POSSIBLE MICROFOSSILS (WARRAWOONA GROUP, TOWERS FORMATION, AUSTRALIA, ~3.3-3.5GA).

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Introduction: Early in the twentieth century there were reports of Archean aged stromatolite-like structures that were similar to organic rich stromatolites from the base of the Cambrian (600 My) [1,2]. It was not until the latter half of this century that fossilized Archean aged (3.9-2.5Ga) life forms were found in the Fig Tree Formation of South Africa and the Towers Formation of Australia [3–7]. Some of the ancient stromatolites contained streaks and clots of kerogen, pyrite grains, remnants of microbial cells, and filaments that represented various stages of preservation while others appeared to lack fossils [8,9]. A set of physical criteria was established for evaluating the biogenicity of these Archean discoveries [10]: 1. Rocks of unquestionable Archean age. 2. Microfossils indigenous to Archean sediments. 3. Microfossils occurring in clasts that are syngenetic with deposition of the sedimentary unit. In the case of bedded cherts, the fossils should predate the cherts. 4. The microfossils are biogenic. 5. Replicate sampling of the fossiliferous outcrop firmly demonstrates the provenance of these microfossils.

Sample 002 from the Precambrian Paleobiology Research Group (PPRG) was examined. This stromatolitic carbonaceous chert contains microbial remains that meets the established criteria [10]. Using the scanning electron microscope we have analyzed the morphologies and chemistry of these possible microbial remains [7,10].

Methods: Freshly fractured chips, and petrographic thin sections were analyzed with an Oxford ISIS energy dispersive spectrometer (EDS) and a Phillips SEM XL 40 FEG (SEM).

Discussion: SEM/EDS analysis of sample 002 indicates the presence of hematite, quartz, barite, carbonate minerals, including iron carbonate (siderite), and kerogen [11,12]. The kerogens are organic derivatives.

Sample 002 includes several morphologic features that are clearly indigenous to the sample and may have been produced by biologic activity. These features include several sizes of spheres, rods the size of bacteria, ellipsoids, filaments and smooth blanketing material resembling present-day biofilms. Each of these features are rich in both iron and carbon compared to the surrounding quartz matrix. X-ray element maps of two of the largest spheres (16-27 μm, 5-12 μm) indicate that the iron and carbon are localized within the spheres, but are nearly absent from the surrounding quartz matrix (Figs. 1, 2, 3). Iron is known to be important in microbial preservation [13].

The spheres are intimately intergrown with the quartz matrix and are clearly indigenous to the sample (Fig. 1). They display a rough, uneven texture. The chemical composition of these spheres is compatible with that of siderite. Siderite can be an indicator of microbially induced precipitation [14]. These spheres are within the size range and appear to be identical to those accepted as biogenic by Schopf [6,7,10].

EDS analysis of smaller spheres that are within the size range of bacterial cocci, as well as filaments and the smooth, blanketing morphology reveal a similar composition, that is the presence of significant levels of carbon and iron and the absence of significant levels of silicon. Comparison with the surrounding matrix indicates that although carbon may occasionally be present in the form of relict calcium carbonate minerals, and iron may occur as irregular hematite grains, the matrix itself is low in both iron and carbon. We interpret all of the carbon and iron-rich features shown in Figures 1, 2, and 3 as biogenic remains of bacterial colonies, individual cells, and biofilms that have been mineralized by replacement with iron carbonate and possibly other iron-bearing minerals. An understanding of the complex processes by which microbes and their products are mineralized and preserved will be important in analyzing additional Mars meteorites and returned samples from Mars. This provides one example showing that likely fossilized microbial features may retain their distinctive morphologic and chemical identity over several billion years of geologic history.

References: [1] Rothplez A. (1916) *Abh. Bayer. Akad. Wiss., 28(4),* 1–91. [2] Walcott D. (1912) *Geol. Surv. Canada Mem, 28,* 16–23. [3] Barghoorn E. S. et al. (1966) *Science, 152,* 758–763. [4] Barghoorn E. S. (1971) *Sci. Amer., 224,* 30–42. [5] Prashnowsky A. A. et al. (1972) in *Advances in Organic Geochemistry. Pergamon,* N.Y., pp. 683–698. [6] Awramik, S. M. et al. (1983) *Prec. Res., 20,* 357–374. [7] Schopf et al. (1987) *Science, 237,* 70–72. [8] Schopf J. W. (1977) *Prec. Res., 5,* 143–173. [9] Gutstadt A. A. et al.

