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Research paper

Palynostratigraphy of the late Palaeozoic of Uruguay, Paraná Basin

Ángeles Beri [a,*], Pedro Gutiérrez [b], Lucía Balarino [b]

[a] Sección Paleontología, Facultad de Ciencias, Iguá 4225, 11400, Montevideo, Uruguay
[b] Museo Argentino de Cs. Naturales "B. Rivadavia"-CONICET, Av. Á. Gallardo 470, C1405DJR Buenos Aires, Argentina

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ABSTRACT

A biozonation for the Permian strata of Uruguay is proposed based on published data from boreholes 201, 221, CLSC 3, 4, 11, 13 and 24 drilled by Dirección Nacional de Minería y Geología of Uruguay (DINAMIGE), as well as two superficial samples and the samples from borehole 254, which are described here. Eighteen samples were retrieved from borehole 254 (DINAMIGE), extending from the San Gregorio to the Yaguarí Formation. One hundred and eighty-four taxa were identified. From their vertical distribution in the column, two assemblages were recognised: a lower assemblage that encompasses the San Gregorio Formation up to the lower part of the Melo Formation (Assemblage I), and an upper assemblage that includes the upper part of the Melo Formation (Assemblage II). The boundary between these two assemblages lies in the Mangrullo Member of the Melo Formation. In ascending stratigraphic order, the zones proposed are the *Cristatisporites inconstans-Vittatina saccata* Assemblage Zone (*IS*) and the *Striatoabieites anaverrucosus-Staurosaccites cordubensis* Assemblage Zone (*AC*). In the *IS* Zone identified in the San Gregorio and Tres Islas Formations and in the basal part of the Melo Formation (Fraile Muerto Member), the assemblages are characterised by trilete spores and monosaccate pollen and, to a lesser extent, by non-taeniate bisaccate, taeniate bisaccate and plicate pollen grains. An early Cisuralian age is proposed for this Zone. The *AC* Zone was identified in the Melo Formation, in the Mangrullo and Paso Aguiar Members. It is characterised by assemblages that are dominated by bisaccate (both taeniate and non-taeniate) pollen grains. These palynological assemblages also include a few plicate and monosaccate pollen grains and trilete and monolete spores. A late Cisuralian–Guadalupian age is proposed for this zone.

1. Introduction

The strata deposited during the late Palaeozoic in Uruguay occupy an area of 94,000 km^2. They are found in the northern region and are part of the Paraná Basin. The outcrops are spread over 24,000 km^2 in the Departamentos Cerro Largo, Tacuarembó, Rivera and Durazno, and the remainder of the sequence is preserved in the subsurface (Andreis et al., 1996). This basin is contiguous with the Chacoparanense Basin in Argentina and with the Paraná in Brazil and has also been named the "Northern Basin" ("*Cuenca Norte*") by de Santa Ana et al. (2006a) (Fig. 1).

According to Andreis et al. (1996), the formations of the upper Palaeozoic are, in ascending order, the San Gregorio, Tres Islas, Melo and Yaguarí formations.

Palaeontological studies of the late Palaeozoic in Uruguay are summarised by Mones and Figueiras (1980), Mones (1986), Andreis et al. (1996), Beri (2003) and de Santa Ana et al. (2006a, 2006b). The first palynological paper focussed on the Palaeozoic was published by Martínez-Macchiavello (1963), who studied the palynomorphs of what he called "the glacial of the base of the Gondwana System," which corresponds to the San Gregorio and Tres Islas Formations. Later, Marques-Toigo (1970, 1972, 1973, 1974) analysed the palynological content of the San Gregorio Formation, proposing an Early Permian age. Beri (1983, 1987, 1988) also studied the San Gregorio and Tres Islas formations. Some years later, Vergel (1985, 1987), Beri (1991, 1997), Anzótegui and Mautino (1992), de Santa Ana et al. (1993), Fasolo and Vergel (1994), Beri and Daners (1995, 1996, 1998), Beri and Goso (1996, 1998), Mautino et al. (1998a, 1998b, 1998c), Beri et al. (2000a, 2000b, 2006a), Beri and Pecoits (2001) and Gutiérrez et al. (2006, 2010) analysed the palynoflora of the San Gregorio, Tres Islas and Melo formations. The first biozonation proposal was the preliminary scheme by Beri et al. (2004).

