First for anyone who doesn't know, NASA's perseverance rover is currently collecting small samples of rock and leaving them on the surface in tubes on Mars. NASA want to return them some time around 2033 and they plan to return its Mars samples of rock and some dust / soil to biosafety level 4 facilities (BSL-4). But the ESF in 2012 said we have to contain ultramicrobacteria from Mars and a BSL-4 can't do that.

We aren't talking about a huge risk here. Ultramicrobacteria from Mars may be as harmless as microbes collected in terrestrial deserts, but they could also have evolved from scratch on Mars in a completely different way from Earth life, or they could have evolved capabilities on Mars through billions of years of evolution that terrestrial life doesn't have.

I think Margaret Race's analogy of a smoke detector sums it up well. The risk of your house going on fire is so low you don't panic about it but it is a sensible precaution to install smoke detectors. NASA is planning to install smoke detectors for Earth in this metaphor but ones that don't really work according to the most recent study on a Mars sample return. Also, NASA aren't responding to public concerns about this. Also this is a house for billions of people. As Carl Sagan said:

> *The likelihood that such pathogens exist is probably small, but we cannot take even a small risk with a billion lives.*
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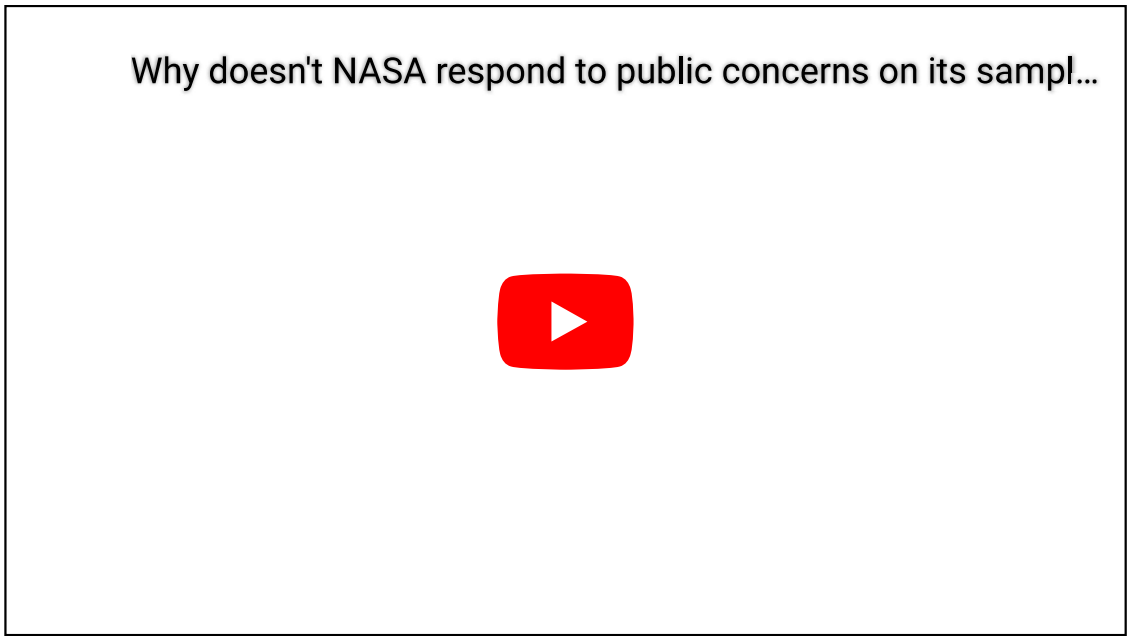
It's generally agreed decisions like this can't be made for the public by scientists and engineers so you all have a say in it. So why aren't NASA responding to the public? I am baffled and don't know why. I'm posting here as I got no replies from NASA and so far all the experts I contacted either didn't reply or just referred me back to NASA. Do comment yourself here, comments close 20th December 2022. []

If this does get through NEPA I expect the presidential directive to stop it, which happens at the end of the legal process and must look at anything if it can be reasonably expected to result in domestic or foreign allegations of major or protracted effects which this surely will be. But it is far better to get it on the right track now than to go through all that.

Video for this blog post here (uses earlier edit of this post)



Click to watch on Youtube: Why doesn't NASA respond to public concerns on its samples from Mars environmental impact statement?

Dear NASA. former and current planetary protection officers, astrobiologists, flight engineers, anyone interested and the general public.

My background is that for the last 2 years I've been working on a paper I hope to submit to astrobiology journals specifically on planetary protection for NASA's Mars sample return mission. I did an early draft as a presentation on a Mars sample return that I prepared but didn't present when I gave this presentation about Enceladus and Europa at a small astrobiology conference in Oxford, in 2015.

. "Super Positive" Outcomes For Search for Life In Enceladus and Europa Oceans - Robert Walker

So I'm reasonably familiar with the literature.

So I was astonished when NASA's Environmental Impact Statement didn't cite this recommendation from the European Space Foundation from 2012. This is the most recent Mars sample return study. How can they not know about it? I'm baffled.

… the ESF-ESSC Study Group recommends that values on level of assurance and maximum size of released particle are re-evaluated on a regular basis.

The release of a single unsterilised particle larger than 0.05 microns is not acceptable under any circumstance

WELL BELOW Biosafety 4 limits - we don't have ANY air filters yet that can do this

Page 48 of 2012. Mars Sample Return backward contamination–Strategic advice and requirements

I looked at the literature, nobody knows how to contain such small particles confidently. Maybe it can be done but a decade later nobody is trying as far as I can tell. There aren't many situations where you need to contain such tiny particles in air.

The ESF also recommended that their size limit and their required level of assurance needs to be re-evaluated on a regular basis and NASA haven't even used the 2012 limit.

Instead they plan to use a standard BSL-4 facility - this recommendation is based on the scientific understanding of 1999 if you trace it back to its original sources. That's more than two decades old science.

I have tried contacting NASA about why they aren't using the most recent European Space Foundation study, and got no response including via public comment on their proposals in May.

