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RESEARCH

Does a Supposed Volcanic Particle Mass Vitiate Claims that Biological Entities Arrive at the Stratosphere from Space?

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A particle mass supposedly from the Eyjafjallajokull volcano has been found to contain a morphological feature which is similar to one seen by us in a stratosphere-isolated particle mass. This similarity could be used to claim that both particle masses originated from a volcano; a conclusion, which if correct, would be damaging to our view that the stratosphere isolated particle mass originated from space and that all of the stratosphere-biological entities isolated by us also originate from this source. Here we present evidence which shows that our stratosphere-sampled particle mass did not, in fact, originate from a volcano and that our claim that biological entities are raining down to Earth from space remains intact.

1. Introduction

We have previously isolated bacterial clumps from the stratosphere at heights up to 41km (Wainwright et al., 2006) and a variety of biological entities from 22–41km (Wainwright et al., 2013a, b). We have also argued that these particles, by exceeding 5 micron, the generally accepted size above which a particle cannot be elevated from Earth to the stratosphere, must therefore be entering the stratosphere from space. We emphasise that while violent volcanic eruptions can eject volcanic dust to the lower stratosphere, any such particles similar in size to those isolated by us (10–300 micron) will quickly fall out from the stratosphere under the effect of gravity. Since our sampling trips were conducted 2 or 3 years after a major volcanic eruption we are confident that the isolated biological particles from the stratosphere do not originate from volcanoes. Obviously the isolation of proven volcanic dust, from the stratosphere (at the heights at which we sampled biological entities) would be highly prejudicial to our theory; to date no such finding has been reported. In fact we argue that such a scenario cannot happen, because according to our current understanding, even if an Earth–derived particle, over 5 micron in radius, did reach the stratosphere it would fall out within a short period of its arrival.

We recently came across a report relating to a particle mass found on Earth which, it is claimed, originated from the volcano which erupted in Iceland in 2010 (http://www.bgs.ac.uk/research/volcanoes/icelandic_ash.html). This particle mass contains a distinct morphological feature which we have also seen in one of stratosphere particles, sampled in 2013. The implications of this finding, if correct, are that the stratospheric particle mass in question was elevated by a volcano into the stratosphere (22–27km) and remained there for 3 years. Both of these claims, unless answered, allow our critics to suggest that our claim that biological entities are continually arriving to Earth from space cannot be sustained. As a result, we wish to discuss why we believe the above mentioned findings are not fatally damaging to this claim.

2. The potentially damaging finding

On the 9th of August, 2010 the British Geological Service published an article on its website relating to the recent findings concerning the Eyjafjallajokull volcanic eruption which had previously seriously curtailed commercial air flights across Europe. The article includes an image of what is claimed to be a clump of Eyjafjallajokull volcanic dust (**Fig. 1A**).

Figure 1B shows a particle mass sampled by us from the stratosphere. The particle mass (Fig. 1A) was sampled from the windscreen of a car in Loughborough, England. A scanning electron micrograph, together with an EDX elemental analysis, of the dust particle mass was also published. In many ways the particle shown in Fig. 1A is unlike most internet-published images of dust particle masses from the Eyjafjallajokull volcano. From our standpoint the potentially worrying, part of the particle mass is shown in **Fig. 2A**. Here is shown a row of parallel square holes which are evenly spaced in what appears to be parallel groove. This feature is of interest because we have found a very similar morphological structure in one of our stratosphere-isolated particle masses (**Fig. 2B**).

