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RESEARCH

Impact Events On A Graphite Stub Provide Evidence That A Biological Entity Arrived To The Stratosphere From Space

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We show that a biological entity, sampled from the stratophere collided with a sampling stub causing damage to both itself and the stub's graphite surface. We argue that this finding povides proof that the biological entity was travelling at speed from space and could not have been elevated from Earth to the stratosphere. We offer this evidence as further support for the Hoyle and Wickramasinghe theory of cometary panspermia.

Introduction

We have previously reported the isolation of a variety of biological entities from the stratosphere at heights of 22–27km (Wainwright et al. 2013a, b). We argue that, since there is no known mechanism by which particles of the size observed can reach the stratosphere, these biomorph-particles entered the stratophere from space. The stratosphere-isolated biological entities are also remarkably free of Earth-derived dust, and are not found on the sampling stubs in association with fungal spores, pollen grains and volcanic dust, a fact wich again suggests a non-Earth origin. Here we provide evidence showing that a biological entity impacted, and damaged both itself and the graphite sampling stub with which it collided. We suggest that this provides proof that the biological entity in question arrived at speed from space and was not "lazily lifted" from Earth to the stratosphere.

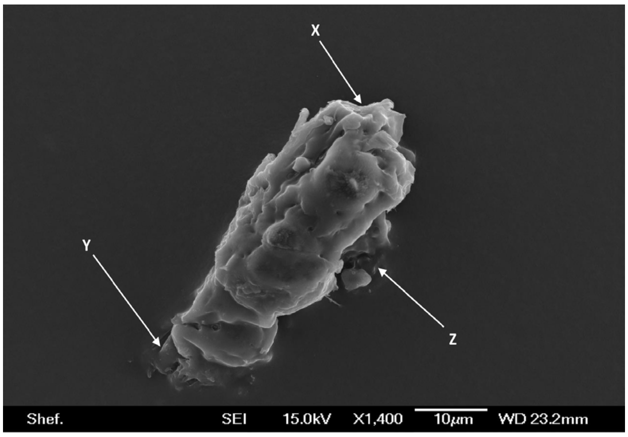

Figure 1: Object impacting graphite sampling stub at two points (Y and Z); X points to breakage point of particle as detailed in Fig. 2A.

Materials and Methods

A balloon-launched sampling device was released from Chester, NW England on 31st July, 2013. The sampler included a drawer mechanism that could be opened and closed at a predetermined height. The stratosphere sampler carried a video camera by which the opening and closing of the sampling drawer could be viewed, confirmed and recorded. The sampling apparatus was protected from downfall of contaminating particulate matter from the balloon by a cover. Prior to launch, the inside of the draw device (**Fig. 1**) was scrupulously cleaned, air blasted and finally swabbed with alcohol. New scanning electron microscope stubs were placed in rows inside the drawer with their top surfaces facing outwards so that when the draw was opened any particulate matter in the stratosphere would attach to them and they could later be removed for examination under the scanning electron microscope. The protective layer on the surface of the stub was peeled off just before launching under a cover to prevent any particulate contamination. After sampling, the apparatus was transported to the laboratory and opened under conditions which avoided exposure of the stubs to contaminating dust and the stubs were similarly transferred under cover to the scanning E/M. The stubs were then sputter-coated with gold for 30 secs at 30 mA and then examined using a SEM (JEOL 6500F).