. Public comment by Robert Walker, May 16, 2022

They still don't mention it in the draft EIS which they published in November.

The public comment period ends on 20th December and after that there is no more chance for public comment as far as I can tell, and they expect it to be completely finished under the fast NEPA process in spring / summer 2023.

But it is kind of weird the argument. All the way through they miss out important studies and misrepresent the sources they do cite. They also contradict themselves pretty much.

It is just so unlike NASA and I don't see how it got through internal review but I have to comment on what I can see there. It's not for me to speculate how it happened.

I've also tried emailing many people, about a dozen so far including experts in astrobiology or planetary protection. So far most haven't replied; others reply just saying to ask NASA which is no use as NASA aren't responding. There are many in the public who have raised concerns of one sort or another. NASA have a section in the draft EIS where they say they responded to public comments, but they don't mention this concern about BSL-4 facilities not being sufficient. There is no response to major concerns raised by the public.

It is really quite extraordinary. Their basic argument is that they claim:

- **Credible evidence says that Mars has been uninhabitable for millions of years**
  (their cite is about searches for local currently habitable regions in a seemingly uninhabitable planet)
- **If there is life on Mars, they say it can't get to Jezero crater**
  (why do we need to consider this if Mars is uninhabitable? And they do this by citing the 2014 MEPAG survey and not the second MEPAG study in 2015, SR-SAG2 which revised all the relevant MEPAG conclusions - the second study draws attention to biofilms a microbe can use to make extreme environments more habitable, says regions that seem uninhabitable from orbit may have localized habitats, and warns that we don't know if terrestrial life can be transported in dust storms - also their MEPAG cite is about forward contamination by terrestrial life, so isn't even about the potential capabilities of any martian life which would have evolved to conditions on Mars and the dust storms over billions of years.)
- **If there is life in Jezero crater, they say it can get here faster and better protected in meteorites**
  (their cites are about rare cases in panspermia such as b subtilis, a very hardy organism, none of their cites say life could get here faster and better protected in a meteorite, and what matters for planetary protection, unlike panspermia, the theory that life could be transferred between planets, is life that can't get here, metaphorically the starlings are the invasive species in the Americas because they can't get across the Atlantic while barn swallows are no problem because they can - and you have microbes too like "Didymo" which is an invasive species in New Zealand because it can't cross oceans and can't even get from one freshwater lake to another in New Zealand without help from humans. There could easily be microbes that could get from one briny seep on Mars to another in the dust storms that could never get to

Earth on a meteorite while it could use a sample tube with a small amount of martian atmosphere sealed in like a miniature spaceship)

- **Because of all this they say that there is no significant risk of environmental effects and nothing needs to be considered about human health except to handle the samples like any other toxic chemical or infectious disease**
  (the NRC study from 2009, which they DO cite, warns that though the risk of large scale effects on the environment or human health is likely low, it is not demonstrably zero, and it warns against using the very meteorites argument that they use)
- **That we have to return the samples to Earth for "safety testing" - this rules out any possibility of a pre-sterilized sample return (sterilized before it gets to Earth) which they don't even mention**
  (actually the permitted biosignatures per gram of rock sample or regolith for the returned rock samples are so high that any tests for life are guaranteed to detect biosignatures from Earth - NASA think they achieved a reduction to 0.7 nanograms per biosignature per gram for the most abundant biosignatures - so the safety testing is useless because their cite says that the only way we can check for safety is to check if there is martian life there since we can't predict effects of introducing novel life to Earth - and again - why are we doing safety testing if they already know Mars is uninhabitable, know it can't get to Jezero crater from elsewhere on Mars and know it can get back to Earth faster and better protected in a meteorite?)

The obvious solution is a presterilized sample return. By presterilized here I mean sterilized before it reaches Earth, either during the return journey, for instance using nanoscale X-ray emitters, or in a receiving satellite in orbit around Earth, so it is sterilized BEFORE any of it can contact Earth's biosphere. This would achieve virtually the same science especially since the samples will have to be sterilized anyway before they can be distributed to geology labs because they can never pass safety testing. To put that in context one nanogram is enough for 10,000 ultramicrobacteria which weigh in at about 0.1 picograms each.

As for astrobiology, with this level of contamination, it's not likely we can do much meaningful of that sort, just yet more studies to prove what we know already that Mars was habitable in the past, in a bit more detail.

[The samples are from Jezero crater from an area which we know used to be a river delta three billion years ago]

So, I suggested bonus samples collected in clean containers. We could add samples of dust, dirt and atmosphere to the ESA fetch rover. These also could be presterilized before they get to Earth, and still retain a great deal of astrobiological interest.

For instance we detect microbes in Japan brought there from dust storms in the Gobi desert. Even if there are small amounts of life in distant regions of Mars there is some chance it could be detected in Jezero crater. Maybe even viable life especially if martian life is adapted to spread in the dust storms.

Also Curiosity detected liquid water indirectly in the sand dunes it drove over in Gale crater in the early morning and evening. These are even more likely at Jezero crater where it reaches 100% humidity at night. They have enough water activity for life at -70°C but far too cold at least for terrestrial life but a biofilm could retain the water through to daytime when it rises to above 0°C sometimes.

If there isn't native martian life there, the salts are still very interesting in clean samples, for prebiotic chemistry and to help with Mars simulation chambers to study what could happen elsewhere on Mars. We could add a small sterile container to the ESA fetch rover to compress the atmosphere, collect dust and as a receptacle for a small scoop of dirt that the rover could dig up and add on top of the sample tubes to return to Earth.

