The Terrestrial Contamination of Meteorites. An Update
A.Steele1,2, J.K.W. Toporksi2, D.S. McKay3, SEEPS, Astrobiology Group, University of Portsmouth, Portsmouth PO1 3QL, UK. andrew.steele@easynet.co.uk; "Mail code SN, JSC, Houston, TX 77058.

We have developed a 4 technique approach for the detection and analysis of terrestrial microbial contamination of meteorites, in combination with a large terrestrial control sample set [1]. The four technique areas thus far utilised are as follows: Microscopy (SEM, FEGSEM and AFM), surface analysis (Time of Flight Secondary Ion Mass Spectrometry (ToFSIMS and XPS)), microbial culturing (using biochemical and 16srRNA identification) and direct isolation of DNA. Microscopy – Investigations of ALH84001, Nakhla, Murchison and the Antarctic chondrite ALH76004 have all shown the presence of organisms beneath the fusion crust. Toporksi et al., (1999, 2000) have shown that, in the case of Nakhla, the meteorite is contaminated through to the center with both cellular structures and what appears to be exopolymers secretions. In some cases the organisms are still actively growing [2,3]. ToFSIMS of all the above meteorites and a terrestrial control sample set have shown the presence of certain potential biomarker/organic contaminant peaks in the mid 400 AMU range. After the ToFSIMS investigation all samples were imaged with a FEG-SEM in an attempt to tie together the spectral data with morphological features. This has shown that certain other characteristic peaks in the mid 500 AMU range may be correlated to cellular features (Fig 1).

The use of simple culturing methods has produced viable identifiable organisms from Nakhla, ALH84001, Murchison, Allende and 2 Antarctic chondrites (ALH76004 and ALH81251). Interestingly in the case of Allende, of the species that have thus far been identified, two Pseudomonads (P. capita and P. auricularis) are found in the eye brows and behind the ears of humans [4]. Direct DNA analysis of an Allende sample has revealed that intact sequencable DNA can be extracted from meteorites using techniques developed to screen soil microbial populations. This technique differentiates between bacterial and fungal populations [4]. Experiments are continuing at this moment on ALH84001 and Nakhla with promising initial results which will be presented.

In a further twist to the meteorite experiment, analysis conducted on organic rich fossils from the Oligocene Enspel Formation in central Germany has shown that after splitting and exposing the fossils to air, an extremely dense growth of contaminating fungi was observed after only a few months. The implications of this research are underline the rapidity of contamination and the care necessary in sample preparation. Currently 9 out of 9 meteorites analysed are contaminated to varying degrees. These observations lead to several very simple questions: (1) Why are the organisms there?. The obvious answer is that the meteorites are providing food in the form of organic molecules. (2) How quickly do meteorites become contaminated?. The experiment on the organic rich fossil has shown that within 6 months there can be growth visible to the naked eye. (3) What is the effect of microbial contamination?. This is the crux of the question the organisms thus far isolated can be found in both soils and on human beings. The soil microorganisms contribute to terrestrial weathering and therefore it is probable that the microorganisms in the meteorites are doing the same thing, ie. making soil.

We therefore, propose that a new slant be taken on meteorite research, namely, to begin with the assumption that apart from some low molecular weight organic material (which must be present for the organisms to utilise as food), all other compounds could be the products of microbial and terrestrial contamination. With the wealth of literature available on the extraterrestrial nature of organics in meteorites this approach is improbable, however, we feel that as a preliminary null hypothesis it is a baseline approach that is worth investigation. The Murchison meteorite has been the source of much of our knowledge of extraterrestrial organics, however, most of the samples of this meteorite were collected some 4 – 6 months after Murchison had landed [5]. We have shown that this is plenty of time for an organic rich substrate to become heavily contaminated.

Furthermore we have completed an initial analysis of the Tagish lake meteorite which has confirmed the presence of small amounts of organic plasticisers on the surface of this meteorite. Further data will be presented at the meeting after analysis with high mass resolution ToF-SIMS.

Figure 1. A) BSE image of a carbonate globule from ALH84001. B) ToFSIMS Si map of same globule. C) Map of distribution of peaks at 533 AMU. D) SEM images of cellular structures found in box 1 of Fig 2C.

It is hoped that by studying contaminated meteorites we will be able to develop a suite of techniques to basically search reliably for life in extraterrestrial materials, including, it is hoped return samples.

References