Microaerobic Fe(II) oxidation could drive microbial carbon assimilation in paddy soil

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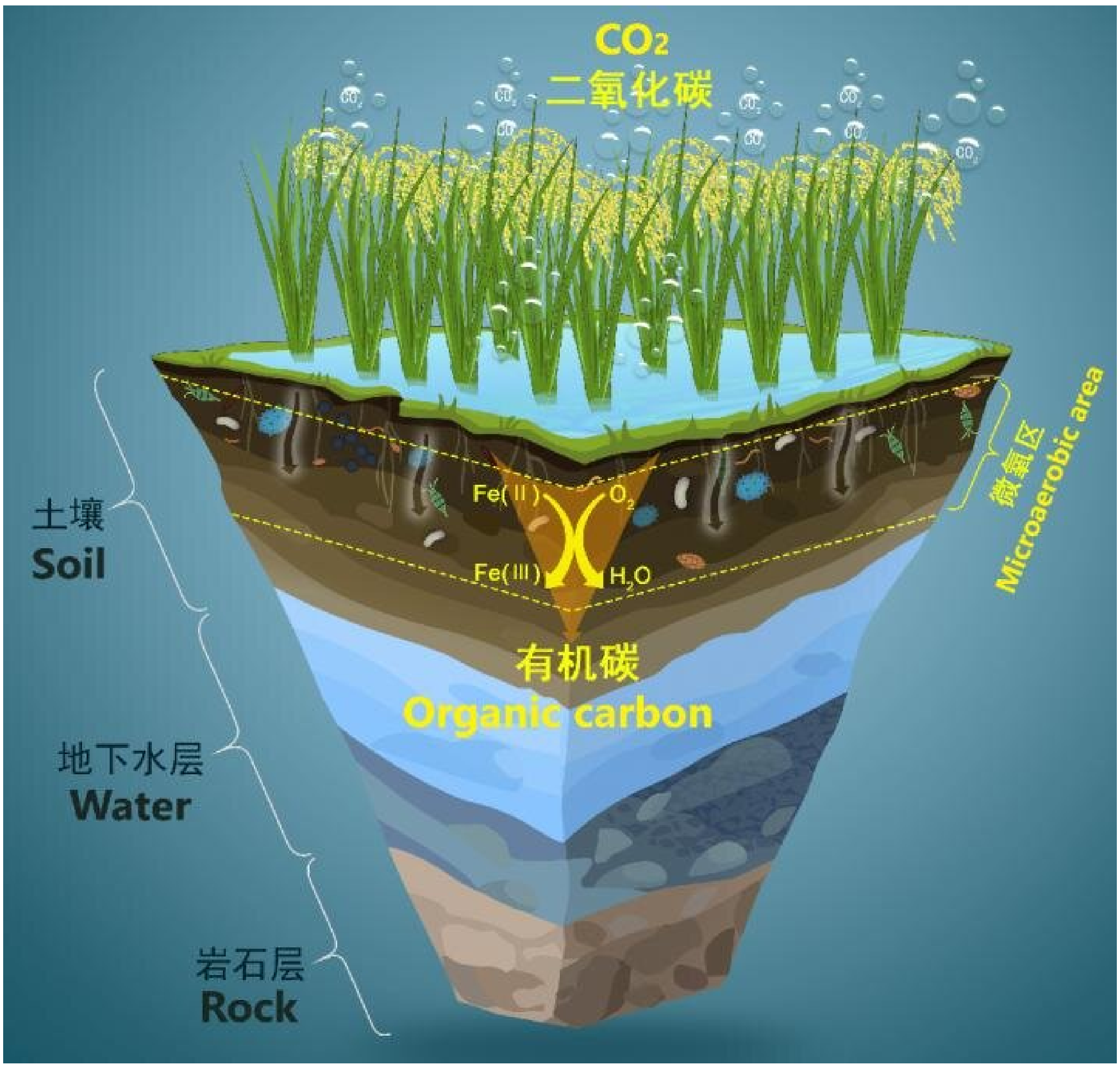

