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Preliminary paleomagnetic results from the Cambrian Mesón Group: Implications for the Bolivian Orocline

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The Andean chain changes its strike near 18°S. This region is called the "Bolivian Orocline", which comprises part of Bolivia, Perú, Chile and Argentina and is characterized by counterclockwise rotations north of the bend and clockwise rotations south of it (Somoza *et al.*, 1996; Beck, 1998; Randalll, 1998). Despite its name, it is not considered at present as a true orocline as was defined by Carey (1958). Current models suggest that the present curvature is the result of an original geometric feature which has been enhanced by Andean tectonism (Kley, 1999). Several different hypothesis about the mechanisms that have caused the systematic rotations detected by paleomagnetism have been proposed, but no general consensus has been yet attained.

Because of the lack of Lower Paleozoic paleomagnetic data from Northwestern Argentina, a reconnaissance paleomagnetic survey was carried out on the Mesón Group, exposed along the Iruya River in the province of Salta (22°49´S-22°50´S y 64°50´W-65°00´W), near the Matancillas anticline.

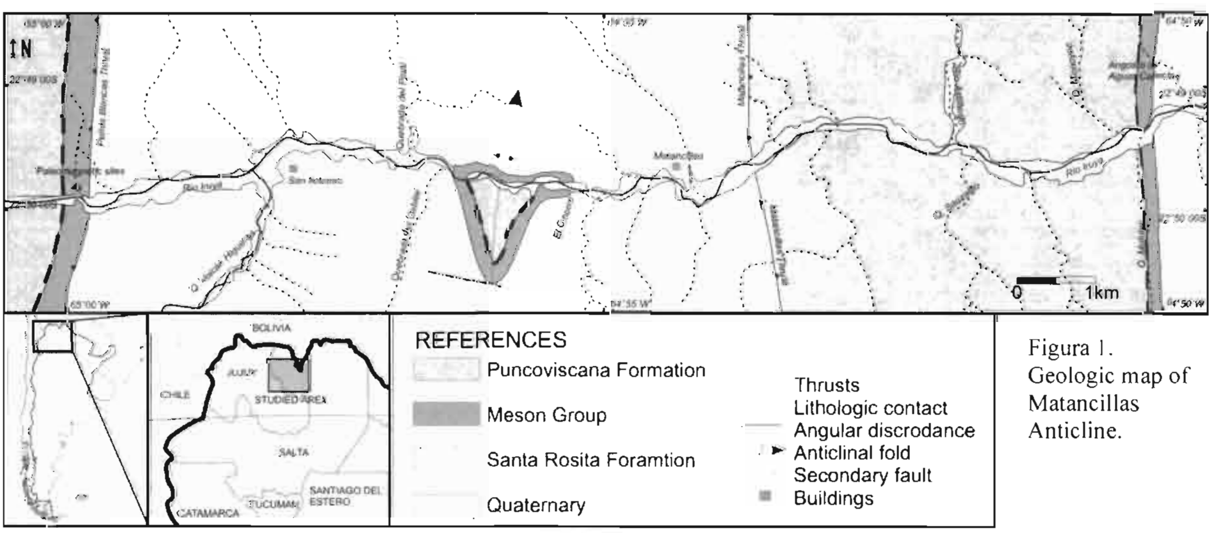

Figura 1. Geologic map of Matancillas Anticline.

The Mesón Group (Turner, 1960) is characterized by extensive outcrops in Northwestern Argentina. Its age is bracketed between the Middle and Late Cambrian from stratigraphic considerations (Turner, 1960). It is divided into the Lizoite, Campanario and Chahualmayoc Formations. The Lizoite Formation yields conglomerates at the base and overlying white-pinkish quartzites and sandstones with cross-bedding stratification. The Campanario Formation is a dominantly fine-grained succession with minor sandstones, while the Chahualmayoc Formation is again a relatively coarse-grained unit.

The main structure in the studied area is the Matancillas Anticline (fig.1), which is a several km N-S structure. It is interpreted as a fault propagated anticline generated during Andean tectonism. The axis of the anticline strikes N26°E and plunges 10° to the north, with a steep (75°) western limb and a gently dipping (17°) eastern one.

Paleomagnetism

89 samples (14 sites) were collected from the Lizoite Formation, but results were negative because the distribution of the obtained components was mainly random.

