

CONTAMINATION OF THE MURCHISON METEORITE. A. Steele, F. Westall and D.S. McKay - Mail Code SN2, JSC, Houston Texas 77058. andrew.steele@easynet.co.uk.

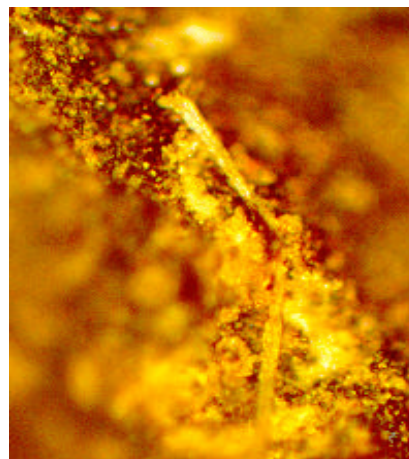
The Murchison meteorite has yielded significant data on the wealth and types of organic material that can be expected in extraterrestrial materials (1). However, the actual history of the meteorite from its fall to now has become somewhat confused. There seems to be a tacit agreement among the community that certain pieces of the meteorite are contaminated and other pieces aren't. The research described here is on a chip from the Field Museum in Australia (courtesy of R. Hoover) and comes from an area within the meteorite close to the fusion crust (3 – 4 mm).

Initially the meteorite was placed under a light microscope in Laminar flow conditions for low magnification mapping of the sample prior to further experimentation. During this investigation small, probably fungal filaments, could be seen protruding from a coarse brown mineral, which seemed to be deposited on the surface (Figure 1). The chip was then taken and placed contaminant side down in Sabouraut Dextrose agar (used for fungal isolation) and incubated at 25°C for 5 days. From this investigation a single Fungal species (identity not determined at time of writing) and a *Bacillus sp* where isolated (Figure 2) (2). The chip was then reincubated on a fresh plate and left for 6 weeks to allow the sample to become moribund. After this time the sample was removed from the medium and submitted to a standard SEM preparation protocol for biological materials (3) after which it was platinum coated for 45 seconds. The chip was imaged using a Philips XL40S field emission SEM fitted with a light element Energy Dispersive X-Ray analysis (EDX).

Figure 1. clearly shows the presence of a fungal hyphae protruding from a brown mineral phase (original magnification was x400, the image has been zoomed for ease of viewing). It was on the strength of this evidence that culturing studies began. Figure 2 shows the under surface of the chip whilst embedded in the culture medium. Lines of growth of the *Bacillus* can be seen traveling through cracks within the medium and onto the surface, joining a continuous colony surrounding the chip. Figure 3 shows the extent of colonisation of the chip. Interestingly as the chip was left to become moribund the vast majority of the circular objects (which are all highly enriched in carbon) are probably bacterial spores (*Bacillus sp.* are known spore formers under environmental stress) (2). The regions either side of the crack through the centre of the image are a wealth of the spores plus cellular debris and a partly mineralised polymer matrix. All the hallmarks of a decaying biofilm. Interestingly on this sample appeared a wealth of new mineral growth usu-

ally on top of the biofilm or embedded within it, (Figure 3. A) . EDX analysis showed these crystals to be Mg and O rich. A clearly defined fungal hyphae can be seen bridging the gap across what is probably a dehydration artefact of the biofilm. Figure 4a. shows what is probably silicified biofilm polymers. From beneath the surface of the structure crystals strongly resembling those seen in Fig 3 can clearly be seen. EDX mapping of this area shows that the whole structure contains Si (Fig 4C). However all the crystal morphologies show increased Mg and O (Figs. B and D) over the rest of the structure that is consistent for the crystals already seen in image 3. The circular break in the external film seen in the centre of the image is both Fe and S rich (Figs E and F) and within 1µm of the Mg minerals. Figure 5 shows what was to be a control sample of murchison imaged 12 years previously by D.S. McKay, when it showed no sign of contamination. However, it has now become extensively contaminated by an obvious fungal species. This could only have happened whilst it resided within one of the standard holders for SEM stubs.

Figure 1. A light microscopy image of a fungal hyphae appearing from a brown secondary replacement mineral.



This sample of the meteorite was without doubt extremely contaminated and it is likely that the fungal species entered the meteorite at the same time the secondary minerals did. Therefore any organic analysis done on chips from the same area of the meteorite as this would also be contaminated. A more detailed history of the samples after falling would be essential in determining which pieces could be contaminated. However until then visual observation for the presence of this mineral could be an aid to avoiding contamination.

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Figure 2. A light microscopy image from the of the murchison chip embedded into the culture medium.

