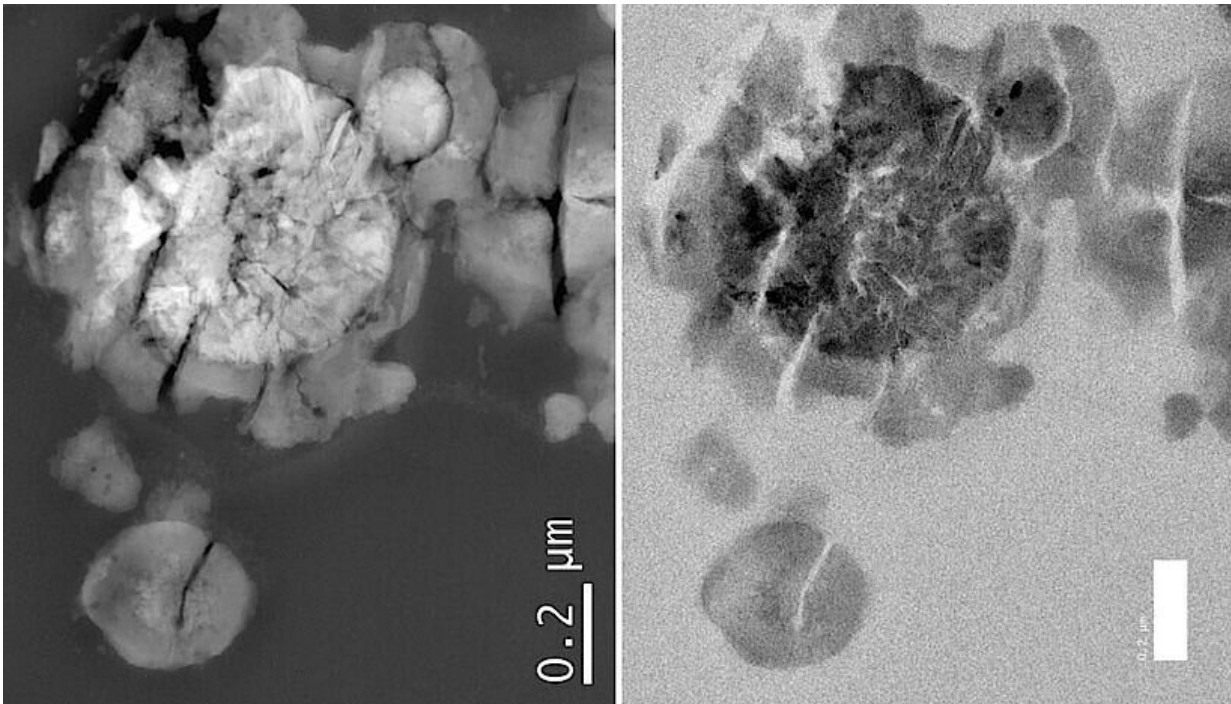


A unique prototype of microbial life designed on actual Martian material

February 22 2021



A unique prototype of microbial life designed on a real Martian material: the scanning transmission electron microscopy image of *M. sedula* cell grown on Black Beauty. Image reveals nonhomogeneous, rugged and coarse cellular interior of *M. sedula* filled with crystalline deposits. Credit: Tetyana Milojevic

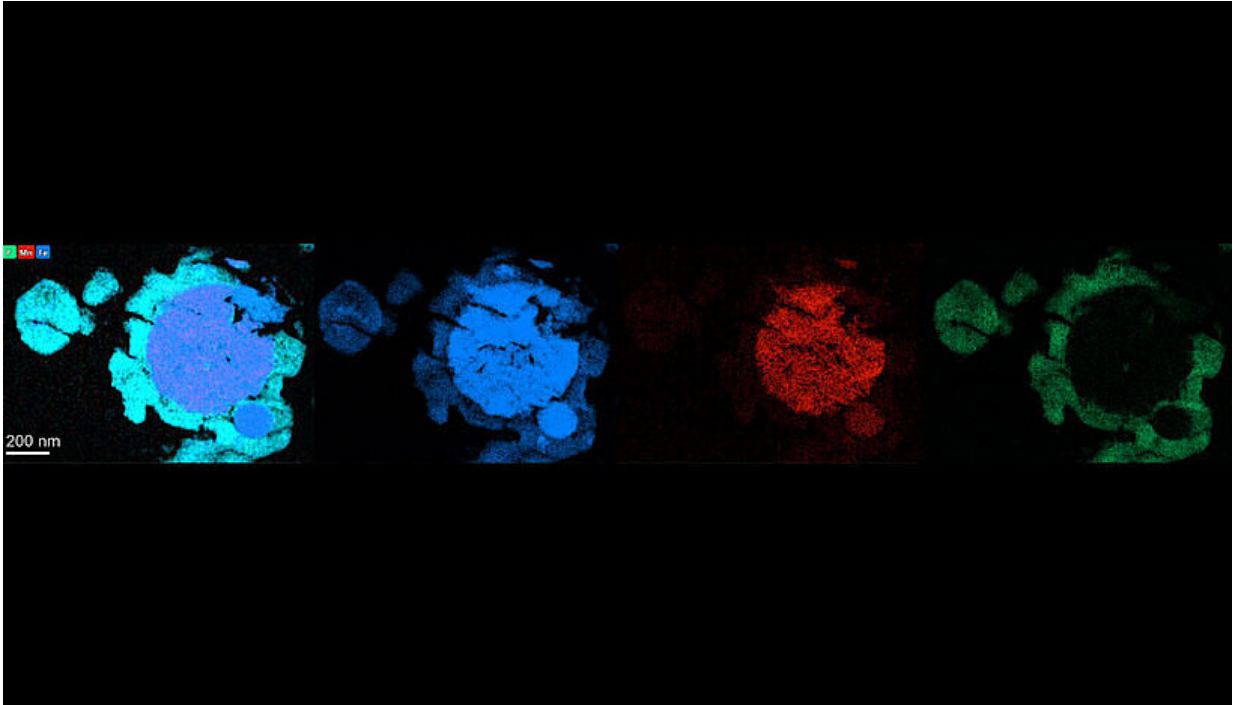
Experimental microbially assisted chemolithotrophy provides an opportunity to trace the putative bioalteration processes of the Martian crust. A study on the Noachian Martian breccia Northwest Africa

