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U–Pb dating of tonstein layers from a coal succession of the southern Paraná Basin (Brazil): A new geochronological approach

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Abstract

This paper presents new radiometric dating of zircons (IDTIMS U–Pb) from tonsteins interbedded with coal seams from the Candiota coalfield (Rio Grande do Sul State). The ages obtained, 296.9±1.65 Ma and 296±4.2 Ma, are consistent within error and are quite different from a previously published age of 267.1±3.4 Ma. Calibrations of palynostratigraphic data with numerical ages showed that the Candiota coals from the southern Paraná Basin, related to the *Protohaploxypinus goraiensis* subzone are constrained to the Asselian. Consequently the basal part of the Gondwana sequence in the southern part of the basin must belong to the Carboniferous–Permian boundary and not to the Sakmarian, as it was previously considered. The new results have far reaching significance for correlations of the Paraná Basin with sequences of the Argentinian Paganzo Basin (302±6 Ma and 288±7 Ma) and also with the Karoo Basin, with the top of the Dwyka tillite (302±3 Ma and 299.2±3.2 Ma) and with the lowermost Ecca Group (288±3 Ma and 289.6±3.8 Ma). This new evidence supports the presence of an active and widespread Upper Carboniferous volcanism in western Gondwana.

Keywords: U–Pb radiometric data; Coal seams; Paraná Basin; Palynostratigraphy; Carboniferous–Permian boundary

1. Introduction

Recent studies have provided important information on the geological history and paleontological records from several terranes belonging to the West Gondwana region (e.g. Vaughan and Pankhurst, 2008; Césari, 2007; Da Silva et al., 2007). The Paraná Basin (1,700,000 km^2), located in southeast South America, a key terrane to address the evolution of West Gondwana, has six depositional supersequences (cf. Milani, 2003) originated by second order eustatic and tectonic events (Fig. 1). These supersequences from base to top are: 1) Rio Ivaí (Ordovician–Silurian), 2) Paraná (Devonian), 3) Gondwana I (Carboniferous–Early Triassic), 4) Gondwana II (Late Triassic), 5) Gondwana III (Jurassic–Early Cretaceous), 6) Bauru (Late Cretaceous).

The Gondwana I Supersequence represents a second order transgressive–regressive cycle. It consists of a basal transgressive unit overlain by a regressive unit. The basal transgressive interval corresponds to the lithostratigraphic units known as Itararé Group and Rio Bonito and Palermo Formations, while the overlying regressive unit consists of the Irati, Serra Alta, Teresina, Rio do Rasto and Sanga do Cabral Formations.

Palynology has been used to establish formal biostratigraphic zonations (Daemon and Quadros, 1970; Marques-Toigo, 1991; Souza and Marques-Toigo, 2005) and it is used also as a tool for correlation both at regional and broader levels. However, the extension of the basin, the endemism of the Gondwana flora, and a very low resolution of facies correlations in contiguous areas of the same basin makes correlation difficult. Hence, a new chronostratigraphic approach was needed.

