Lichen and Foraminifera on Mars

Horace Heffner 2004, Updated 2008

Following below are excerpted and lightly edited posts made by me to the vortex-l list, which is archived here:

http://www.mail-archive.com/vortex-l%40eskimo.com/

This is highly speculative and fun stuff regarding the possibility, more importantly the photographic evidence, that living lichen exists on Mars, and that also Foraminifera may have lived on Mars.

NASA is the source of photos included here, but this is not to imply endorsement by NASA of anything stated or implied here. NASA's media policy can be found here:

http://www.nasa.gov/centers/ames/multimedia/media_policies.html

The journey began with a prospective species of lichen on Mars I identified and called "matchstick lichen" because it looks like miniature 7 mm long matchsticks.

An earthly equivalent, Pilophoron aciculare, can be seen by serching for "Pilophoron aciculare" in the page:

<http://waynesword.palomar.edu/pljan98c.htm>

Pilophoron aciculare has a perfect matchstick shape, long podetia tipped with apotheca. Other lichen like species continue to be identified. Confirmation of this level of life continues even today with data from the Phoenix mission.

Recollection of the long and continuing jouney to this conclusion begins ...

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February 10, 2004

The Sol 17 microscopic images from Opportunity show a patch before and after a depression is made, forcing various the sandstone-like objects down into the soil. However, if you look carefully at the edge of the holes where objects have been pressed into and under the surface, you will see fibrous stalks, some with little white heads on them, similar to some molds and lichens. The soil appears to be fibrous, not sandy. This kind of texture should come from a living fungus or plant, not a dead one.

The raw images from the mars rovers can be located via:

<http://marsrovers.jpl.nasa.gov/gallery/all>

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Perhaps Mars has a tiny lichen similar in structure to bouquet fog lichen (Niebla combeoides)? It lives on fog instead of water in the soil. Maybe some variety can live with almost no air or water. A picture of Niebla combeoides is at:

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<http://www.lichen.com/bigpix/Ncombeoides.html>

The version on Mars are without flower-like heads, but rather have bead-like heads like some of the stalks in the above URL. If it is lichen the stalks are really packed together tightly on Mars.

The Sol 17 microscopic images from Opportunity show a patch before and after a depression is made, forcing various of the sandstone-like objects down into the "soil". However, if you look carefully at the edge of the holes where objects have been pressed into and under the surface, you will see fibrous stalks, some with little white heads on them, similar to some molds and lichens. The soil appears to be fibrous, not sandy. This kind of texture should come from a living fungus or plant, not a dead one.

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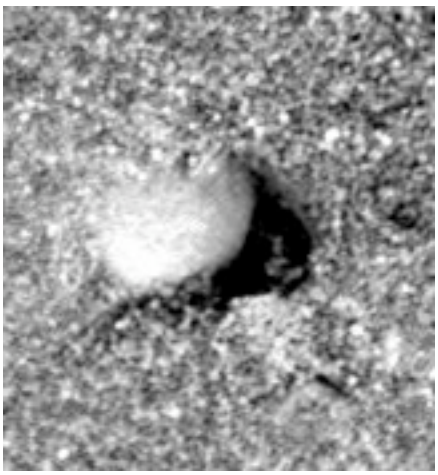
http://marsrovers.jpl.nasa.gov/gallery/all/1/m/017/1M129695998EFF0322P2953M2M1.JPG



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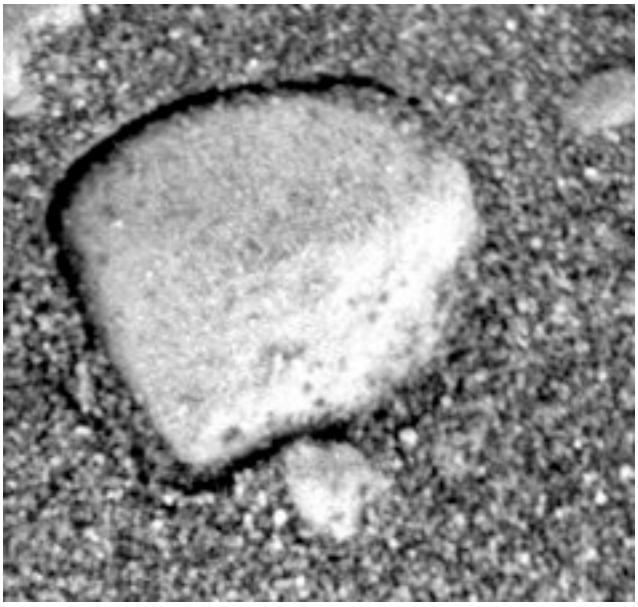

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Some lichen have spherical fruiting bodies. Perhaps the little spheres in the sandstone were nucleated by hard shell fruiting bodies from lichen which grew eons ago.

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February 16, 2004

The Sol 22 Opportunity microscopic images, especially:

http://marsrovers.jpl.nasa.gov/gallery/all/1/m/022/1M130137205EFF0382P2959M2M1.JPG

show especially clear examples of matchstick type lichen. Many of the better examples are toward the bottom of the jpg. Twenty minutes of looking at the bottom third of the photo yields dozens of examples where the entire white tipped matchstick structure is clearly visible.

Also of interest is the possibility (and this is especially speculative) that the white fibrous looking piles seen in other photos may be frozen yet still (long-term) decaying white fruiting bodies. A few of the white spheres in the above photo look like they may be just starting to decay. If so, they likely aren't fossils and likely aren't rocks. They are not like the blueberries cemented into the sandstone-like rock. Though this notion is highly speculative, it gives a perspective that may be useful in examining future photographs.

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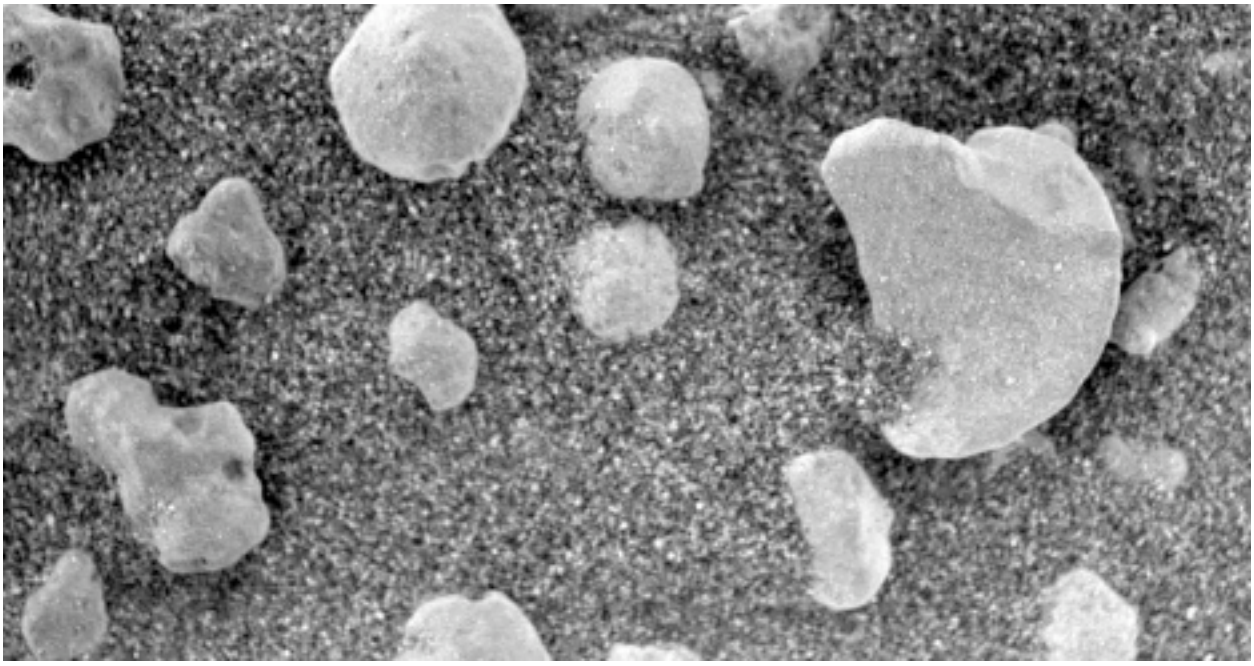

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Using the Spirit microscopic images of the rock grinding hole, which is 45.5 mm in diameter, the radius can be measured at about 450 pixels. This means that there are 450 pixels per 22.75 mm, or 19.78/mm, or about 20 pixels per mm, or 100 pixels per 4 mm.

