

Late Jurassic-Early Cretaceous Erg Deposits in the Mengyin Basin, Western Shandong Province, China: Inferences about the Wind Regime and Paleogeography

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How to cite this paper: Xu, H., Liu, Y.Q., Kuang, H.W., Peng, N., Xu, K.M. and Chen, J. (2019) Late Jurassic-Early Cretaceous Erg Deposits in the Mengyin Basin, Western Shandong Province, China: Inferences about the Wind Regime and Paleogeography. *Open Journal of Geology*, **9**, 700-703.

<https://doi.org/10.4236/ojg.2019.910079>

Received: August 17, 2019

Accepted: September 22, 2019

Published: September 25, 2019

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Abstract

The Late Jurassic-Early Cretaceous Santai Formation, sporadically distributed in western Shandong Province, comprises terrestrial alluvial-eolian successions, which records regional wind patterns and paleogeography in eastern North China. This paper conducts an analysis of eolian stratification, bounding surfaces, facies architecture and paleowind direction of the Santai Formation in the east of the Mengyin Basin, western Shandong Province. Three basic types of eolian stratification are recognized in the Santai Formation, including grainflow strata, wind ripple strata and adhesion strata, and have been grouped into eolian dune and interdune facies associations. The occurrences of reactivation surfaces and superimposition surfaces within eolian dune deposits indicate active compound dunes or draas. The association of adhesion strata with grainflow or windripple strata is the development of a wet eolian system. Cross-strata dip direction indicates different paleowind directions from the lower to the upper part of the Santai paleoerg. The lower part of the paleoerg was characterized by paleowinds blowing from northwest to northeast, whereas the upper part was under the influence of paleowinds consistently towards east to northeast. The identified changes in wind directions possibly suggest wind regime shifts from monsoon circulation to westlies of planetary wind system, which may be related with the collapse of the East China Plateau during the Late Jurassic to Early Cretaceous.

Keywords

Late Jurassic-Early Cretaceous, Santai Formation, Western Shandong

1. Introduction

The sedimentary record of eolian system, extending from the Archean to the Quaternary, is widespread on earth [1]. It not only contains a large amount of information on paleogeography, paleoclimate and wind regime, but also provides clues on the geological evolution of desert basins and the relative role of allocyclic controls as tectonic and orbital forcing and its effects on preservation [2] [3] [4].

Previous workers have conducted extensive studies on the Precambrian to Cenozoic eolian deposits widely distributed at North America, South America, Africa and western Europe, including macro-micro identification of eolian deposits, bedform reconstruction and modeling, dry/wet/stabilized eolian system reconstruction, atmospheric circulation, and orbital-driven climatic fluctuations [1], and reference therein. In contrast, the studies of eolian deposits in China mainly focus on the Cretaceous, Tertiary and Quaternary, especially the pre-Cenozoic eolian deposits have been poorly studied [4]. The Late Jurassic-Early Cretaceous erg deposits present in the Mengyin Basin would provide an excellent opportunity to analyze the eolian stratigraphic architecture, regional paleogeography and wind regime.

2. Geological Setting

The Mengyin Basin is located at the east of North China Craton as well as western Shandong Province. The Jurassic-Cretaceous fill of the basin, in ascending order, can be subdivided into the Late Jurassic-Early Cretaceous Santai Formation, the Early Cretaceous Laiyang Group and Qingshan Group. The Santai Formation rests unconformably on the mudstone and carbonate rocks of the Late Carboniferous Benxi Formation or Early Permian Taiyuan Formation and is unconformably overlain by conglomerate of the Paleogene Changlu Formation or mudstone of the Early Cretaceous Laiyang Group. It consists of alluvial successions in the southeast of the basin, whereas the eolian sandstone dominantly occurs at the northwest of the basin. Some theropod dinosaur footprints *Grallator* have been found within the alluvial deposits.

3. Eolian Stratification and Sedimentology

Three basic types of stratification have been identified, including grainflow strata, wind ripple strata and adhesion strata, which are arranged into trough and planar cross-bedding and parallel bedding. Grainflow strata, 0.8 - 10 cm thick, commonly present at the upper part of the cross-beds pinch out downward and are characterized by internally structureless or inverse grading. Wind ripple strata occurring at the cross-beddings or parallel beddings, consist of 0.1 - 0.6 cm thick, low angle and horizontal laminations, and usually alternate or merge

with grainflow strata. Adhesion strata characterized by adhesion ripples and adhesion wavy are 0.2 - 2 cm in thickness and occur at the base of the cross-bedding and parallel bedding. These stratifications have been grouped into eolian dune and interdune facies associations. Eolian dune deposits composed of grainflow, wind ripple and adhesion strata are internally bounded by reactivation surface and superimposition surface, suggesting active compound dunes or draas. Interdune deposits separated from eolian dune deposits with interdune surfaces consists dominantly of wind ripple strata and adhesion strata. The occurrence of adhesion strata in eolian dune and interdune deposits not only indicate high water table level, but also suggest wet eolian system [3].

4. Discussion and Conclusions

The combined analysis of cross-strata dip directions and bedform types indicates various paleowind directions across the outcrop area of the Santai paleoerg. The lower part of the eolian succession was characterized by paleowind blowing from northwest to northeast. Combined with eolian cyclic cross-bedding composed of a regular interaction of grainflow and wind ripple packages, suggesting monsoonal wind regime, similar as the reports from the Upper Jurassic Sergi Formation in Brazil [5]. In contrast, the paleowind direction of the upper part of the eolian succession consistently towards east to northeast, possibly implies westlies circulation wind regime, consistent with the atmospheric circulation of the middle paleolatitude regions in the Early Cretaceous [6]. The change from monsoon circulation to westlies of planetary wind system indicates northward movement of North China from low to middle paleolatitude regions in the Late Jurassic to Early Cretaceous (coupling with paleomagnetism data from Yi *et al.*, 2019, *in press*) and the breakup of monsoon wind region prevailed in Pangea supercontinent during the Triassic-Late Jurassic [7]. The collapse of the East China Plateau in the Late Jurassic to Early Cretaceous may be a paleogeographic factor controlling the erg evolution and atmospheric circulation. The subsequent Early Cretaceous thick fillings of the Jiaolai Basin in the eastern Shandong Province are a sedimentary response to the post-collapse of the East China Plateau.

Acknowledgements

This work was supported by the National Natural Science Foundation of China (grant Nos. 41802009, 41672111, 41688103, 41272021) and the China Geological Survey (grant No. DD20190005). This is a contribution to UNESCO-IUGS IGCP Project 679.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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