Sulfur record of rising in marine sulfate levels 800 million years ago

XIANGUO LANG[1], SONGZHUO LI[1], HAORAN MA[2], BING SHEN[2]

[1] Institute of Sedimentary Geology, Chengdu University of Technology, Chengdu 610059, China
[2] School of Earth and Space Sciences, Peking University, Beijing 100871, China

The Earth experienced the second rise of atmospheric oxygen levels (pO_2) in the late Neoproterozoic that is collectively known as the Neoproterozoic oxidation event (NOE). Lines of geochemical evidence suggest the rise of pO_2 commenced at ca.820–750 million years ago (Ma). However, marine oxidants levels during the initial stage of the NOE remain unclear. In order to address this, we report organic carbon ($\delta^{13}C_{org}$) and pyrite sulfur ($\delta^{34}S_{py}$) isotopes of the Hetong and Gongdong formations (ca.800–720 Ma) in Nanhua Basin, South China. The Hetong and Gongdong formations, mainly consisting of turbiditic laminated mudstone and thin bedded sandstone, were deposited in deep water envrionment. $\delta^{13}C_{org}$ of these formations varies between -35.2‰ and -25.8‰ (average: -31.7‰, n=119), with total organic carbon content (TOC) ranging from 0.03 wt.% to 0.68 wt.% (average: 0.23 wt.%, n=119). $\delta^{34}S_{py}$ remains invariant (~-10‰) throughout the Hetong Formtion and shows secular variation (-20.2‰–+9.8‰) in stratigraphy in the Gongdong Formation. In addition, all samples have relatively high pyrite content (average: 0.99wt.%, n=95). Here we use numerical models to simulate the observed sulfur record. The modeling results suggest the microbial sulfate reduction is occurred within sediments and $\delta^{34}S_{py}$ is mainly controlled by TOC, sedimentation rate and seafloor redox. The results also show that the invariant $\delta^{34}S_{py}$ with high pyrite content from the Hetong Formation indicate a moderate marine sulfate level of ~5 mM. Wide variations in $\delta^{34}S_{py}$ from the Gongdong Formation are resulted from local changes in sedimentation rate rather than fluctuations of seawater redox. Our study confirms the increasing of marine oxidants levels ~800 million years ago and suggests that $\delta^{34}S_{py}$-pyrite content system is more applicable in quantifying ancient sulfur cycles.