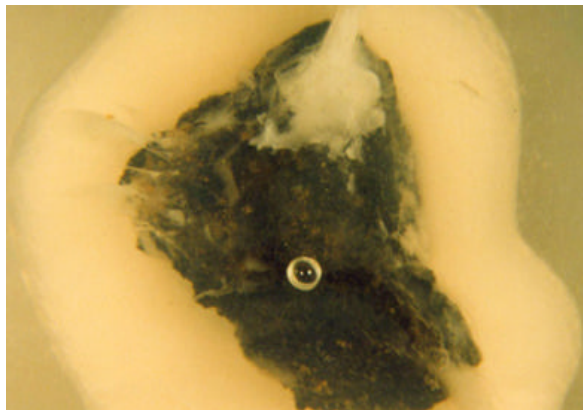
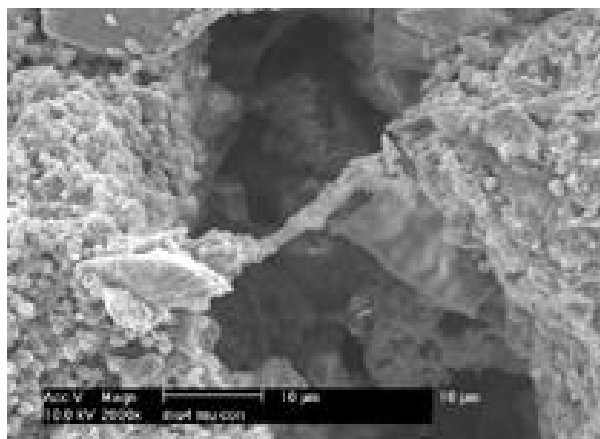


Figure 3. An SEM image of a fungal hyphae crossing a gap in the disrupted biofilm. (Bar - 10µm)



The wealth of features displayed after deliberate culturing of the known contamination illustrates the power of microorganisms to influence their environment. This is exemplified by the close proximity of FeS and MgO minerals. A parallel could be drawn with the rims of the ALH84001 carbonate globules, however the morphologies of the two are completely different in appearance (4). The fact that fungi could grow extensively on a coated sample within a sealed SEM box is ominous. It then brings into doubt meteorite storage methods and maybe the protocols for meteorite storage should be looked at again.

This study has shown the potential value of contaminated meteorites in understanding microbe mineral interactions. It is only through using such tools that an effective biomarker, which could be used to detect life on other extraterrestrial materials, will be found.

Figure 4. An area of the surface of the contaminated chip showing what appears to be silicified biofilm. A) SEM image (x1500). B-F), EDX maps of the same area, B) Oxygen, C) Silicon, D) Magnesium, E) Iron G) Sulphur.

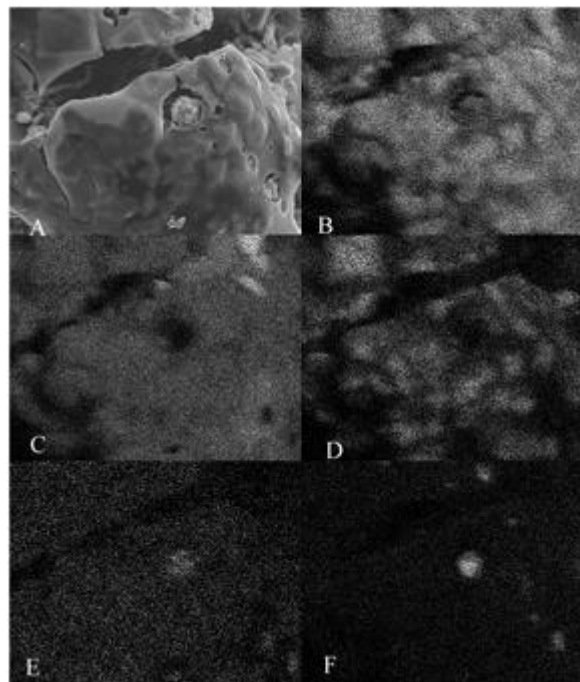
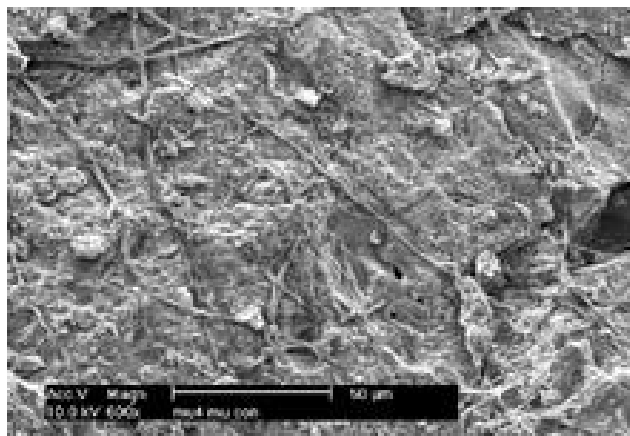


Figure 5. AN SEM image of the contamination across the Murchison control surface. (Bar – 50µm).



References

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Acknowledgements

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