Coupling of continental weathering and marine phosphorus cycle

BING SHEN[1], RUIMING WANG[1], XIANGUO LANG[2], WEIMING DING[1], YARONG LIU[1]

[1] Key Laboratory of Orogenic Belts and Crustal Evolution, MOE & School of Earth and Space Sciences, Peking University, Beijing 100871, China
[2] State Key Laboratory of Oil and Gas Reservoir Geology and Exploitation & Institute of Sedimentary Geology, Chengdu University of Technology, Chengdu 610059, China

Evolution of intellectual human beings requires the Earth system remain habitable for more than 540 million years (Myr). A habitable Earth is featured with the global temperature within the range that animal life can tolerant and atmospheric pO_2 level high enough for animal breath. Both attributes are largely controlled by organic matter production and decomposition, which is the engine of global carbon cycle, sequestering atmospheric CO_2 into lithosphere and releases O_2 into the atmosphere. Organic matter production is primarily controlled by riverine influx of phosphorus in the geological time scale, while bio-available nitrogen (e.g. ammonium and nitrate) can be sysnthesized by diazotrophs by using unlimted N_2 gas as ingradient. Seawater phosphate could be removed by authigenic phosphate formation and iron-bound phosphorus deposition, resulting in the reducing of the phosphate availability in the ocean inventory. In order to understand how marine primary productivity was modulated by phosphorus, here we developed a numerical model to simulate the secular variations of terrestrial phosphorus input (P_{in}) and the fraction of organic phosphorus burial (R_p) in the past 540 Myr. The model result indicates that P_{in} was high before 400 million years ago (Ma), decreased in the following 100 million years, remained at a low level between 300 and 100 Ma, and increased in the rest Phanerozoic. In contrast, P_{in} and R_p are negatively correlated, suggesting the coupling of continental weathering and marine phosphorus cycle. We suggest that an increase of P_{in} would associate with an enhanced inorganic phosphorus burial due to more active iron redox cycle, which efficiently removes phosphorus from the ocean inventory. Thus, the coupled continent weathering and marine biogeochemical cycle might be responsible for the long-term stability of the Earth system, paving the way for the evolution of Human beings.