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Journal of South American Earth Sciences 19 (2005) 193–204

Journal of
South American
Earth Sciences

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Long-term landscape development: a perspective from the southern Buenos Aires ranges of east central Argentina

A. Demoulin[a,*], M. Zarate[b], J. Rabassa[c]

[a]*Department of Physical Geography and Quaternary, University of Liège, Sart Tilman, B11, 4000 Liège, Belgium*
[b]*CONICET/UNLPAM, Avenida Uruguay 151, 6300 Santa Rosa, La Pampa, Argentina*
[c]*CONICET/CADIC, Laboratorio de Geologia del Cuaternario, Ushuaia, Argentina*

Received 1 December 2002; accepted 1 December 2004

Abstract

Traditionally, the long-term landscape evolution of the southern Buenos Aires ranges of east central Argentina has been related to the influence of the Andean orogeny. We describe the large-scale morphological units and associated weathering products in the Tandilia and Ventania ranges. Two main planation surfaces are encountered at varying altitudes in different sectors of these ranges. The lower surface is characterized by roots of kaolinized weathering profiles in the Tandil area and silicified conglomerates around Sierra de La Ventana. In an interpretative model linking the range morphogenesis to the tectonosedimentary evolution of the bordering Salado and Colorado Basins, we suggest that the main morphogenetic stages are related to the late Jurassic-early Cretaceous south Atlantic rifting and Miocene tectonic reactivation induced by the Andean orogeny. Thus, the uplifted surfaces appear much older than commonly believed: pre-Cretaceous and Paleogene. Although they contradict recent results of apatite fission-track studies along the South America and South Africa passive margins, the implied low denudation rates ($\sim$4 m/My) can be explained by the limited Meso-Cenozoic uplift suffered by the southern Buenos Aires ranges. The discussion also shows the limits of the comparison that can be made with the South African planation surfaces.

Keywords: Argentina; Denudation; Long-term landscape evolution; Passive margin; South America

1. Introduction

During the past decade, apatite fission-track (AFT) studies often have led researchers to interpret landforms as much younger than previously thought (e.g. Miller and Lakatos, 1983; Brown et al., 2000; Kerr et al., 2000). Traditional geomorphological studies of planation surfaces frequently assign Mesozoic or early Cenozoic ages to extended surfaces in different parts of the world, mainly in passive margin contexts (South Africa, King, 1962; King, 1983; Partridge and Maud, 1987; Australia, Twidale, 1994; Sri Lanka, Bremer, 1981; South America, Bigarella and Ab'Saber, 1964; Zonneveld, 1985; NW Europe, Klein, 1990), justified by either the preservation of dated covering sediments (Demoulin, 1995) or, more questionably, geometrical relationships and associated weathering features. Such old ages imply very low denudation rates that have been contradicted by AFT data that yield, for example, rates on the order of 10–100 m/My for Brazil and South Africa (Gallagher et al., 1994; Harman et al., 1998; Brown et al., 2000).

However, because the AFT technique's resolution is unable to detect erosional signals of limited amplitude ($<$500 m) typical of areas of low tectonic uplift (Gunnell and Fleitout, 2000), the morphological approach remains an important tool for unraveling long-term landscape evolution in these regions. Unfortunately, the absence of correlative sediments on the land surfaces and uncertainty about their linkage to buried counterparts often requires information from offshore sedimentary basins or tectonic models. The ambiguity in such studies often comes from inferring tectonic phases from a pattern of stepped surfaces rather than explaining the pattern on the basis of a preestablished tectonic history (Partridge and Maud, 1987; Klein, 1990).

* Corresponding author. Tel.: +32 4366 5660; fax: +32 4366 5722.
E-mail addresses: ademoulin@ulg.ac.be (A. Demoulin), mzarate@exactas.unlpam.edu.ar (M. Zarate), jrabassa@infovia.com.ar (J. Rabassa).

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doi:10.1016/j.jsames.2004.12.001

This article aims to decipher the long-term morphological evolution of cratonic east central Argentina from a strict integration of landforms in a regional evolutionary scheme derived from independent tectonic and sedimentary data. We reconstruct the story from recent events and forms to more ancient events, which are decreasingly well documented. We then evaluate the reconstructed landscape evolution by examining how well the associated weathering features comply with the regional paleoclimatological data. Finally, we compare the denudation information provided by this tentative model with that obtained by AFT analysis in other areas. Our study is based on a field survey and the analysis of topographical maps and profiles. In the absence of high resolution DEM, terrain models such as GTOPO30 USGS EROS Data Center, 1996), with 30×30 in. mesh (~750×925 m in the study area) cannot reliably reveal the surface remnants preserved in the ranges, which makes a statistical extraction of topographical features at the desired scale unsatisfying.