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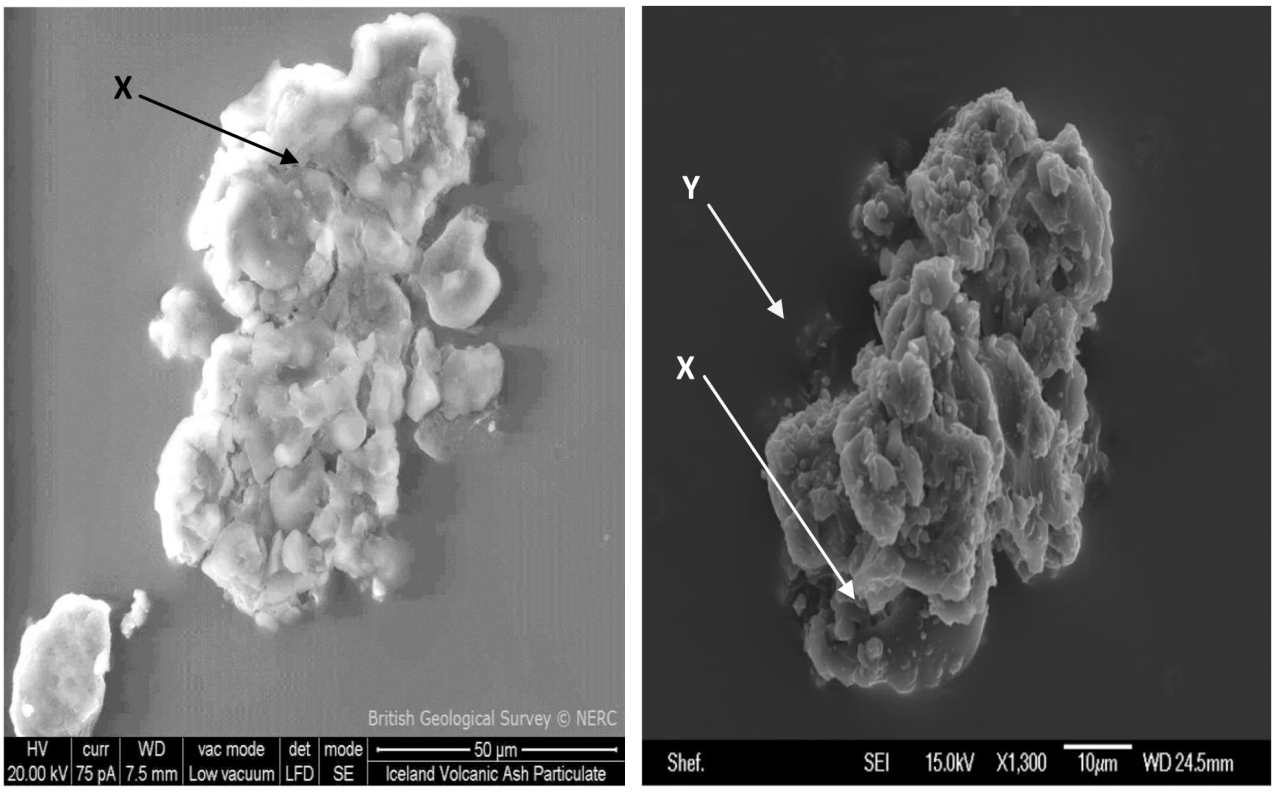

Fig. 1: A) The claimed volcano-derived particle mass. **B)** The particle mass sampled, by us, from the stratosphere.

Since these two particle masses contain an almost identical morphological feature it will be argued that both have the same origin, i.e. the Eyjafjallajokull volcano. In our previously published work (Wainwright et al 2013, b), we suggest that the morphological feature in question is part of diatom frustule. We argue this on the basis that non-biological features do not consist of parallel lines which contain almost square holes located at roughly equal distance from one another.

The obvious question arising from the Geological Survey Report is - did the particle isolated from a car windscreen in Loughborough unequivocally originate from the Eyjafjallajokull volcano? Obviously the sampling strategy used here is far from ideal and rather than originating from a volcano on Earth, the Loughborough particle mass could have come down from the stratosphere, or indeed from the surface of the Earth.

We calculate that the transport of solid particles from ground level to the troposphere and stratosphere will depend on gas drag due to weather fronts that can produce vertical motion of air. Uplift by this process leads in general to sustained upward gas motions with speeds no more than ~20cm/s. Thunderstorms can sometimes produce velocities of u ~100 mph ~0.45km/s, but dust particles carried by such surface updrafts reach at most heights $h \sim u^2/2g = 0.5$km. Sustained transport of solid particles in typical fronts with vertical velocities u = 10 – 20cm/s will be possible provided the force due to momentum transport from colliding gas molecules exceeds gravity. This condition for a spherical particle of radius a and specific gravity s can be shown to lead to

