WAS IT ALIVE? DISTINGUISHING BIOLOGICAL FROM NON-BIOLOGICAL MINERALIZATION AND GEOLOGICAL STRUCTURES. M. N. Spilde[1], P. J. Boston[2,3], and D. E. Northup[3], [1]Institute of Meteoritics, Department of Earth and Planetary Sciences, University of New Mexico, Albuquerque NM 87131, USA, [2]Complex Systems Research Inc., P.O. Box 11320, Boulder CO 80301, USA, [3]Department of Biology, University of New Mexico, Albuquerque NM 87131, USA.

Biologists studying unusual microorganisms in exotic environments often ask the question “Is it alive?” Geomicrobiologists and mineralogists face an even harder question…“Was it ***ever*** alive?” Organisms can leave extensive traces of their presence long after death. Of course, the obvious, clear structural fossils are usually the most straightforward to identify. However, other traces of the byproducts of life, e.g. biomineralization, are much more difficult to interpret. In our work in caves, we have discovered many structures and mineral types that appear to be biological or the indirect result of biological activity. Are they? How can we tie these apparent remains to the organisms that may have created them?

Even with investigators on site, bringing in equipment, taking samples back to well-equipped, sophisticated scientific laboratories, the status of a natural object as once alive or not alive can be equivocal. How much more difficult, then, will it be to conduct such studies in environments that are unimaginably remote and inaccessible like Mars?

We will present examples of materials from our own work that have made us face these questions and detail the methods that we are employing in our on-going attempts to answer them.

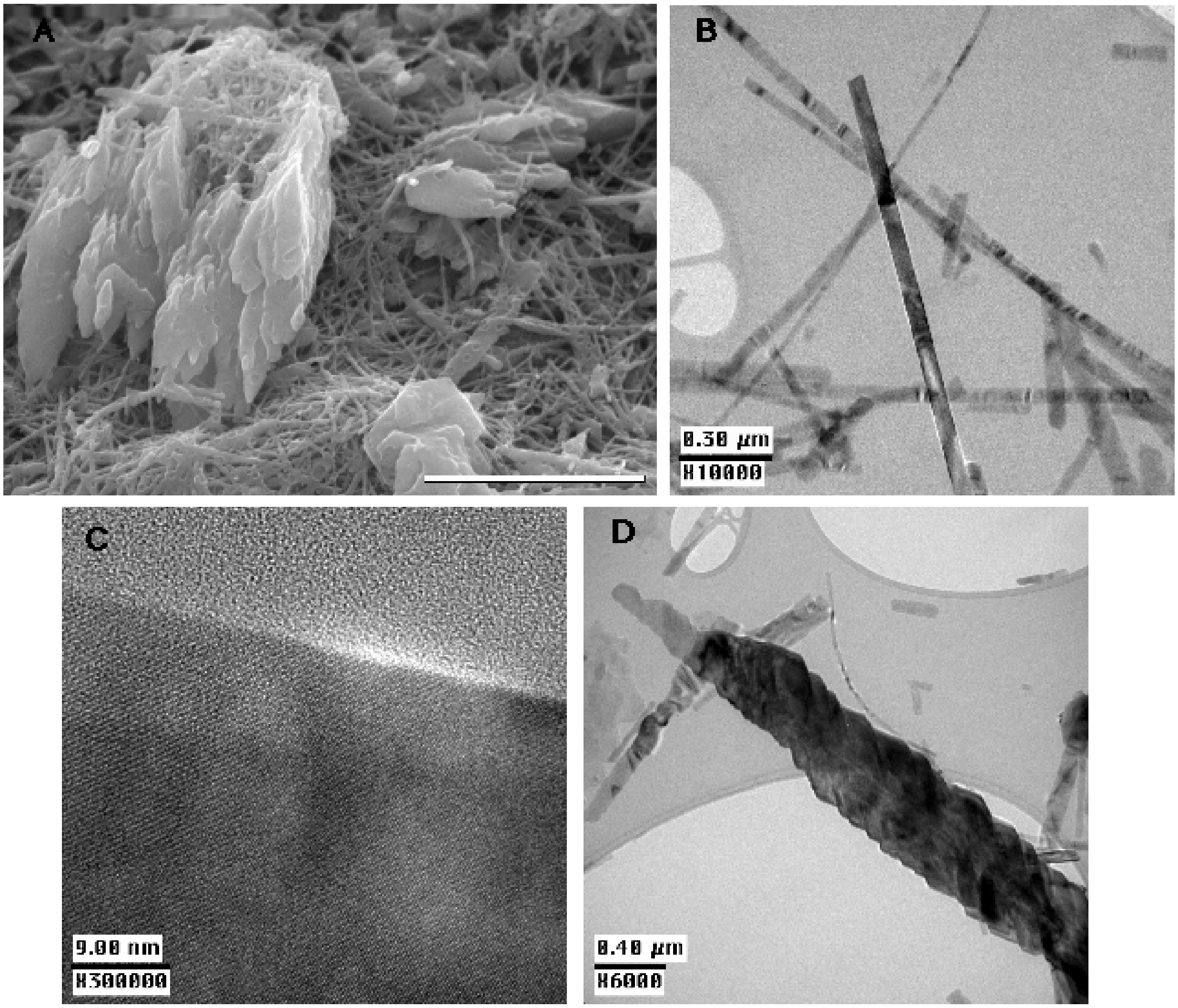

Figure 1. “Are you now, or have you ever been ALIVE?” If only we could directly ask that of this fibrous calcite from Spider Cave, Carlsbad Caverns National Park, New Mexico. (A) SEM micrograph of fibrous calcite sometimes referred to as moonmilk. Both fibers and corroded calcite crystals are present. Scale bar = 5 µm. (B) TEM image of individual cyrstalline fibers prepared from the moonmilk. These particles appear to be elongate crystals of calcite. Scale bar = 300 nm. (C) High resolution image of a calcite fiber showing well-ordered crystalline structure. Scale bar = 9 nm. (D) Large calcite particle apparently composed of stacked rhobohedrons, similar to the corroded crystals in SEM image (A). Scale bar = 400 nm. (Spilde, Boston, and Northup, 1999).