Constrain the global redox state of post-Marinoan ocean with paired Mo-U isotopes

M. CHENG[1], C. LI [1*], F. ZHANG[2], A. ANBAR[2]

[1] State Key Laboratory of Biogeology and Environmental Geology, China University of Geosciences, Wuhan, 430074, China (chaoli@cug.edu.cn)

[2] School of Earth & Space Exploration, Arizona State University, Tempe, AZ 85287, USA

Morphologically differentiated eukaryotes and possible animal embryo first occurred in the early Ediacaran Period. A significant oxygenation in the ocean has been suggestted for this interval (Sahoo et al., 2012 Nature), but been challenged by recent study (Miller et al., 2017 CG), leaving the role of O_2 in the evolution of earliest animals an open question. To constrain the global ocean oxygenation in the post-Marinoan Ediacaran ocean, we provided paired Mo-U isotopes in black shales from the Doushantuo Member II (~635-630 Ma) Yuanjia section.

δ^{98}Mo (relative to NIST SRM 3134 = +0.25 ‰) show a continuous rise from −1.41 ‰ to +0.94 ‰ in the basal to the middle of the record (LM: from 0 to 2 m), and stabilized around +0.6 ‰ in the upper (UM: from 2 to 3.5 m). δ^{238}U (relative to standard CRM145) display an opposite stratigraphic trend compared to δ^{98}Mo, vary from ~+0.3 ‰ in the LM to ~−0.1-0 ‰ in the UM. The Mo-U isotopic variations cannot be explained by perturbations of local redox condition since Fe speciation data indicate persistently euxinic depositional environments.

δ^{238}U show strong negative linear corelation with δ^{98}Mo (R^2 = 0.88, p <0.01) for the LM, but no statistically significant corelations were observed for the UM. δ^{238}U also show strong positive linear corelation (R^2 = 0.86, p <0.01) with U concentations in the LM, but no correlation between Mo isotopes and Mo concentrations is observed. This pattern indicate that the Mo and U isotopes in the LM are not changed independently, and thus do not reflect changes of the seawater isotopic compositions. One hypothesis to explain these data is some unknown local process controlling both Mo and U isotopic fractionations. The relatively stable and decoupled Mo-U isotopes in the UM might record the contemporaneous seawater isotopic compositions. If this is correct, using an isotopic mass balance model, the Mo-U isotopic data in the UM indicate widely expanded anoxia/euxinia in the ocean.