1999). The Abancay deflection is also presently in front of the Nazca ridge that limits the southern edge of the flat slab segment below central Peru. A counter-clockwise rotation is a main characteristic of the geodynamic evolution of the Peruvian Andes (Heki *et al*. 1985; Kono *et al*. 1985; Rousse et al. 2003; Macedo-Sánchez *et al*. 1992a,b; Roperch, Carlier, 1992). Further work in Southern Peru (Roperch, *et al*. 2006, 2011) has

clearly documented evidence for Eocene-Oligocene large counter-clockwise rotations. Here we report paleomagnetic results from southern Central Peru in order to better describe the changes in rotation pattern from Central to southern Peru.

2. Paleomagnetic sampling and experiments

The paleomagnetic sampling was done in the region between the main towns of Pisco and Ayacucho (Figure 1). The coastal batholith was sampled at 17 sites and Late Cretaceous volcanic rocks were sampled at 6 sites on the eastern edge of the batholith. 64 sites were drilled in Late Eocene – Miocene rocks of the Andean Plateau at elevation above 4000m. 40Ar/39Ar plateau ages were obtained on 14 samples to constrain the age of the sampled units. Early Miocene volcanism is widely distributed across the plateau while Late Eocene –Early Oligocene volcanism is found in a more deformed belt west of the Chonta fault.

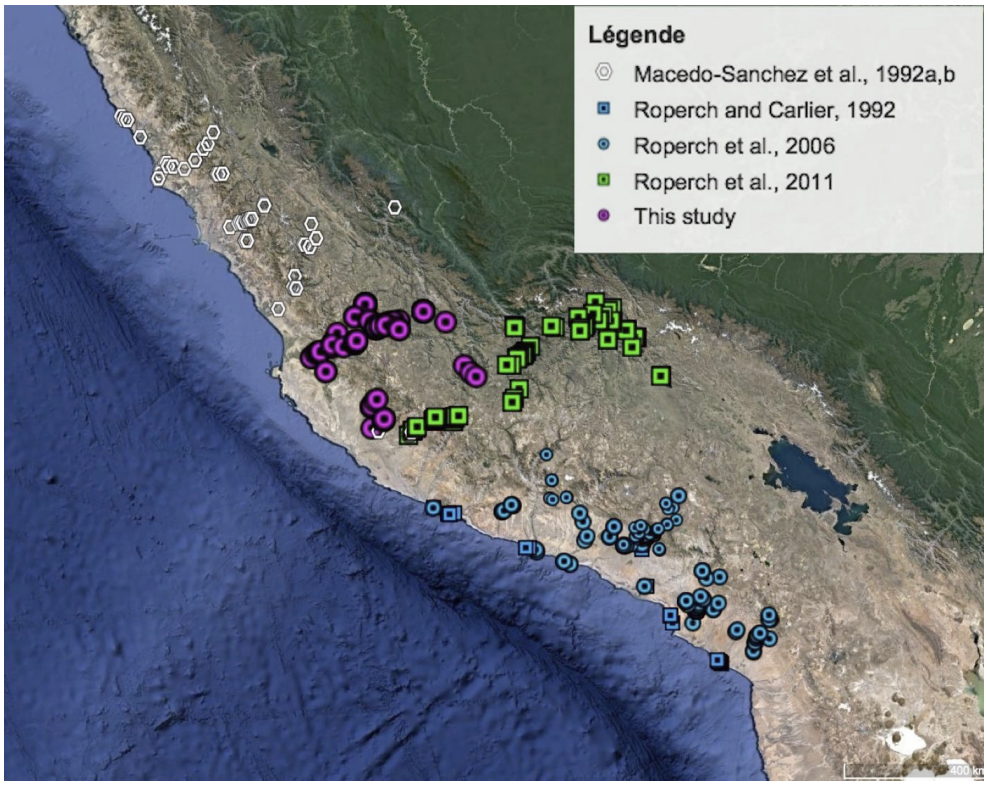

Figure 1. Google Earth image with paleomagnetic sampling in Central and Southern Peru.

3. Paleomagnetic results

In most cases a Characteristic Remanent Magnetization (ChRM) of primary origin was recovered after thermal and AF demagnetization. At fives sites of Late Oligocene – Miocene rocks, a secondary magnetization with reverse polarity was isolated (Figures 2 and 3).

