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Magnetostratigraphy of the Miocene Las Arcas Formation, Santa María Valley, northwestern Argentina

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ABSTRACT

The first magnetostratigraphic study of the Las Arcas Formation (Late Miocene) was carried out in Las Totoritas creek (26°12′S; 65°47′W, NW Argentina), a key place in between of two geological provinces: Northwestern Pampean Ranges and Eastern Cordillera, in northwestern Argentina. This was accompanied by isotopic dating (9.01 ± 0.12 Ma, ^{40}Ar–^{39}Ar in amphibole) of the unit, obtained from a 3.4 m thick tuff intercalated at ~45 m above the base. The Las Arcas Formation is 810 m thick at the sampling locality and it is mainly composed of tabular reddish conglomerates, sandstones and siltstones in both coarsening- and thickening-upward arrangements. The exposed section was sampled at 48 sites, 26 of which are interpreted as carrying primary magnetization. The new magnetostratigraphic column was correlated with the Geomagnetic Polarity Time Scale (GPTS), and suggests that deposition of the Las Arcas Formation strata started at around 9.1 Ma and ended around 6.8 Ma. The paleomagnetic pole obtained for this unit (Dec = 8.7° Inc = −43.9° dp = 14.9 dm 9.3) indicates that this area underwent non-significant rotation (11.0° ± 13.6°) since the Late Miocene.

1. Introduction

Since Matuyama (1929) found paleo-directions of Earth's magnetic field in volcanic rocks from Japan and North China corresponding to normal and reverse polarities, numerous magnetostratigraphic studies have been carried out around the world for stratigraphic correlations and relative geochronological studies (e.g. Opdyke and Channell, 1996), especially in Cenozoic sedimentary foreland successions (e.g. Johnson et al., 1986; Reynolds et al., 1990; Homke et al., 2004; Sun et al., 2005), due to the high Cenozoic reversal frequency and the high sedimentation rates of these deposits. Successful magnetostratigraphic studies permit assigning a quasi-continuous age to sedimentary successions by correlating the local magnetostratigraphic column with the Global Polarity Time Scale (GPTS, Cande and Kent, 1995; Huestis and Acton, 1997; Gradstein et al., 2004, 2012). The southern Central Andes are characterized by a complex magmatic and tectosedimentary evolution (e.g. Jordan et al., 1993; Marrett and Strecker, 2000; Kay and Mpodozis, 2002; among others). Numerous magnetostratigraphic studies in Neogene Andean foreland successions have been published in the last two decades (e.g. Johnson et al., 1986; Reynolds et al., 1990, 2001; Jordan et al., 1990; Malizia et al., 1995; Irigoyen et al., 2000; Ré, 2008; Zambrano et al., 2010; Galli et al., 2014).

Many authors postulate a Cenozoic tectonic rotation pattern in NW Argentina (Aubry et al., 1996; Taylor et al., 2005; Arriagada et al., 2006). When the data are analyzed in detail, the pattern is not continuous (Aubry et al., 1996; Spagnuolo et al., 2008; Zambrano et al., 2010; Japas and Ré, 2012) nor it is related to a large scale rigid body rotation (oroclinal bending) but to local block rotations associated to displacements along major oblique lineaments, such as the Tucumán and El Brete Lineaments (Mon, 1979). Some authors suggested that the rotations found in NW Argentina are controlled by two large lineaments (Tucumán Lineament and Valle Fértil Fault Zone) and smaller parallel lineaments (Vizán et al., 2013) in a fractal model (Ré et al., 2001). At around 27° S the subduction angle of the Nazca Plate beneath South America changes from normal (~30°) in the north to subhorizontal in the south. Associated with it, a major physiographic change occurs at the transition between the Puna and the Pampean Ranges. Also in that

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region lineaments oblique to the Andean chain are notorious (Fig. 1). The Tucumán Lineament has been called Tucumán Transfer Zone (TTZ; de Urreiztieta et al., 1996; Coutand et al., 2001) being a dextral transpressive zone of SW–NE strike (Mon, 1976, 1979; de Urreiztieta et al., 1996; Coutand et al., 2001). Correlation between the topography of the basins and ranges with the regional pattern of thrust faults characterizes the region (de Urreiztieta et al., 1996). To the north of 27° S, the basins and ranges are elongated into a NNE direction (Laguna Blanca and Quilmes Ranges) while to the south of the 27°30′S they are NW trending (Velasco, Ambato-Ancasti Ranges). In the transition zone (TTZ) the trends are approximately NE (Hualfín-Las Cuevas, El Durazno, Nevados de Aconquija, Belén), suggesting possible tectonic rotations associated with these lineaments (Vizán et al., 2013). Their influence however, in the kinematic and tectonic evolution of the Andean Orogen and in the Neogene basins is far from being well understood. New paleomagnetic data from Cenozoic sedimentary strata in this region may help in constraining the kinematic evolution of the Andean foreland at these latitudes.

