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# Biogeochemical and microbiological characterization of rust tubercles induced by microbial activity

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*Figure 1: top: photographs of the two tubercles, the cross indicates the spot where the microsensor measurements were performed, bottom: photographs of the field motor/micromanipulator and microsensor set up in the field.*

Corrosion of metal structures in the environment can be highly accelerated through microbially induced corrosion (MIC) in biofilms forming at the metal surface [1]. Within the project “RimiK” (risk factors and indicators of microbially induced corrosion), we aim to biogeochemically and microbiologically characterize corrosive biofilms occurring in federal German waterways. Therefore, we applied a field microsensor multimeter coupled to a micromanipulator (Unisense, DK) on corroding sheet piles in a lock (Upper Havel Waterway, Regow, Germany) and investigated rust tubercles formed by MIC. Using a custom-made motor and micromanipulator holder we attached the whole set-up to the sheet pile walls using strong neodymium magnets (Figure 1). Thus, we were able to measure profiles into two tubercles directly in the field. We recorded profiles of redox potential ($E_h$), $O_2$, $H_2S$ and pH with 500 µm spatial resolution.

Overall, measured analytes are similar between the two tubercles. However, despite sulfate reducers are thought to play an important role in MIC we detected no free $H_2S$. Yet, high Fe(II) concentrations may precipitate all free $H_2S$ produced by sulfate reduction, forming FeS. This was confirmed by a release of $H_2S$ after acidification of the tubercle.

$O_2$ concentrations decrease towards the inside of the tubercles, with a maximum penetration depth of ~12 mm. A small increase in $O_2$ concentration close to the surface of one tubercle was observed, likely due to the presence of photosynthetic algae. The pH decreases towards the center of the tubercle and reaches weakly acidic conditions of ~5.5, confirming the anodic reaction that takes place there. Redox potential decreases to -350 and -500 mV, indicating a reducing environment.

MIC strongly influenced the chemical micro-environment within the rust tubercles, leading to a micro-environment highly different from the surrounding air/water phase. Using microbial community analysis (NGS) and electron microscopy we will further investigate the spatial organization of the microbial community within the tubercles.

References

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