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Evidence and impacts of paleowildfires in the eastern Central Asian Orogenic Belt during the Early Cretaceous

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Wildfire is a fundamental disturbance agent in terrestrial ecosystems, influencing global carbon cycling and climate change. The Early Cretaceous, a typical greenhouse climate period that witnessed prevalent paleowildfire activity, offers a critical record for understanding deep–time climate feedbacks. The Middle Jurassic–Lower Cretaceous Longzhaogou Group is well preserved and exposed in the eastern Central Asian Orogenic Belt. It is characterized by marine-continental interaction sedimentary formation, distributed in Hulin, Heilongjiang Province, China. From bottom to top: the Peide, Qihulin, Yunshan, and Zhushan formations[1]. Evidence of paleowildfire events is reported from the coal-bearing strata of the Zhushan and Yunshan formations during the Early Cretaceous (Albian).

Coal petrology, plant anatomy, and organic geochemistry provide direct evidence for the identification of paleowildfires. Oil-immersion fluorescence microscopy identifies inertinite. Scanning electron microscopy (SEM) reveals homogenization of plant cell walls. The detection of specific biomarkers indicate the presence of thermogenic polycyclic aromatic hydrocarbons (PAHs), particularly with PAH ratios of BaA/(BaA + Chy) > 0.35 and IP/(IP + BghiP) > 0.5. In addition, inertinite reflectance temperatures were calculated to be approximately 483 ℃ in the Yunshan Formation and approximately 445 ℃ in the Zhushan Formation, indicating surface fire. This study provides the first quantitative fire behavior data for the study area during the Early Cretaceous.

The paleogeographic reconstruction indicates that the study area was located at near 55°N in the Albian, situated in the transitional zone between the Warm Temperate and Boreotropical climate zones[2]. During this period, the global average atmospheric oxygen content reached 26.5–27.8%, significantly higher than the present atmospheric level of 21% [3]. The high oxygen content increases vegetation flammability, allowing paleowildfires to spread even in wet environments[4]. The results highlight fire–vegetation–climate feedback as the driving mechanism of the Early Cretaceous paleowildfires.

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[3] Mills, Krause, Jarvis & Cramer (2023), Annual Review of Earth and Planetary Sciences 51, 253–276.

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