2. The southern Buenos Aires ranges

Located in the southern part of the Buenos Aires province, the ranges of east central Argentina contrast sharply with much higher ranges located farther north along the south Atlantic passive margin. Whereas the southeastern Brazil ranges have a mean elevation of approximately 1200 m (with elevations up to 2000 m) and form a margin escarpment, the Tandilia and Ventania ranges rise only a few 100 m above the flat, low Pampean plain. They are isolated in a province of Cenozoic sedimentation (Fig. 1) and did not undergo episodes of strong rifting-related uplift similar to those that induced the development of great escarpments and high denudation volumes in Brazil or South Africa.

Although the planation surfaces of central Argentina have received little attention, diverging opinions have been expressed about their evolution. Most authors relate the sequence of uplifted remnants found in the southern Buenos Aires ranges to tectonic pulses induced by the Andean orogeny. Thus, they ascribe the landscape evolution of the sierras chiefly to the Neogene and explain the stepwise arrangement of the surfaces by faulting (Keidel, 1916; Schiller, 1930; Teruggi and Kilmurray, 1975). However, Du Toit (1927), noting the similarities between the surfaces and weathering products of the Buenos Aires ranges and the corresponding features of the Cape province in South Africa, proposed a common Gondwanic origin for both landscapes and, therefore, an older, partly Mesozoic age for the Argentinean paleosurfaces. Such an old age of the main geomorphic features of the sierras also is acknowledged by Rolleri (1975). Furthermore, Bigarella and Ab'Saber (1964) attributed Cretaceous (i.e. Gondwanic) and Paleogene ages to the highest surface remnants (Pd4 and Pd3) that they described in southeastern Brazil. Recently, Pereyra and Ferrer (1995) have pointed out that the higher planation surface of the northeastern ranges of Ventania probably was formed in the time between the Permian collision of Patagonia and central Argentina and the late Jurassic

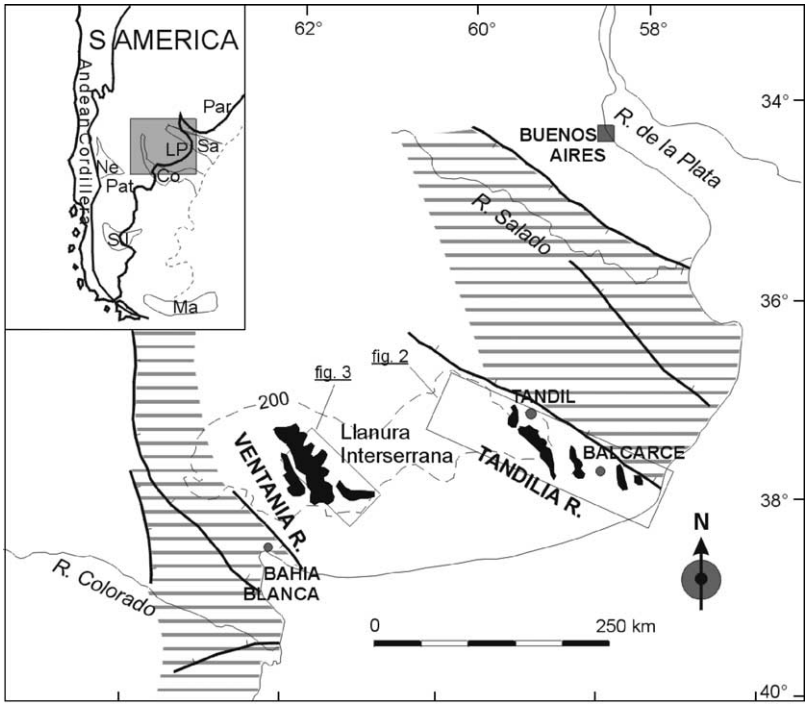

Fig. 1. Location map, with hatched basin areas. The dashed 200 m contour line roughly encircles the study area. Par, Parana Basin; Sa, Salado Basin; LP, La Plata craton; Co, Colorado and Macachin Basins; Ne, Neuquen Basin; Pat, Patagonian massif; SJ, San Jorge Basin; and Ma, Malvinas Basin.