Cranbrook Institute of Science
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Elemental Relics: Biosignatures for Microbial Life in Terrestrial Hot Springs on Ancient Earth and Mars

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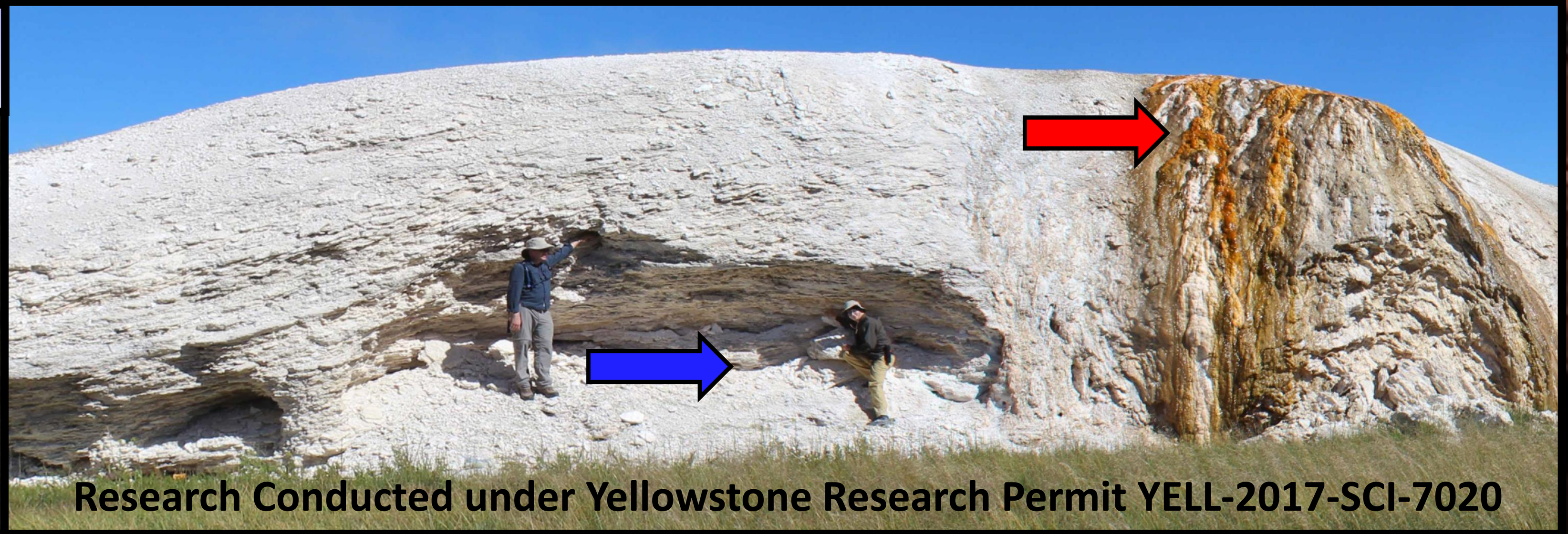
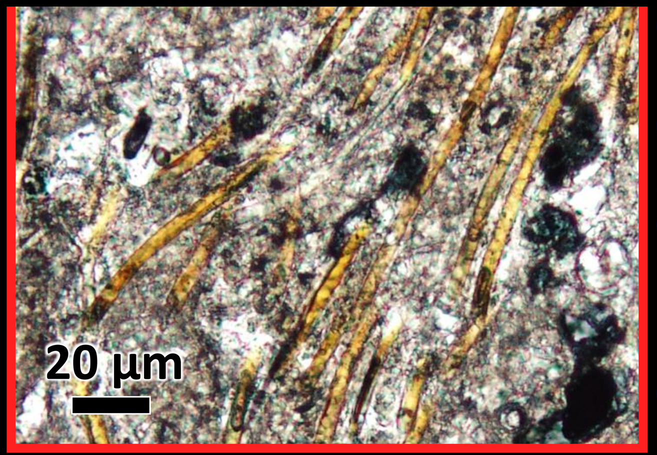
Summary

Terrestrial hot springs are teeming with microbial life. This life is commonly preserved due to silica precipitating from the spring water and entombing the microorganisms. Comparisons from modern and ancient spring deposits suggest that several elements associated with preserved microbial remains can be utilized as robust biosignatures to aid in the search for life on Mars.

