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# Atomic Force Microscopy study of microfossils

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The study of traces of life in ancient rocks and, eventually, in returned rocks from Mars, requires the use of sophisticated instrumentation because of the subtle nature of these traces/ Ancient rocks dating from the Proterozoic, such as from the Draken (800 Ma) or the Gunflint Formations (1.9 Ga), or from the older Barberton and Pilbara Greenstone belts (3.3-3.5Ga) contain an important variety of microbial fossils [1-4], some of which are $< 1\mu$m in size. Even though colonies may be observed by optical microscopy, observation of the individual microfossils needs to be made with high magnification microscopes, such as electron microscopes or the Atomic Force Microscope (AFM) [4,5], since one of the criteria of biogenicity is their morphology. In this study, we used AFM for microfossils observation. This technique has a very high magnification ($<$1nm) and requires minimal sample preparation (microfossil traces can be detected in a simple polished surface). Biofilms and the microfossils they contain in thin sections of Barberton and Pilbara cherts are being studied by AFM.

The direct correlation of AFM observations with other *in situ* techniques that provide mineralogical/chemical information vastly increases the usefulness of the technique in providing reliable indications of biogenicity of the observed structures for instance AFM interfaced with confocal-Raman microscope. Raman imagery has been used in the past to observe microfossils [4,6] and the matching of this to methods is very promising. This non destructive method should be used in the future to study the hypothetical microfossils from Mars. Although the AFM has been developed also for space missions, [7] (FaMars, MIDAS, Phoenix), the necessity of some sample preparation plus the addition of other complementary methods of investigation mean that martian microfossil studies will have to be undertaken on Earth on returned samples.

In terms of the origin of life, information from the experimental fossilisation of prebiotic molecules, bacteria and viruses is important for the interpretation of structures found in ancient terrestrial rocks and, more specifically, in returned martian rocks. AFM can be used in such studies where no sample preparation is required.

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