Balloon launch: The balloon was launched from an open field near Dunham on the Hill (near Ellesmere Port, Cheshire, England) during daylight hours and traversed to just south of Wakefield in West Yorkshire (England). The sampling drawer was opened for 17 minutes as the bal-

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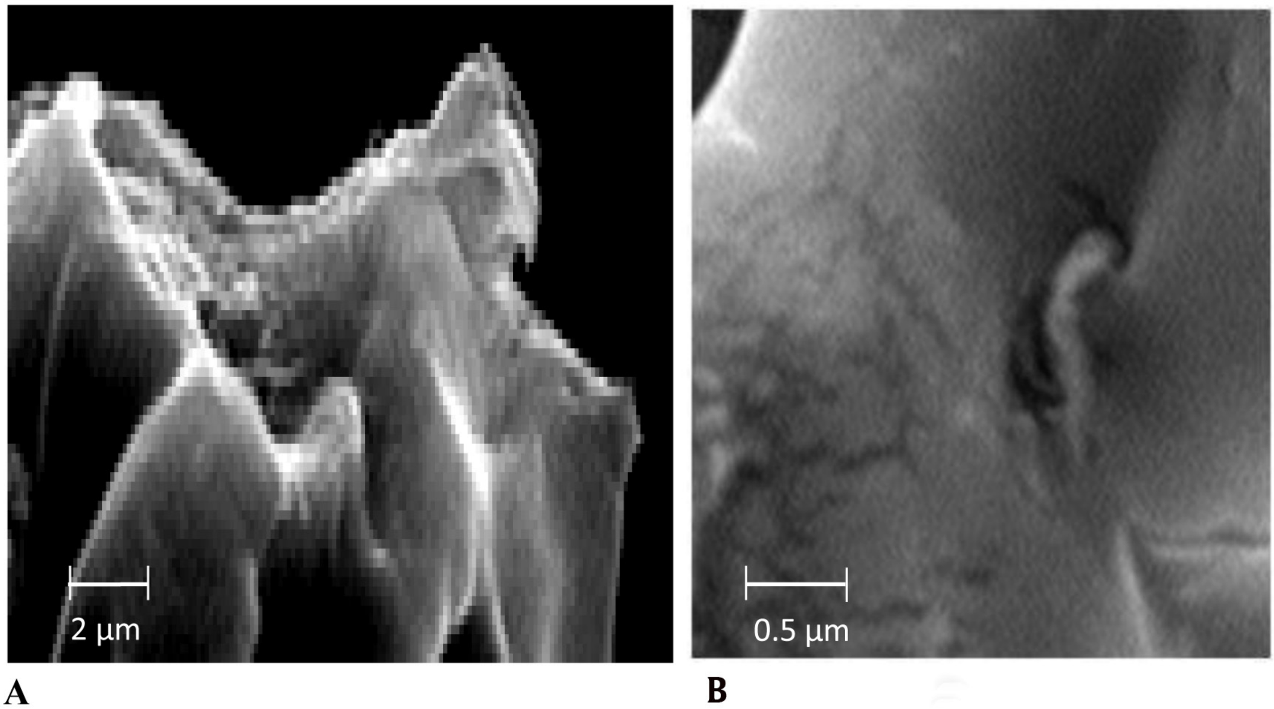


Figure 2: Detail of the impacting object. **A)** top of object showing spongiform nature of interior and potential point of breakage (as indicated by X in Fig. 1), **B)** a "wormlike" structure emerging from a surface (NB this was obtained from a slightly different image of the impacting object and is not seen in Fig. 1).

loon rose from 22026m to 27008m. The sampling apparatus was returned to Earth (by parachute) undamaged and completely intact.

Control flight: A separate control flight was made to the stratosphere prior to the sampling flight, when the drawer was not opened, but all other sampling procedures were observed. No particulate matter was found (using the SEM) on any of the unexposed microscope stubs, This shows that the drawer remained airtight and that none of the stubs was exposed to particles at, or near, ground-level or at any height up to the stratosphere. These results also show that no particles contaminated the stubs during any of the sample processing procedures, thereby demonstrating that the scrupulous procedures used to prevent ground-level contamination proved effective and that no such contamination occurred.