As an alternative to sterilizing the astrobiology samples on the return journey before they get to Earth, we could return these unsterilized bonus samples above GEO (Geostationary Earth Orbit) to a safe orbit while returning all the geological samples presterilized to Earth for the geologists. This is just like several published ideas such as HERRO and the the Lockheed Martin "Stepping Stones" to Mars and Mars Base Camp, all proposals for astronauts exploring Mars telerobotically from orbit to explore Mars at less expense from orbit and safely for both Mars and Earth life before we know what's there. See:
. HERRO mission to Mars using telerobotic surface exploration from orbit

. Comparison of Deimos and Phobos as destinations for human exploration, and identification of preferred landing sites

. Mars Base Camp: An Architecture for Sending Humans to Mars

We can't rely on human quarantine, I give many examples in my preprint, e.g. the two Zinnia plants in the ISS which died of a crop opportunistic fungal pathogen Fusarium oxysporum brought there in an astronaut's microbiome. Fusarium oxysporum is also a sometimes deadly pathogen for immunocompromised humans, actually second after Aspergillus in harm to humans for fungi - but obviously had no symptoms with that young healthy astronaut. And some natural analogue of hachimoji DNA or mirror life independently evolved on Mars could be harmless in an astronaut's microbiome but spread and cause major problems in terrestrial biomes once they get back.

[Hachimoji DNA has 8 bases instead of 4 but is dependent on chemicals only available in the laboratory, so it's safe on Earth, but a natural analogue from Mars may be able to live here, and mirror life is life that started off with mirror chemicals early on and has DNA spiralling the other way, starches, proteins and enzymes reversed, all independently evolved but reversed as in a mirror.

If half the life in your forests, soils and oceans is mirror life will it function the same way - after the decades to centuries it might take to adapt to live here?]

And we can send over 7 tons in one payload to above GEO (Geostationary Earth orbit) already with the Ariane 5 rocket, enough for hundreds of remote life detection instruments in one payload because astrobiology instruments have been so miniaturized in the last couple of decades. These have automatic sample preparation as there are many such instruments designed for remote operation on Mars.

This is mentioned in the draft EIS, they say samples have to come back to Earth for sample preparation but they don't for life detection. There's even SETG, an end to end gene sequencer which does the sample preparation all the way through to the gene sequencing which requires large amounts of data but it does all the number crunching too and just sends the gene sequence back to Earth.

. SETG: nucleic acid extraction and sequencing for in situ life detection on Mars

I'm no lawyer, and they would need to ask an expert in environmental law, but on the face of it NASA actually may be in some legal jeopardy. By a 7th circuit decision in 1997 it is not permitted to define the scope of an EIS so narrowly as to exclude reasonable alternatives, which the presterilized return certainly is. The remedy back then was that the agency was told to cancel the project to build a reservoir because they improperly excluded the option of two smaller reservoirs. Not because two smaller reservoirs were better, just because they didn't assess that option.

And since we can keep Earth totally safe with virtually no loss of science, why would NASA not even want to consider the pre-sterilized samples option? I just don't get it, I'm totally baffled and have no explanation.

So anyway that's what I wanted to ask you [interested experts] about.

Do you have any idea what is going on? Why NASA aren't responding to me? Is there anything we can do to get answers to this for the general public?

Do feel free to share this email with anyone else. If you know of anyone else I can contact about it also do say.

You can contact me at support@robertinventor.com

I did a blog post and a preprint and an annotated version of the draft EIS that goes into a lot more detail.

You can skip through sections of the blog post with the skip to next section links. I do the articles as like mini abstracts. So you can click through and read the titles of the sections and look at the graphics for each section for

a first impression, then drill down into any section of interest. My academic analysis of the draft EIS is done similarly (though with out the skip to next section links) so you can get a good overview of the paper by just reading the contents list then drill into any section of interest.

I've also done an annotated copy of the draft EIS which you can look at to see the passages highlighted that I see as of most concern, along with my comments on them.

. NASA - Your Samples From Mars Need A Better Than Biosafety Level 4 Facility - NOT Designed To Contain Even Earth's Tiniest Cells

I hope we can get to the bottom of this. The public surely need answers to their questions and as John Rummel once wrote, which I quote in that blog post:

> *"Broad acceptance at both lay public and scientific levels is essential to the overall success of this research effort."*

Even if it does go through NEPA, at the end of all the legal process, the president has to look at it, if it can be reasonably expected to result in domestic or foreign allegations of major or protracted effects. So he will have to look at this Environmental Impact Statement carefully, and the current draft EIS will just fall apart on any close study, if they just check the cites, or read my comments on the draft EIS and check them out.

> "It should be understood that experiments which by their nature could be reasonably expected to result in domestic or foreign allegations that they might have major or protracted effects on the physical or biological environment or other areas of public or private interest, are to be included under this policy even though the sponsoring agency feels confident that such allegations would in fact prove to be unfounded.
>
> . NSC-25: Scientific or Technological Experiments with Possible Large-Scale Adverse Environmental Effects and Launch of Nuclear Systems into Space

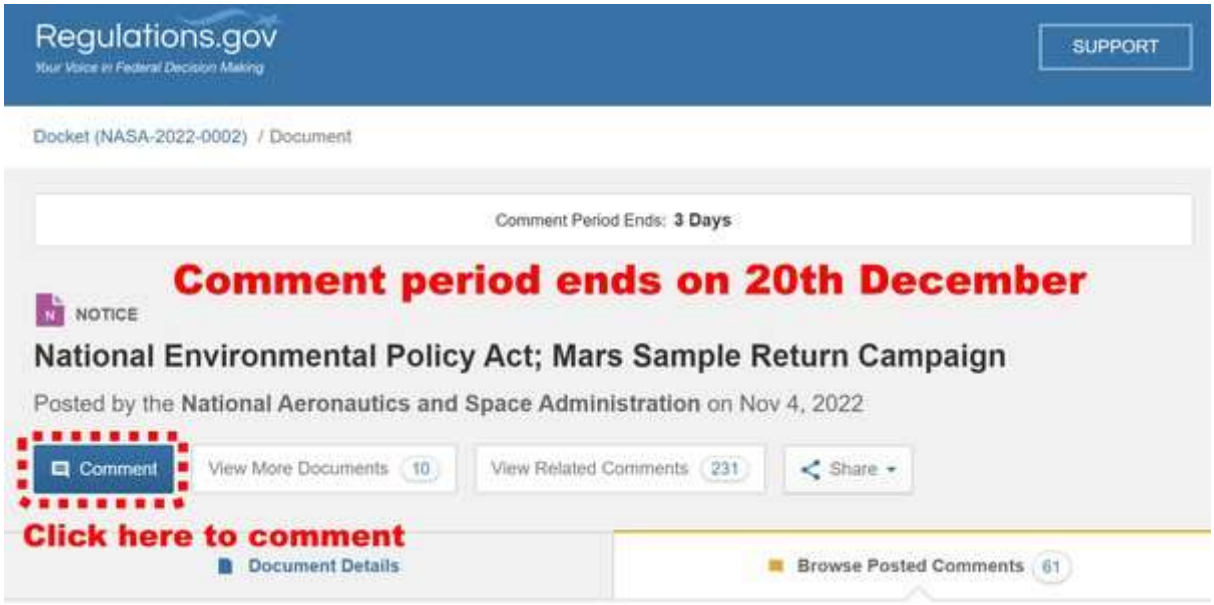
I just want NASA to do it right and it will be a very interesting mission especially if they do the bonus samples for astrobiologists.