Steep Cone, Yellowstone



Recent Silicified Filaments



Older Silicified Filaments

Left:

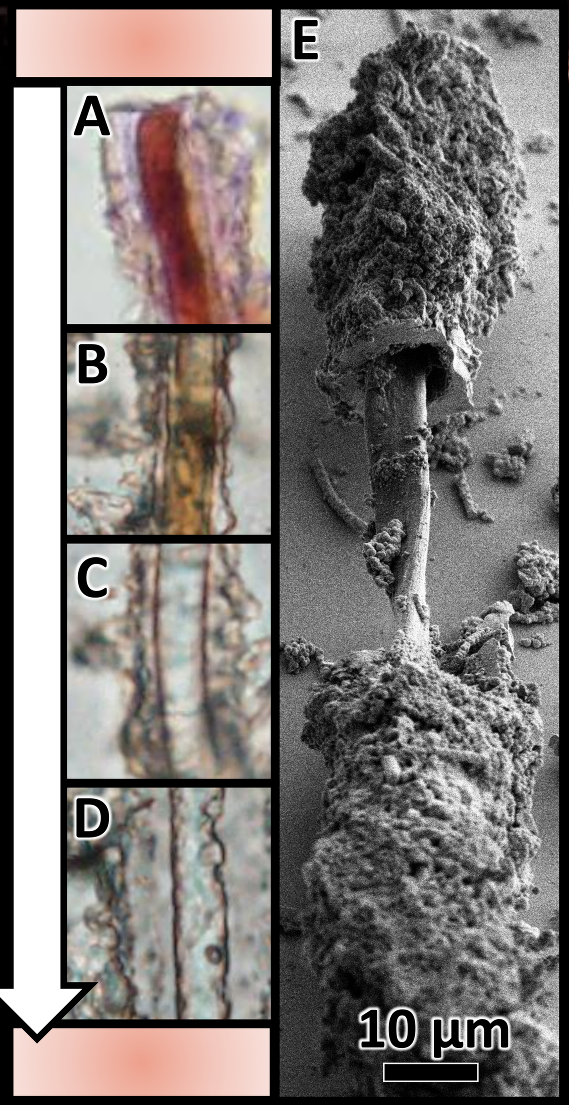
The Red Panel shows recently silicified microbial filaments from the top strata of Steep Cone, displaying an orange pigment. The Blue Panel shows older silicified microbial filaments from the base strata of Steep Cone, displaying the same size and morphology as the recently silicified filaments from the top strata of Steep Cone, but no pigment.

Right:

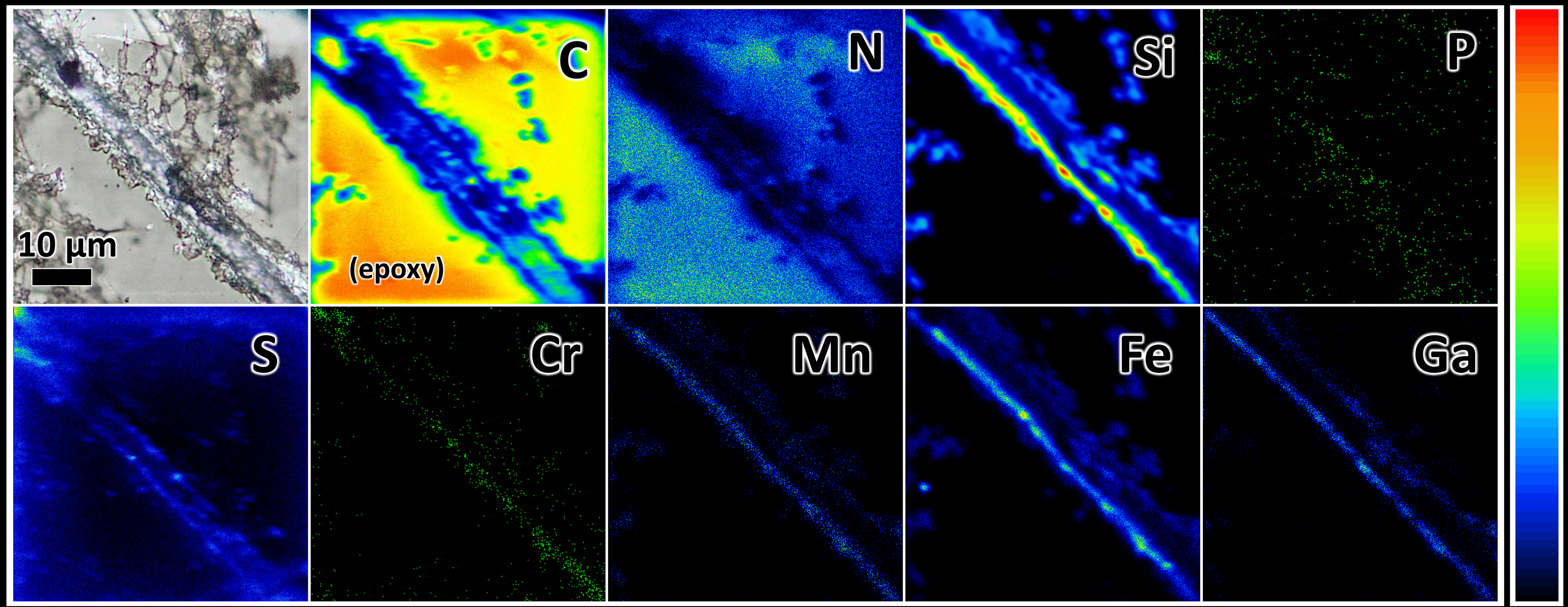
A succession of microbial samples obtained from Steep Cone, starting with a live filament obtained from an active discharge channel (A), followed by a recently silicified filament (B), a silicified filament from the mid-strata of Steep Cone (C), and finally a silicified filament from the base strata of Steep Cone (D). (E) shows an SEM image of the live filament from (A).

