Nitrogen isotope evidence for nitrogen cycle and redox variations in the Nanhua basin during Cryogenian non-glacial period

DAN WANG[1], XIANGKUN ZHU[1*], BIN YAN[1] , YANAN SHEN[2]

[1] MLR Key Laboratory of Isotope Geology, Institute of Geology, Chinese Academy of Geological Sciences, Beijing 100037, China (njuwangdan@163.com; *xiangkun@cags.ac.cn; yanbin703@163.com)

[2]School of Earth and Space Sciences, University of Science and Technology of China, Hefei 230026, China (yashen@ustc.edu.cn)

The Cryogenian is a crucial interval, marked by extreme climatic fluctuations (Snowball Earth events), marine environmental perturbations and diversification of multicellular eukaryotes. Nitrogen is an essential component of macromolecules and an important biolimiting nutrient for life. The nitrogen isotope signals preserved in ancient sediments has great potential to reveal the co-evolution of marine nitrogen cycle, redox environments and early life. Here we report nitrogen isotopic compositions for the Datangpo/Xiangmeng Formations from three typical Cryogenian interglacial successions, Daotuo section (slope), Minle section (lower slope) and Xiangtan section (deep basin) in the Nanhua basin, South China. The $\delta^{15}N_{bulk}$ values for all three sections lie between +2‰ ~ +6‰, which usually reflect an aerobic nitrogen cycle as in modern ocean [1]. This result is consistent with the flourish of marine planktonic N-fixing cyanobacteria, implying an oxygenated and non-limited nitrogen Cryogenian ocean which provided hospitable environment for the non-nitrogen-fixing eukaryotes [2]. Furthermore, the $\delta^{15}N_{bulk}$ profiles exhibit apparent spatial variations in the lower-middle part of the Datangpo/Xiangmeng Formations, which is characterized by higher and more stable $\delta^{15}N_{bulk}$ values at basinal Xiangtan section than the other two sections. This observation possibly indicate redox stratification and anoxic conditions in the deep-basin realm. Upward, the overall $\delta^{15}N_{bulk}$ distributions for all three studied sections are consistent with increasing oxygenation of seawater during the late Cryogenian interglacial period.

[1] Stüeken, E.E., Kipp, M.A., Koehler, M.C., Buick, R., 2016. Earth-Sci Rev 160, 220-239.

[2] Sánchez-Baracaldo, P., Ridgwell, A., Raven, J.A., 2014. Current Biology 24, 652-657.