Best wishes,

Robert

I have sent variations on this letter to a dozen people so far and got no response or just told to communicate my concerns to NASA which I've already done. The public comment period ends on 20th December.

Do comment yourself here:



Text in red: Comment period ends on 20th December

(blue button to the left, circled with a red dashed line)

Click here to comment

Page is here: National Environmental Policy Act; Mars Sample Return Campaign

You don't need to be expert to comment. This is for responses from the general public just as for a new motorway or reservoir.

Also it's not restricted to the public in the USA - you are asked to give your country of origin in the feedback form as indeed is proper for such a mission.

It doesn't matter where you life, in Indonesia, Vietnam, Mexico, China, Japan, India, anywhere in the world you can go comment here and state your concerns. It's just not had much publicity.

To answer a couple of common questions from the general public:

Yes Martian life might be able to survive on Earth

If there is life on Mars it is like life in the driest coldest deserts here. We do find life almost everywhere and terrestrial microbes use biofilms as a home to live in otherwise inhospitable places, for instance to retain water and protect from UV etc. Chroococcidiopsis can even reconstitute its DNA when chopped into pieces with double strand breaks by ionizing radiation by using other copies not broken in that place (possibly a by-product of its UV resistance. Amongst other theories, it may have retained this as a capability since the Precambrian era more than half a billion years ago, when it had to cope with intense UV before the ozone layer formed).

> *Since cyanobacteria originated in the Precambrian era, when the ozone shield was absent, UVR has presumably acted as an evolutionary pressure leading to the development of different protection mechanisms (Rahman et al., 2014) including avoidance, the scavenging of ROS by antioxidant systems, the synthesis of UV-screening compounds, and DNA repair systems for UV-induced DNA damage and protein resynthesis (Rastogi et al., 2014a).*
>
> . Response of endolithic Chroococcidiopsis strains from the polyextreme Atacama Desert to light radiation.

Also, life on Mars would be likely to be a polyextremophile (microbe able to live in diverse extreme environments) like Chroococcidiopsis, a blue green algae which is extraordinarily versatile and is one of our top candidates for life that could survive on Mars from Earth. It is found in Mars analogue deserts such as in the McMurdo dry valleys in Antarctica, in hot dry deserts, tropical reservoirs and seas, and it has so many and such diverse metabolic pathways that even though it normally uses photosynthesis it doesn't need it and it has even been found in complete darkness over 100 meters below the sea bed.

So, since life from Earth could survive on Mars, there may be life from Mars could survive on Earth. Indeed I found one very speculative paper suggesting that chroococcidiopsis perhaps did get here from Mars in the distant past. See:

. Was Earth ever infected by Martian biota? Clues from radioresistant bacteria

If so it might have caused the most major transformation of Earth's biosphere known, the oxygenation of our atmosphere and seas.

Yes though life from Mars could be as harmless to us as microbes from terrestrial deserts there are also many scenarios where it could harm us so we do need to protect Earth

Life from terrestrial deserts is harmless to us and perhaps martian life is too. But there are many ways it could be harmful, in minor or even major ways.

Life could have developed capabilities on Mars that Earth life doesn't have such as resistance to UV or ionizing radiation or ability to flourish at very low temperatures in freezers (which are kept at -20 C because no terrestrial life can grow below this temperature - what if martian life can grow down to -30 C say, we'd all need new freezers).

It could produce accidental toxins similar to ergots disease, botulism or tetanus not adapted to harm us. Algal blooms in the great lakes kill cows and dogs that eat the algae (if you see your dog eating algae on the sea shore or lake shore stop it as it could be harmful) - the algae have toxins that are meant for other microscopic life but accidentally destroy the livers of cows or dogs. Or it could be a fungus or mold that can harm our crops or ourselves.

Or it could be some independently evolved life with a different biochemistry and our ecosystems might not work the same way if half the microbes are based on a different type of biology with chemicals perhaps that terrestrial life can't use or are poisonous to it.

Another example, a computer search turned up nearly 4,000 biologically reasonable amino acids. Many of those won't occur in nature, but terrestrial biology also includes non natural amino acids. Meanwhile also many of the natural amino acids don't occur in terrestrial biology and might potentially be used in extraterrestrial biology.

2013. Beyond terrestrial biology: Charting the chemical universe of α-amino acid structures

Certain algae blooms, including Chroococcidiopsis produce β-N-methylamino-L-alanine or BMAA which is a neurotoxin which can contaminate drinking water and in worst cases cause death. This time it isn't an exotoxin (toxin produced to attack other microorganisms). The poisoning is accidental, it gets misincorporated because of its accidental partial resemblance to the amino acid l-serine

If two biospheres collide based on a different vocabulary of amino acids, there may be many such accidental similarities. For BMAA, proteobacteria in our gut provide some protection by removing it. However we mightn't have any helpful microbes to remove similarly close analogs of our amino acids from an alien biochemistry.