If the microscopic imager has no zoom, then it appears most of the photos have about 4 cm width for the 1024 pixels. ... The matchstick stalk is about 12 pixels long, so is about a half mm long.

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February 17, 2004

Looking at Sol 22 Opportunity microscopic images, especially:

http://marsrovers.jpl.nasa.gov/gallery/all/1/m/022/1M130137277EFF0382P2959M2M1.JPG

there are lots of good examples of the lichen matchsticks, especially where the lichen has overgrown rock surfaces, like at 606,844 in the above photo. This gives a good opportunity to measure the stalks, as they some are all laid out straight over the rock surface, and it appears they are about 14 pixels long. At 20 pixels per mm, that would be about 0.7 mm.

Most of the white "rocks" or balls in this photo look like they might be decaying, some more than others. They are all covered with fuzzy stuff too, and it is not frost-like, so it looks like they have been there quite a while. Many are settled down into or partly buried in the local medium

or crust, whatever it is. They all have a somewhat fibrous look in this photo. It makes me want to speculate that the white layer under the top crust may consist of decayed or decaying fibrous (ball) material.

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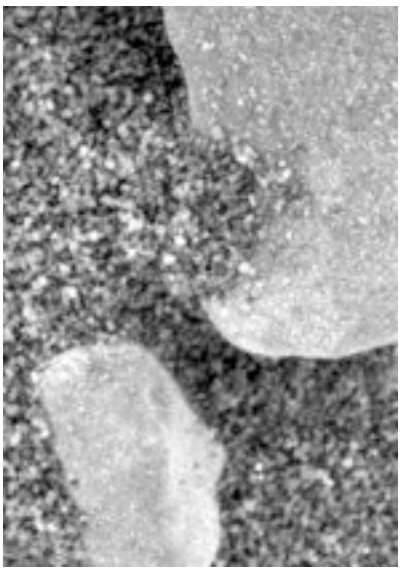

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February 17, 2004

http://marsrovers.jpl.nasa.gov/gallery/press/spirit/20040116a/misol003_15ana_new-A13R1.jpg

The above 3D press image of martian soil taken by Spirit looks like a picture of a shag rug. It is simply a mass of vertical fibers or tubes. WIthout 3D glasses it looks flat. With 3D it looks like a sculptured shag rug. The fibers on top are white, grey and black, like they are dirty. However, some are pure black, at least on the top part which is visible. There appears to be an underlying layer of fibers that is all white though. Really very strange. I wonder what the NASA folks made of that!

There aren't many stalks (carpet fibers) that look like matchsticks. But no big surprise there. This is on the far side of Mars from Opportunity.

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Note: 3-D red-blue glasses needed to view:

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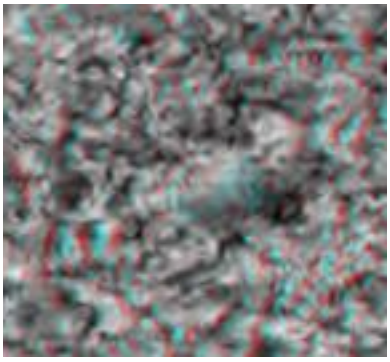

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February 19, 2004

Finding that soralia are the terrestrial equivalent to the little white match heads I felt was somewhat of a substantiation of the Mars lichen hypothesis.

To obtain a better substantiation, I decided to look for a terrestrial feature of the fruiting bodies I did not feel I had seen on Mars yet. This is then a prediction made as a result of a hypothesis, and not the other way around. (I realize I may have subconsciously noticed it though, so this is very unscientific!)

Here is the definition:

"Periphysis: a hair-like projection inside the ostiole of a perithecium or pycnidial conidioma. pl. periphyses."

I found a good fit in the older microscopic images for Opportunity, namely the photo: 1M129514984EF0312P2953M2M1.JPG

A clip of the feature is attached. This feature was on the far left border of the photo. You can see a little filament coming right up out of the ostiole of the perithecium. If that's an ostiole that is. If that osteole is on a perithecium. If that perithecium-like thing is really a fruiting body of a lichen. If lichen really exists on Mars. Well ... at least it's probably on Mars anyway! 8^)

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I still think we are seeing lichen fruiting bodies... [They] take on various forms, including spherical and disk shaped. The hole
you see in the middle I think is not where a stalk was attached, but rather
is called an ostiole, from which spores issue. I think we have seen a
number of varieties of lichen similar to terrestrial lichens known as
Crustose Lichens. They form a gelatinous surface crust (see
<http://www.nps.gov/olym/lichen/micro.htm> for sample crust cross section)
and produce fruiting bodies called perthecium, which have ostioles, or
apical pores.

[Other cross sections:

http://www.teara.govt.nz/TheBush/NativePlantsAndFungi/Lichens/1/ENZ-Resources/Standard/2/en

http://www.eoearth.org/article/Lichen

http://www.biology.ed.ac.uk/research/groups/jdeacon/FungalBiology/lichen.htm

http://commons.wikimedia.org/wiki/Image:Lichen_cross-section.png

http://herbarium.usu.edu/fungi/funfacts/lichens.htm

and of course google lichen cross section]

Check out:

http://waynesword.palomar.edu/pljan98.htm#polly2a.gif

look for "Verrucaria maura" and "perithecia", each with a minute apical
pore, and also the microscopic image of "Pyrenocollema halodytes".

I think the carpet like material we see in the 3D microscopic photo by
Spirit at:

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http://marsrovers.jpl.nasa.gov/gallery/press/spirit/20040116a/misol003_15ana_new-A13R1.jpg

may just be decomposing/sublimating lichen, where we get a good look at the underlying rhizinae and/or mycelium.

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Check out "Dimelaena thysanota" at the URL:

http://waynesword.palomar.edu/pljan98b.htm

That black and white mottled look seem familiar?

Also locate "Bryoria fuscescens", at URL

http://waynesword.palomar.edu/pljan98c.htm

It's common name is "hair lichen", but notice the white tips! Little "matchsitck" lichen right here on earth.

[Note - also check out “Pilophoron aciculare” - a perfec matchstick shape, long podetia tipped with apotheca.]

It seems to me completely plausible that Martian lichen-like species having various of the traits of terrestrial lichen could evolve, assuming that Mars at one time had plentiful water. It even seems probable when assuming that terrestrial lichen may be over 500 million yeas old and may be the ancestor of plants.

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February 23, 2004

I noticed that the big dark blue rocks in one of the spirit photos look like they are actually brown rocks that are coated with something. On many rocks the coating is darker on top, and some rocks look like thay were turned over after they were coated. This is very reminiscent of "desert varnish." See:

http://www.desertusa.com/magdec97/varnish/dec_varnish.html

especially about the third example down that has a knife in the photo. The desert varnish there looks like it is dark blue. It comes in many colors though.

Yet more evidence for cyano-bacteria on Mars.

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February 25, 2004

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Not all the Opportunity grind photos are completely fuzzy. For example:

http://marsrovers.jpl.nasa.gov/gallery/all/1/m/030/1M130859833EFF0454P2959M2M1.JPG

This photo shows twisted rope-like fiber bundles at pixel coordinates:

494,392; 530,188; 341,136.