(NWA) 7034, composed of ancient (ca. 4.5 Gyr old) crustal materials from Mars has delivered a unique prototype of microbial life experimentally designed on actual Martian material. As the researchers show in the current issue of *Nature Communications Earth and Environment*, this life form of a pure Martian design is a rich source of Martian-relevant biosignatures. The study was led by Tetyana Milojevic, the head of the Space Biochemistry group at the University of Vienna.

Early Mars is considered as an environment where life could possibly have existed. There was a time in the geological history of Mars when it could have been very similar to Earth and harbored life as we know it. Contrary to the current Mars conditions, bodies of liquid water, warmer temperature and higher atmospheric pressure could have existed in Mars' early history. Potential early forms of life on Mars should have been able to derive energy from inorganic mineral sources and transform CO₂ into biomass. Such living entities are rock-eating microorganisms called "chemolithotrophs," which are capable of transforming energy of stones to energy of life.

Martian rocks as energy source for ancient life forms

"We can assume that life forms similar to chemolithotrophs existed there in the early years of the red planet," says astrobiologist Milojevic. The traces of this ancient life (biosignatures) could have been preserved within the Noachian terrains with moisture-rich ancient geological history and mineral springs that could have been colonized by chemolithotrophs. In order to properly assess Martian-relevant biosignatures, it is crucially important to consider chemolithotrophs in Martian relevant mineralogical settings.



Elemental ultrastructural analysis of an *M. sedula* cell grown on the genuine Noachian Martian breccia Black Beauty. Credit: Tetyana Milojevic

One of rare pieces of Mars rocks was recently crushed to envisage the characteristics of life based on Martian materials. The researches used the genuine Noachian Martian breccia Northwest Africa (NWA) 7034 (nicknamed "Black Beauty") to grow the extreme thermoacidophile *Metallosphaera sedula*, an ancient inhabitant of terrestrial thermal springs. This brecciated regolith sample represents the oldest known Martian crust of the ancient crystallization ages (ca. 4.5 Ga).

A specimen of "Black Beauty"

"Black Beauty is among the rarest substances on Earth, a unique Martian breccia formed by pieces of Martian crust (some of them are dated at

4.42 ± 0.07 billion years) and ejected millions years ago from the Martian surface. We had to choose a pretty bold approach of crushing few grams of precious Martian rock to recreate the possible look of Mars' earliest and simplest life form," says Tetyana Milojevic, corresponding author of the study, about the probe that was provided by colleagues from Colorado, U.S..

As a result, the researchers observed how a dark, fine-grained groundmass of Black Beauty was biotransformed and used in order to build up constitutive parts of microbial cells in form of biomineral deposits. Using a comprehensive toolbox of cutting-edge techniques in cooperation with the Austrian Center for Electron Microscopy and Nanoanalysis in Graz, the researchers explored unique microbial interactions with the genuine Noachian Martian breccia down to nanoscale and atomic resolution. *M. sedula* living on Martian crustal material produced distinct mineralogical and metabolic fingerprints, which can provide an opportunity to trace the putative bioalteration processes of the Martian crust.



4.42 billion years old Black Beauty specimen arrived at the Space Biochemistry Group, Vienna University (Milojevic Tetyana (left), Kölbl Denise) from Colorado, USA. A fragment of the genuine Noachian Martian breccia NWA 7034 (Black Beauty) used in the study. Credit: Oleksandra Kirpenko

Analyzing metabolic and mineralogical fingerprints

"Grown on Martian crustal material, the microbe formed a robust mineral capsule composed of complexed iron, manganese and aluminum phosphates. Apart from the massive encrustation of the cell surface, we have observed intracellular formation of crystalline deposits of a very complex nature (Fe, Mn oxides, mixed Mn silicates). These are distinguishable unique features of growth on the Noachian Martian breccia, which we did not observe previously when cultivating this microbe on terrestrial mineral sources and a stony chondritic meteorite," says Milojevic, who recently received an ERC Consolidator Grant for her research further investigating biogenicity of Martian materials.

The observed multifaceted and complex biomineralization patterns of *M. sedula* grown on Black Beauty revealed the rich, diverse mineralogy and multimetallic nature of this ancient Martian meteorite. The unique biomineralization patterns of Black Beauty-grown cells of *M. sedula* emphasize the importance of experiments on genuine Martian materials for Mars-relevant astrobiological investigations. "Astrobiology research on Black Beauty and other similar samples can deliver priceless knowledge for the analysis of returned Mars samples in order to assess their potential biogenicity," concludes Milojevic.

More information: Tetyana Milojevic et al. Chemolithotrophy on the Noachian Martian breccia NWA 7034 via experimental microbial biotransformation, *Communications Earth & Environment* (2021). [DOI: 10.1038/s43247-021-00105-x](https://doi.org/10.1038/s43247-021-00105-x)

Provided by University of Vienna

Citation: A unique prototype of microbial life designed on actual Martian material (2021, February 22) retrieved 17 July 2024 from <https://phys.org/news/2021-02-unique-prototype-microbial-life-actual.html>

This document is subject to copyright. Apart from any fair dealing for the purpose of private study or research, no part may be reproduced without the written permission. The content is provided for information purposes only.