Possible Biofilms in ALH84001. David S. McKay[1], E. K. Gibson[1], K. Thomas-Keprta[2], C.S. Romanek[3], and C.C. Allen[2]. [1]NASA-JSC, Houston, TX 77058, [2]LESC-NASA-JSC, Houston, TX, [3]SREL, Aiken, SC.

The possibility of early life on Mars as possibly recorded in martian meteorites was discussed by (1). It has been know for some time that a signature of microorganism activity in natural geologic settings is the formation of structures which are formed external to cells and made of organic polymers. These structures have been called biofilms or external polymer secretions (EPS) and are made of polysaccharides (2,3,4). The polymer structures have morphologies ranging from simple thin films to elaborate three dimensional networks within which a colony of cells live. The biofilms and their structures apparently help to provide a confined volume in which the microenvironment may be changed by cell activity to be more suitable to cell metabolism and growth. They may also help conserve moisture in desiccation environments (5) or provide a structure to anchor the cells and protect them from external forces and movement (2, 3).

We report here on several examples of thin structures or films found in martian meteorite ALH840001. Several chips of ALH84001 were lightly etched in dilute HCL or H_3PO_4. Chips were examined with high resolution field emission scanning electron microscope. Other unetched chips were examined for comparison. Eched chips display a number of features. One of the most striking is a small network structure firmly attached to a pyroxene grain (Fig 1-2) . When examined in stereo, the structure is seen to consist of curved enclosures or capsules made of very thin (a few 10's of nm) sheets and somewhat thicker columns. This structure is very similar to the EPS structure shown in (2). EDXA analysis of such a small filmy structure is difficult, but no Al was observed in the spectrum, making it unlikely that this is an Al-containing clay mineral. By analogy with known terrestrial examples, we propose that this structure may be a biofilm or EPS. EDXA analysis of the structure showed a slight relative enrichment in carbon compared to the general material in the etched carbonate. Other irregular patches of possible biofilm material from H_3PO_4-etched ALH84001 are shown in Fig. 3-4. A vug in the same chip is partially covered by a thin discontinuous film and contains additional film within its interior (Fig 5). An unetched, chip also revealed a filmy layer in some areas, in a region of the fine-grained crushed zone of the chip (Fig 6). Etched carbonate globules display thin lacy films on top of the etched clevage blocks (Fig. 7-8). Biofilms are common in acid-etched terrestrial carbonate samples (2,6). This material in ALH84001 was apparently resistant to the acids, suggesting that it may be organic. (7) also suggests, on the basis of atomic force microscope data, that the unetched ALH84001 carbonates contain biofilms.

While complete identification of these features must await detailed chemical and characterization, the striking similarity of some of them to known biofilm structures allows us to propose that they may be biofilm structures formed on Mars. Other possible interpretations include smectite-type clay minerals, other kinds of clay minerals, and inorganic fibrous kerite polymers (8). The lack of detectable aluminum argues against many kinds of clay minerals, but other types cannot be eliminated. The observed structures do not really resemble the kerite fibers described by (8) which were elongated and much larger; averaging about 15μm in diameter and typically 100 μm or more in length. Biofilms could conceivably be formed in Antarctica by microbial activity on or within the ice fields, but biologic activity there has not been reported, and the close association with the carbonates which surely formed on Mars (1) suggests that at least some of the filmy structures also formed on Mars.

Figure Captions: Fig. 1, Patch of lacy material on H3PO4-etched chip of ALH84001. Scale bar is 10 μm; Fig. 2, Closer view of patch in Fig. 1. Scale bar is 1 μm. Fig. 3, Another patch of lacy material in H3PO4-etched ALH84001 chip. Scale bar is 2 μm. Fig. 4, Another patch of lacy material in H3PO4-etched ALH84001 chip. Width of field is 10 μm. Fig. 5, Discontinuous lacy material partially covering and within a vug in H_3PO_4-etched chip of ALH84001. Width of field is 10μm. Fig. 6. Unetched, untreated chip of ALH84001 showing lacy morphology partially covering a patch of fine-grained material. Width of field is 20 μm. Fig. 7-8, HCl-etched carbonate globules in ALH84001. The delicate filmy material partially covering the etched carbonate cleavage blocks remained after most of the carbonate had been removed by etching. Width of field is 4 μm (Fig. 7). Scale bar is 1 μm (Fig. 8).

References: (1) D. S. McKay et al. (1996) Science 273, 924; (2) C. Defarge et al. (1996) Journal of Sed. Research, 66,935; (3) H. S. Chafetz and C. Buczynski (1992) Palaios 7, 277; (4) T. L. Kieft (1997) *Non-Culturable Microorganisms in the Environment*, R. R. Colwell and B. J. Grimes, ed (in press); (5) S. M. Allison. and J. L.Prosser (1991) FEMS Microbiology Lettr. 79, 65: (1991) (6) C. Allen et al. (1996) this volume; (7) A. Steele et al. (1997) this volume; [8] N.P.Yushkin (1996) J. Crystal Growth 167, 237.