Sampling on the Campanario Formation comprised 4 sites (23 samples). Paleomagnetic results from all sites indicate that the characteristic remanence can be isolated from thermal demagnetization but not from alternating field demagnetization. The blocking temperature (680°C) suggests that hematite is the carrier of the remanence. A mean sample characteristic remanence direction (fig.2) shows a slight increase in their statistical parameters, after bedding correction. In situ: dec=78.2°; inc=78.1°; α_{95}=7.5°; k=15.2; R=24.4; N=26; and after correction: dec=83.8°; inc=43.9°; α_{95}=7.0°; k=17.4; R=24.6. The slight statistical improvement and lack of resemblance of in situ direction to any expected post-Andean direction strongly suggests that the magnetization is pre-tectonic. The calculated paleomagnetic pole is at 4.5° S and 359.0°E with α_{95}=7.0°.

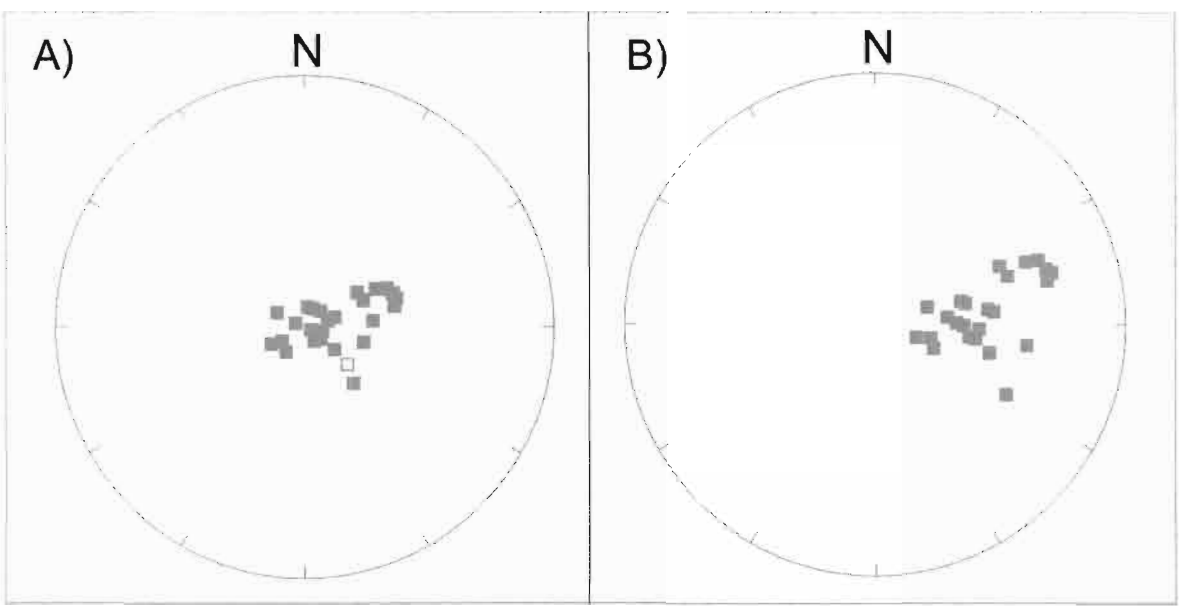

Figure 2. Distribution of paleomagnetic characteristic components of the Campanario Formation. The filled (empty) squares represents the lower (upper) hemisphere. A- In situ distribution. B- Restored to paleohorizontal.

This pole is not consistent with the Cambrian to Ordovician poles of Gondwana, nor is it coincident with younger poles. Taking the ~495 Ma mean pole of Gondwana (Grunow, 1999) as reference, an anomaly of 38° ± 8° in the declination value (fig.3) and an insignificant 5° ± 9° in flattening is observed.

The difference in the declination value can be interpreted as a clockwise rotation of at least 30° around a vertical axis of the studied region since the Ordovician. A simple explanation for this rotation is to relate it to the Central Andes rotation pattern (CARP, Somoza *et al.*, 1996). The observed sense and magnitude are consistent with rotations recorded in Mesozoic and/or Cenozoic rocks in the region (Beck, 1998; Randall, 1998) (fig.4).