One of the features is cut and attached.

There are also various depressions that have the look of containing a disrupted and mangled fiber mat. Not as clear as the twisted fiber bundles noted above, but it still looks like the grind area had a lot of fibrous material in it.

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Februrary 27, 2004

The lichen fibers are microscopic and mostly water. Their action under pressure should not be much different from ordinary frost - especially if the lichen is dead and decaying. Various of the white berries look under 3D to be little balls of sublimating ice - just what a mostly water fruiting body in decay might be expected to look like. The temperature there is almost always below freezing, but the gel-like insides of Martian lichen would likely have some kind of anti-freeze property like that developed in arctic animals (e.g. propylene glycol in the blood, foot pads, etc.)

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February 29, 2004

Get a look at the wispy cotton-like stuff in the Spirit Sol 46 microscopic images for Sol 46, especially:

http://marsrovers.jpl.nasa.gov/gallery/all/2/m/046/2M130463808EFF0900P2953M2M1.JPG

You can see the soil right through the stuff. This stuff is fully consistent with the hypothesis that fibers are left over when lichen decays, that the piles of fibrous material we've seen on the surface before (and in the subject photos) are decaying fruiting bodies. The fiber under this

hypothesis is decaying medulla, which consists of lots of one celled hyphae, very thin long white fibers.

The wispy stuff could also be parachute or airbag fiber.

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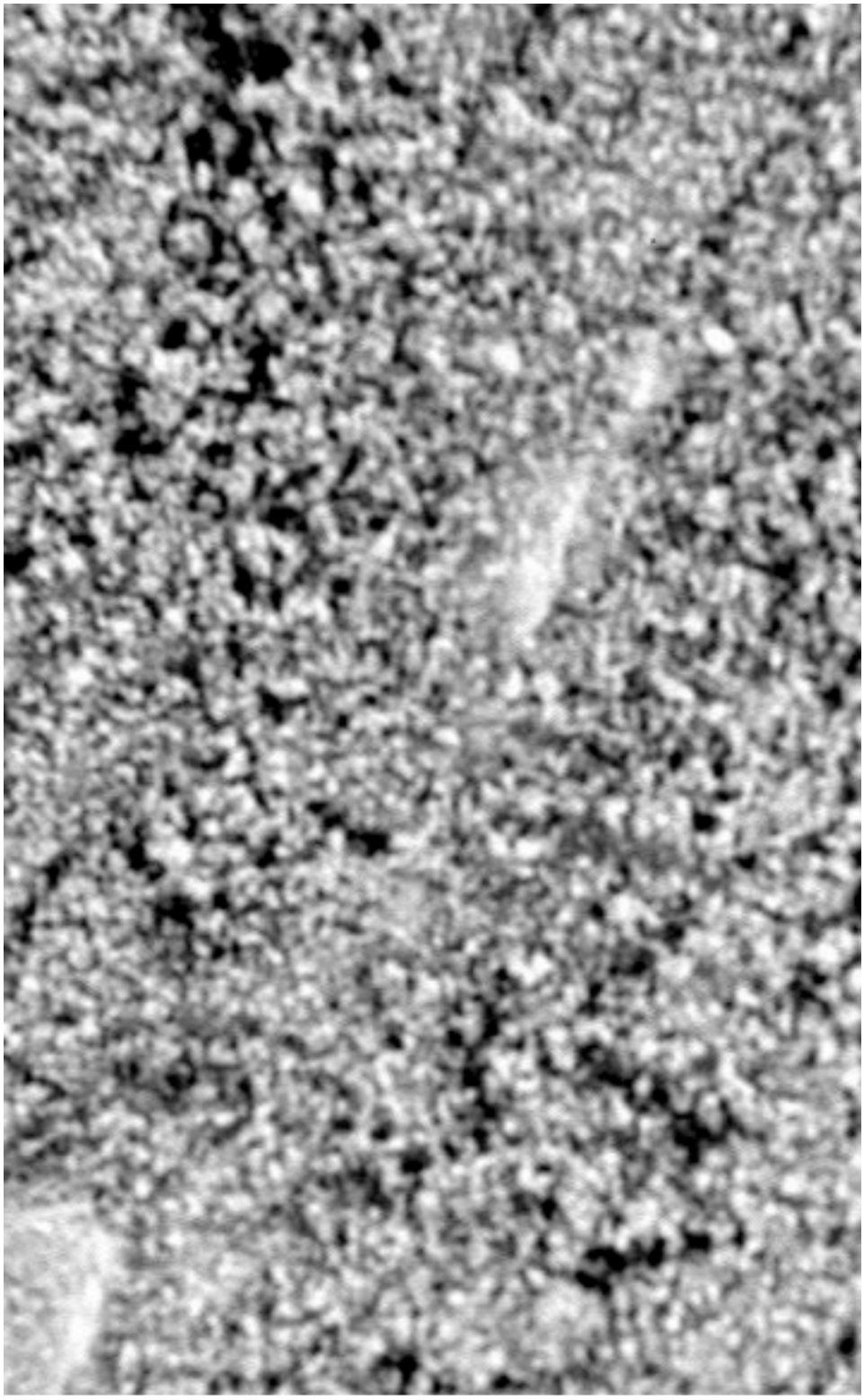

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March 2, 2004

There is no need to dream up exotic alien metabolisms (not that they might not exist!) because it is well known that some terrestrial species of lichen can live in a martian atmosphere at martian temperatures. This kind of experiment was done (I think by NASA I think) way back in the 60's or 70's if memory serves. It was also done back then by high school kids for science projects.

There is no need for a continual intense light source. That is because the lichen on Mars, if it exists, is only thawed when the light source is strong. It "lives" only a small percentage of time. It is frozen the rest. What a weird existence.

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Major amounts of ice on Mars just below the surface is very old news:

http://science.nasa.gov/headlines/y2002/28may%5Fmarsice.htm

Methinks there must have been an elephant in the room. 8^)

I suppose hindsight is 20-20, but a soil conductivity tester would have cost almost nothing to put on the rover, in either dollars or weight. OTOH, perhaps some people don't want to test for conditions that contradict their mental models. The apparent lack of biologists on the rover team is certainly noteworthy.

An obvious test for surface water is to dig/brush a hole in one of the wet flat sandy looking areas.

As to the mission, the stated goal was to prove/disprove surface water in the history of Mars. Given that Global Surveyor already has shown shallow subsurface water exists on Mars, this seems at present to be a somewhat conservative goal.

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March 7, 2004

There is no reason to expect ordinary fruit structures in a lichen fruiting body, i.e. in the perithecium. There ARE no seeds. Internal structures would not be clearly visible. They consist of microscopic mycelium filaments embedded with single cell bacteria and spores. The structure, e.g. the periphysis, and the open ostiole, or apical pore, only develops when the fruiting body is ready to release spores. What you are seeing in cross section is an unripe and either frozen or petrified perithecium. In many of the photos the pre-ostiole structure (called by some a "naval") is clearly visible at the opposite end from the stem. The outer structures

certainly are clearly defined at all times, however, unless the fruiting body is damaged and "rotting" and sublimating, in which case it looks like a snowball evaporating. Attached is (again) a clip of one such decaying perithecium, in which the periphysis is clearly visible in the apical pore.

It looks to me that in many cases what we see as "rocks" really are not rocks at all, but rather frozen masses of mycelium. It is essentially a glacier formed from saturated brine and which is in the form of a gel. It is (or was) alive when unfrozen. The outer crust on this "ice" normally prevents ordinary "evaporation", i.e. sublimation. You can still see the root-like rhizine filling some of the holes that permeate the stuff like swiss cheese. Here and there you can see crustose lichen growing on the surface of the frozen ice mass (or former ice mass.) There appears to be a mix of lichen-like species involved.

