PROGRESSIVE DIAGENETIC ALTERATION OF MACRO- AND MICRO-SCOPIC BIOSIGNATURES IN ANCIENT SPRINGS AND SPRING-FED LACUSTRINE ENVIRONMENTS. S.L. Potter-McIntyre[1] J. Williams[1], C. Phillips-Lander[2], and L. O'Connell[1]. [1]Southern Illinois University, Geology Department, Parkinson Lab Mailcode 4324, Carbondale, IL, 62901, Email: pottermcintyre@siu.edu, [2] University of Oklahoma, School of Geology and Geophysics.

Introduction: Biosignatures can be preserved via microbial enhancement of mineral precipitation during deposition and/or early diagenesis [e.g., 1,2,3]. Preservation of any type of microbial fossil or chemical or textural biosignature depends on the degree of alteration during diagenesis and factors such as exposure to diagenetic fluids [1,2]. Microbial carbonates have been extensively examined in modern systems; however, little is known about the transformation of biosignatures during diagenesis over geologic time [4,5]. Understanding the alteration and preservation of biosignatures is essential for recognizing these signatures in the rock record of both early Earth and Mars.

Purpose of study: Mineralogical and morphological biosignatures in modern spring deposits are compared with the Quaternary (100-400ka) and Jurassic examples to show how these biosignatures are altered during diagenesis. These successively older carbonate microbialites provide a novel opportunity to investigate how macroscopic features diagnostic of spring deposits and microscopic biosignatures are progressively altered and preserved on geologic time scales.

Study site: Spring systems are important because they also may represent a formation mechanism of some carbonates in the solar system, particularly analogous to those present in lacustrine settings such as the carbonates at Gale crater, Mars [6]. Ten Mile Graben, UT, USA hosts a cold spring system that is an exceptional site to evaluate diagenetic alteration of biosignatures due to the presence of modern springs with actively precipitating microbial mats and a series of progressively older tufa terraces (<400ka) preserved in the area from the same spring system [7]. A Jurassic laminated carbonate deposited in a restricted spring-fed hypersaline lake environment within the upper part of the Brushy Basin Member of the Morrison Formation is also exposed in Ten Mile Graben [8]. Silcretes (bedded silica-rich lenses) that increase in abundance beneath the thickest parts of the carbonate provides additional evidence that this carbonate was spring-fed and the presence of barite suggest the spring was hot [8].

Macroscopic Spring Features: Macroscopic features associated with spring deposits are preserved throughout geologic time, even delicate macroscopic features such as terracettes and bushy spheres. Secondary processes such as vein precipitation during early diagenesis and Ostwald ripening likely does affect and degrade some of these macroscopic features; however, these processes do not completely destroy the identifying structures.

Two Types of Biomineralization: The data highlight two distinct methods of biosignature formation: 1. microbial metabolic activity induces mineral precipitation in a solution with nearly undetectable amounts of reactants, and 2. minerals nucleate on charged cell surfaces [9]. Minerals such as hematite and ferrihydrite precipitate from very low to undetectable amounts of iron suggesting microbial metabolisms are responsible for the iron minerals that render spring deposits red. Microbes also produce trace fossils by creating an environment conducive to mineral precipitation and, in turn, the presence of these minerals help preserve these features.

Although organic matter may decompose in oxidizing near-surface conditions, this study shows that some microbial body fossils and trace fossils such as honeycomb textures can persist due to encasement by iron (oxyhydr)oxides and/or by entombment via Ostwald ripening of carbonates. For example, early permineralization of sheaths of Leptothrix render this microbial population particularly resistant to destruction and degradation during early diagenesis. Features such as sheaths and honeycomb trace fossils were preserved in the Jurassic example due to Ostwald ripening encasing these features and shielding them from diagenetic alteration and destruction on hundred million year time scales.

This field site preserves an excellent record to understand the taphonomy of macroscopic and microscopic biosignatures preserved in discrete time slices in the geologic record. Recognizing spring-fed, biogenic tufas is crucial for astrobiological research and the search for life on Mars.

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