Development of Longitudinal dunes under the Pangean atmospheric circulation

*Hiroki Shozaki[1], Hitoshi Hasegawa[2]

1. Faculty of Science, Kochi University, 2. Faculty of Science and Technology, Kochi University

From the Permian into the Early Jurassic, the supercontinent Pangea dominated our planets. Because of its largest landmass in the Earth’ s history, atmospheric circulation at this period is thought to be significantly different from today. Modelling experiments have suggested cross-equatorial Hadley circulation and its seasonal overturning. However, there are large discrepancy between model-generated surface wind pattern and geological evidence of paleo-wind pattern recorded by eolian sandstones in the central-western U.S.A. Previous study suggested that its discrepancy can be caused by the wrong interpretation of how winds shaped the dune in Pangea. Here, we re-examined Lower Jurassic eolian sandstone records in U.S.A. and reconstructed paleo-wind pattern with focusing on its dune morphology and orientation. Based on the recently revised paleomagnetic reconstructions, sand dune sea was widespread at about 24˚–33˚N. Spatial pattern of paleo-wind directions suggests influence of multi-directed paleo-winds, with dominant westerly winds in northern area and northeasterly winds in southern area. The reconstructed paleo-wind pattern appears to be consistent with the modelling results of paleo-location of subtropical high-pressure belt in the boreal winter of the Early Jurassic. In addition, spatial pattern of eolian slipface orientations suggest that dunes are mainly consists of longitudinal dunes with NNW–SSE orientation in Pangean time, which are markedly different from orientation direction of longitudinal dunes in present desert. We proposed that the development of NNW-SSE oriented longitudinal dunes could be formed by orbitally-induced latitudinal shifts of subtropical high-pressure belt in Pangea supercontinent. Modeling experiments also generated large modulation of strength and location of subtropical high-pressure belt in response to orbital-scale insolation changes. Reconstructed surface wind pattern and different directions of longitudinal dune orientation recorded in Jurassic eolian sandstone records therefore represent a distinct pattern of Pangean atmospheric circulation.

Keywords: Eolian dunes, Navajo sandstone, Pangean supercontinent, Paleowind systems, Atmospheric circulation

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