That's the way it looks to me, anyway. I haven't seen anything that contradicts the notion that most of the surface where Opportunity is roving is comprised at least in part of a crustose lichen crust, or that just subsurface is a layer of (mycelium) ice everywhere. The "berries" certainly appear to be perithecia.

One thing seems sure to me, and that is that even if the air there were breathable, it would stink to high heavens!

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Well this is all speculation, but it appears to me that most of the mycelia (actually called medulla when in a large mass) is probably dead. On earth such a thing would be similar to layers of prairie piling up on top of each other, ending up as one big flat compost heap. However, on Mars, the composting doesn't go very fast due to long periods of freezing, excellent desiccation protection by the mycelial sheath, and lack of microbes to do the composting. The layers of stuff probably act like fertile soil for some species of lichen that are capable of shooting rhizinae, which are root-like structures, down into the ice. There is plenty of evidence that

such structures exist or existed in the ice in the form of brown rope or string-like structures. That is a good partial explanation for why there are so many holes. In addition, if patches of crustose lichen forms on the surface of the exposed ice, it should bore down into it in a manner similar to the way rocks and pebbles bore down into ordinary glaciers - by absorbing light and radiant heat and warming up enough to increase the sublimation rate beneath themselves. Such holes, when caused by rocks or pebbles on glaciers, are called cryoconite holes. These holes in glacial ice look similar to the holes that gas bubbles leave in magma. It would be easy to mistake one for the other if (a) it was not known that one was looking at ice-like material and not rock and (b) the material were laying on its side.

There is additional evidence that much of the stuff we've seen is ice-like. That is the fact that the stuff which sits in what appears to be the sandy remnants of a puddle, often casts a shadow about the rim of its base, showing an indentation in the base. This indentation may well have been caused by the material dissolving and/or melting into the puddle. The melting rate at the base of chunks of ice in a puddle of water is increased by exposure to the liquid water. The effect would not be as great for frozen medullary material, but should still exist, especially if the material were dead. Further, the presence of the water itself, can only be explained by the melting ice. The ancient ice is the only clearly available source of water.

It looks like the craters in the vicinity of opportunity made have been made in an ice field. The entire area may be one big shallow glacier.

Again, all speculation. But if correct, it means that some of the stuff is dead, and a lot of it is currently alive. The well formed "blueberries" are likely alive, and the deteriorating white ones, which look like fibrous snowballs, are likely dead. Further, if the above speculation is correct, it means water is all about and yet so far unnoticed. I wonder if that is possible? Wouldn't one of the NASA instruments detect this? It is already known for sure that large parts of Mars have water or ice just below the surface. See:

http://science.nasa.gov/headlines/y2002/28may%5Fmarsice.htm

It is hard to believe that the NASA folks could mistake ice for rock, or lichen for sand for that matter. That makes me think the all above ideas are completely wrong. On the other hand, there IS shallow subsurface water on Mars and crustose lichen would provide an ideal explanation as to why it has not all sublimated. It would also explain the "canals on Mars" which grow or grew in the Martian summer. It would also help explain the crust on the soil, and the white layer that is exposed in the trenches and tracks made by the landers.

All very self-contradictory. It will be interesting to see the outcome.
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Lots of very fine filaments can found when carefully scrutinizing:

http://marsrovers.jpl.nasa.gov/gallery/all/1/m/039/1M131647698EFF0544P2953M2M1.JPG

http://marsrovers.jpl.nasa.gov/gallery/all/1/m/039/1M131647578EFF0544P2953M2M1.JPG

http://marsrovers.jpl.nasa.gov/gallery/all/1/m/039/1M131647639EFF0544P2953M2M1.JPG

Toggeling between the images shows them not to be artifacts, but real things in the photos. They are not quite as thick or pronounced as earlier fibers, but they can not be from the airbag because many of them clearly emerge from or enter the soil.
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March 8, 2004

Little balls on stalks in sulfurous environment:

<http://www.lichen.com/bigpix/Cfurfuracea.html>

Lots of little balls with holes in the ends sitting on the surface:

<http://www.lichen.com/bigpix/Cmaritimum.html>

Or if you want little balls with exactly the same surface features as seen on Mars see:

<http://www.lichen.com/bigpix/Dbaeomyces.html>

Or if you want to see shiny fruiting bodies see:

<http://www.lichen.com/bigpix/Llinita.html>

It just does not take a lot of imagination to see that a species of lichen with many of these combined qualities could evolve. Lichen can grow on rocks or sand. It is self-sufficient, given a source of light, minerals, and water. It can grow in arctic conditions and high altitudes. Some species can even grow at Mars atmospheric pressure. This is a just a no-brainer.
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Get a look at the fuzzballs in this Opportunity photo:

http://marsrovers.jpl.nasa.gov/gallery/all/1/m/039/1M131648609EFF0544P2951M2M1.JPG

They appear to be dead and decaying. The one at the top right appears to have broken off from a joined pair. It sure is fuzzy on the top side.
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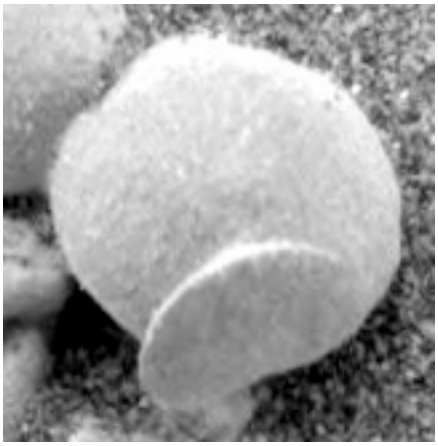

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March 9 2004

The NASA people should buy the lichen book advertised at

<http://www.lichen.com>

or better yet get the experts themselves.

The only real stretch of imagination required is to see that all that white stuff showing up in the photos is frozen water.

As for the problem grinding Flat Rock, I guess it is simply pretty hard to grind a sponge-like material with a low power grinder designed to be positioned on hard rock.

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March 10, 2004

I think such filaments in lichen are called rhizinae. Perithecia (spherical berry-like things that typically grow on the end of a stalk) and apothecia (irregular enlargements in stalks that look something like a tumor) are both primarily bags of medullary matrix (fungal filaments) that enclose lots of one celled animals which can either bacteria or algae. Lichen is merely a symbiotic organism. It takes both a fungus and a symbiant to make a lichen. Like fungi, it reproduces multiple ways.

... the perithecia produce spores. But that is not the only means of lichen reproduction.

... assuming the life form is water based, there can be no doubt that it is frozen much of the time. It is likely only able to reproduce in (comparatively) warm weather, above something like -25 C,

which is not often except maybe in summer. Also it is clear from the photos that there are berries in a state of disintegration, that appear to be dead, or at least mostly composed of sublimating ice. The fuzzy powder left behind is likely nonviable unless it contains microscopic hard shelled reproductive agents of some kind. Layer upon layer of such material, however, buried not sublimated, would leave a great legacy of water and nutrients for subsequent generations though.

It also seems to me to be true that there is so much dissolved material in the water that fossilization must be (or at least have been) a very fast process on Mars. Some of the berries are likely fossils. In fact if you look at the CETI web page there is photographic evidence there of meteor carried fossilized lichen-like structures bearing "berries."

It strikes me as likely that fruiting bodies can self-bud during their formation. This is likely merely a genetic defect. In the high background radiation of Mars mutation rates must be very high. Given that the life forms spend most of their time frozen, their life spans must be very long indeed. Mutation, however, carries on its merry way even when things are frozen. This then must provide a very high mutation rate. Fungal cells provide the overall lichen structures. If in the process of specialization to produce fruiting bodies a fungal cell is mutated, it might in fact revert back some steps in the production of the berry, and thus produce a bud on the berry itself.

