TRACKING THE EVOLUTION OF FE-,TI-OXIDE PRECIPITATION IN MICROBIAL FOSSILIZATION EXPERIMENTS: USING MINERALS AS BIOSIGNATURES.

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Introduction One of the main goals of the astrobiology community is the detection of extra-planetary life using easily discernible biosignatures. On Earth, these biosignatures are preserved in the rock record and include biologically derived geochemical/molecular signatures and morphological features that mimic living microorganisms. This paper presents preliminary results from laboratory experiments designed to elucidate these signatures using Fe-,Ti-oxides.

Discussion: As sediments are deposited and microbial communities are buried, the original organic matter is either broken down or preserved as microfossils in the process of mineral precipitation [1,4]. As more and more time passes, very little syngenetic-biogenic carbon remains. Difficulties also arise when abiogenic and biogenic carbonaceous matter and associated fossil-like microstructures share similar geochemical and morphologic characteristics [6]. For these reasons, it becomes necessary to use mineralogy to aid in the determination of biogenicity. The mineralization of microfossils and preservation of morphologic characteristics occurs throughout the geologic record, yet biogenic minerals and the processes involved in biomineralization leading to fossilization are still not well understood. In many ancient sedimentary rocks on Earth, the microfossils are preserved along with Fe and Ti-oxides that contain trace amounts of graphitic carbon [2-3,5,7]. To determine if Fe- and Ti-oxide intergrowths can be established as mineralogic biosignatures, precipitates of iron and titanium oxides produced by microbes were compared to those formed abiotically. The samples were tracked over time to monitor changes in the state of organic matter along with the phase changes in minerals. This was carried out under laboratory controlled conditions of increasing temperatures and pressures to mimic the effects of diagenesis and low-grade metamorphism. The main analytical technique used to identify the minerals and carbonaceous compounds in these samples was Micro Raman spectroscopy. Spectral maps coupled with high resolution images show the spatial relationships between microstructures and mineral phases. To compliment this technique, NanoSims measurements of C, O, Fe, and Ti isotopes were also made on samples analyzed by TEM. Collectively, the results show a correlation between the type of Fe- and Ti-oxide intergrowths precipitated and the presence of microbes.

Summary: Many ancient sedimentary rocks contain microstructures that resemble modern microbial structures. These "fossil" microstructures often contain interesting mineral assemblages that are dominated by clays and metal oxides. Much of the mineralic makeup of the subaerially exposed rocks we see today, however, is not the same as what was originally formed with the rocks billions of years ago. This can be attributed to the complicated histories and atmospheric influences of the surface rocks. The complex relationships between microbes and minerals under different chemical and geologic conditions over time is still not well constrained. In order to properly identify life on other planets, it is necessary to first understand the processes involved.

Concluding Remarks: The preliminary results presented here are part of an ongoing study and can be applied to understanding the origins of life on Earth and on other planets. Here we can establish mineralic biosignatures, and in the process continue to perfect instrumental techniques to be used on future exploration missions.

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