$$(a/cm) < 8.74 \times 10^{-7} (u/cm\ s^{-1})^2$$

for an atmospheric pressure of 760mmHg. For an upward wind velocity of 20 cm/s this leads to an upper limit of ~4μm for the radius of particles transported into the stratosphere. This value agrees with the current paradigm which states that only particles of size 5 micron and below can be ejected from Earth to the lower stratosphere (Rosen, 1969). Although a passing internet reference claims that a particle of size 27 micron can make this journey (*http://curator.jsc.nasa.gov/dust/tersmpl.cfm*), the claim appears to be confused, as the size limit given does not correlate with the findings given in the paper which is cited to substantiate it (Zolensky and Mackinnin, 1985). Volcanic dust particles of around 30 micron have also been found at 17–19 km in the stratosphere, these appear to have been elevated by minor volcanic eruptions (Reitmeijer, 2012). In any event, many of the biological entities and associated particles which we have isolated from the stratosphere exceed this supposed upper size limit and as far as we can determine no reports exist of relatively large volcanic particle being elevated above 22 km. It must also be emphasised that we have not seen any typical volcanic ash particles on our sample collectors, nor for that matter, pollen grains, or spores of fungi such as species of *Aspergillus* and *Penicillium*, any, or all, of which would be expected if the isolated stratosphere-biological entities originated from Earth.

It may be that a) the particle mass found on the car windscreen originated from the stratosphere, or lower atmosphere and not from the Eyjafjallajokull volcano, b)