Again, the above is all very speculative, but it is also based on somewhat on well known facts. It will be most interesting to hear what NASA has to say about the origin of the berries and the current presence of water.

The water issue, it me seems to me to be no issue at all. It has already been detected at shallow levels by NASA via satellite a couple years ago.
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March 14, 2004

Consider:

http://marsrovers.jpl.nasa.gov/gallery/all/1/m/046/1M132266947EFF05AMP2987M2M1.HTML

It appears the above is a "before" photo, i.e. before the scrunch from the spectrometers. An "after" photo is at:

http://marsrovers.jpl.nasa.gov/gallery/all/1/m/046/1M132267006EFF05AMP2937M2M1.JPG

I suspect in the "before" URL the balls rest exactly where they were when their gel matrix surface, their cortex, lost its integrity and they started to sublimate. In other words the balls were originally both larger

and both connected. What we see remaining now is merely the internal fibrous medulla. The sublimation process at this point results in the outer fibrous layer of the medulla continuously converting to powdery salts and continuously creating desiccated fungal filaments, all of which eventually ablate in sandy wind and blow away. Live fungal spores and bacteria may possibly also blow away in the process. I suspect the tendril-like things that remain between the balls are filament bundles that for some reason did not desiccate as fast, possibly because they have some special structure, like that of rhizinae or more likely the precursors of periphyses, i.e. hair-like projections inside the ostiole of a perithecium or pycnidial conidioma. Certainly such filament bundles between two balls are more protected from the wind than others, being sheltered by the two close balls.

However, there certainly are other possibilities, like the possibility you suggest, that the balls were separated by some force, or the possibility that some structure was built between the two balls by living tissue. Funny, it coincidentally almost looks like lines of electrostatic flux between the balls. I just feel like the sublimation hypothesis is more likely. It even appears that some of the balls sit in little indentation about the size the original balls should have been. It seems more consistent, or at least explanatory to me, but it would of course be much better to hear the opinion of an expert lichen biologist.

It is also interesting the way the crust forming lichen appears to implant little units of itself on the balls and munch away. It is difficult even to tell if the fruiting bodies are the same species as the crust forming lichen. It is not possible to tell if the little crustal matchstick lichen stuff got there via spores form the ground or via spores in the fruiting body itself. Too bad the rovers don't have lichen test kits (which are very simple) to distinguish lichen species! 8^)

One thing I am certainly very happy about. That is that the stuff in the above URL's (in the "blueberry bowl" I assume) they chose to look at has the decaying variety of lichen. Those balls have to have some water content. They are not petrified. Hopefully there will remain no reasonable doubt at NASA that they are looking at living or decaying life forms.
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March 18, 2004

Notice that where Spirit disrupted the surface it separated out a bunch of miniature potato-like objects:

http://marsrovers.jpl.nasa.gov/gallery/all/2/m/073/2M132842904EFF2000P2977M2M1.HTML

These can be seen growing in the crustose lichen at the surface of the sand dune, more or less in

cross-section at:

http://marsrovers.jpl.nasa.gov/gallery/all/2/m/073/2M132842196EFF2000P2977M2M1.HTML

And similar Sol 73 photos. Further, it appears there is a fairly large round ball under the surface right at the corner of cut of the trench, under the long shadow from Spirit.

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...living matter is apparently NOT one of the NASA working hypotheses. Apparently the they are not taking into account their own findings that a large part of Mars has water or ice just under the surface. See:

<http://science.nasa.gov/headlines/y2002/28may%5Fmarsice.htm>

It is unfathomable to me that despite the above findings, the geologists seem unable to identify the ice they are churning up on the surface, or to realize that it is a life form that is making the crust which traps the water underground.

Further, the scientists involved in the pronouncements are geologists. They seem to not have enough scientific integrity and conservatism to permit a team with proper credentials, i.e. exobilogists or even biologists, to deliver or even make the determinations that are necessary. It would appear that, as geologists, the only thing on their brains are rocks. They apparently can not conceive of the subject minerals being in solution or gel form, or distributed in a fibrous matrix, or being part of a living thing. I wonder how they would explain the fact that the surface features of some lichen has exactly the same surface features as seen on Mars "berries". See:

<http://www.lichen.com/bigpix/Dbaeomyces.html>

It seems like a safe bet that in general the instruments being applied were calibrated on terrestrial rocks, and certainly NOT very likely on terrestrial life forms having a high sulfur content.

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Notice that where Spirit disrupted the surface it separated out a bunch of miniature potato-like objects which more or less floated (via stirring disruption) to the top of the soil in the ditch:

http://marsrovers.jpl.nasa.gov/gallery/all/2/m/073/2M132842904EFF2000P2977M2M1.HTML

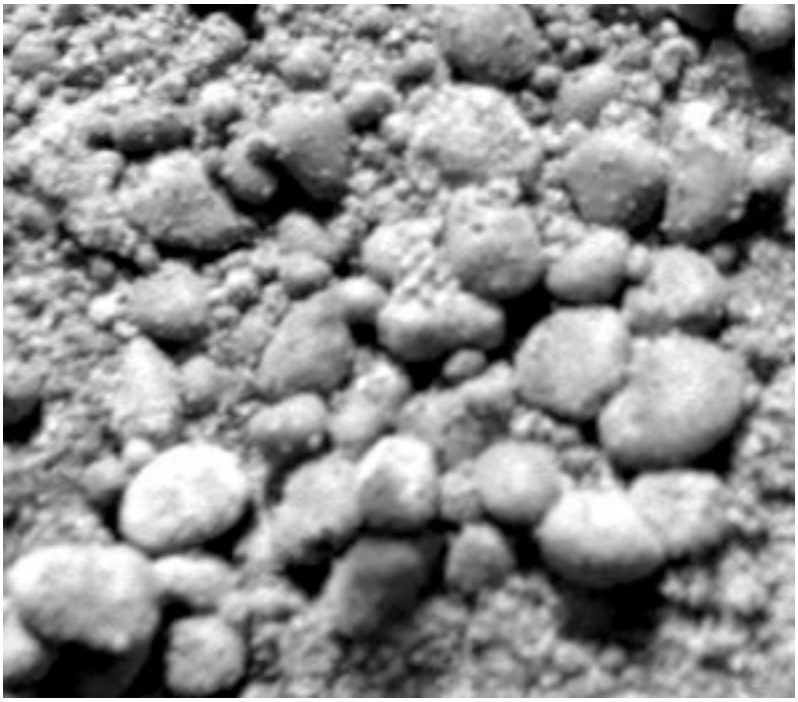
These can be seen growing in the crustose lichen at the surface of the sand dune, more or less in cross-section at:

http://marsrovers.jpl.nasa.gov/gallery/all/2/m/073/2M132842196EFF2000P2977M2M1.HTML

and in similar Sol 73 photos. Further, it appears there is a fairly large round ball under the surface right at the corner of the cut of the trench, under the long shadow from Spirit.

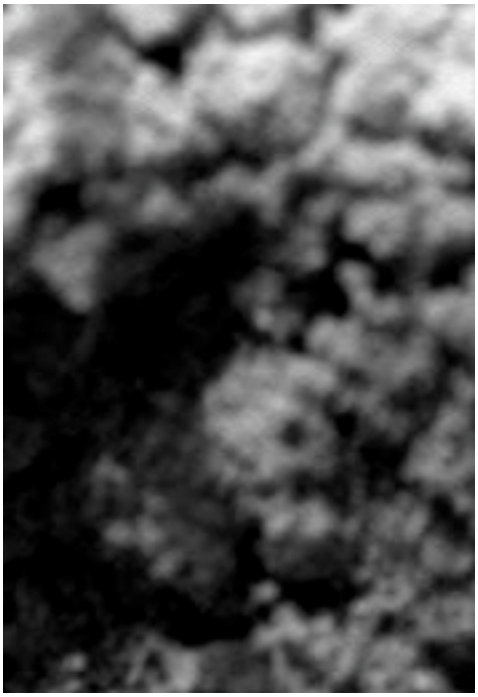
It appears to me that the surface of the sand is covered with a crustose lichen similar to various terrestrial lichen, and to the ANderson lichen seen earlier near Spirit's landing site. The fruiting bodies in this case are not the perithecium like those seen by Opportunity, but rather are apothecium or asci which grow down in the hymenium, and not on stalks.