(1969) *Nature, 233,* 165–167. [10] Schopf et al. (1992) *Proterozoic Biosphere*, Cambridge Univ. Press, 1348 pp. [11] Schopf J. W. (1983) *Earth's Earliest Biosphere,* Princeton Univ. Press, 543 pp. [12] Morris et. al. (1998) *LPSC XXIX*. [13] Ferris G. et. al. (1988) *Geology*, *16*, 149–152. [14] Liebig K. et. al., (1996) *N. Jb. Geol. Palaeont. Abh, 199,* 269–293.

Acknowledgments: We wish to thank L. Hulse for many hours of help on the SEM, E. K. Gibson for obtaining the sample from the PPRG. This investigation was supported by NASA Grant NAG9-980, NAG9-867.

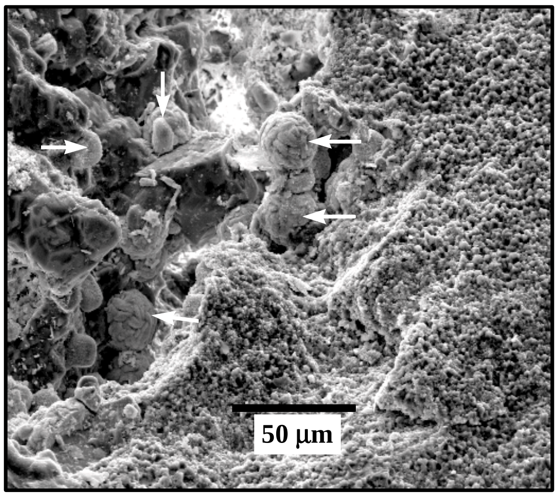

Figure 1. SEM image of x-ray element maps for iron and silica. Arrows indicate some of the biogenic spheres.

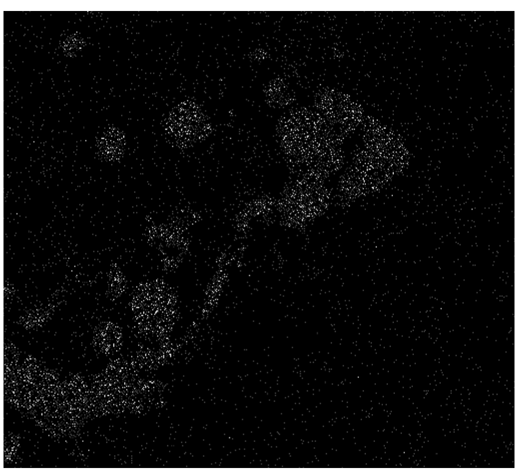

Figure 2. X-ray element map for iron. Iron is found in association with biogenic spheres that are indicated in Figure 1.

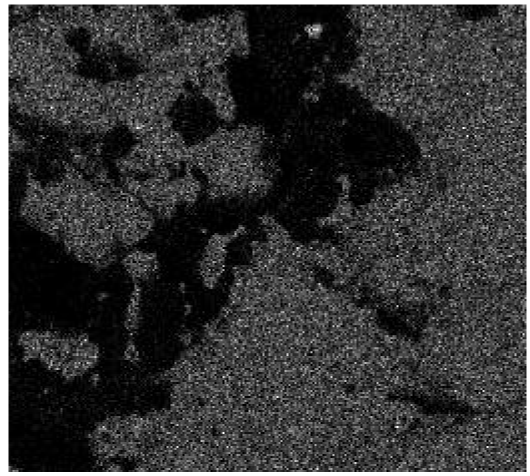

Figure 3. X-ray element map of silicon. The areas occupied by the biogenic spheres lack this element.

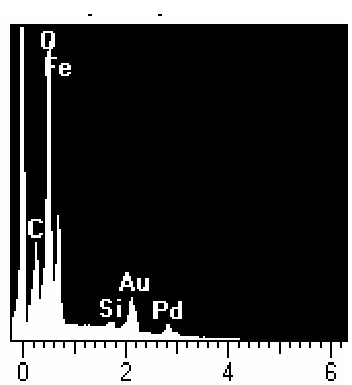

Figure 4. EDS analysis of biogenic spheres at low kV. Notice the relative abundance of carbon, oxygen, and iron (Fe/L) in relation to silicon. The specimen was coated with gold and palladium for 30 seconds.