The mid Cretaceous batholith records a normal polarity magnetization in agreement with the radiometric ages indicating an emplacement during the Cretaceous normal polarity superchron. Reverse polarities were observed in the youngest Late Cretaceous volcanics. Normal and reverse polarity ChRMs were found in the Cenozoic units. A significant scatter mainly due to the record of secular variation is observed in these rocks. At one locality, where a sequence of seven flows was drilled within a 100 m thick sequence, a volcanic flow recorded a transitional direction from a R-N reversal. This direction was omitted from the calculation of the mean field direction.

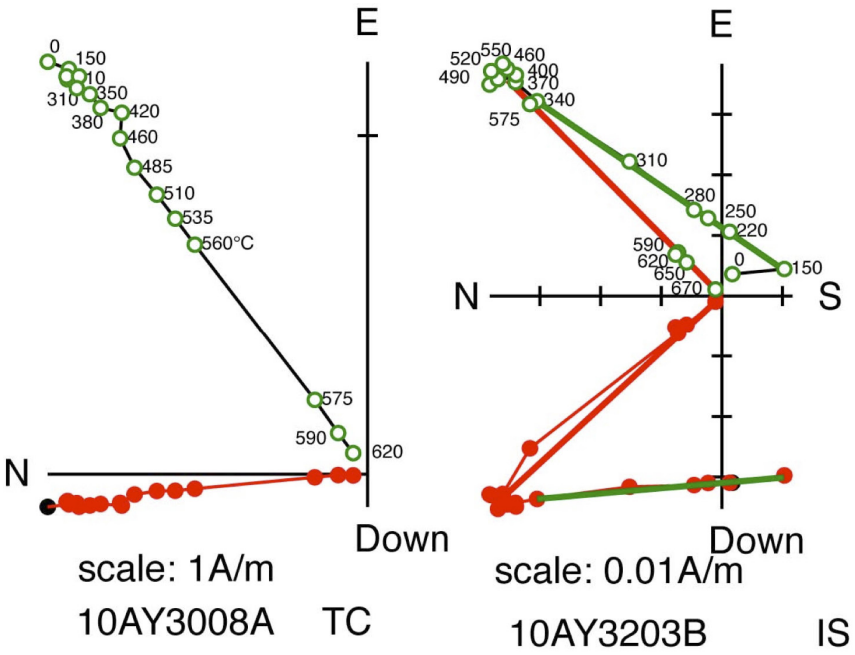

Figure 2. Example of orthogonal plots of thermal demagnetization. In sample 10AY3203B, a secondary component of magnetization (green line) was identified in the temperature range 150-370°C. Open (filled) symbols correspond to projection in the vertical (horizontal) planes.

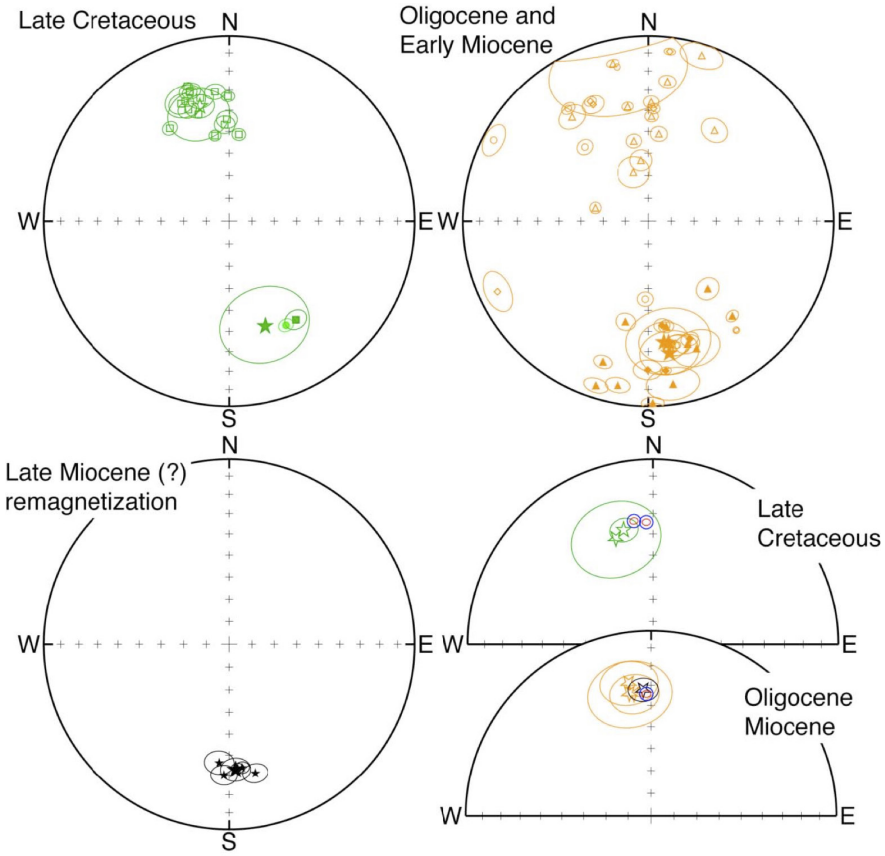

Figure 3. Stereonets of paleomagnetic results from Central Peru. Open (filled) symbols correspond to negative (positive) inclinations