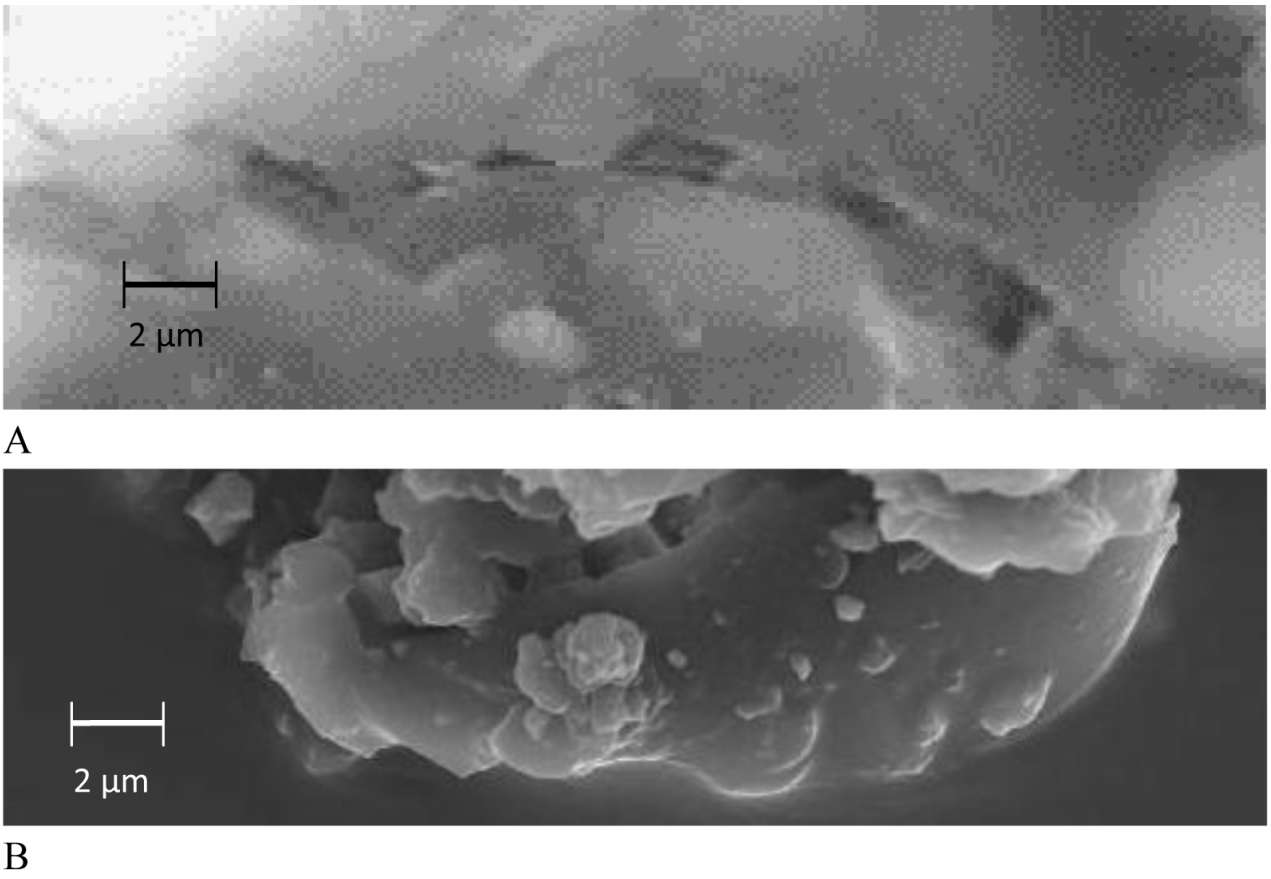

Fig. 2: Details of the observed morphological features; **A)** the claimed Eyjafjallajokull volcano particle mass (area labelled X on Fig. 1A) and, **B)** the stratosphere-sampled particle mass (area labelled X on Fig. 1B).

the morphological feature we observe in both particle masses is not a diatom but can formed independently (by a non-biological process) in both volcanic particle masses and in a particle mass originating from space.

Figure 3 shows that at the point of impact the stratosphere-isolated particle mass damaged the graphite sampling stub. We suggest that this shows the particle mass must have been travelling at considerable speed (>km/s) when it impacted the stub. It was not therefore "lazily drifting" up from Earth when sampled, nor was it projected by a violent volcanic eruption (none of which occurred within three years of the sampling date). If the morphological feature present in our stratosphere-isolated particle mass is indeed a diatom then this impact event also provides unequivocal evidence for the arrival of a biological entity to the stratosphere from space.

The simple, and obvious fact is that even in the extremely unlikely event that a particle mass from the Eyjafjallajokull volcano could be elevated to the height at which it was sampled it could not have remained there for some three years. In other words the stratosphere-isolated mass, even if it has morphological features which might be found in a volcanic particle mass, did not originate from the Eyjafjallajokull, or any other volcano.

Finally, we tentatively suggest a theory which might bring some measure of agreement between ourselves and those biologists who cannot accept that relatively complex life is continually arriving to Earth from space. The theory is that the stratosphere-derived biological entities were millions of years ago Earth organisms which were ejected into space by a major asteroid or cometary impact event, and are now returning. This tentative suggestion obviously needs very careful consideration before it can be offered as a viable explanation for our findings. For the moment, we remain content to reit-

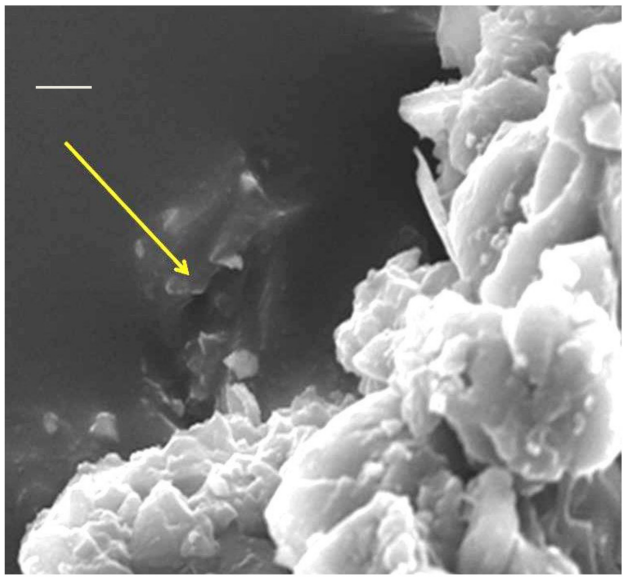

Fig. 3: Detail of the stratosphere sampled particle mass showing impact damage to the surface of the graphite sampling stub (area labelled Y on Fig. 1B). White bar on top left represents length of 1.5microns.

erate our view that our findings suggest that biological entities are continually arriving to Earth from space.

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