
Widespread euxinia during the late Ediacaran ocean oxygenation event (Shuram) in South China

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Abstract

The Ediacaran Period was a critical time in Earth history, connecting the 'snowball Earth' Cryogenian glaciations and the emergence and rapid diversification of bilaterian animals. The largest negative $\delta^{13}\text{C}_{\text{carb}}$ excursion in Earth history, the Shuram/DOUNCE event, occurred towards the end of the Ediacaran Period, and led into the Ediacaran-Cambrian radiations. In China, the DOUNCE excursion appears to have lasted about ten million years, beginning around ca. 570 Ma within Doushantuo Formation Member III, but extending into Doushantuo IV (the 'Miaohe' black shale), the top of which records the isotopic recovery in organic carbon isotopes. $\delta^{13}\text{C}_{\text{carb}}$ turns positive in the immediately overlying dolomitic basal Dengying Formation. Previous studies suggested that anoxic ferruginous conditions in the deep marine environment gave way to more oxic conditions after the c.580 Ma Gaskiers glaciation in Newfoundland. However, over the South China Craton, the ocean seems to have been strongly redox-stratified, with some authors proposing an oxic surface layer resting above a sulfidic wedge that was sandwiched within ferruginous deep waters and some argue further for increasing water column oxygenation and deepening of the chemocline using abundance of framboidal pyrites in the Doushantuo Fm. Because the Doushantuo Fm can be traced widely across the craton and in evidently different depth settings, South China offers a unique opportunity to study the redox structure of the productive ocean margins of the Ediacaran ocean (Nanhua basin) during the DOUNCE excursion, which has been interpreted by some to indicate ocean oxygenation. A range of redox-sensitive elemental (e.g. Mo) and isotope (e.g. Mo, U, S) data from Doushantuo IV have been used to support this global oxygenation event. Fe speciation studies can shed light on the redox state of the paleo-ocean but have only been applied to a limited range of sections during this time interval. This study reports new Fe speciation data from the upper Doushantuo Fm. at seven different sections, ranging from shelf to slope settings throughout the Nanhua basin, and $\delta^{98}\text{Mo}$ from one slope section. With the data, we offer an attempted spatial reconstruction of the redox state of the Ediacaran ocean and our reconstruction confirms that pyrite deposition beneath euxinic waters was widespread along productive margins during the latter stages of the Shuram/DOUNCE excursion, and supports the idea that pyrite burial contributed to oxygenation during the late Ediacaran.

Keywords: Ediacaran, Shuram/DOUNCE excursion, Nanhua Basin, Iron speciation, Mo isotopes

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