IMPLICATIONS FOR ASTROBIOLOGY AND EARLY LIFE ON EARTH FROM STICHTITE ($Mg_6Cr_2(OH)_{16}[CO_3]\cdot 4H_2O$).
E. B. Melchiorre[1] K. Luu[1], and A. Garcia[1] [1]Geology Department, California State University, 5500 University Parkway, San Bernardino, CA 92407 emelch@csusb.edu.

Introduction: Light stable isotope values of divalent cation carbonates can provide a detailed temporal record of past climate and biological activity[1,2]. While this is often used for low temperature systems, applications for rare carbonate minerals in higher temperature systems such as hydrothermal ones are more rare [3].

Stichtite as a paleoenvironemntal indicator: Stichtite, a carbonate member of the hydrotalcite group, is found in association with Archean to Phanerozoic chromite-rich serpentinite breccia-pipe rocks around the world. Natural stichtite shows a range of Cr-Fe-Al compositions within the hydrotalcite group, and a range of reaction completion textures with unique trends reflecting both history and evolution of the serpentinite host body, and depth within the serpentinizing system. Paragenetic analysis clearly reveals that stichtite forms during active serpentinization, not as a surface weathering product of chromium deposits. The chemistry of the chromite associated with stichtite indicates formation in fore-arc rocks by chromite reacting with methane- or H_2-rich serpentinizing fluids. The most advanced reaction completion textures are associated with the stichtite 2H polytype (nee barbertonite) + aragonite ± antigorite, suggesting these samples experienced higher pressures and/or temperatures. Carbon stable isotope analyses of stichtite suggest carbon sourcing from marine kerogen with a minor marine carbonate component in some samples [4]. The combined carbon and hydrogen stable isotope profile of stichtite ranges from the field of methane from active serpentinizing zones, to deep organic thermogenic methane. The combined evidence suggests that stichtite forms during serpentinization of fore-arc setting rocks in a methane/H_2-rich environment within fluid conduits, ranging from near the surface to depths experiencing 1.2 to 0.8 GPa and ~300°C [5]. The unique chemical, isotopic, and textural properties of stichtite provide a window into the conditions associated with a potentially habitable environment on early Earth and other bodies of the solar system.

Biocatalytical potential of stichtite: Recent work on hydrotalcite minerals suggests a plausible pathway for the origin of life, while our extraction and characterization of relict nitrogen biomarkers from ancient hydrotalcite minerals may record the effect of the 2.35 Ga Great Oxidation Event. Minerals of the hydrotalcite group have a unique ability to store specific molecules such as peptides and amino acids within the variably hydrated interlayer between their brucite-like layers [6,7]. This family of minerals may serve as a molecular sieve to accumulate simple organic materials in the presence of catalysts. As catalysts assemble larger molecules within the interlayer, the clay-like structure of the hydrotalcite may serve as a genograph or repeating template into which these trapped organic molecules are stored. If this forms repeating organic molecules, or generates macromolecular descendants, this could lead to self-replicating molecules upon which life is based (RNA First). Alternately, this organic accumulation could have been hosted by clay-like hydrotalcite minerals capable of catalyzing primitive metabolic reactions (Metabolism First). Hydrotalcite minerals occur within ancient, warm, and nutrient-rich serpentinizing environments which are similar to the proposed environment in which LUCA lived [8]. Serpentinizing systems are known to occur on both Earth and Mars, providing a possible mechanism for origins of life in the Solar System.

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