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Desiccation tolerance of iron bacteria biofilms on Mars regolith simulants

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Iron oxidizing bacteria play an important role in the geological redox cycling of iron on earth. The redox change between Fe(II) and Fe(III) can be used for biological energy production [1]. Therefore iron oxidation in the iron rich martian soils may be or may have been microbially mediated. The microbial conversion of iron is considered to be an ancient form of metabolism [2], so it might have evolved on Mars as well. However, to exist in recent martian soils, bacteria must be able to endure dry and cold conditions.

Neutrophilic iron oxidizers can be found in various iron rich aquatic environments, where they lead to the precipitation of insoluble ferric hydroxides. Some of these environments fall temporarily dry, what could have led to an adaptation to desiccation by bacteria, existing there. One strategy of iron bacteria to endure drought stress might be the formation of biofilms by excreting Extracellular Polymeric Substances (EPS). The deposition of iron hydroxides could enable them to endure dry conditions as well.

For our experiments, neutrophilic iron oxidizing bacteria have been isolated from a creek in Bad Salzhausen/Hesse and temporarily drying out pools in Tierra del Fuego. Strains from aquatic environments in the national park "Unteres Odertal" and from water wells in Berlin/Brandenburg are included in the tests as well.

In desiccation experiments, the capability of iron bacteria to tolerate dry conditions are investigated. The aim of our first experiment is the adaptation to dry conditions. Biofilms of 15 strains are grown on ceramic beads in liquid medium containing complexed Fe(II), established biofilms contain Fe(III) precipitates. The cultures are desiccated in a sterile airflow until the weight of the cultures remained constant. After a desiccation period of 9 h up to 7 d, the beads are transferred to fresh liquid medium.

Adapted strains are used in further desiccation experiments, where biofilms are grown on two martian regolith simulants. These mineral mixtures were developed and produced by the Naturkundemuseum Berlin according to recent data of Mars research missions [3, 4, 5, 6, 7]. The minerals are attached to object slides with potassium silicate and biofilms are grown on the mineral surface. The biofilms are quantified by cell counting and the structure is evaluated by epifluorescence microscopy. After desiccation in a sterile airflow, the survival of cells is determined by fluorescence staining.

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