. Murky Water: Cyanobacteria, BMAA and ALS.

So, though life from Mars may well be as harmless as microbes from terrestrial microbes, we don't know this for sure. The precautions aren't a formality. It is because there is a real possibility that independently evolved life on Mars could be harmful to Earth.

That is a possible future - but not one to worry space colonization enthusiasts. Astronauts and settlers on Mars's moons Phobos and Deimos would be of great value in some future where Mars has, say, mirror life or life with extra amino acids that can never return to Earth. They would explore it in spectacular orbits or from its moons, much like the ISS and they could also explore the surface with immersive virtual reality, like exploring a computer game landscape - with the far better VR technology of the next decade, and experience it better than they could in clumsy spacesuits, even as virtual miniature avatars or avatars that can fly about in the Marscopters on Mars from one place to another, totally safe from contamination and with no risk to Mars life too if 100% sterile.

Composite of photo from the Cupola of the ISS , Russian cosmonaut Dmitri Kondratyev (left), Expedition 27 commander; and Italian Space Agency/European Space Agency astronaut Paolo Nespoli in the Cupola, use still cameras to photograph the topography of points on Earth. Picture taken by 3rd crew member, Cady Coleman and Photograph of Mars taken by the Hubble Space Telescope during opposition in 2003.

In this video, I use a futuristic spacecraft called the "Delta Flier" in Orbiter as that was the easiest way to do it in the program I used to make the video. Apart from that, it is the same as the orbit suggested for HERRO, a sun syncrhonous roughly 12 hour orbit that approaches the opposite sides of Mars as it faces the sun twice a day.

https://youtu.be/BftmbvBd5m4

See my

https://marsandspace.quora.com/Why-space-explorers-should-care-about-any-life-on-Mars-and-its-capabilities-to-protect-themselves-and-Earth-as-they-ex

See also

https://debunkingdoomsday.quora.com/This-is-your-opportunity-to-tell-NASA-you-want-to-keep-Earth-extra-safe-during-their-samples-from-Mars-mission

also

https://marsandspace.quora.com/NASA-please-take-MORE-CARE-with-Mars-samples-ESF-in-2012-say-a-biosafety-level-4-laboratory-is-NOT-enough-to-protect-E

also

https://marsandspace.quora.com/Eager-To-Return-Mars-Rocks-Why-Would-NASA-Build-Our-House-With-No-Smoke-Alarms-Or-Fire-Extinguishers-Please-Ask-Us

also

https://marsandspace.quora.com/So-many-serious-mistakes-in-NASAs-Environmental-Impact-Statement-for-a-Mars-Sample-Return-the-best-they-can-do-is-star

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We aren't talking about a huge risk here. Ultramicrobacteria from Mars may be as harmless as microbes collected in terrestrial deserts, but they could also have evolved from scratch on Mars in a completely different way from Earth life, or they could have evolved capabilities on Mars through billions of years of evolution that terrestrial life doesn't have.

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It's generally agreed decisions like this can't be made for the public by scientists and engineers so you all have a say in it. So why aren't NASA responding to the public? I am baffled and don't know why. I'm posting here as I got no replies from NASA and so far all the experts I contacted either didn't reply or just referred me back to NASA. Do comment yourself here, comments close 20th December 2022.

Video for this blog post here (uses earlier edit of this post)

https://www.youtube.com/watch?v=iWUlpZUPUag

Dear NASA. former and current planetary protection officers, astrobiologists, flight engineers, anyone interested and the general public.

My background is that for the last 2 years I've been working on a paper I hope to submit to astrobiology journals specifically on planetary protection for NASA's Mars sample return mission. I did an early draft as a presentation on a Mars sample return that I prepared but didn't present when I gave this presentation about Enceladus and Europa at a small astrobiology conference in Oxford, in 2015.

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  (the NRC study from 2009, which they DO cite, warns that though the risk of large scale effects on the environment or human health is likely low, it is not demonstrably zero, and it warns against using the very meteorites argument that they use)
- **That we have to return the samples to Earth for "safety testing" - this rules out any possibility of a pre-sterilized sample return (sterilized before it gets to Earth) which they don't even mention**
  (actually the permitted biosignatures per gram of rock sample or regolith for the returned rock samples are so high that any tests for life are guaranteed to detect biosignatures from Earth - NASA think they achieved a reduction to 0.7 nanograms per biosignature per gram for the most abundant biosignatures - so the safety testing is useless because their cite says that the only way we can check for safety is to check if there is martian life there since we can't predict effects of introducing novel life to Earth - and again - why are we doing safety testing if they already know Mars is uninhabitable, know it can't get to Jezero crater from elsewhere on Mars and know it can get back to Earth faster and better protected in a meteorite?)

The obvious solution is a presterilized sample return. This would achieve virtually the same science especially since the samples will have to be sterilized anyway before they can be distributed to geology labs because they can never pass safety testing. To put that in context one nanogram is enough for 10,000 ultramicrobacteria which weigh in at about 0.1 picograms each.

As for astrobiology, with this level of contamination, it's not likely we can do much meaningful of that sort, just yet more studies to prove what we know already that Mars was habitable in the past, in a bit more detail.

[The samples are from Jezero crater from an area which we know used to be a river delta three billion years ago]

So, I suggested bonus samples collected in clean containers. We could add samples of dust, dirt and atmosphere to the ESA fetch rover. These also could be presterilized before they get to Earth, and still retain a great deal of astrobiological interest.

For instance we detect microbes in Japan brought there from dust storms in the Gobi desert. Even if there are small amounts of life in distant regions of Mars there is some chance it could be detected in Jezero crater. Maybe even viable life especially if martian life is adapted to spread in the dust storms.

