Evidence for non-productivity-controled oceanic anoxia in early Cambrian

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Debate exists on the redox state of the early Cambrian ocean. In different views, the anoxic black shales that widely developed in the lower Cambrian have been contrastingly regarded as a result of oxygen minimum zone (OMZ) related to high productivity (Guilbaud et al., 2018), or of anoxic deep waters in a redox stratified ocean caused by low atmospheric oxygen level (Jin et al., 2016). To constrain the redox state of the early Cambrian ocean, we carried out an integrated study of Mo isotope, iron speciation, and nutrient elements on the basinal Yuanjia section in South China.

Iron speciation data indicate persistently euxinic bottom water condition because Fe_{HR}/Fe_T are >0.38 and Fe_{py}/Fe_{HR} are >0.7. Mo isotope ($\delta^{98}Mo$) data range from −0.10 ‰ to +1.94 ‰, with a negative correlation with Mo/TOC (an indicator for Mo availability), indicating the control of local water sulfidity rather than global redox state. Nutrient elements of Cu, Ni, Zn, Cd show variable enrichments relative to the continental crust and a negative correlation with $\delta^{98}Mo$, excluding the effect of varied local redox condition and depositional rate, pointing to the variation of productivity. The negative coupling between local sulfidity and productivity can be explained by the varying local water renewal rate, probably by upwelling of anoxic deep ocean waters. Fast water renewal rate can promotes the replenishment of Mo and the supply of nutrient elements to the basin, but suppresses the buildup of H_2S, resulting in high productivity and low $\delta^{98}Mo$. Vice versa. Our study thus provides evidence for non-productivity-controled local anoxia, thus not supporting the OMZ hypothesis for the early Cambrian ocean.

Reference:

Guibaud et al., 2018. Oxygen minimum zones in the early Cambrian ocean. Geochem. Pers. Lett. 6: 33-38.

Jin et al., 2016. A highly redox-heterogeneous ocean in South China during the early Cambrian (~529-514 Ma): Implication for biota-environment co-evolution. Earth Planet. Sci. Lett. 441: 28-51.