Below:

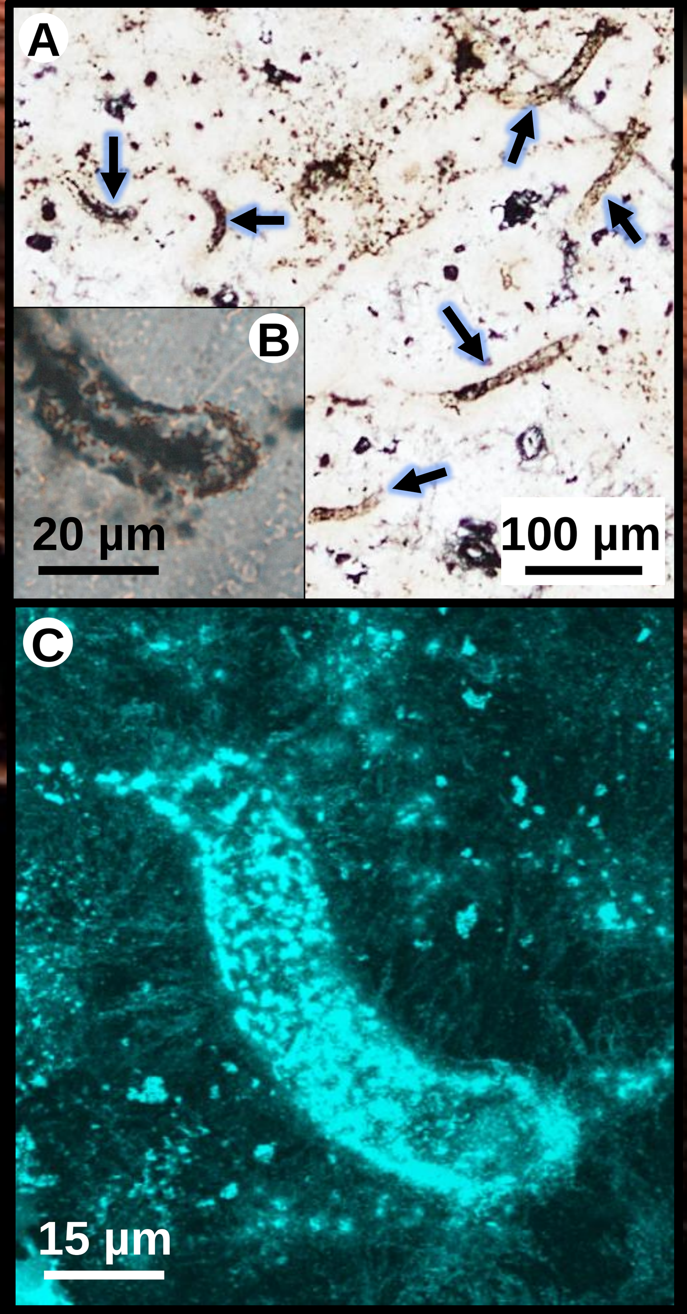
Silica sinter samples from Steep Cone were analyzed using a Secondary Ion Mass Spectrometer (SIMS) to map various elemental distributions. Silicified microbial filaments were consistently shown to sequester several elements (both primary and trace elements).