Also Curiosity detected liquid water indirectly in the sand dunes it drove over in Gale crater in the early morning and evening. These are even more likely at Jezero crater where it reaches 100% humidity at night. They have enough water activity for life at -70°C but far too cold at least for terrestrial life but a biofilm could retain the water through to daytime when it rises to above 0°C sometimes.

If there isn't native martian life there, the salts are still very interesting in clean samples, for prebiotic chemistry and to help with Mars simulation chambers to study what could happen elsewhere on Mars. We could add a small sterile container to the ESA fetch rover to compress the atmosphere, collect dust and as a receptacle for a small scoop of dirt that the rover could dig up and add on top of the sample tubes to return to Earth.

As an alternative to sterilizing the astrobiology samples on the return journey before they get to Earth, we could return these unsterilized bonus samples above GEO (Geostationary Earth Orbit) to a safe orbit while returning all the geological samples presterilized to Earth for the geologists. This is just like several published ideas such as HERRO and the the Lockheed Martin "Stepping Stones" to Mars and Mars Base Camp, all proposals for astronauts exploring Mars telerobotically from orbit to explore Mars at less expense from orbit and safely for both Mars and Earth life before we know what's there. See:
. HERRO mission to Mars using telerobotic surface exploration from orbit

. Comparison of Deimos and Phobos as destinations for human exploration, and identification of preferred landing sites

. Mars Base Camp: An Architecture for Sending Humans to Mars

We can't rely on human quarantine, I give many examples in my preprint, e.g. the two Zinnia plants in the ISS which died of a crop opportunistic fungal pathogen Fusarium oxysporum brought there in an astronaut's microbiome. Fusarium oxysporum is also a sometimes deadly pathogen for immunocompromised humans, actually second after Aspergillus in harm to humans for fungi - but obviously had no symptoms with that young healthy astronaut. And some natural analogue of hachimoji DNA or mirror life independently evolved on Mars could be harmless in an astronaut's microbiome but spread and cause major problems in terrestrial biomes once they get back.

[Hachimoji DNA has 8 bases instead of 4 but is dependent on chemicals only available in the laboratory, so it's safe on Earth, but a natural analogue from Mars may be able to live here, and mirror life is life that started off with mirror chemicals early on and has DNA spiralling the other way, starches, proteins and enzymes reversed, all independently evolved but reversed as in a mirror.

If half the life in your forests, soils and oceans is mirror life will it function the same way - after the decades to centuries it might take to adapt to live here?]

And we can send over 7 tons in one payload to above GEO (Geostationary Earth orbit) already with the Ariane 5 rocket, enough for hundreds of remote life detection instruments in one payload because astrobiology instruments have been so miniaturized in the last couple of decades. These have automatic sample preparation as there are many such instruments designed for remote operation on Mars.

This is mentioned in the draft EIS, they say samples have to come back to Earth for sample preparation but they don't for life detection. There's even SETG, an end to end gene sequencer which does the sample preparation all the way through to the gene sequencing which requires large amounts of data but it does all the number crunching too and just sends the gene sequence back to Earth.

. SETG: nucleic acid extraction and sequencing for in situ life detection on Mars

I'm no lawyer, and they would need to ask an expert in environmental law, but on the face of it NASA actually may be in some legal jeopardy. By a 7th circuit decision in 1997 it is not permitted to define the scope of an EIS so narrowly as to exclude reasonable alternatives, which the presterilized return certainly is. The remedy back then was that the agency was told to cancel the project to build a reservoir because they improperly excluded the option of two smaller reservoirs. Not because two smaller reservoirs were better, just because they didn't assess that option.

And since we can keep Earth totally safe with virtually no loss of science, why would NASA not even want to consider the pre-sterilized samples option? I just don't get it, I'm totally baffled and have no explanation.

So anyway that's what I wanted to ask you [interested experts] about.

Do you have any idea what is going on? Why NASA aren't responding to me? Is there anything we can do to get answers to this for the general public?

Do feel free to share this email with anyone else. If you know of anyone else I can contact about it also do say.

You can contact me at support@robertinventor.com

I did a blog post and a preprint and an annotated version of the draft EIS that goes into a lot more detail.

You can skip through sections of the blog post with the skip to next section links. I do the articles as like mini abstracts. So you can click through and read the titles of the sections and look at the graphics for each section for a first impression, then drill down into any section of interest. My academic analysis of the draft EIS is done similarly (though with out the skip to next section links) so you can get a good overview of the paper by just reading the contents list then drill into any section of interest.

I've also done an annotated copy of the draft EIS which you can look at to see the passages highlighted that I see as of most concern, along with my comments on them.

. NASA - Your Samples From Mars Need A Better Than Biosafety Level 4 Facility - NOT Designed To Contain Even Earth's Tiniest Cells

I hope we can get to the bottom of this. The public surely need answers to their questions and as John Rummel once wrote, which I quote in that blog post:

> *"Broad acceptance at both lay public and scientific levels is essential to the overall success of this research effort."*

Even if it does go through NEPA, at the end of all the legal process, the president has to look at it, if it can be reasonably expected to result in domestic or foreign allegations of major or protracted effects. So he will have to look at this Environmental Impact Statement carefully, and the current draft EIS will just fall apart on any close study, if they just check the cites, or read my comments on the draft EIS and check them out.

