PALEOLATITUDES AND VERTICAL-AXIS ROTATION IN AZUERO PENINSULA, PANAMA

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ABSTRACT

The study of the Isthmus of Panama is important to understand the tectonic evolution of the northern areas of South America and the global biotic and environmental repercussions of the closure of the Central American seaway. The Azuero Peninsula is an important locality for the paleomagnetic study of the Isthmus. It is located in the southwestern part of Panama and it is separated in two different terrains by the Azuero-Soná Fault Zone. We collected ninety oriented cores in nine different localities as result of one month of fieldwork in the southwestern part of the Azuero Peninsula. After processing two pilot samples per site, each one subjected to a different demagnetization technique (alternating fields and thermal), the most appropiate demagnetization technique was adopted. Preliminary results are presented that suggest that the rotation of the blocks in Azuero Peninsula was independent of the principal activity of the Azuero-Soná Fault Zone. The data also preliminarlly suggests that paleolatitudes were close to the ecuatorial line.

Keywords: paleomagnetism, axis-vertical rotation, Azuero Peninsula.

Introduction

The study of Isthmus of Panama is important to understand the tectonic evolution of the north of South America and the global biotic and environmental repercussions of the closure of the Central American seaway. Some geologic models of Panama used paleomagnetic studies in order to understand the evolution of the Isthmus. Paleomagnetism is a relevant tool in the construction of tectonic models because it allows determining the rotations and the paleolatitudes of geological blocks at different ages. The Azuero Peninsula is located in the southwestern part of Panama and it is separated in two different terrains by the Azuero-Soná Fault Zone. The terrains are autochthonous north of the fault and allochthonous to the south. This geological background makes it as a potentially interesting area for paleomagnetic studies in view of the description of relative movements of both terrains and to constrain the evolution of the southern edge of the Caribbean Plate. Paleomagnetic data can contribute in the determination of the paleolatitudinal evolution of the Caribbean Plate, i.e. whether it has an origin in the Pacific (Pindell *et al*., 1990) or it is authochthonous (James *et al*., 2009).

Geological framework

The Azuero Peninsula is separated into two different parts: the areas to the north of the Azuero-Soná Fault Zone correspond to an autochthonous arc terrain constructed in southern edge of the oceanic Caribbean Plateau (CLIP). The southern part is constructed by accreted seamounts that are unconformably overlain by forearc sediments (Buchs *et al*., 2011). Later studies have made detailed descriptions in all secuences of igneous rocks of the seamounts described by Buchs *et al*. (2011) as well as the sedimentary units of the forearc basin. Previous paleomagnetic analysis in Panama suggests large counterclockwise vertical-axis rotations in the autochthonous terrain for the middle Eocene (Montes *et al*., 2012), but there is scarce

paleomagnetic information in the Azuero Peninsula. Di Marco (1995) and Frisch (1992) presented some paleomagnetic data from the Azuero Peninsula, however, these investigations were not focused on this peninsula and are not sufficient for a robust paleomagnetic analysis of the area.

Methodology

Ninety oriented cores from nine different localities were collected in the southwestern part of the Azuero Peninsula. This work was performed with the collaboration of the 2014 geology field course of the Universidad de los Andes. Field work was divided into two parts. (a) Mapping and description of different localities in the peninsula (Fig. 1). In the map, it is possible to recognize important geologic elements of the region, in particular the Azuero-Soná Fault Zone, basalts with different affinities, the Ocú Formation, and other important geologic elements of the peninsula. (b) Identification of different localities for paleomagnetic sampling and core collection.