SIMS Elemental Mapping of a Silicified Microbial Filament (CAMECA IMS-7f-GEO)



Comparison with Drummond Basin – An Extinct Terrestrial Hot Spring from the Mid-Paleozoic

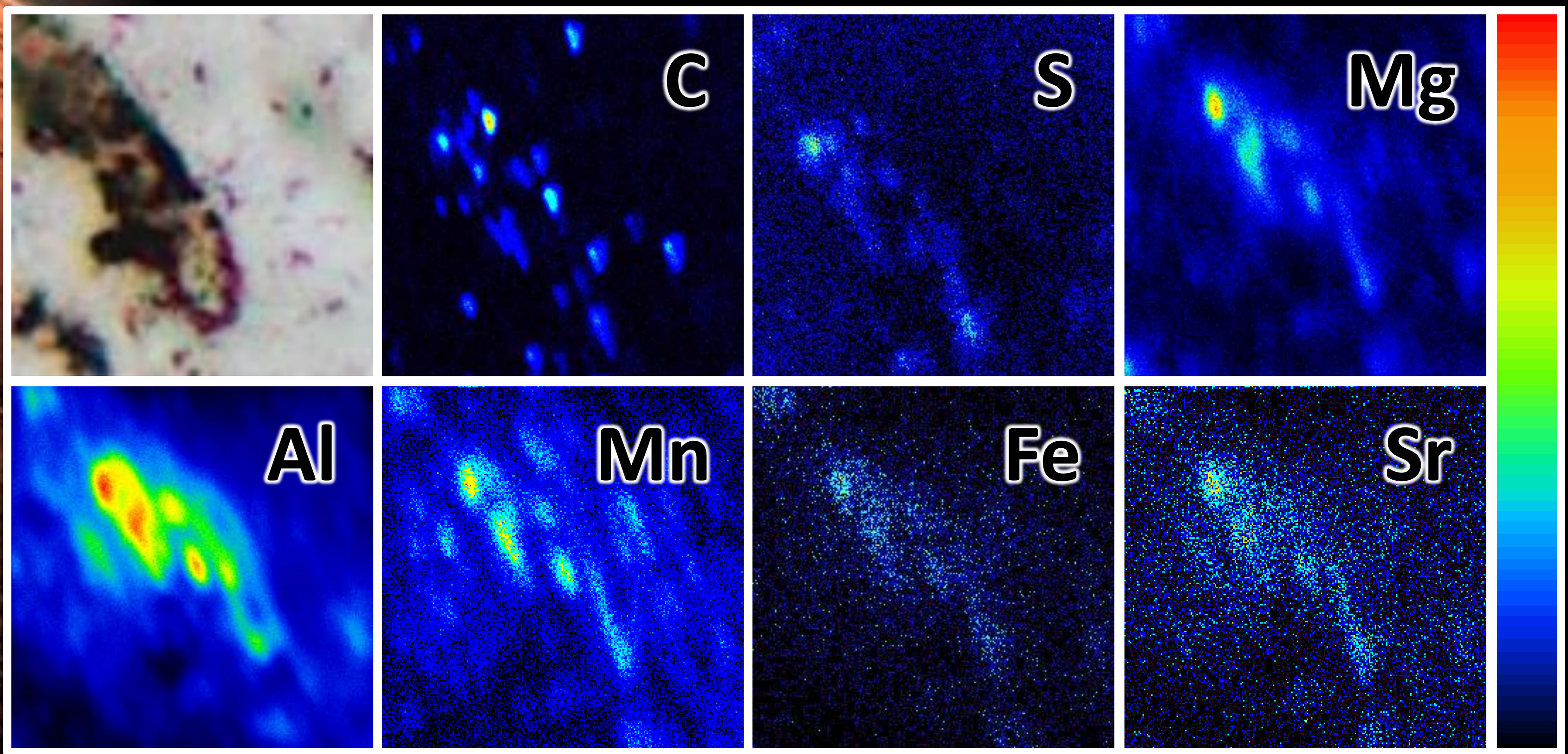


Left:

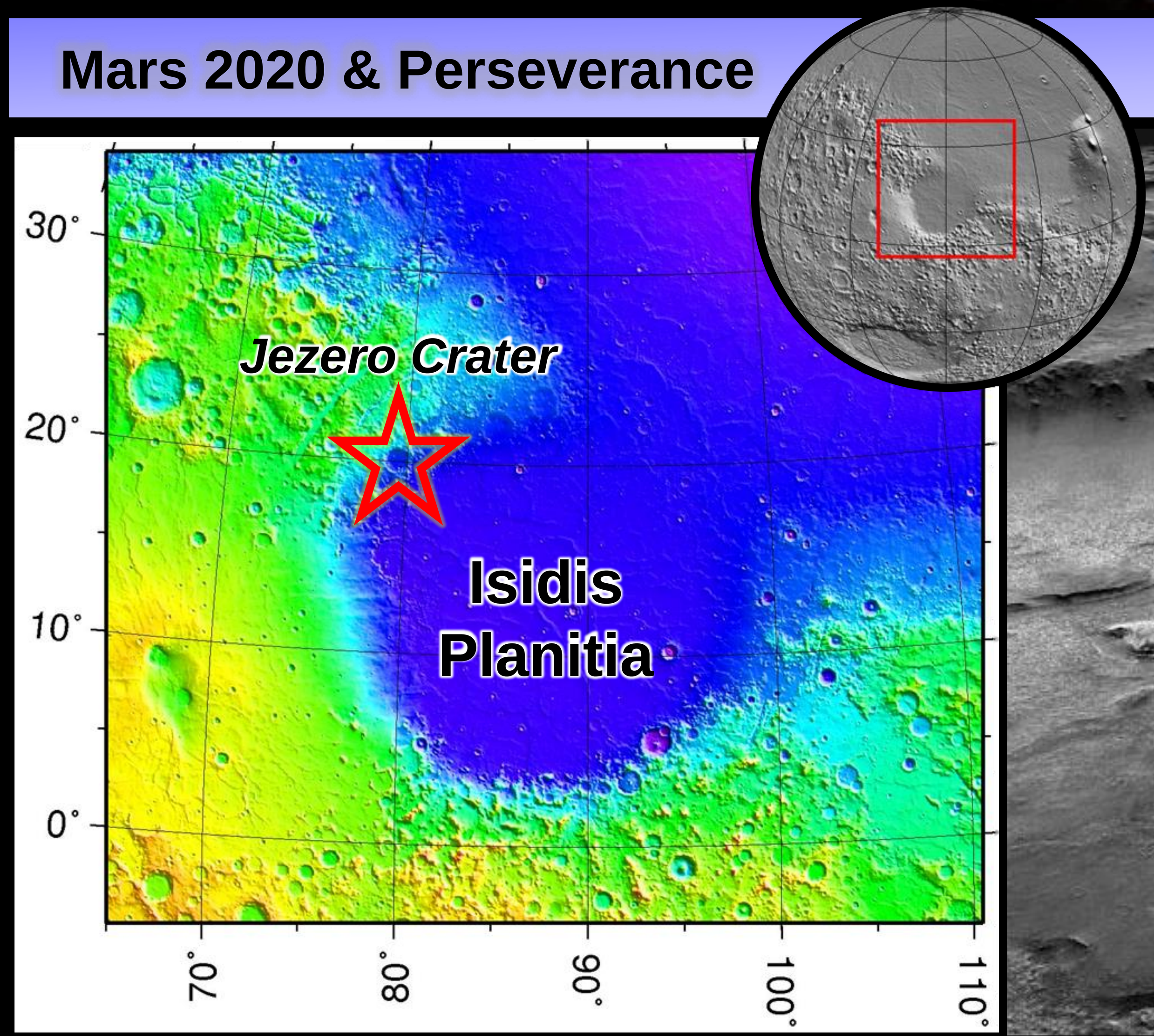
Filamentous microfossils from the mid-Paleozoic Drummond Basin, an extinct terrestrial hot spring deposit in Queensland, Australia. These microbial fossils share the same size, shape, geologic setting, and potentially metabolism as microbial remains from Steep Cone. (A) Plane-polarized light photomicrograph of several well-preserved microfossils, indicated by arrows. (B) Detailed view of a microfossil from panel A (indicated by the left-most arrow in panel A). (C) Confocal laser scanning microscope image of the microfossil from panel B, highlighting the organic cell walls via fluorescence.