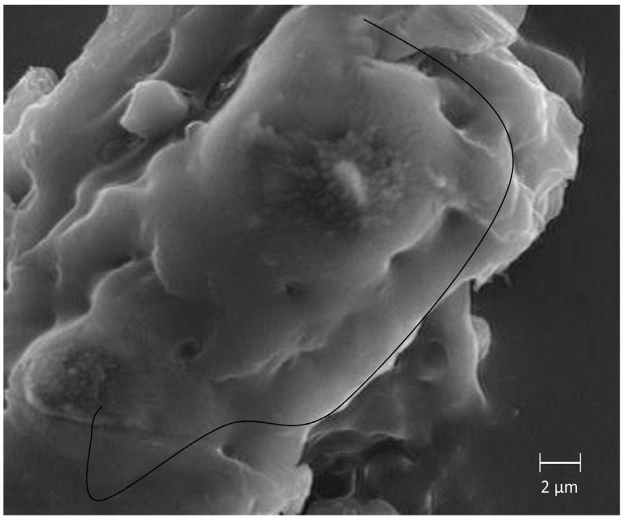


Figure 3: Detail of the main body of the object showing pores located in a comma-shape (emphasized by added line).

Is the object shown in Fig. 1 biological in nature?

Figure 1 shows an object of around 50 x 20 microns in size. It is clearly not a piece of inorganic dust but appears to be biological in nature. The images of the biological entities which we have obtained from the stratosphere which we have discussed previously are all single organisms which posses a clear morphology. It is not clear however, if this object is a single entity or part of a larger biological structure or, indeed, a group of smaller forms massed together.

Fig. 2A shows that the internal make up of the object is spongiform and cellular in nature; this irregular termination of the object suggests that this is the point at which it broke away from a larger mass. **Fig. 2B** shows another biological-like feature in the form of an emerging, "wormlike" structure (about 1 micron in length) which may be a bent seta, or some kind of a germinating entity. The assertion that this impacting object is biological in nature is also based on the presence of "spiracle-like" pores. These pores do not occur randomly but instead have a regular comma-shaped distribution, which follow a distinct pattern, as is shown by the added line (**Fig. 3**). Close ups of some of the individual pores show that they are complex structures (**Fig. 4**). These presumably have a physiological role, for example one related to gas or water exchange, although they may possess other biological functions, e.g. they may be openings from which setae or flagella originate, however, no remnants of these are present within