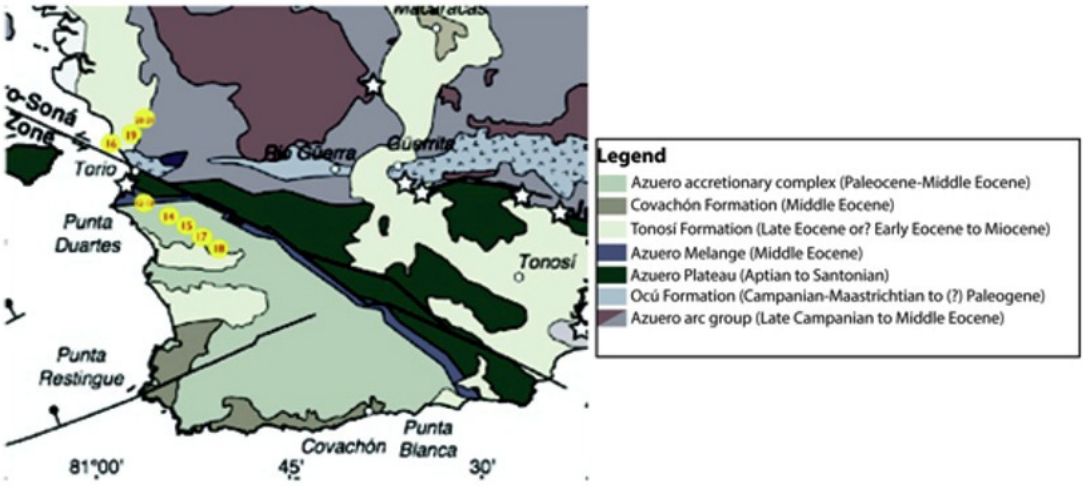

Figure 1. Geological map of the southwestern part of the Azuero Peninsula. Modified after Buchs *et al*. (2011). Location of sampling sites is shown in yellow.

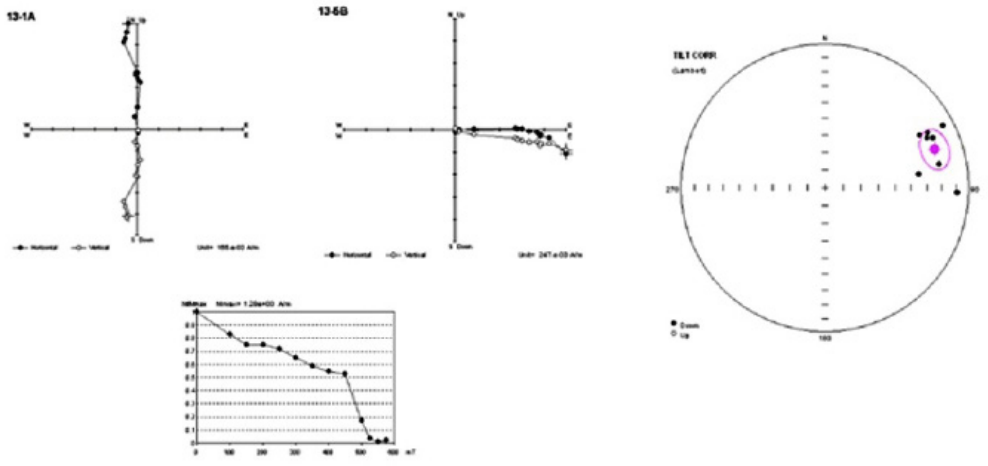

Figure 2. Characteristic demagnetization diagrams for locality 990013 and characteristic directions for all samples of this site. Note the good directional consistency

The identification of appropriate localities for paleomagnetism was the result of different considerations. In the volcanic rocks, the basalts are considered the best option because they cool very fast which limits alteration of the rocks and therefore the likelihood of disturbance in the recording of the magnetic field. In sedimentary rocks, the mudstones were considered the best option, mainly due to its small grain size. Another important factor in paleomagnetism are the structural relations of the rocks making the identification of these relations and its quantification very significant.