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Figure 1

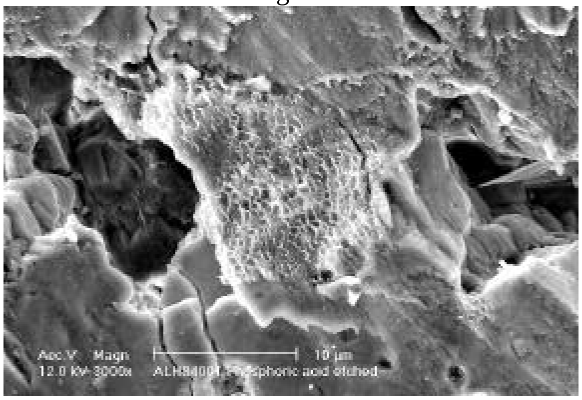


Figure 2

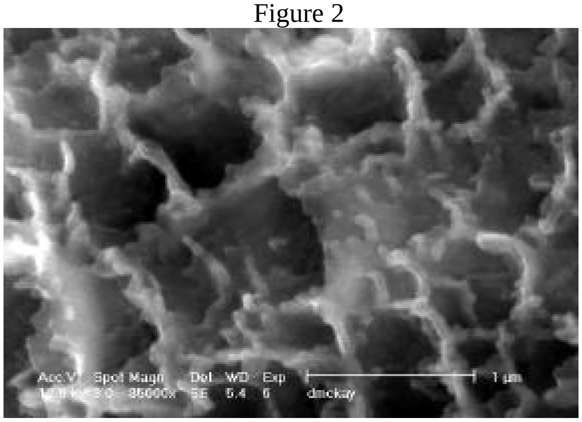


Figure 3

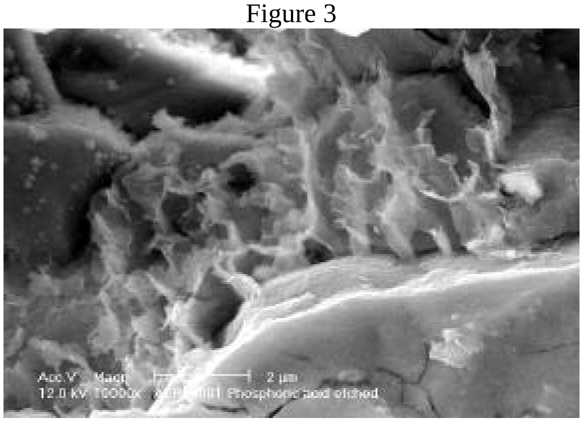
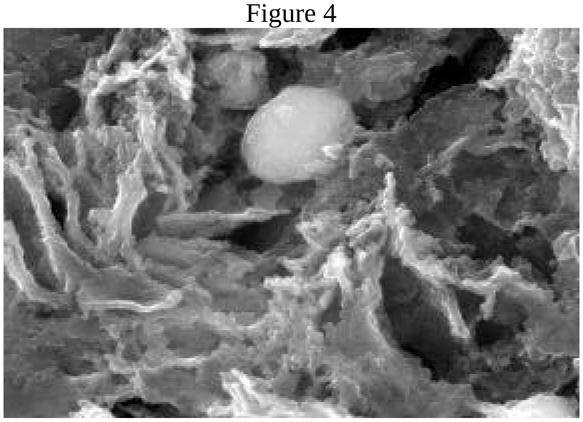


Figure 4



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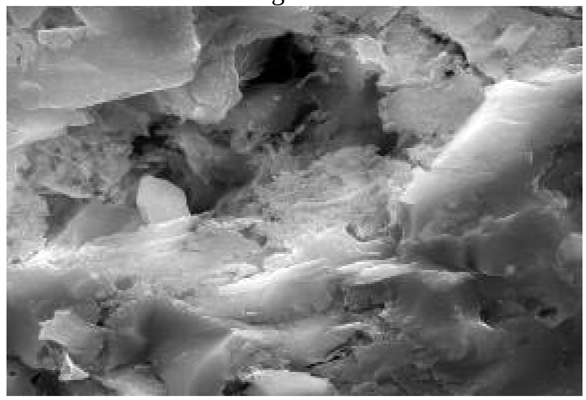

Figure 6

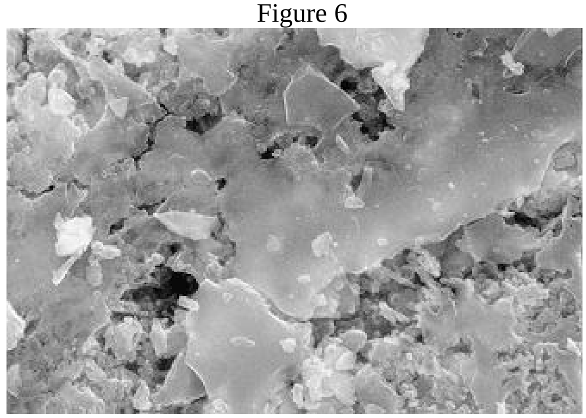

Figure 7

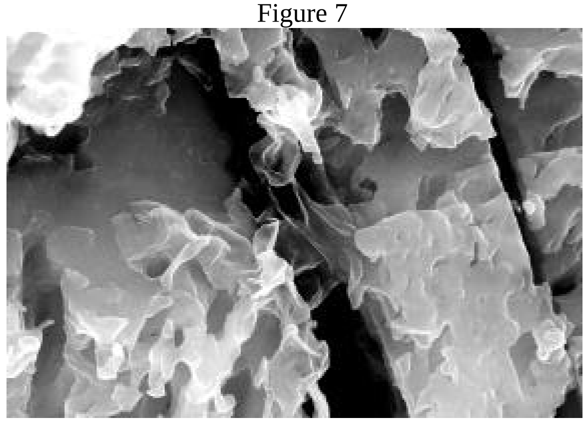

Figure 8