Previous paleomagnetic studies indicate that rotations of this magnitude and sense associated to the Bolivian Orocline (CARP, Somoza *et al.*, 1996) should have affected the present studied area. Therefore, the Campanario Formation pole may reflect a regional clockwise rotation associated to the development of the Bolivian Orocline. On the other hand, Kley and Monaldi (1999) described the presence of transfer zones in the Andean margin in northern Argentina and southern Bolivia (fig.4). According to Kley (1996) the existence of structural "obstacles" that restrict the eastward propagation of anticlines in the subandean region, associated to the Cretaceous rift, served as transfer zones. According to this model, the Matancillas Anticline would be located along a dextral transfer zone, that produced clockwise deflections of the structural trends. Thus, a local block rotation associated to these structures may have also caused the observed paleomagnetic rotation.

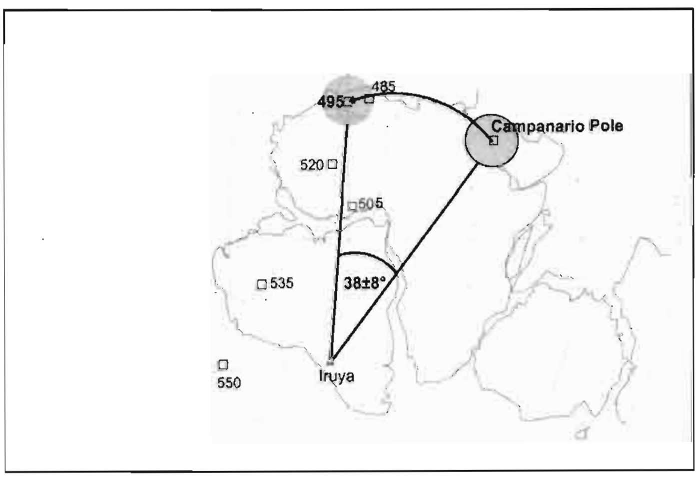

Figure 3. Average poles from Gondwana (Lower Paleozoic) (Grunow, 1999; Meert, 1999; Rapalini y Cingolani, 2004)

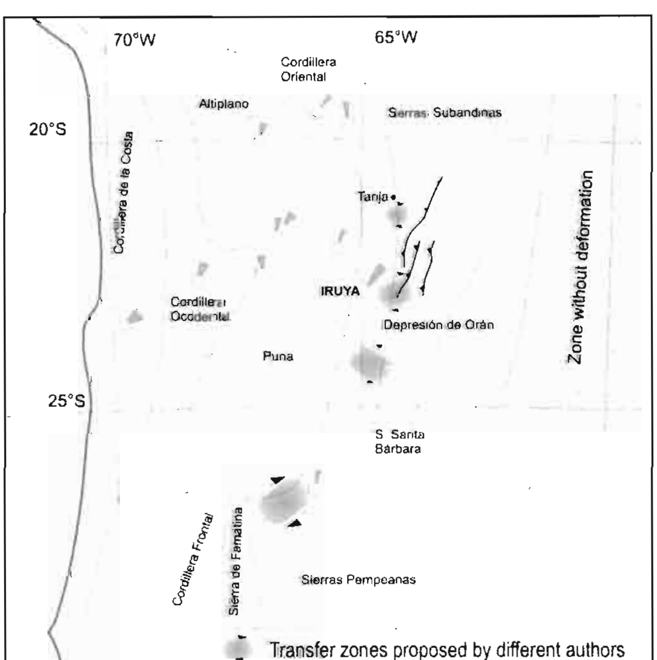

Figure 4. Paleomagnetic sites with their rotations (Somoza et al., 1996; Randall, 1998; Beck, 1998)

Conclusion

A reconnaissance paleomagnetic study was carried out on the Lizoite and Campanario Formations exposed along the Iruya River in the province of Salta, Argentina, near the Matancillas anticline. Paleomagnetic results of Lizoite Formation were negative. The Campanario Formation, on the other hand, carried stable and possibly primary magnetic remanence, which permit the calculation of a paleomagnetic pole (4.0°S; 359.0°E). This pole is not consistent with the Cambrian to Ordovician poles of Gondwana, indicating an anomaly of 38° ± 8° in declination value is observed. This suggests a clockwise rotation of the studied area of around 30°, which may be related to the regional deflections associated to the Bolivian Orocline, or to local crustal block rotations related to a dextral transfer zone along the Andean front.

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