The aims of this study are to establish a palynologically based zonal scheme for the upper Palaeozoic units of Paraná Basin (Uruguay), to define the age of the sequence, and to contribute to the understanding of the late Palaeozoic evolution of the basin. In previous palynologically based studies, an informal biozonation for Uruguay was published (Azcuy et al., 2007; Souza et al., 2007). However, this is

* Corresponding author. Fax: +598 5258617.
E-mail address: beri@fcien.edu.uy (Á. Beri).

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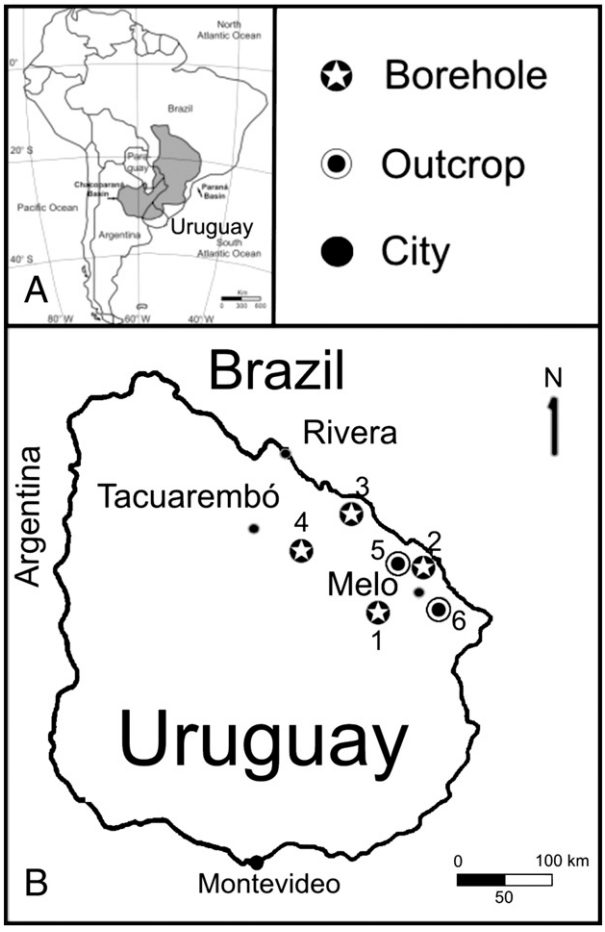

Fig. 1. A: Distribution of the Paraná Basin of South America. B: Locations of boreholes and outcrops (borehole 1: CLS3, 4, 11, 13 and 24; 2: 201 Paso de Melo; 3: 221 Cerrillada; 4: 254 Paso de Las Toscas; outcrop 5: Cañada El Barón; 6: Route 26).

de Santana *et al.* (2006)	Bossi and Navarro (1991)		Andreis *et al.* (1996)
Buena Vista Formation			
Yaguarí Formation	Yaguarí Formation		Yaguarí Formation
Paso Aguiar Formation	Melo Formation	Paso Aguiar Member	Melo Formation
Mangrullo Formation		Mangrullo Member	
Fraile Muerto Formation		Fraile Muerto Member	
Tres Islas Formation	Tres Islas Formation		Tres Islas Formation
Cerro Pelado Formation	San Gregorio Formation		San Gregorio Formation
San Gregorio Formation			

Fig. 3. Comparison chart of Carboniferous–Permian stratigraphic schemes for the Paraná basin in Uruguay.

the first time that a palynostratigraphic scheme for the late Palaeozoic of Uruguay has been proposed.