Schematic diagram of microaerobic Fe(II) oxidation coupled to carbon assimilation processes driven by microbes from paddy soil. Credit: ©Science China Press

The carbon assimilation process driven by soil microorganisms is important to maintain the production and ecological function of paddy fields. A recent publication from Prof. Fangbai LI's group has found that Fe(II) oxidation under microaerobic conditions could drive microbial carbon assimilation in paddy soil, and identified the potential microaerophilic Fe(II)-oxidizing bacteria (FeOB). These findings provide an insight into the ecological function of iron cycling in the critical zone of red soil.

The research paper, "Microaerobic Fe(II) oxidation coupled to carbon assimilation processes driven by microbes from paddy soil," has been published in *Science China Earth Sciences* (2019, vol.62). The corresponding author of this study is Prof. Fangbai LI from Guangdong Institute of Eco-Environmental Science & Technology, China. The first author is Prof. Xiaomin LI from SCNU Environmental Research Institute (SERI), South China Normal University (SCNU), China. The researchers employed gradient tubes and a 13C-labeled technique to investigate the processes of microaerobic Fe(II) oxidation coupled to carbon assimilation in the paddy soil from South China, and identified the associated microaerophilic FeOB.

Microbial growth using iron as substrate is believed to be an ancient form of metabolism, which likely evolved during the great oxidation event about 2.4 billion years ago, leading to banded iron formation (BIF). With a gradual increase in atmospheric O2 concentrations over time, the habitats for microaerophilic FeOB became restricted to the iron-rich oxic-anoxic interfaces, such as groundwater, freshwater iron seeps, wetlands, sediments and marine hypothermal vents. Most of the paddy soils in China are located in the southern region's red soils, where potential microaerobic conditions can be developed during the flooding season, such as the water-soil interface, and rice rhizosphere. However, few studies report such coupled processes in paddy soil of the critical zone in South China.

In this study, rhizosphere soil from flooded paddy fields was used as the inoculum to enrich the microaerophilic FeOB in gradient tubes with different Fe(II) substrates (FeS and FeCO3) and 13C-biocarbonate as inorganic carbon source to track the carbon assimilation. Kinetics of Fe(II) oxidation and biomineralization were analyzed, and the composition and abundance of the microbial community were profiled using 16S rRNA gene-based high-throughput sequencing.

Results showed that microbial cell bands were formed 0.5-1.0 cm below the medium surface in the inoculated tubes with Fe(II) substances. The yields of 13C-biocarbonate incorporation was FeCO3 (1.61-1.98 percent) > FeS (0.44-0.54 percent), and the Fe(II) oxidation rate was FeS (0.156 mM d-1) > FeCO3 (0.106 mM d-1). Relative to the agar only control, the abundances of Clostridium and Pseudogulbenkiania increased with FeS, while those of Vogesella, Magnetospirillum, Solitalea, and Oxalicibacterium increased with FeCO3.

The results obtained in this study confirmed that microorganisms enriched from the paddy soil in the red soil area could couple microaerobic Fe(II) oxidation to carbon assimilation. Although it is difficult to evaluate the contribution of such coupling processes to iron mineral formation and carbon assimilation in the paddy field, such coupling processes driven by microorganisms should not be ignored, particularly during the iron-carbon transformation in the critical zone of red soils, given that several habitats potentially exist in paddy field for microaerophilic FeOB.

At the oxic-anoxic interface and rice rhizosphere, the microaerobic Fe(II) oxidation not only coupled carbon transformation, but also formed Fe(III) minerals with high surface area and reactivity, which can strongly influence the fates of heavy metals and other hazardous organic pollutants by adsorption, complexation, and redox reaction.

More information: Xiaomin Li et al, Microaerobic Fe(II) oxidation coupled to carbon assimilation processes driven by microbes from paddy soil, *Science China Earth Sciences* (2019). DOI: 10.1007/s11430-018-9329-3

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