



# Late Permian palaeoenvironmental evolution of the Matinde Formation in the Muarádzi Sub-basin, Moatize-Minjova Basin, Mozambique

Gilda Lopes<sup>a,\*</sup>, Zélia Pereira<sup>b</sup>, Paulo Fernandes<sup>a</sup>, Márcia Mendes<sup>c</sup>, João Marques<sup>d</sup>, Raul C.G. S. Jorge<sup>e</sup>

<sup>a</sup> CIMA – Centre for marine and Environmental Research, Universidade do Algarve, Campus de Gambelas, 8005-139, Faro, Portugal

<sup>b</sup> Laboratório Nacional de Energia e Geologia (LNEG), Rua da Amieira, Apartado 1089, 4466-901, S. Mamede de Infesta, Portugal

<sup>c</sup> Laboratório Nacional de Energia e Geologia (LNEG), Bairro da Val D'Oca, Apartado P. 14, 7601-909, Aljustrel, Portugal

<sup>d</sup> Gondwana Empreendimentos e Consultorias, Limitada, Rua B, No. 233, Bairro da COOP, Caixa Postal 832, Maputo, Mozambique

<sup>e</sup> Instituto Dom Luiz (IDL), Faculdade de Ciências, Universidade de Lisboa, Campo Grande, Edifício C6, Piso 4, 1749-016, Lisboa, Portugal

## ARTICLE INFO

### Keywords:

Palynology  
Palynofacies  
Biostratigraphy  
Palaeoecology  
Karoo  
Gondwana

## ABSTRACT

A multidisciplinary study involving lithofacies analysis, palynofacies, and palynology is presented for the Muarádzi Sub-basin. This sub-basin is part of the Moatize-Minjova Basin (MMB), an important Karoo aged coalfield in Mozambique.

A total of 99 core samples from 3 coal exploration boreholes (DW11, DW21, and DW141) were analysed and all the successions were assigned a Lopingian age based on palynology. According to the data, in the Muarádzi Sub-basin, a vast lowland fluvial setting existed with floodplains and wetlands, in an area controlled by tectonic movements associated with a continental rifting phase. Typical vegetation of the *Glossopteris* Province is recorded in the palynological assemblages of this sub-basin, which allowed for the characterization of a flora dominated by glossopterids (*Protohaploxylinus* and *Striatopodocarpites*) and gymnosperm pollen (*Alisporites*). Other palynomorphs revealed the presence of ginkgoales, ferns (Filicopsida), sphenopsids, and lycopsids in the area, indicating a typical lowland setting. Humid and warm climates, associated with higher CO<sub>2</sub> atmospheric levels, promoted the growth of widespread vegetation that led to the development of the thick coal beds in anoxic to dysoxic depositional environments.

## 1. Introduction

During Permian-Triassic times, vast extensional rift-related sedimentary basins with graben to half-graben geometries were formed in the central part of Gondwana (Catuneanu et al., 2005). These continental basins, some occupying a significant area along the Zambezi River Valley of Mozambique, have economically important coal deposits of Permian age, which are part of the Karoo Supergroup succession (e.g., Carvalho, 1977; Catuneanu et al., 2005; GTK Consortium, 2006) (Fig. 1).

In the Moatize-Minjova Basin (MMB), located in the Tete Province in central-NW Mozambique, the Karoo Supergroup comprises thick sequences of siliciclastic continental sedimentary rocks of Permo-Triassic age, as well as Lower Jurassic volcano-sedimentary rocks (e.g., Real, 1966; GTK Consortium, 2006). These sedimentary units vary laterally in thickness, lithofacies, and diachroneity due to the tectonic framework of

this broad basin (Fig. 1). This basin includes the Muarádzi Sub-basin and over the past century several studies on the MMB have been published, including research on general geologic mapping and mineral resources (e.g., Real, 1966; GTK Consortium, 2006), volcanism (e.g., Carvalho, 1977), coal deposits (e.g., Afonso, 1984; Falcon et al., 1984; Vasconcelos, 1995), organic maturation studies (e.g., Vasconcelos, 1995; Costa, 2015; Correia, 2016; Costa et al., 2016), thermal history (e.g., Fernandes et al., 2015), and palynology/palynofacies (e.g., Galasso et al., 2019a,b; Pereira et al., 2016; 2019; Götz et al., 2020).

The Permian age of strata in the region, as well as the characterization of palaeoenvironmental, palaeoecological, and palaeoclimatic trends in the different sub-basins have been challenging to determine, partly due to the exclusive continental setting of the MMB (e.g., Galasso et al., 2019b; Götz et al., 2017; 2020). This feature hinders biostratigraphic control as no other independent time markers have yet been

\* Corresponding author.

E-mail addresses: [gmlopes@ualg.pt](mailto:gmlopes@ualg.pt) (G. Lopes), [zelia.pereira@lneg.pt](mailto:zelia.pereira@lneg.pt) (Z. Pereira), [pfernandes@ualg.pt](mailto:pfernandes@ualg.pt) (P. Fernandes), [marcia.mendes@lneg.pt](mailto:marcia.mendes@lneg.pt) (M. Mendes), [joaomarques@gondwana.co.mz](mailto:joaomarques@gondwana.co.mz) (J. Marques), [rjorge@fc.ul.pt](mailto:rjorge@fc.ul.pt) (R.C.G.S. Jorge).

<https://doi.org/10.1016/j.jafrearsci.2021.104138>

Received 29 May 2020; Received in revised form 1 February 2021; Accepted 4 February 2021

Available online 9 February 2021

1464-343X/© 2021 Elsevier Ltd. All rights reserved.