

Research Advances

The Relationship between Phototropism and Plate Motion

JIANG Zikun^{1,*}, HUANG Min¹, LIU Benpei², LU Yuanzheng³,
DENG Shenghui³ and WANG Yongdong⁴

¹ Chinese Academy of Geological Sciences, Beijing 100037, China

² China University of Geosciences, Wuhan 430074, Hubei, China

³ Research Institute of Petroleum Exploration & Development, PetroChina, Beijing 100083, China

⁴ Nanjing Institute of Geology and Palaeontology, Chinese Academy of Sciences, Nanjing 210008, Jiangsu, China

Objective

Plant phototropism means that trees on the side directly exposed to sunlight generally grow faster than those on the opposite, and positive phototropism is easy to observe in crown and trunk. In this study, we chose the transverse section of tree trunk to observe. The definitive intensity of plant phototropism ranges regularly from strong to weak and finally disappeared along with the latitudinal change from high to low. In the well-preserved in-situ petrified wood phototropism phenomenon also exists. Different plates have different tectonic movements. Some rotated during certain geological time, which recovered from the palaeomagnetic records. The eccentricity of tree growth rings should be related to the direction of sunshine. In addition, we compared the phototropism direction of the trunk of the fossil wood with the living normal growth stumps, thus verifying the paleomagnetic evidence whether the plates rotated or not.

Methods

This work introduces a new method. The positive phototropism is received by measuring the eccentricity of the growth rings. The eccentricity is the direction from the pith to the longest part of the transverse section of the trees. We measured the eccentricity of the in-situ preserved fossil trunks and the extant normal growth stumps in the same latitude without any disturbing elements such as shading, gravity and wind direction. Paleomagnetic data were collected from previous documents. We compared the eccentricity of the fossil and living stumps in certain geological times. With the latitude changing from pole to equator, the definitive intensity of tree phototropism varies regularly and apparently from strong to weak and finally disappeared in equator areas. The difference of the two data of the eccentricity may

reflect the differences in latitude, which can deduce whether plate rotation occurs.

Results

The silicified wood in the Xiadelongwan area of Yanqing, north of Beijing, was firstly discovered in the Yanqing World Geopark of Silicified Wood. The in-situ silicified stumps were preserved in the Tuchengzi Formation of the Late Jurassic. One well-preserved petrified stump showing distinct growth rings was chosen for measuring the positive phototropism direction, and the result is SW235° (Fig. 1). The in-situ fossil forest locality

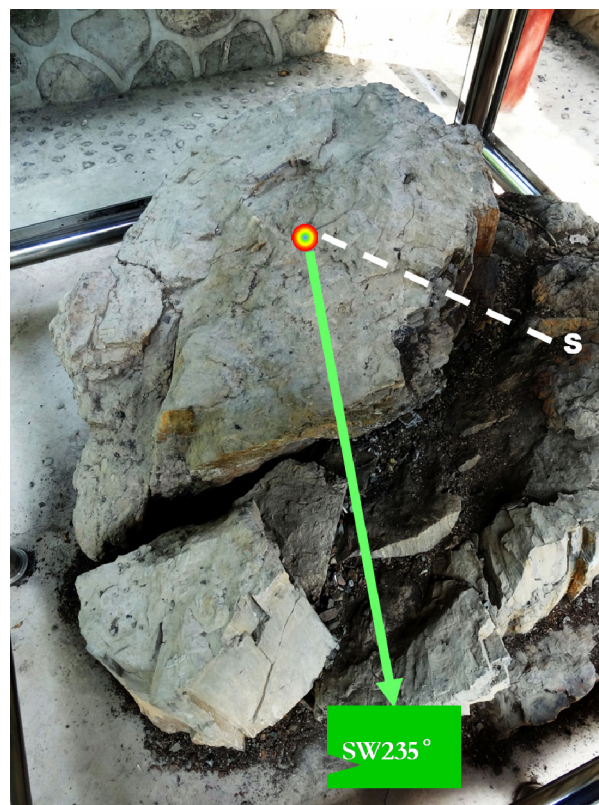


Fig. 1. Phototropism direction of preserved in-situ fossil wood in the Yanqing World GeoPark.

* Corresponding author. E-mail: jiangmaomao_925@sina.com

is located within the Upper Jurassic Shishugou Formation and lies approximately 17 km north of Jiangjunmiao at the eastern margin of the Dzungar basin, Xinjiang Uygur Autonomous Region. Unfortunately, most of the transverse sections were badly weathered. Only few trunks remain well-preserved distinct growth rings with average eccentricity of SW220°.

For comparison with the relevant data of living trees in the same area, without any other disturbing factors, they exhibit a positive phototropism direction of SW210°±5°.

Palaeomagnetic studies show that the North China Plate had rotated counterclockwise in an angle of 43° from the Middle Triassic to the Middle Jurassic. However, there are different opinions about the rotating direction and degrees of the plate during the Late Jurassic to the Early Cretaceous.

According to the paleomagnetic study of Mesozoic continental sediments along the northern Tianshan Mountains (China) and southern border of the Dzungar Basin, east of Urumqi (44.2°N, 86.0°E), the total India-Siberia convergence remained approximately constant, although the Dzungar block has a slight counterclockwise during the Jurassic to Early Tertiary. The slight counterclockwise could be ignored during the geological time.

Conclusions

This work compared the positive phototropism direction

in the Middle Jurassic fossil stump of Yanqing Geopark with the positive phototropism direction in the modern normal growth stumps in the same area, and infers that the phototropism evidence supports the conclusion that the North China Plate rotated clockwise after the Late Jurassic.

Comparing the phototropism of the silicified wood in Dzungar Basin with the modern normal growth stumps in plain area, we found that both of them have eccentricity towards about SW219°±5°, indicating that the Dzungar Block from the Late Jurassic to the present did not rotate almost.

Acknowledgments

This work was financially supported by the National Natural Sciences Foundation of China (grants No. 41402004, 41272010, 41572014 and 41302004), the Strategic Priority Research Program (B) of the Chinese Academy of Sciences (grant No. XDB18000000), the State Key Program of Research and Development of Ministry of Science and Technology, China (grant No. 2016YFC0600406) and the Team Program of Scientific Innovation and Interdisciplinary Cooperation of CAS. This is a contribution to IGCP 632.