Lithium isotopic composition of the Carboniferous seawater: implications for initiating and maintaining the Late Paleozoic Ice Age

YANGYANG WANG[1], YILIN XIAO[1,2*], HE SUN[3], FENGTAI TONG[1], HAIOU GU[3], YIGAN LU[1]

[1]CAS Key Laboratory of Crust-Mantle Materials and Environments, School of Earth and Space Sciences, University of Science of Technology of China, Hefei, 230026, China (*correspondence:ylxiao@ustc.edu.cn)

[2]CAS Center for Excellence in Comparative Planetology, China

[3]School of Resources and Environmental Engineering, Hefei University of Technology, Hefei, 230009, China

The mechanisms for decreasing atmospheric CO_2 concentration and initiation of the Late Paleozoic Ice Age (LPIA), which are closely linked to continental silicate weathering, are still in great debate. In order to assess the contributions of continental silicate weathering for the LPIA, this study reconstructs Li isotopic composition of the Carboniferous seawater based on East Fenghuangshan carbonate section in Chaohu city, China. Our results show seawater Li isotopic composition (δ^7Li_{SW}) was roughly steady (ca. 20‰) in the late Tournaisian and early Visean, and decreased to ca. 8‰ in the late Visean and then gradually increased to ca. 22‰ in the Kasimovian and Gzhelian. Simulation results indicate that decrease of δ^7Li_{SW} requires exponential increase of riverine Li flux by a factor of 25 under 2 times longer ocean residence time, meaning enhanced continental silicate weathering that likely results from colonization of deep-rooted plants. Plants with deep roots facilitated weathering of large quantities of rocks in the deep level, which combined with the plant expansion, draw down atmospheric CO_2 concentration and probably made a profound effect on the initiation of the LPIA. By contrast, uplift of the Hercynian orogen is responsible for the increase of δ^7Li_{SW}, which resembles the effect of Himalaya orogen on the Cenozoic seawater. High relief due to the Hercynian orogen exposed fresh rocks for weathering by removing the thick soil and saprolite cover. Such a process is beneficial for keeping high-level CO_2 consumption and low atmospheric CO_2 concentration, and thus plays a significant role in maintaining long-time large-scale glacial period. To sum up, colonization of deep-root plants and uplift of the Hercynian orogen are the key drivers for initiating and maintaining the LPIA.