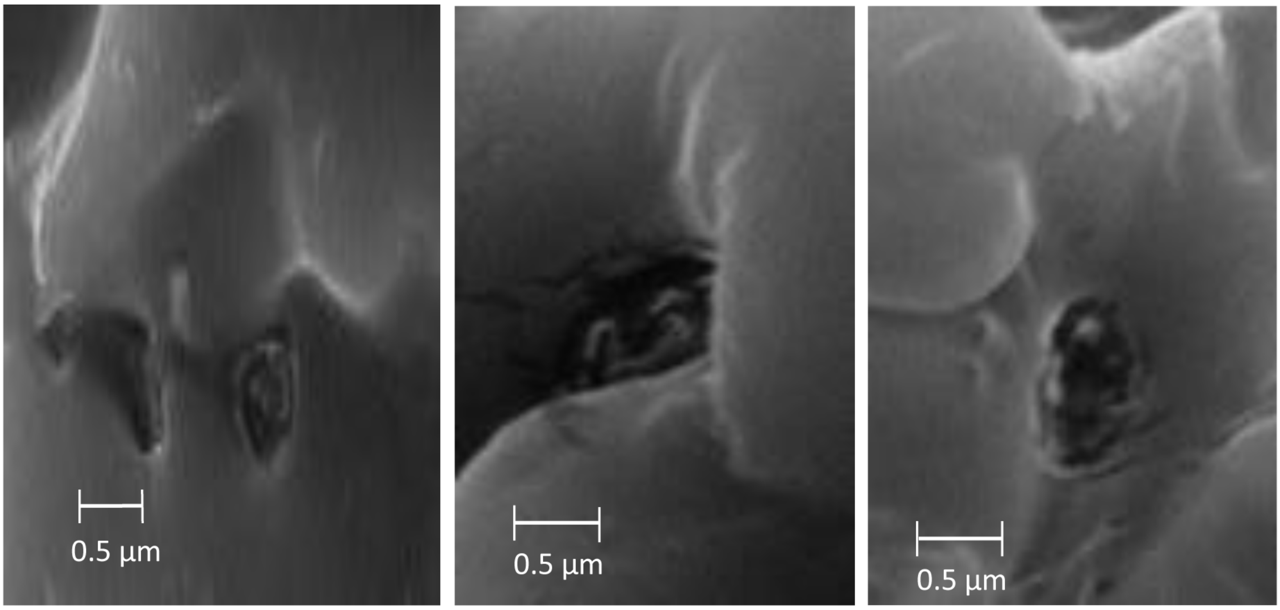
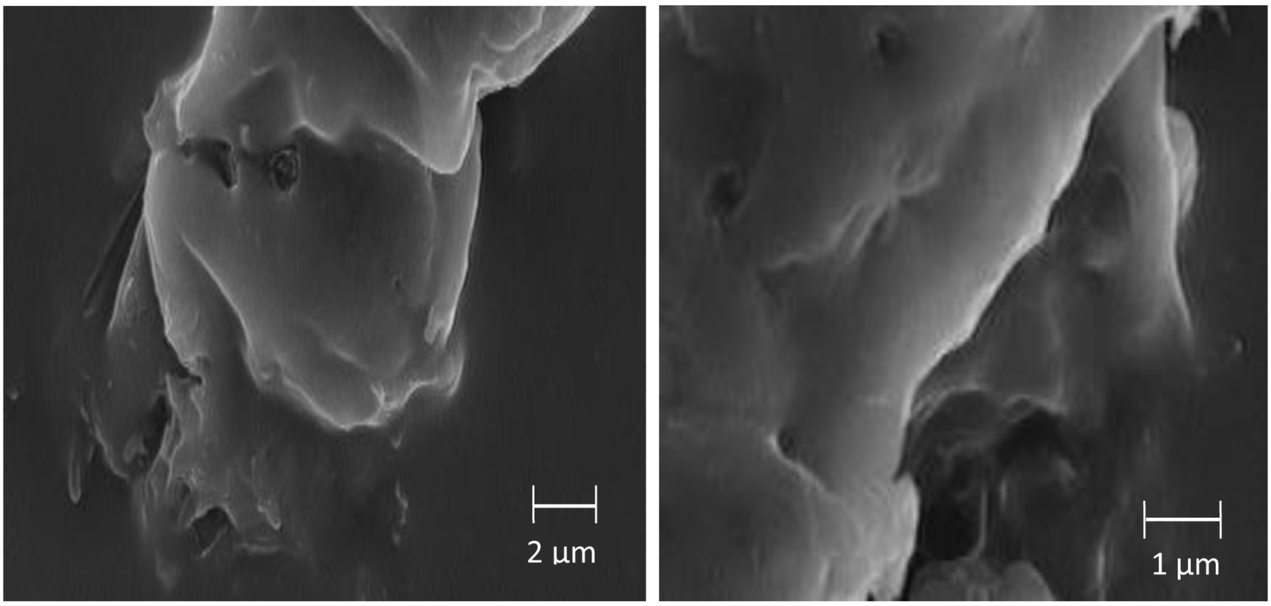


Figure 4: Details of pores showing internal holes and structure.



A **B**

Figure 5: Damage caused by object impacting graphite sampling stub. **A)** bottom impact damage (indicated by Y in Fig. 1); **B)** mid-right impact (indicated by Z in Fig. 1).

the pores. We base our claim that Fig. 1 shows a biological entity. Non-biological entities do not exhibit non-randomly situated pores and if they did, they would not exhibit the type of morphological complexity shown in Fig. 4. We may be accused of suffering from pareidolia, but we remain confident that morphological complexity of the type shown in the above figures is only exhibited by biological entities.