> "It should be understood that experiments which by their nature could be reasonably expected to result in domestic or foreign allegations that they might have major or protracted effects on the physical or biological environment or other areas of public or private interest, are to be included under this policy even though the sponsoring agency feels confident that such allegations would in fact prove to be unfounded.
>
> . NSC-25: Scientific or Technological Experiments with Possible Large-Scale Adverse Environmental Effects and Launch of Nuclear Systems into Space

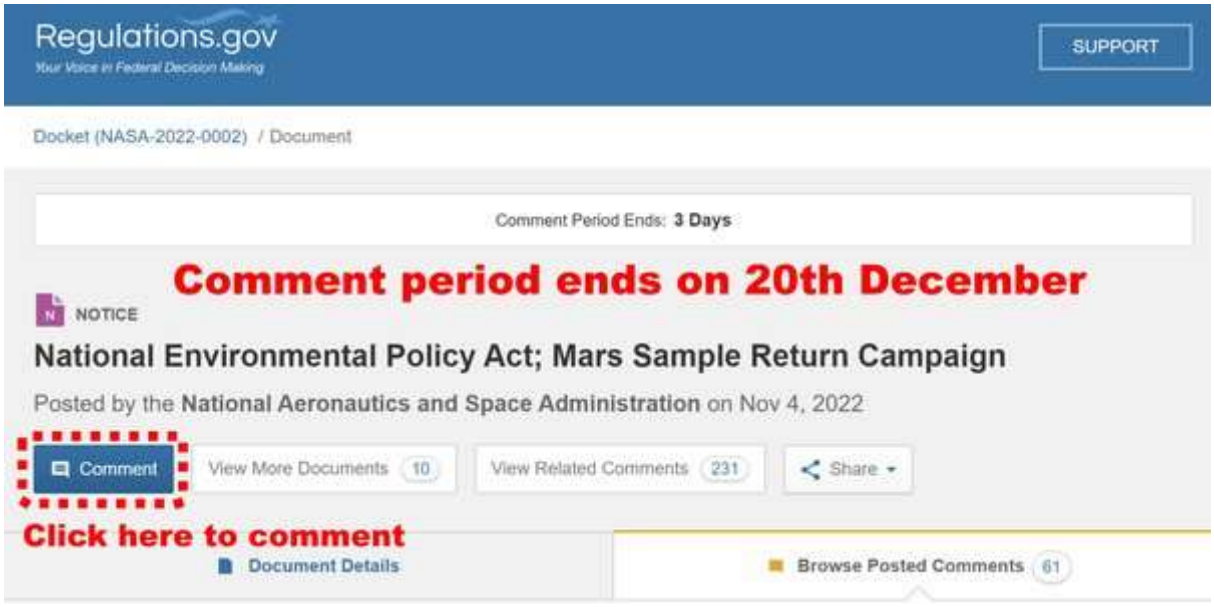
I just want NASA to do it right and it will be a very interesting mission especially if they do the bonus samples for astrobiologists.

Best wishes,

Robert

I have sent variations on this letter to a dozen people so far and got no response or just told to communicate my concerns to NASA which I've already done. The public comment period ends on 20th December.

Do comment yourself here:



Text in red: Comment period ends on 20th December

(blue button to the left, circled with a red dashed line)

Click here to comment

Page is here: National Environmental Policy Act; Mars Sample Return Campaign

You don't need to be expert to comment. This is for responses from the general public just as for a new motorway or reservoir.

Also it's not restricted to the public in the USA - you are asked to give your country of origin in the feedback form as indeed is proper for such a mission.

It doesn't matter where you life, in Indonesia, Vietnam, Mexico, China, Japan, India, anywhere in the world you can go comment here and state your concerns. It's just not had much publicity.

To answer a couple of common questions from the general public:

Yes Martian life might be able to survive on Earth

If there is life on Mars it is like life in the driest coldest deserts here. We do find life almost everywhere and terrestrial microbes use biofilms as a home to live in otherwise inhospitable places, for instance to retain water and protect from UV etc. Chroococcidiopsis can even reconstitute its DNA when chopped into pieces with double strand breaks by ionizing radiation by using other copies not broken in that place (possibly a by-product of its UV resistance. Amongst other theories, it may have retained this as a capability since the Precambrian era more than half a billion years ago, when it had to cope with intense UV before the ozone layer formed).

> *Since cyanobacteria originated in the Precambrian era, when the ozone shield was absent, UVR has presumably acted as an evolutionary pressure leading to the development of different protection mechanisms (Rahman et al., 2014) including avoidance, the scavenging of ROS by antioxidant systems, the synthesis of UV-screening compounds, and DNA repair systems for UV-induced DNA damage and protein resynthesis (Rastogi et al., 2014a).*
>
> . Response of endolithic Chroococcidiopsis strains from the polyextreme Atacama Desert to light radiation.

Also, life on Mars would be likely to be a polyextremophile (microbe able to live in diverse extreme environments) like Chroococcidiopsis, a blue green algae which is extraordinarily versatile and is one of our top candidates for life that could survive on Mars from Earth. It is found in Mars analogue deserts such as in the McMurdo dry valleys in Antarctica, in hot dry deserts, tropical reservoirs and seas, and it has so many and such diverse metabolic pathways that even though it normally uses photosynthesis it doesn't need it and it has even been found in complete darkness over 100 meters below the sea bed.

So, since life from Earth could survive on Mars, there may be life from Mars could survive on Earth. Indeed I found one very speculative paper suggesting that chroococcidiopsis perhaps did get here from Mars in the distant past. See:

. Was Earth ever infected by Martian biota? Clues from radioresistant bacteria

If so it might have caused the most major transformation of Earth's biosphere known, the oxygenation of our atmosphere and seas.

Yes though life from Mars could be as harmless to us as microbes from terrestrial deserts there are also many scenarios where it could harm us so we do need to protect Earth

Life from terrestrial deserts is harmless to us and perhaps martian life is too. But there are many ways it could be harmful, in minor or even major ways.

Life could have developed capabilities on Mars that Earth life doesn't have such as resistance to UV or ionizing radiation or ability to flourish at very low temperatures in freezers (which are kept at -20 C because no terrestrial life can grow below this temperature - what if martian life can grow down to -30 C say, we'd all need new freezers).

It could produce accidental toxins similar to ergots disease, botulism or tetanus not adapted to harm us. Algal blooms in the great lakes kill cows and dogs that eat the algae (if you see your dog eating algae on the sea shore or lake shore stop it as it could be harmful) - the algae have toxins that are meant for other microscopic life but accidentally destroy the livers of cows or dogs. Or it could be a fungus or mold that can harm our crops or ourselves.