It is interesting that some of the small surface features include many branching tendrils like the veins of small leaves.



Lichen and Foraminifera on Mars

Horace Heffner 2004, Updated 2008



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March 26, 2004

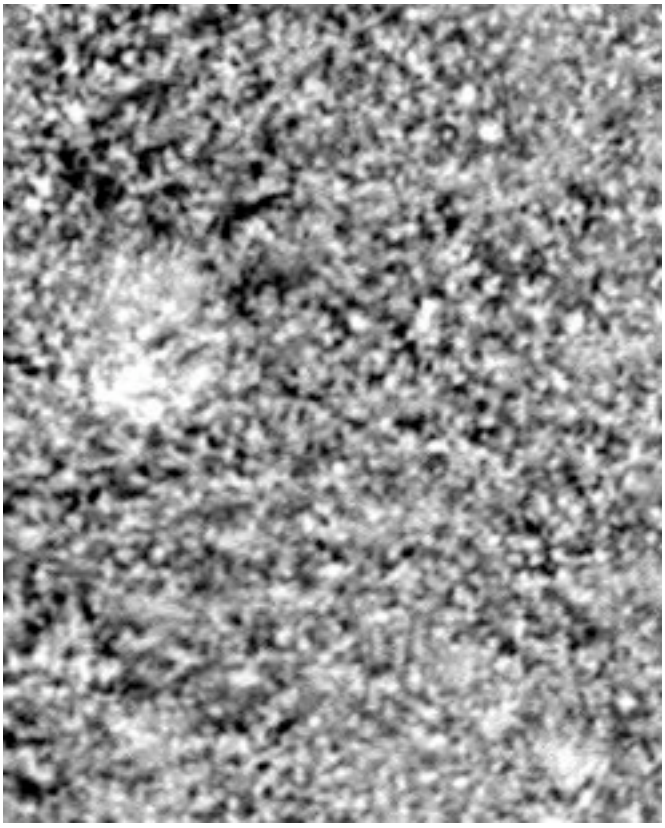
Opportunity is taking some great photos of the "matchstick lichen" and decomposing fruiting bodies now that it is out of eagle crater and out on the ice field surface.

http://marsrovers.jpl.nasa.gov/gallery/all/1/m/059/1M133421584EFF0830P2977M2M1.JPG

There are lots of places where long strands of the stuff can be seen laying on the surface. It seems larger or more mature than the stuff in Eagle crater. It must grow better out where there are more hours of sun?
- - - -
Part of above referenced photo follows:

Lichen and Foraminifera on Mars

Horace Heffner 2004, Updated 2008



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March 18, 2004

Maybe I have limited vision in this case, vision limited by my bias to see the stuff as lichen. However, I just see the stuff in that "Brian's Choice" photo as similar to the stuff covering the ice field outside Eagle crater, and visible in most soil photos. I think it is just lichen. You can see the stalks and in some cases the heads. This is the stuff I have called matchstick lichen. It grows thick, like a very thick shag rug. The close proximity of the strands traps water vapor escaping from the frozen soil below. It is the crustal lichen that forms the crust that preserves the ice below from sublimation. You'll notice that the soil is highly disrupted in "Brian's Choice" from the pressure of a spectrometer. I think that is why in some cases the individual strands of lichen are so visible. If you keep in mind that they are typically frozen, then it becomes clear that when disrupted they can fracture and look like worms when strewn about.

There seem to be various forms of lichen. Some are the crustal form that produce irregular shaped apothecia (fruiting bodies) produced below the surface, and some produce the "berry on a stalk" perithecia (fruiting

bodies.) The fruiting bodies appear to be in various stages of growth and decay in the various photos, depending on location. It wouldn't surprise me to find out that many of them blew into the crater from long distances away.
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April 3, 2004

The ostioles of many lichen parithecia on the Meridiani Planum ice field in the Opportunity photo referenced below are open and thus in the bloom state:

<http://tinyurl.com/2lupj>

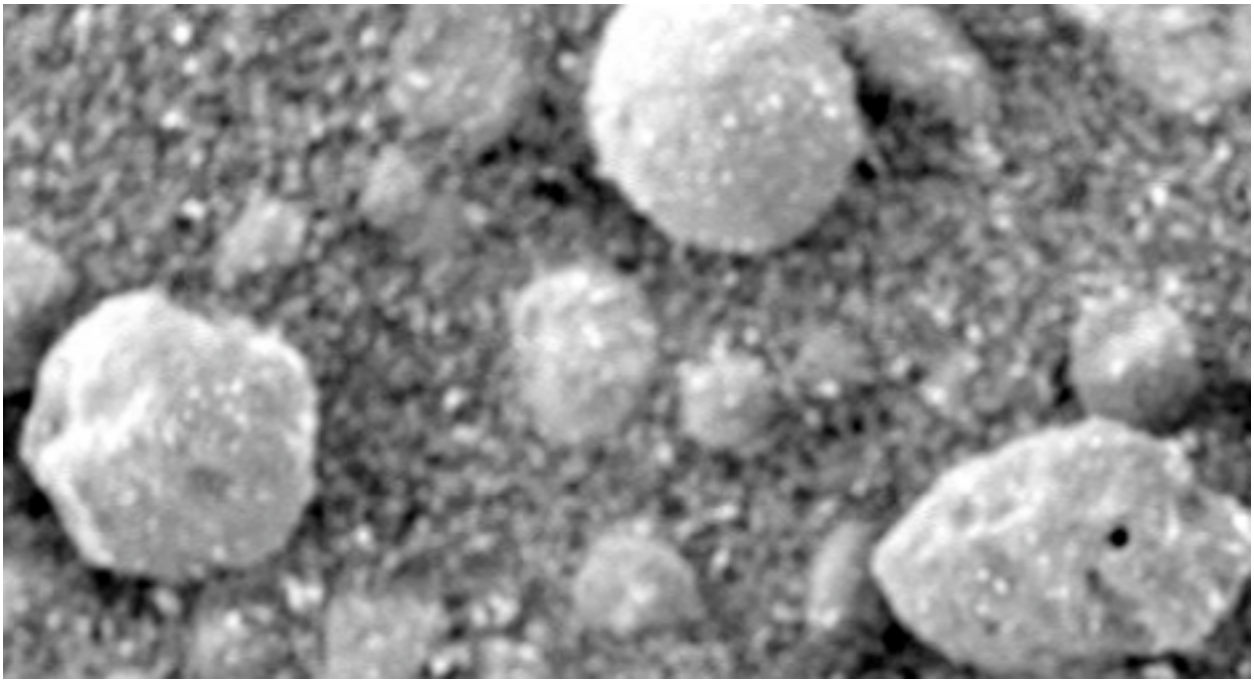
Perhaps they are frozen in that state this late in the year. There are also many little white blossom-like things that appear to be attached to the surfaces of the perithecia.

The smell on Meridiani Planum must be horrific to any but native creatures. The air must be full of hydrogen sulfide, and full of spores during blooming season. Mars suits will likely need more than gas compressors. They will either need purification units or to be fully self contained breathing apparatus.
- - - -
Selection from the above referenced photo:

http://marsrovers.jpl.nasa.gov/gallery/all/1/m/068/1M134219713EFF08AQP2956M2M1.JPG

Lichen and Foraminifera on Mars

Horace Heffner 2004, Updated 2008



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June 26, 2008

Phoenix finds Foraminifera?

http://phoenix.lpl.arizona.edu/images/gallery/lg_4859.jpg

The dark object in the center of the left micrograph appears to be Foraminid-like. See:

http://www.ucl.ac.uk/GeolSci/micropal/foram.html

for a discussion and photos of various Foraminifera.

