Pulsed oxidation of deep ocean of early Cambrian revealed by phosphate nodule

WANG HUAJIAN[1, 2], ZHANG SHUICHANG[1, 2], YE YUNTAO[1, 2], WANG XIAOMEI[1, 2]

[1]Key Laboratory of Petroleum Geochemistry, China National Petroleum Corporation, Beijing 100083, China
[2]PetroChina Research Institute of Petroleum Exploration & Development, Beijing 100083, China
Corresponding author: wanghuajian@petrochina.com.cn

A mass of benthic algae and metazoan fossils were found in the later Ediacaran and early Cambrian black shale. Geochemical evidence of bulk rocks showed anoxic or even euxinic bottom-water conditions, which is contradictory with the survival of aerobics breathing life. Small-scale spatial and high-frequency temporal variations in the microenvironment might be the most likely factor. Thus, some special nodules or concretions rich in redox sensitive elements, such as phosphate nodule and iron manganese concretion, which recorded the continuous variations of water-rock interface, can provide more precise and visual evidence.

The phosphorus-rich sediments, including phosphate nodules and phosphate rock, at the bottom of the Lower Cambrian black shale, were widely found in China. It can be found in the inner- and outer-shelf, and the basin. So it was considered as one of the most important chemical symbol layers in early Cambrian, and also one significant revolution on the earth surface system during the turning period of Proterozoic-Phanerozoic.

Laser ablation-inductively coupled plasma-mass spectrometry system (LA-ICP-MS) was used to do *in situ* multi-elements imaging in the micro areas of phosphate nodule, which was collected from the black shale of Niutitang Formation in Jinsha Country, Guizhou Province. The results showed that, the element distribution in the phosphate nodule recorded the micro-environment variation tendency during its formation. Wherein, the co-enrichment of Ca, P and the deficit of Si in the phosphate nodule, means the enrichment of P was resulted from the formation of authigenic apatite; the co-enrichment of Mn, Zn with P in the interior, means an oxic bottom water during the initial formation time of phosphate nodule; the enrichment of As, Mo, V in the surrounding rocks or black shales, means the bottom water was gradual reduced and resulted in euxinic.

Considering the pulsed oxidation of deep-ocean during the Doushantuo Formation[1], the transition of Proterozoic-Phanerozoic ocean might not be obvious. Globally stratified oceans might still extensively exist during the early Cambrian.

Reference:
[1] McFadden KA, et al. Pulsed oxidation and biological evolution in the Ediacaran Doushantuo Formation. PNAS 2008, 105(9): 3197-3202