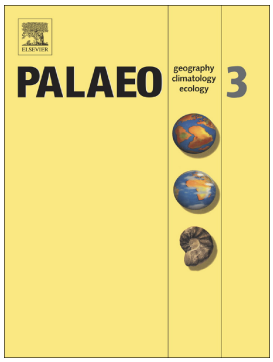


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# Late Early Cretaceous climate and $pCO_2$ estimates in the Liupanshan Basin, Northwest China

Baoxia Du[ab*], Xiangtong Lei[a], Mingzhen Zhang[c*], Sen Wang[a], Aijing Li[a], Zhen Du[a], Weiwei Xing[d]

[a] School of Earth Science, Lanzhou Universityand Key Laboratory of Mineral Resources in Western China (Gansu Province), Lanzhou 730000, China

[b] State Key Laboratory of Palaeobiology and Stratigraphy, Nanjing Institute of Geology and Palaeontology, Chinese Academy of Sciences, Nanjing 210008, China

[c]Key Laboratory of Petroleum Resources, Gansu Province/ Key Laboratory of Petroleum Resources Research, Northwest Institute of Eco-Environment and Resources, Chinese Academy of Sciences, Lanzhou 730000, China

[d] Hebei Institute of Regional Geology and Mineral Survey, Langfang, Hebei, 065000 China

[*]Correspondence author: Baoxia Du and Mingzhen Zhang Email: dubx@lzu.edu.cn; zhangmzh08@lzb.ac.cn

**Abstract:** The extinct conifer family Cheirolepidiaceae, especially *Pseudofrenelopsis*, is commonly used to reconstruct the atmospheric palaeo-$CO_2$ concentration ($pCO_2$) during the Cretaceous period. In recent years, many *Pseudofrenelopsis* specimens have been collected from the uppermost stratum of the Naijiahe Formation in the Liupanshan Basin, Ningxia Hui Autonomous Region, Northwest China. The stomatal parameters, such as stomatal density, stomatal index, stomatal pore length, and stomatal pore depth, and the stable carbon isotope composition of the present *Pseudofrenelopsis* were analyzed. The palaeo-$CO_2$ levels of the Liupanshan Basin during the late Early Cretaceous (late Albian) were reconstructed using stomatal ratio (SR) and mechanistic model approaches. The SR method yielded a semi-quantitative $pCO_2$ estimate of 620 ppmv on the basis of the Recent standardization and 1030 ppmv on the basis of the Carboniferous standardization, which show similarities with other SR-based and geochemical-based reconstructions for the late Early Cretaceous. The $pCO_2$ was about 670 ppmv on the basis of mechanistic model method, similar to the estimated $pCO_2$ values recovered by the SR method corrected with the Recent standardization. Based on comparative studies of previously published $pCO_2$ results of the Early Cretaceous, $pCO_2$ levels varied during the Early Cretaceous, and $pCO_2$ was relatively stable during the late Early Cretaceous. Furthermore, environmental conditions of the Liupanshan Basin during the late Early Cretaceous were studied. The stable carbon isotope composition of *Pseudofrenelopsis* leaves ranged from −21.5‰ to −24.3‰, with an average of −22.8‰, indicating an arid/semi-arid and high-evaporation climate during the late Early Cretaceous in the Liupanshan Basin. These environmental conditions were also supported by palynological, lithological, and geochemical evidence.