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A portion of above referenced photo was attached to the above June 26, 2008 post:

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July 18, 2008

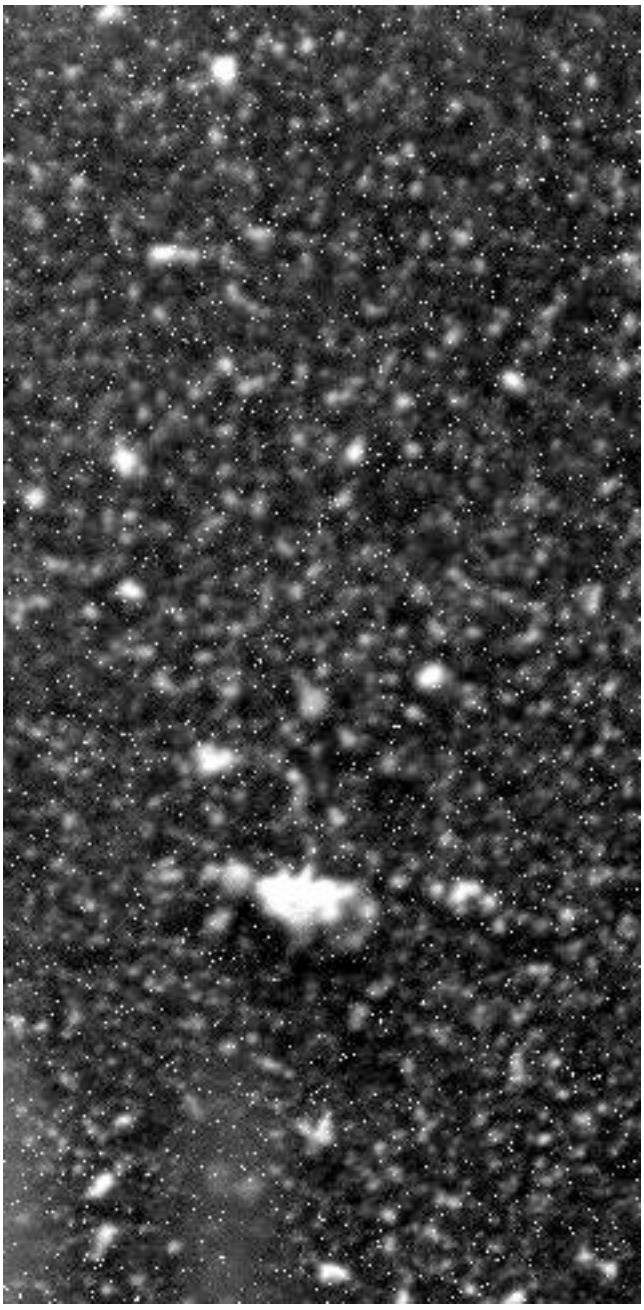
Polar "matchstick" lichen in bloom on Mars

Lichen and Foraminifera on Mars

Horace Heffner 2004, Updated 2008

Now detected by the Phoenix:

http://phoenix.lpl.arizona.edu/images/gallery/lg_14017.jpg



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August 12, 2008

Lichen and Foraminifera on Mars

Horace Heffner 2004, Updated 2008

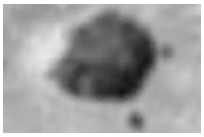
Interesting white blobs sticking to Phoenix:

http://phoenix.lpl.arizona.edu/images/gallery/lg_19371.jpg

Another fairly clear shot of a Foraminid:

http://phoenix.lpl.arizona.edu/images.php?gID=20373&cID=212

Clip of Foraminind from top middle of above photo:



Here's the amazing thing about his.

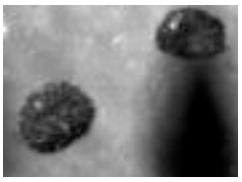
The image:

http://phoenix.lpl.arizona.edu/images.php?gID=20373&cID=212

Is a re-take of a section of the left photo in:

http://phoenix.lpl.arizona.edu/images/gallery/lg_4859.jpg

The Foraminid is clearly the same, with similar particles around it, though in better focus. However, the two objects at the bottom left, which could also be Foraminids or Ostracodes, are in much better focus, and have moved apart from each other, possibly due to manipulation:



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Aug. 24, 2008

It may well be that some of the objects in the Phoenix photographs I have taken for Foraminids may in fact be ascomata, fruiting bodies. For a good photographic match see the photo:

http://www.mycolog.com/4_Trochila_unopened.jpg

which can be found in context by locating Trochila in the page:

http://www.mycolog.com/CHAP4b.htm

Trochila is about halfway through this very large web page. This kind of ascoma opens somewhat like a clam, because a lid pops off, exposing the white hymenium underneath.

Looking back through the micrographs, there appears to be plenty of evidence of split ascoma remains, as well as hyphal blooms. The Sol 73 photos show some good examples. The photo:

http://phoenix.lpl.arizona.edu/images.php?gID=19228&cID=209

shows various bodies that appear to be fragments of or split ascoma, especially the following:

Though the Trochila is a fungus, lichen is essentially comprised of a symbiotic mix of fungus and algae, so any fungal structure is a candiate to be observed in a lichen on Mars.

Note also the "matchstick" like structures found in Order Clavicipitales, found also described in:

http://www.mycolog.com/CHAP4b.htm

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August 29, 2008

New symmetric particles in Mars micrograph:

http://phoenix.lpl.arizona.edu/images.php?gID=25876&cID=259

Possibly opening ascomata, similar to Trochila ascomata:

http://www.mycolog.com/4_Trochila_unopened.jpg

There appear to be hyphal blooms in the vicinity as well, at the bottom of the photo.

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August 31, 2008

Compare:

Lichen and Foraminifera on Mars

Horace Heffner 2004, Updated 2008

Sol 68, time 10:40:06, position 23077, FOCUS 49111, illumination blue:

http://phoenix.lpl.arizona.edu/images.php?gID=17626&cID=198

to the micrograph:

Sol 93, time 17:21:00, position 23104, focus 49111, illumination blue:

http://phoenix.lpl.arizona.edu/images.php?gID=25876&cID=259

The stage location is significantly shifted so it takes some sliding of the registration before toggling between photos. Things have changed so much it is difficult to pick out landmarks to do the registration. I picked the dark spot adjacent to a large white spot and a small white spot, located half way down and a bit to the right of center. A photo of it is attached.

I found it useful, once proper registration of the two windows was achieved, to position the cursor near something of interest so as to be sure of the location after toggling.

Over the 25 days some things have remained an place but tendrils attached have moved. Some things have moved slightly and changed shape. Some things have changed color. Some things have not changed position or appearance. Some things have disappeared, and some new things have arrived. Some white things have grown larger. Taken all together this looks like a pretty good indication of life. Where oh where are the atomic force microscope images! The original mission duration is over and yet no meaningful AFM photos??

Looking at the first photo, the width of the large white spot is about 7 pixels. At 3.91 microns/pixel, that's 27.4 microns, or 2.74x10^-5 m, or about a thousandth of an inch wide. That is a very small dot. The diameter of a human hair ranges from 17 to 181 microns.

