Redox evolution of the Ediacaran ocean and atmosphere constrained by chromium isotopes

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The oxygenation of the Ediacaran ocean is thought to be a likely stimulus for the emergence of early animals. Chromium isotope system has become an emerging proxy for revealing the redox states of the ocean and atmosphere in the geological time[1,2]. In the study Cr isotopic data from two distinct Ediacaran deposits are reported, including Doushantuo and Dengying formations at Wangji, Hubei, deposited in the inner shelf of Yangtze platform during the Ediacaran Period, and the Lantian Formation at Shiyu, Anhui, deposited in the slope/basin environment, corresponding to the Doushantuo formation[3].

Our data show that shortly after the Marinoan glaciation, the atmospheric oxygen level rised to a relatively high level to oxidize the Cr(III)-bearing minerals ($\delta^{53}Cr_{shales}$ in the Doushantuo formation rised up to 1.1‰). Another oxygenation occurred just before the “Shuram” event ($\delta^{53}Cr_{carbonates}$ rised up to 0.96‰), and might oxidize the dissolved organic carbon in deep water, leading to the negative excursion of C isotope. However, the lack of positively fractionated chromium isotope values in Lantian formation indicates that contemporary deep water might still be anoxic, and the terrestrial Cr was reduced and deposited before transferring to Shiyu. Comparing these two sections of different depositional environments, we suggest that the Ediacaran ocean was heterogeneous and turbulent. The gradual oxygenation of ocean may pave the way for macrobiota, but their habitable space might be limited.

[1] Frei et al. (2011). Earth Planet. Sci. Lett. **312**, 114-125.

[2] Planavsky et al. (2014) Science **346**, 635-638.

[3] Jiang G et al. (2011) Gondwana Res. **19**, 831-849.