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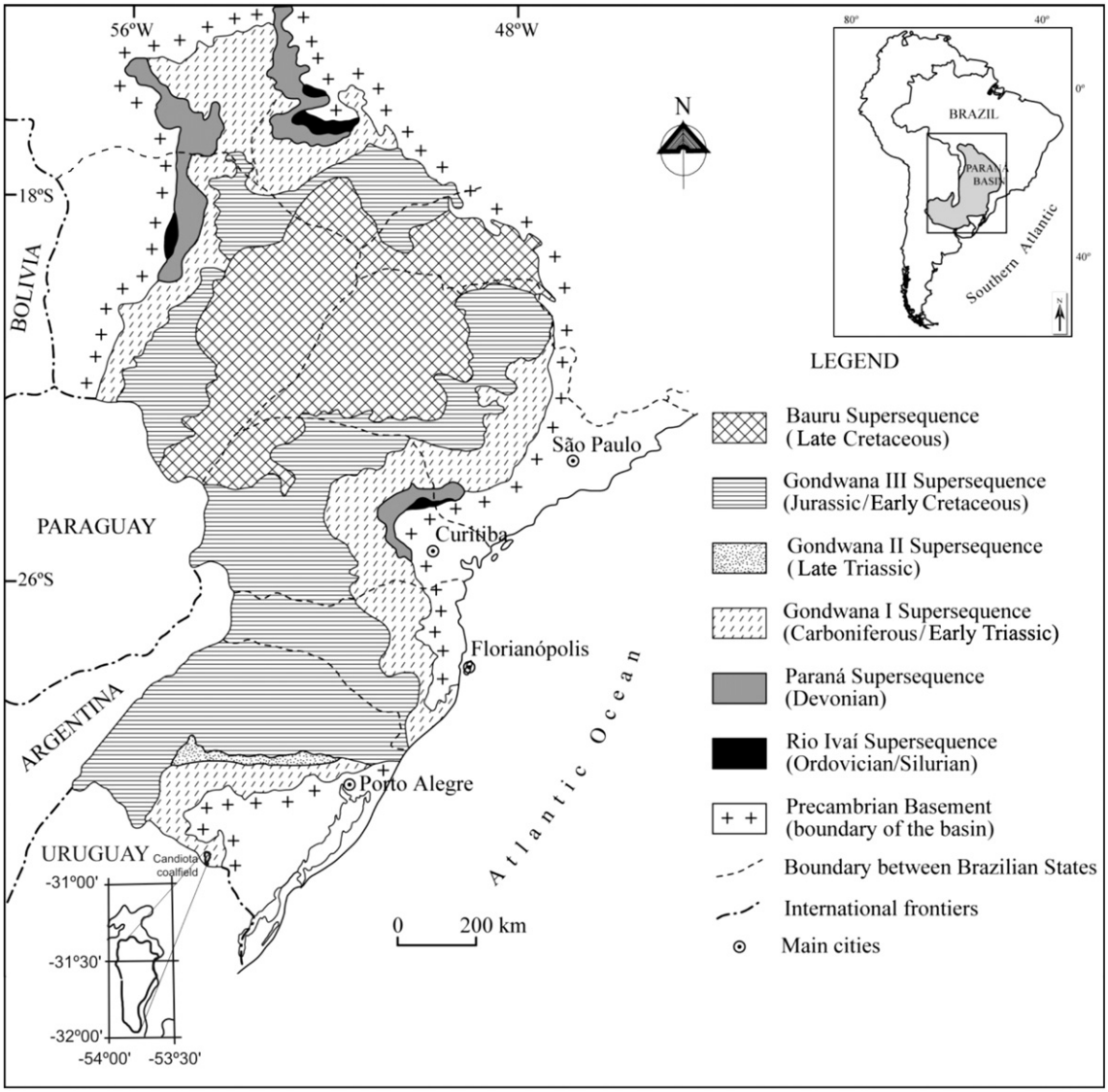

Fig. 1. Simplified geological map of the Paraná Basin in Brazil with major tectonic elements, geographic references (after Milani, 2003) and location map of the Candiota coalfield.

Evidence of volcanic activity is widespread and recorded in the southern Paraná Basin in a coal succession included in the Rio Bonito Formation, by discrete and continuous horizons of clay beds identified as tonsteins, synchronous with interbedded coal seams in the Candiota, Faxinal, Sul do Leão and Água Boa coalfields (Formoso et al., 1999).

The calibration of biostratigraphy by radiometric dating of tonstein layers and correlative coal strata facilitates their application as isochronous markers and, consequently, as useful stratigraphic tools.

The first attempt to establish radiometric data in claybeds characterized as tonsteins in the southern Brazilian coal succession was made by Matos et al. (2000, 2001), using IDTIMS U–Pb of zircons in the Tonstein A, interbedded with the Lower Candiota Coalfield. The U–Pb 267.1±3.4 Ma age constrained the interval of deposition to the top of the Kungurian, base of the Roadian, according to the chronostratigraphic framework of Jin et al. (1997) or to the Wordian, according to the Stratigraphic Chart of Gradstein et al. (2005). The absolute age of 267.1±3.4 Ma was, according to Matos et al. (2001) compatible with the main derived volcanic activity in western Gondwana: the tephra would be derived from the Choiyoi Province (Argentina) to the depositional areas of the Paraná Basin. A comparison of the U–Pb 267.1±3.4 Ma minimum age from Candiota tonsteins (Paraná Basin) with those obtained by Bangert et al. (1999) for the Dwyka Group, Karoo Basin in the Cape Province (288±3 Ma and 289.6±3.8 Ma) and Namibia (302±3 Ma and 299.2±3.2) led Matos et al. (2001) to the conclusion that the U–Pb radiometric ages obtained in those basins were not equivalent. Cazzulo-Klepzig et al. (2002), related the microflora of coals and interbedded tonstein in the Candiota coalfield to the *Caheniasaccites ovatus* subzone of Marques-Toigo (1991), considered later by Souza and Marques-Toigo (2005) as an ecofacies of the *Protohaploxipinus goraiensis* subzone, without stratigraphic significance.