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Compare:

Sol 68, time 10:40:06, position 23077, FOCUS 49111, illumination blue:

http://phoenix.lpl.arizona.edu/images.php?gID=17626&cID=198

to the micrograph:

Sol 93, time 17:21:00, position 23104, focus 49111, illumination blue:

Lichen and Foraminifera on Mars

Horace Heffner 2004, Updated 2008

http://phoenix.lpl.arizona.edu/images.php?gID=25876&cID=259

These can also be seen in the original photos at:

Older:

http://phoenix.lpl.arizona.edu/images/gallery/lg_17626.jpg

Newer:

http://phoenix.lpl.arizona.edu/images/gallery/lg_25876.jpg

If you carefully register and then toggle between the above two photos you can see that the vertical thin line [in the white spot area referenced Aug 31, 2008 above] actually doesn't grow from nowhere, but separates, or disappears anyway. In the *newer* photo, Sol 93, there are actually two small white dots at the end points of where the line was, each about 2 pixels wide. Trailing off to the right of the dots, at a 45 degree angle toward each other, are what appear to me to be very fine white lines, perhaps about a pixel wide. As you toggle between the two photos it looks to me that the thick white line in the *older* Sol 68 photo separates into the two thinner disjoint lines. In any case, the fine white lines that trail off on an angle appear in the second photo, but the thick line between the dots disappears. I think the lines lie mostly in the focal plane, i.e. are not vertical, because there is no sign of depth of field problems, or shadows. That's how I see it, though that is a matter of interpretation, while the order of events is not.

More speculatively, since the small objects involved are only about 4 to 8 microns in size, perhaps we have here a record of a very slow form of asexual reproduction? I suppose it could be so slow because the life form is often frozen, or in some kind of sludge state?

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September 18, 2008

Registering and toggling the following three photos, all in red light, slightly differing focus points, shows progressive and unmistakable motion of many objects, some flat or leaf-like.

http://phoenix.lpl.arizona.edu/images.php?gID=32742&cID=298

http://phoenix.lpl.arizona.edu/images.php?gID=32764&cID=298

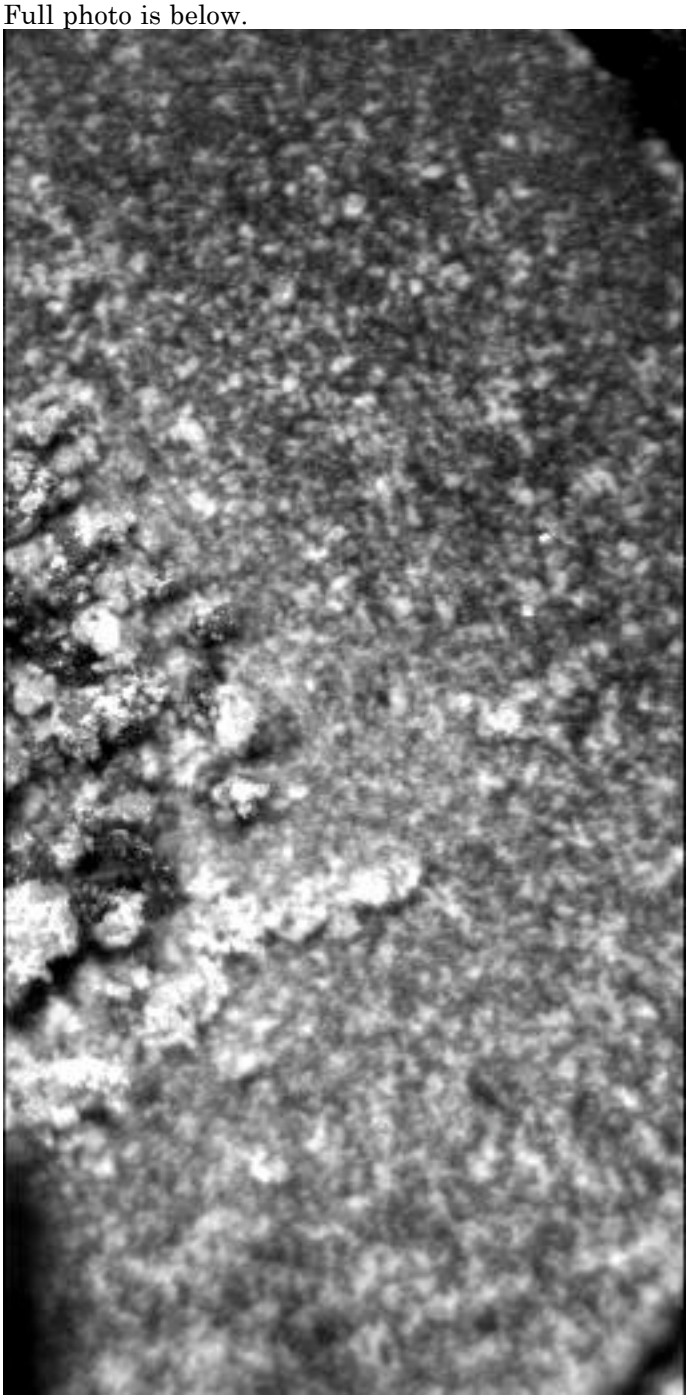
http://phoenix.lpl.arizona.edu/images.php?gID=32772&cID=298

Some of the Sol 112 photos show what may be perithecia, little ball-like fruiting bodies with now opening ostioles from which spores are issued. An area to the mid left in the above photos, with a possible perithecium with open ostiole, is attached.

Lichen and Foraminifera on Mars

Horace Heffner 2004, Updated 2008

Full photo is below.



Lichen and Foraminifera on Mars

Horace Heffner 2004, Updated 2008

The stuff in motion in these photos look to me to be living lichen-like material. It certainly doesn't look like just ice and dirt. For a video comprised of the above three frames, carefully aligned for overlap, see:

http://www.youtube.com/watch?v=0O68Xop-WpM

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October 3, 2008

The following animation, by "hortonheardawho" shows "bugs" in the lichen, in color no less.

http://www.flickr.com/photos/hortonheardawho/2899678725/sizes/o/

http://tinyurl.com/3oqhvk

Source of information is this blog:

http://www.marsroverblog.com/dyn/entry/70561/discussion_page/381

http://tinyurl.com/4csbhh

If you look carefully you can see the little moving brown things appear to have very thin straight short legs or protrusions on their sides located low and almost horizontally. A couple of them momentarily show spade tipped protrusions, maybe tails or probosci? If you use full screen mode you can see the same features in the movie I made from other NASA photos and which is here:

http://www.youtube.com/watch?v=0O68Xop-WpM

http://tinyurl.com/4qzcl8

Note - the rotational position for the above is 6134, located on substrate OM35, which is a weak magnet.

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October 4, 2008

Another Mars "bug" caught in motion in these NASA Phoenix Sol 123 photos:

http://phoenix.lpl.arizona.edu/images.php?gID=36456&cID=321

http://phoenix.lpl.arizona.edu/images.php?gID=36497&cID=321

http://phoenix.lpl.arizona.edu/images.php?gID=36498&cID=321

Lichen and Foraminifera on Mars

Horace Heffner 2004, Updated 2008

These are animated in a video at:

http://www.youtube.com/watch?v=Qb_aNjkHlSc

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October 5, 2008

The following NASA information casts some doubt about the nature of the "bugs" on Mars. The substrate for the Sol 123 photos in question is magnetic. The orange rocks are magnetic. The "bugs legs" may be magnetic dust attracted in filament form. I don't know what would explain the spade like "tails" that stick up occasionally though.

http://www.nasa.gov/mission_pages/phoenix/images/press/StrongMagPart.html

http://tinyurl.com/3gsp6b

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October 11, 2008

Here is a movie made from NASA Phoenix Sol 132 photos.

http://www.youtube.com/watch?v=xhyCh1BlNsI

http://tinyurl.com/4phxrs

It is not very exciting. Hard to tell exactly what the motion is from. Nothing definitively bug-like visible. Again, the subject is located on a string magnet substrate (OM33). All photos were in green. Stage position 5411.

Sample photo located here:

http://phoenix.lpl.arizona.edu/images.php?gID=38681&cID=341

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