Or it could be some independently evolved life with a different biochemistry and our ecosystems might not work the same way if half the microbes are based on a different type of biology with chemicals perhaps that terrestrial life can't use or are poisonous to it.

Another example, a computer search turned up nearly 4,000 biologically reasonable amino acids. Many of those won't occur in nature, but terrestrial biology also includes non natural amino acids. Meanwhile also many of the natural amino acids don't occur in terrestrial biology and might potentially be used in extraterrestrial biology.

2013. Beyond terrestrial biology: Charting the chemical universe of α-amino acid structures

Certain algae blooms, including Chroococcidiopsis produce β-N-methylamino-L-alanine or BMAA which is a neurotoxin which can contaminate drinking water and in worst cases cause death. This time it isn't an exotoxin (toxin produced to attack other microorganisms). The poisoning is accidental, it gets misincorporated because of its accidental partial resemblance to the amino acid l-serine

If two biospheres collide based on a different vocabulary of amino acids, there may be many such accidental similarities. For BMAA, proteobacteria in our gut provide some protection by removing it. However we mightn't have any helpful microbes to remove similarly close analogs of our amino acids from an alien biochemistry.

. Murky Water: Cyanobacteria, BMAA and ALS.

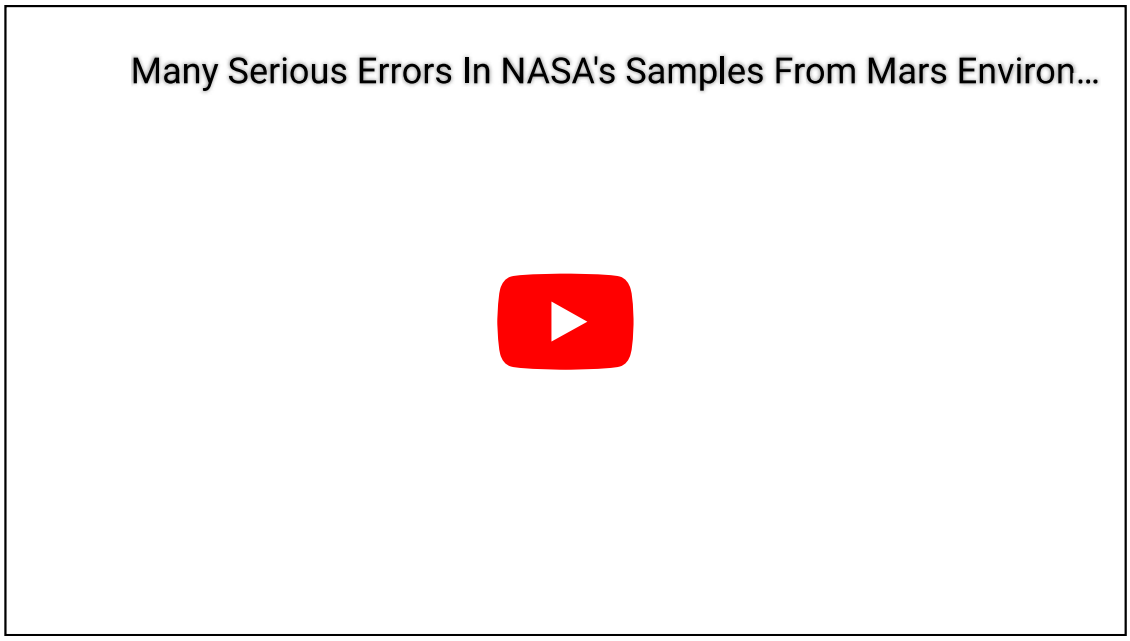
So, though life from Mars may well be as harmless as microbes from terrestrial microbes, we don't know this for sure. The precautions aren't a formality. It is because there is a real possibility that independently evolved life on Mars could be harmful to Earth.

That is a possible future - but not one to worry space colonization enthusiasts. Astronauts and settlers on Mars's moons Phobos and Deimos would be of great value in some future where Mars has, say, mirror life or life with extra amino acids that can never return to Earth. They would explore it in spectacular orbits or from its moons, much like the ISS and they could also explore the surface with immersive virtual reality, like exploring a computer game landscape - with the far better VR technology of the next decade, and experience it better than they could in clumsy spacesuits, even as virtual miniature avatars or avatars that can fly about in the Marscopters on Mars from one place to another, totally safe from contamination and with no risk to Mars life too if 100% sterile.

Composite of photo from the Cupola of the ISS , Russian cosmonaut Dmitri Kondratyev (left), Expedition 27 commander; and Italian Space Agency/European Space Agency astronaut Paolo Nespoli in the Cupola, use still cameras to photograph the topography of points on Earth. Picture taken by 3rd crew member, Cady Coleman and Photograph of Mars taken by the Hubble Space Telescope during opposition in 2003.

In this video, I use a futuristic spacecraft called the “Delta Flier” in Orbiter as that was the easiest way to do it in the program I used to make the video. Apart from that, it is the same as the orbit suggested for HERRO, a sun syncrhonous roughly 12 hour orbit that approaches the opposite sides of Mars as it faces the sun twice a day.

Video:



Click to watch on Youtube: One Orbit Flyby, Time 100x: Mars Molniya Orbit Telerobotic Exploration in HERRO Mission

Short summary and link to other posts:

. This Is Your Opportunity To Tell NASA You Want To Keep Earth Extra Safe During Their Samples From Mars Mission

For space colonization enthusiasts see my:

. Dear Space Explorers - Yes We Do Need To Protect Ourselves And Earth From Any Microbes In Mars Rocks As We Explore

I mentioned colonizing Callisto and Titan in the far future at the end of the video, I talk about both of them in my blog post here:

. Value Of Titan As Base For Humans In Saturn System - Surprisingly - Once There - Easier For Settlement Than Mars Or The Moon

nce again, do comment yourself if you have thoughts about the project - go here, and click on the blue button to the left of the page to add a comment:

. National Environmental Policy Act; Mars Sample Return Campaign