This contribution also includes the Paso de las Toscas No. 254 borehole drilled by the Dirección Nacional de Minería y Geología (DINAMIGE) in the Paso de Las Toscas, Departamento de Tacuarembó, NE of Uruguay (Fig. 1). The results from previous studies of the boreholes Paso de Melo 201, Cerrillada 221 and Distrito Cerro Largo Sur (DCLS) No. 3, 4, 11, 13, and 24, as well as data from two superficial samples are also included.

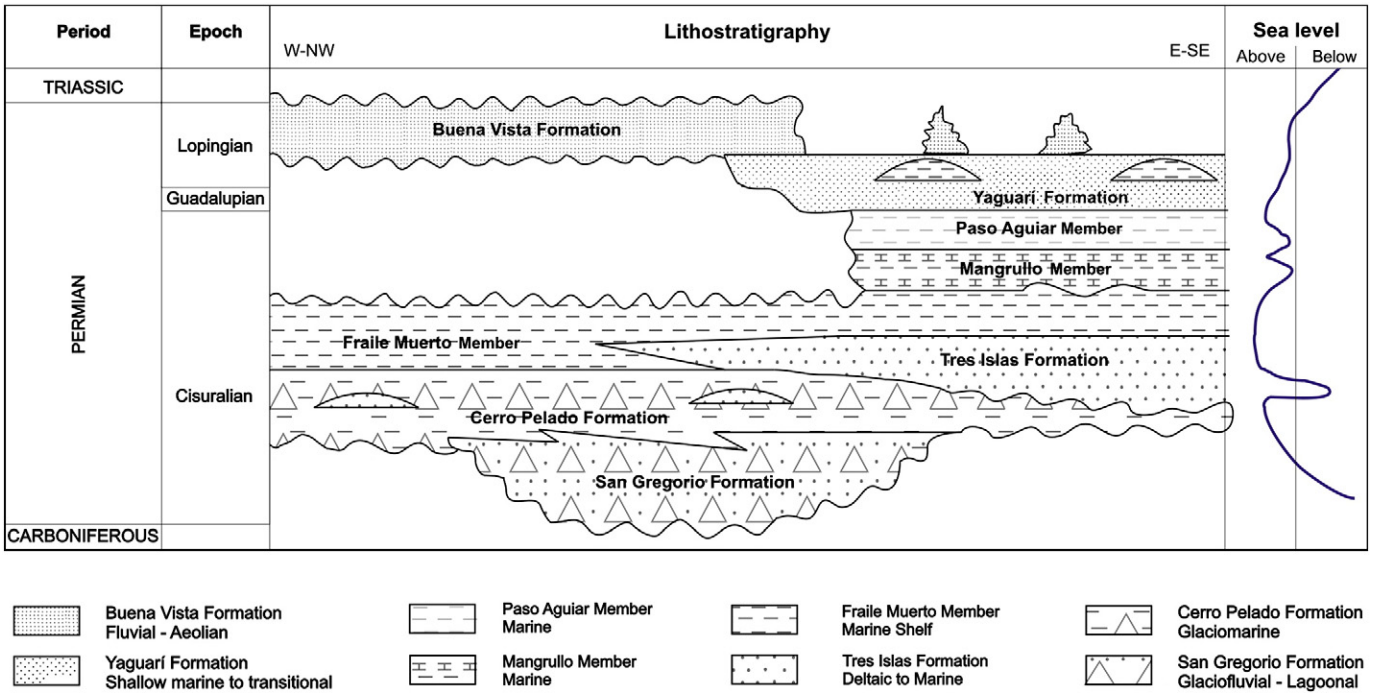

Fig. 2. Temporal and spatial distribution of lithostratigraphic units in the Paraná Basin (Uruguay) (modified from De Santa Ana et al., 2006a,b). The three Members (Fraile Muerto, Mangrullo and Paso Aguiar) of the Melo Formation are depicted separately.