Right:

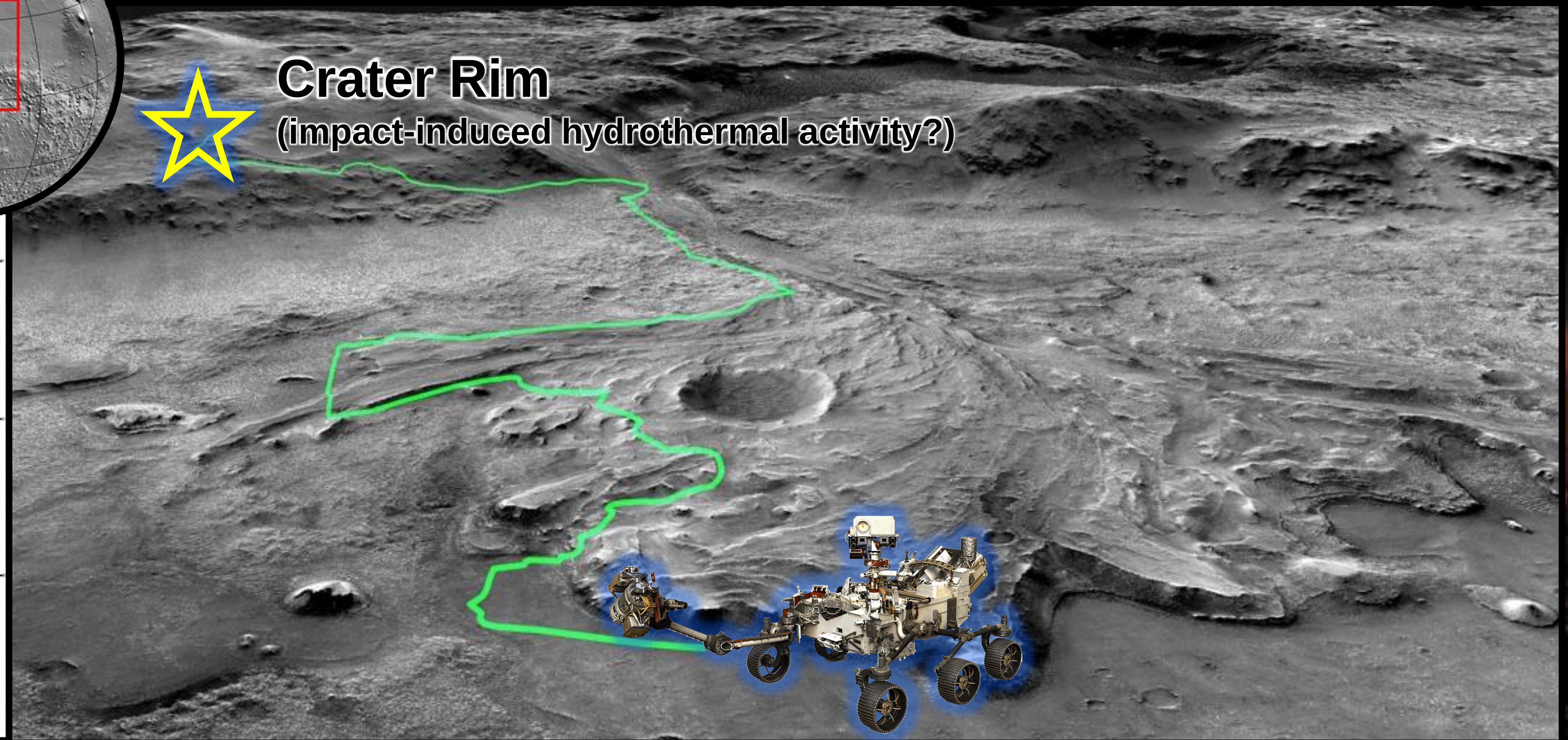
SIMS elemental mapping of a Drummond Basin microfossil. Several elements are found in association with the microfossil body similarly to what was observed in microbial remains from Steep Cone hot spring. These elemental signatures are thus apparently preserved despite substantial host-rock alteration and the passage of hundreds of millions of years.



Mars 2020 & Perseverance



Relevance to the Search for Signs of Past Life on Mars



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