The mean field direction for each group, despite the scatter, is well defined (Figure 3). When compared to the expected direction for South America (Torsvik *et al*. 2012), the error in inclination is almost null, while tectonic rotations decrease from 11°± 6 ° counterclockwise in the batholith to 5°± 10° counterclockwise in Early Miocene rocks. The re-magnetization is almost not rotated suggesting possible Late Miocene hydrothermal events as a source for the re-magnetization.

The new results from Central Peru confirm the sharp transition in the rotation pattern between Central and Southern Peru with counter clockwise rotations not exceeding 11° in the study area.

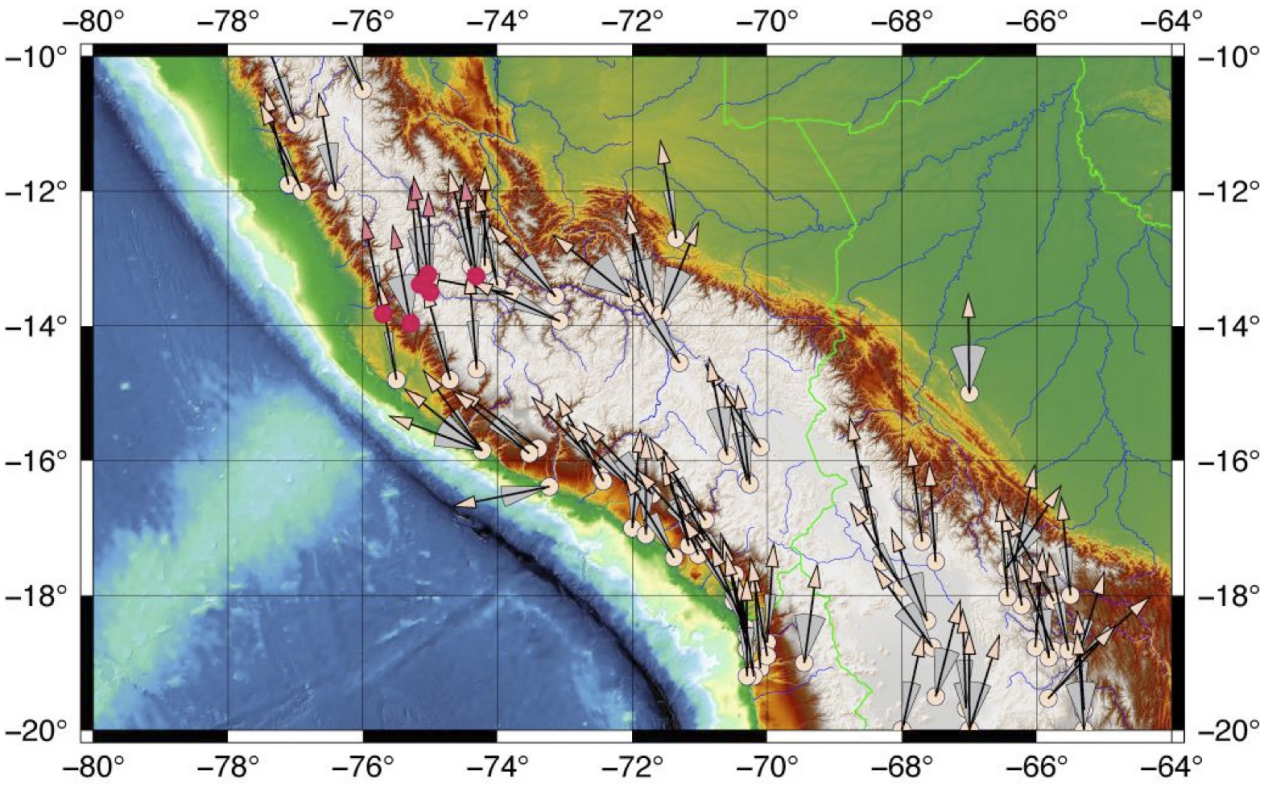

Figure 4. Plot of the tectonic rotations in the central Andes. (modified from Arriagada et al. (2008) and Roperch *et al.* (2011)). The location of the present study is shown by the red circles.

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