Evidence for multiple redox zones in early Cambrian ocean

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Ocean redox state is basically controlled by the balance between oxidizers and reductants. In theory, in addition to conventional oxygen and sulfate, Mn-Fe oxides and nitrate can serve as the oxidizer, whose reductions have been hypothesized to have generated manganous-ferruginous and nitrogenous zones between oxic and sulfidic zones in a highly stratified ocean of early Earth (>520 Ma; Li et al., 2015). To test this hypothesis, we conducted a high-resolution Fe-S-C-N and trace-element geochemical study of the early Cambrian Qingxi Formation in a deep-water setting at Silikou, Guangxi Province, South China. Integrated Fe-Mo-S-C-N data demonstrate an overall marine redox transition at Silikou from euxinic to oxic conditions up section, which is consistent with the gradual oxygenation of early Cambrian ocean observed widely in South China (Jin et al., 2016). However, our data also clearly reveal the developments of manganous-ferruginous and nitrogenous conditions during the transition as suggested by higher sedimentary Mo concentrations relative to U due to the adsorption to Mn-Fe oxides and subsequent reductions(i.e., the activity of Mn-Fe shuttle) and the abrupt increase of the organic N isotope from +2 ‰ to +5 ‰. The occurrence of these redox zones reflects the successive use of oxygen, nitrate, Mn-Fe oxides and sulfate as the oxidizers in early Cambrian oceans. Thus our study for first time provides direct evidence for the existence of these hypothesized redox zones in early Earth’ s oceans, which is of significance to our understanding of elemental biogeochemical cycles in early Earth’ s oceans and their impacts on biological evolutions.

References

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