Geochemical patterns and microbial contribution to iron plaque formation in the rice plant rhizosphere

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1. Background

Wetland plants - especially Rice - developed strategies to counteract soil toxicity at elevated levels of Fe²⁺ in the rhizosphere:

Aerenchymatous tissues contrive gas exchange between the atmosphere and water-saturated anoxic soils.

Radial oxygen loss from roots increases redox potential around roots. Fe²⁺ gets oxidized and precipitates as Fe(III)-minerals along the roots.

These precipitates have been described as iron plaques (Fig. 1):

- Microbially driven iron redox cycling can control the formation and dissolution of ferriferous minerals along the roots (Fig. 2).

But it is currently unknown whether microbial activity triggers or inhibits iron plaque formation.

2. Goals & Concepts

Our goal is a comprehensive study that combines vegetative development of the rice plant and its effects on the rhizosphere soil geochemistry, mineralogy and microbial diversity with respect to iron biogeochemical cycling.

Our concept will involve the correlation of microbial, geochemical and mineralogical small scale variations as a function of plant and root development.

3. Methods & Preliminary Results

Rice Plant Growth

Glass Containers were used to cultivate rice plants (Oryza sativa) on phytoagar to visually follow growth of the roots and iron plaque development.

SEM-Imaging

Iron-minerals found on root surface

Radial Oxygen Loss

significantly higher Oxygen release from roots in setups amended with 0.5 mM Fe²⁺

Vercelli Field Samples

Fe(III)-Reducer

Connections between oxidizing and reducing processes at redox interfaces and relevance for Fe-mineral formation?

4. Open Questions & Outlook

Dynamic geochemical and iron-microbial patterns following vegetative development of the rice plant Oryza sativa.

Quantification and identification of iron(II)-oxidizing and iron(III)-reducing microorganisms in native rice paddy soil.

Connections between oxidizing and reducing processes at redox interfaces and relevance for Fe-mineral formation?

Geochimical characterization and mineralogical identification of in-situ iron plaque formation.

Acknowledgement: This work is supported by funding from the German Research Foundation to C. Schmidt and A. Kappler.