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F. C. Lopes, P. A. Dinis, L. V. Duarte, P. P. Cunha

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The Permo-Triassic boundary in the N'Condédzi sub-basin, Moatize-Minjova Coal Basin, Mozambique: palynology, $\delta^{13}C_{org}$ variation and paleoenvironments

A fronteira Permo-Triássico na sub-bacia de N'Condédzi, Bacia Carbonífera de Moatize-Minjova, Moçambique: palinologia, variação $\delta^{13}C_{org}$ e paleoambientes

Z. Pereira (1), P. Fernandes (2), M. Mendes (1), G. Lopes (2,3), J. Marques (4), R.C.G.S. Jorge (5) and L. Albardeiro (6)

(1) Laboratório Nacional de Energia e Geologia (LNEG), Rua da Amieira, Apartado 1089, 4466-901, S. Mamede de Infesta, Portugal.
(2) Centro de Investigação Marinha e Ambiental, (CIMA), Universidade do Algarve, Campus de Gambelas, 8005-139, Faro, Portugal.
(3) Plants, Photosynthesis and Soil, School of Biosciences, University of Sheffield, Alfred Denny Building, Western Bank, Sheffield S10 2TN, UK.
(4) Gondwana Empreendimentos e Consultorias, Limitada, Rua 1.335, No. 233, Bairro da COOP, Maputo, Moçambique.
(5) Universidade de Lisboa, Departamento de Geologia da Faculdade de Ciências, Instituto Dom Luiz, Campo Grande, Edifício C6, Piso 4, 1749-016, Lisboa, Portugal.
(6) Laboratório Nacional de Energia e Geologia (LNEG), Bairro da Val d´Oca. Ap. 14, 7601-909 Aljustrel, Portugal.

Sumário: *A Bacia carbonífera de Moatize-Minjova em Mozambique, compreende a sub-bacia de N'Condédzi. Esta última possui um registo sedimentar, importante para compreender as principais alterações ambientais ocorridas durante a fronteira Permo-Triasico. Para o estabelecimento da idade da sequência estratigráfica e a identificação dos ambientes deposicionais, foi realizada a revisão do estudo palinoestratigráfico da sondagem CIMT-14, combinada com a análise da variação δ^{13}Corg e complementada com novos dados de palinofácies. As espécies-guia de esporomorfos reconhecidas possibilitaram a identificação de quatro associações, de idade compreendida entre o Pérmico superior (Lopingiano) e o Triásico Superior (Carniano). Os dados de palinologia e as variações de $\delta^{13}C_{org}$, no limite Permo-Triasico, assinalam uma mudança abrupta dos ambientes deposicionais. Os ambientes dominados por vastos pântanos, onde se depositou o carvão, associado a climas húmidos e quentes, sofreram uma abrupta reorganização para sistemas fluviais em climas áridos e semi-áridos, que marcam o Triasico inicial. O contacto Permo-Triasico é assinalado por uma excursão negativa de $\delta^{13}C_{org}$, seguido por uma recuperação lenta da variação $\delta^{13}C_{org}$ e da microflora.*

Palavras-chave: *palinologia, palinofácies, Lopingiano, Induano, Olenekiano, Karoo*

Keywords: palynology, palynofacies, Lopingian, Induan, Olenekian, Karoo

The N'Condédzi sub-basin is part of the central Moatize-Minjova Coal Basin (Fig. 1). During the last decades, very few palynological, paleontological, and palaeoecological studies have contributed to the biostratigraphic knowledge of this area, in which they tried to integrate and improve the biostratigraphic correlations in the Permo-Triassic of Moatize-Minjova Coal Basin (Karoo Supergroup, Mozambique). The recent palynostratigraphic study from Galasso *et al.* (2019) was revisited, using improved palynological assessments to constrain the age and paleoenvironments of the CIMT-14 borehole. The Matinde and Cádzi formations were analysed in the latter borehole, with one hundred and one core samples being studied for palynostratigraphic and palynofacies techniques. Using a qualitative and quantitative approach, the key palynomorph taxa recorded have provided information that suggests three different stratigraphically constrained age assemblages (A to C) ranging from late Permian to early Triassic, namely: A) Lopingian (L3 Biozone, *Osmundacidites senectus*), B) Induan (T1 Biozone, *Densoisporites nejburgii*), C) Olenekian (T2 Biozone, *Platysaccus queenslandi*). Furthermore, a heterogeneous palynofacies assemblage (with common non-opaque phytoclasts and palynomorphs) stands out in the coal-bearing swamp environments

associated with fluvio- depositional systems during Late Permian times.

A coarse-grained conglomerate overlays the Late Permian coal-bearing strata. High-resolution $\delta^{13}C_{org}$ variation across this part of the section denotes a short negative excursion (from 23.5 to -30.5 ‰), which is tentatively attributed to the Permo-Triassic boundary. $\delta^{13}C_{org}$ values remain consistently negative (-26 to -28‰) through a ca. 20 m thick interval of siltstones before returning to mean values recorded during the Late Permian.

The palynofloral record from the latter part of the borehole shows a discrete floral change at the Permo-Triassic boundary. The spore and pollen diversity decrease during the lowermost Triassic (Induan), indicating a mixed Permian-Triassic trend, composed of common gymnosperms pollen and lycophyte spores with the income of new spore taxa. This could correspond to a reworking of the Permian sediments by fluvial erosion of Lower Triassic alluvial systems.

Above this interval, more than 150 m of early Triassic sediments did not preserve palynomorphs, suggesting a slow and gradual flora recovery after the end-Permian biotic crisis. This period ends with a change in sedimentation with the deposition of Olenekian age red beds. The palynological assemblages reveal an evident decline in the taeniate bissacate pollen group, while trilete and monolete spores, monosaccate and non-taeniate bissacate pollen, show an increasing trend to the top of the stratigraphic sequence. This tendency may reflect a change to warmer and arid/dry conditions during the early Triassic, probably punctuated by short-lived episodes of high precipitation that allowed the income of new spore taxa.

At the top of the borehole, a Carnian age was defined. No Middle Triassic rocks were identified, corresponding to a sedimentary hiatus that may fit a critical tectonic event with uplift and erosion, as suggested by Fernandes *et al.* (2015).

Despite this, the palynofacies record shows intensely altered and opaque phytoclasts and frequent amorphous organic matter. This could result from prolonged transport or even post-depositional reworked processes.

Altogether, these new results constrain the age of the Karoo Supergroup formations of Mozambique, and it is a significant contribution to a better understanding of the palaeoecological-palaeoclimatic changes that occurred at the Permo-Triassic boundary in continental settings of the central Gondwana.

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