Laboratory analyses were made at IGEBA (Instituto de Geociencias Básicas, Aplicadas y Ambientales de Buenos Aires) Buenos Aires, Argentina. We demagnetized two pilot samples per site, in most of the localities, one with each demagnetization technique (alternating fields and thermally). The demagnetization with alternating fields was performed using the sequence of 2, 4, 6, 8, 10, 15, 20, 25, 30, 40, 50 and 60 mT, and in the thermal demagnetization the sequence was 100, 150, 200, 250, 300, 350, 400, 450, 500, 525 and 550º C. Two magnetometes, JR-6 Agico and Cryogenic 2G 755R were used for measuring the remanence. Analysis of data was performed with software RemaSoft 3.0 (Agico). After pilot treatments the most effective demagnetization technique for each site was applied to the remaining samples (Fig. 2 and 3).

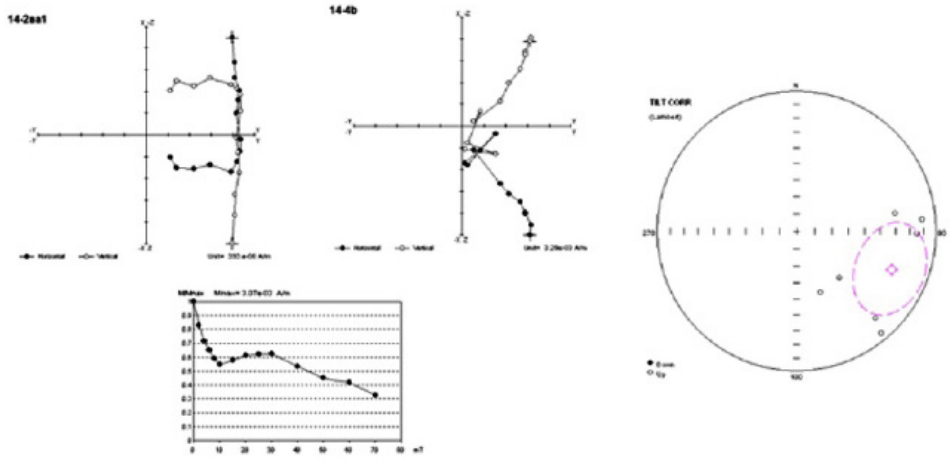

Figure 3. Idem Fig.2 for locality 990014. Note the relatively poor directional consistency

Results and Discussion

After demagnetization and first analysis, we found consistent paleomagnetic results at eight sites. Figure 4 illustrates preliminary site mean directions after tilt correction. It is evident good directional consistency for several sites. Approximately an 80º anomaly in declination is observed, whether this corresponds to large CW or CCW rotations is not clear. The mean magnetic inclination of the studied sites rocks is 0.7°, indicating that cooling of the volcanic rocks occurred very close to the equatorial line.

As preliminary conclusion we can suggest that the rotation of the blocks in the Azuero Peninsula was independent of the principal activity of the Azuero-Soná Fault Zone. The data also preliminary suggests that paleolatitudes were close to the ecuatorial line

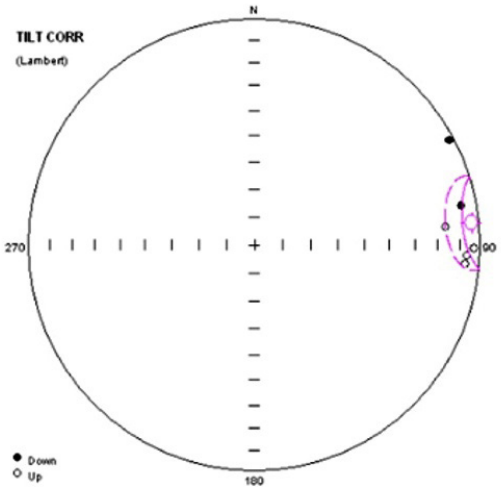

Figure 4. Equal-area stereoplot of mean site, characteristic remanence directions and overall mean from selected localities. Note the large declination anomaly and very low mean inclination.

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