The Santa María-Hualfín Basin (Fig. 1) originated with extension and active faulting from the Paleogene until 4.8 Ma when regional compression began (Bossi and Muruaga, 2009). Ages from apatite fission tracks (Sobel and Strecker, 2003) suggest a 6 Ma uplift of the Aconquija, Quilmes and Cumbres Calchaquíes Ranges, which arose as deformation migrated to the south (Mortimer et al., 2007). Strecker (1987) defined the beginning of the compressive phase

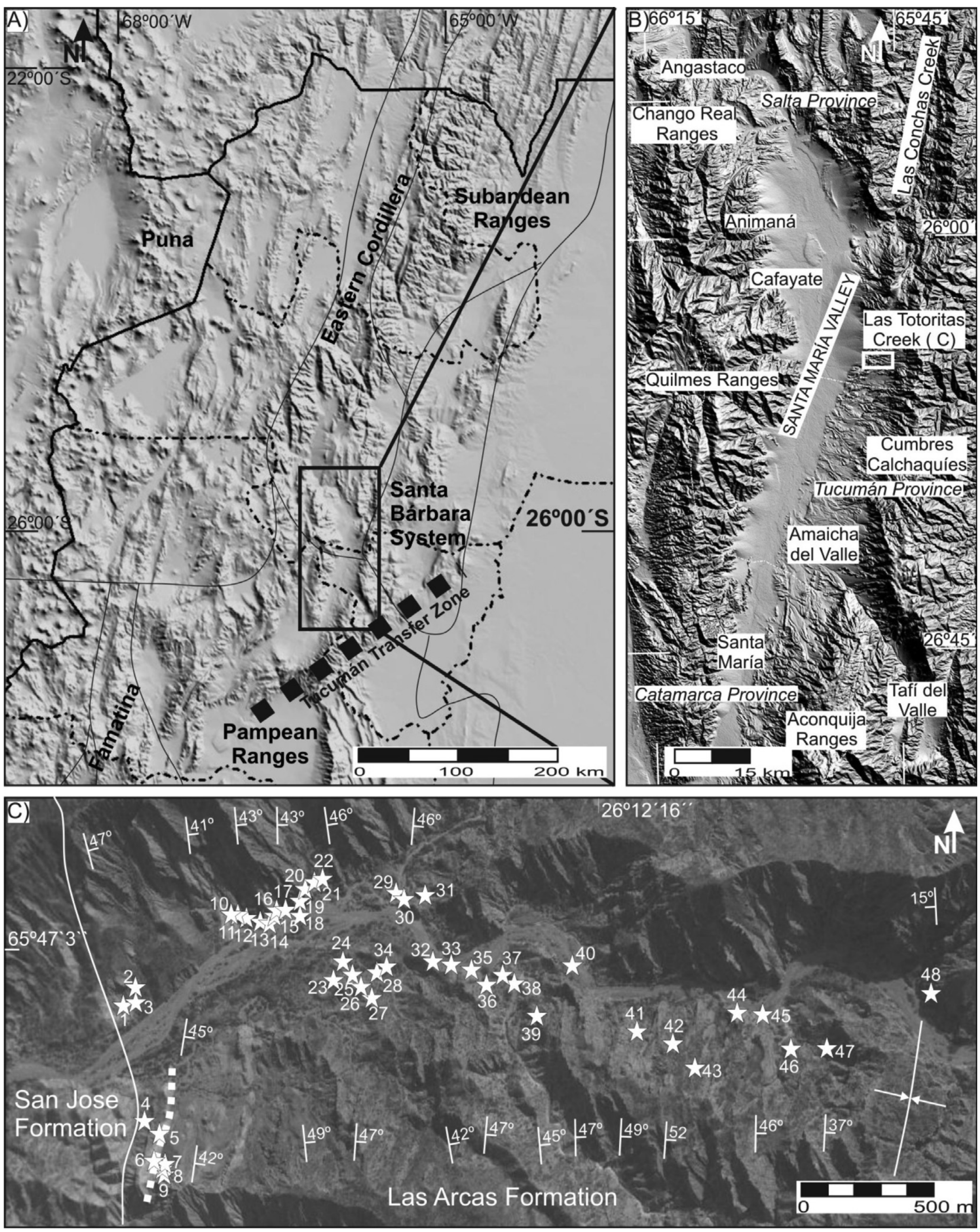

Fig. 1. A) Digital elevation model (DEM) of NW Argentina. B) DEM of the Santa María Valley with the location of the sampling area (Las Totoritas creek). C) Aerial photograph of the Las Totoritas creek with the paleomagnetic sites and geological information. Full line: contact between formations. Dotted line: tuff outcrops.