What does the observed impact event tell us?

The object has clearly impacted the graphite scanning electron microscope stub, an event which has caused considerable damage to the objects lower end (**Fig. 5A**) and to its top mid- right (**Fig. 5B**). The significance of this object in relation to our claim that the biological entities we have isolated from the stratosphere lies not so much in its morphology (which is intriguing), but in the fact that it has clearly impacted the graphite electron microscope stub at sufficient speed to cause damage to both itself and to the graphite surface.

The falling speed of a solid particle at a particular height in the stratosphere depends on its size (radius), and this in turn determines the excavated graphite volume d^3. A part of the kinetic energy of the impacting particle would be transferred to the graphite stub as shock heating that could dislodge atoms from the graphite lattice, leading to indentation or crater formation. A comparable part will go to disrupting the biological structure at the point of impact.

Assuming that half the kinetic energy of the impacting meteoroid contributes to sublimating or dislodging carbon atoms, we can estimate the volume of material displaced. Since the heat (enthalpy) of vaporisation of graphite is ~1.42 x 10^{11} erg/g (e.g. JANAF Thermochemical Tables) an upper limit to the mass of displaced stub material is:

$$\frac{1}{4}\left(\frac{4}{3}\pi a^3\right)v^2/(1.42\times10^{11})\ \text{g} \qquad (1)$$

The corresponding volume of graphitic material (specific gravity ~2.25) is therefore estimated as ~d^3 with

$$d \cong \left(\frac{a}{\mu m}\right)(3.28)^{1/3}\times10^{-4}v^{2/3}\ \mu\text{m} \qquad (2)$$

The observed crater dimension of 0.5μm is, according to (2), consistent with a cometary ice particle of radius 200μm travelling vertically downwards at a speed of 2km/s, capable of excavating a crater of dimension of 5μm. A 200μm radius ice housing around the putative biological structure would have caused crater of dimensions of ~0.5μm with a comparable scale of damage on the structure itself.

The damage seen in Fig. 5 cannot be caused by a) a particle of this size "lazily floating up from the Earth" to a height of 22–27 km, even if ejected to this height by a violent volcanic eruption (none of which occurred within three years of our stratosphere sampling), or b) by any known, or to date suggested mechanism, by which particles can cross the tropopause into the high stratosphere. In our earlier papers we have conceded that parsimony dictates that there must be an, as yet unrecognized, mechanism by which particles of relatively large size (in excess of 65 micron) are lifted from Earth to the stratosphere. Such a mechanism would have to transfer particles from Earth to a height of 22–27 km at a high velocity, equivalent to that associated with a particle entering the stratosphere from space and no such mechanism has yet been suggested.

It is of considerable interest that we find craters on our graphite sampling studs which are clearly caused by cosmic dust particles impacting at speed. As shown in **Fig. 6** such particles form craters whose centres are blown out, and inside can be clearly seen the particles responsible for the impact event. It could of course be argued that the stratosphere-biological entities we have found contaminated the graphite stub post-micrometeorite impact.

We emphasise that that the relatively large mass seen in Fig. 1 is impacting the graphite stub at a speed which is sufficient to cause damage both to itself and the graphite sampling stub. This impact event proves that the biological entity shown in Fig. 1 did not originate as a contaminant from the balloon, during the balloon's decent, or when subsequently handled in the laboratory. We argue therefore that this biological entity was entering the stratosphere from space when it collided with the sampling stub.

A notable feature of the biology entity shown is that, as with all the other biomorphs which we have recently

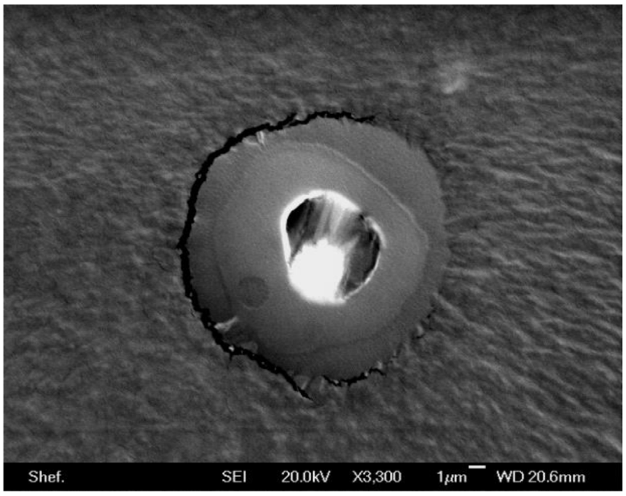


Figure 6: A micrometeorite impact event occurring on one of the graphite sampling stubs.

isolated from the stratosphere, it that it is remarkably free of contaminating dust particles, soil or the normal components of the Earth's atmosphere such as volcanic dust (which typically has a highly porous structure), including pollen grains, and the spores of fungi (such as *Aspergillus, Alternaria*, and *Penicillium*). Had the biological entities we have isolated come from Earth then they should have been associated with common terrestrial and, or atmosphere-related biology, notably volcanic ash particles, none of which we see. We would ask our critics to suggest a mechanism that can select these biomorphs from a mass of contaminating atmospheric material and then deposit them in a pristine state in the stratosphere.

We assert that since this biological entity (and the others which we have isolated from the stratosphere) is free from Earth-related materials this points to it having originated from a watery environment. Since water spouts do not reach the stratosphere from Earth (and if they did, would carry with them large quantities of terrestrial material which would contaminate our samplers), we conclude that the stratospheric-biomorphs we have isolated originate from a cosmic, watery environment, namely comets.

Rate of entry of biological entities

We next consider the rate of ingress of biological entities from comets on the basis of our sampling experiment on 31st July 2013. If a stationary collecting area of $27cm^2$ corresponding to 25 electron microscope stubs intercepted the 10 or so biological entities we have identified, the rate of collection is ~4000 $m^{-2}h^{-2}$ which would be reckoned excessive. In reality, however, the balloon and the collecting surfaces would be drifting due to stratospheric winds at ~10mph and this would have happened throughout the 17 minutes when the stubs were exposed. This implies a "trailing" collecting area of the moving stubs totalling ~4.5 x 10^7cm^{-2} and giving a rate of incidence amounting to ~7.8 x $10^{-3}m^{-2}h^{-1}$ at the site of our sampling over Wakefield in July 2014. We need to make additional assumptions in order to a rate of ingress over the whole Earth. With the reasonable supposition that there is a patchiness of incidence amounting to a 1% coverage we arrive at an average global input of biological entities of ~1 tonne per day, which is a percent of the estimated total input of cometary material.

Concluding remarks

A number of critics have stated that if our work is correct then the surface of the Moon and the planets should be covered with a layer of diatom fragments and other biological entities from space, and clearly this is not the case. Similarly, they argue that NASA would have found them on the outside of their space stations. The obvious answer to this apparent conundrum is that neither of these places supports an atmosphere, and as a result, any biological particles impacting their surface would be obliterated. The Earth, in fact, provides a "Goldilocks' atmosphere" which is "just right" for demonstrating neopanspermia.

Finally we are plagued by the use, by our critics, of the aphorism "extraordinary claims require extraordinary evidence". Implicit in this statement is the idea that a novel scientific idea can only be suggested if all the information demonstrating its veracity is available. History informs us however, that science does not progress in this manner but instead proceeds by the accumulation of small increments of new knowledge. We prefer another of Carl Sagan's quotes namely that "somewhere, something incredible is waiting to be known." We offer this discussion as a contribution to furthering the Hoyle and Wickramasinghe theory of cometary panspermia (Hoyle & Wickramasinghe, 1981).

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