Sample Return Mission to Mars

- The dilemma of planetary contamination versus the search for life and its origins

Sergio Carrasco-Martos

Introduction

More than thirty years have passed since the Viking spacecrafts were sent to Mars in search of signs of life [1]. Since then, there have been and there are plans for the more ambitious sample return missions (SRM) to Mars for as early as the next decade [2], [3] and [4]. The ideal approach for a mission like this is to launch an unmanned spacecraft to Mars, land on its surface, collect soil samples, put them in a sample container and, by means of a Mars Ascent Vehicle (MAV) and an Earth Return Capsule (ERC), return the container back to Earth. Nowadays there is no clear evidence of microbes living on Mars. This mission would therefore allow scientists on Earth to search for life on those samples with their Earth-based equipment, answering the question whether there is life on Mars or not.

However, so-called cross contamination risks arise, namely: forward contamination, this is, bringing terrestrial microorganisms and spores to Mars; and backward contamination, i.e., bringing hypothetical Martian microorganisms to Earth. The latter brings in two new categories of planetary protection requirements that have to be dealt with: on the one hand, contamination of Earth's biosphere due to possible Martian native biohazard contained in the samples; on the other hand, contamination of the samples brought back from Mars, which must follow strict safety protocols before their exposure to human beings [3]. To avoid forward contamination, cleaning and sterilization methods are applied to ensure the spacecraft leaves Earth carrying as few microorganisms as possible. To
prevent backward contamination, a sample return (or containment) facility would be mandatory to ensure Earth protection.

Of course, there are agents in favour and against this type of mission. Those against, such as the International Committee Against Mars Sample Return (ICAMSR), claim that assuming Earth contamination risks might cause a pandemic and eventually our extinction, and therefore want to increase public awareness as well as enforce more stringent containment facility requirements for the samples brought back from Mars. Those in defense of the mission think that opponents are exaggerating and that any cross-contamination is unlikely to happen.

It is the purpose of this essay to present the more relevant ethical issues concerning such a mission, as well as remarking the arguments from the different actors involved in this matter. Finally, a critical and ethically acceptable solution for a SRM to Mars is proposed.

Identifying the problem

The ethical dilemma at stake

The main ethical issue on interplanetary missions is to find a reason why planetary contamination should be allowed and how can contamination risks be avoided. Scientists claim that knowing more about the geology and chemical composition of our neighbour planets (Venus, Mars) and moons (Europa, Titan, Enceladus) might help us gather knowledge about the origin of life in the universe and on Earth. Moreover, astrobiology is becoming a brand new trend in space research, aiming for extra-terrestrial life of any kind. But does the premise "we need to study Mars to understand the origin of life on Earth" give us the right to take the risk of contaminating Mars, and hence the Earth?

In arising this ethical question one could argue that space agencies should not keep considering this moral issue as a secondary matter, as they do due to several reasons. One of them being the mission budgetary constraints that do not allow to fully implement the agency’s Planetary Protection Policy (PPP); another reason being the assumption that enough care is being taken on moral issues based on feeble arguments like the fact that since no evidence of life has been found so far, there is no risk involved in backward contamination; or also, that there have already been similar, successful missions that have not supposed a threat to us, thus the
same can happen to a SRM to Mars. A quick look at these words lets us see the vagueness of their statements. This is obviously a moral issue which will be further developed and argued in following sections.

This urge of developing a mission to Mars (specially for NASA, ESA and the Russian space agency) within the next decade might lead to ethically ruinous consequences, even if the results of this mission are successful, basically because it would mean that these agencies would have acted seeking short-term results (technology milestones, maximization of the scientific return, expertise for a future manned mission to Mars), dismissing ethical issues concerning planetary protection and hence discarding side effects (forward-, backward-contamination).

Reliability of current planetary protection standards

From the Viking space programme to Mars (1975 and 1976) interesting conclusions were extracted [7]. Biological experiments were designed to find Martian life, but their results were negative [8]. However, it is quite contradictory to see that there were barely any planetary protection issues taken into account for the Viking probes, because it was not known at the time whether life exists outside of the Earth. So, on the one hand they did not know (and according to this an appropriate planetary protection approach was not followed), but on the other hand they wanted to know, for which dedicated experiments to detect life on Mars were designed. The contradiction results thence clear.

What is quite shocking regarding the necessity of the Martian samples to be considered safe upon release to science investigators is that "the Planetary Protection Officer's (PPO) draft requirements (from 2003-2005) equated this to sterilizing the entire Mars Lander spacecraft to the same levels as achieved on the Viking mission using dry heat or some method shown to be equivalent" [3]. Moreover, citing the then PPO, John Rummel (now Senior Scientist for Astrobiology at NASA SMD Planetary Sciences Division): "even today, planetary protection plans and reports refer to Viking-level sterilization procedures." This means that NASA wants to base its PPP for the SRM to Mars on technology standards from thirty years ago, just because the Viking probes did not find life on Mars.

The fact that the Viking probes were not able to find Martian life does not imply neither that there is no life there at all nor that planetary protection is not to be underrated. The sensitivity of the instruments on the Viking probes was certainly not as good as that of present space instruments,
which could have been the reason why nothing was detected. Also, due to the lesser care given to planetary protection issues, Viking probes might have caused forward contamination, unintentionally killing any Martian microorganisms around them (either upon landing on Mars; or because of careless manipulation of the soil samples; or due to any remaining terrestrial microorganisms that survived the trip to Mars and could have become hazardous to Martian life forms). It is therefore suspicious that these planetary protection standards have been kept for thirty years, and instead more care and monetary effort has been put into other technological issues. We will delve deeper into this matter later.

Furthermore, when asked about the availability of a high-level containment facility for avoidance of contamination from possible Martian microorganisms, Dr. Cassie Conley (NASA's current acting PPO) answers "We have no containment facilities yet built for a restricted sample that might be returned to Earth. Building those facilities would require quite a lot of money, and they really should be put in progress about 10 years before you actually plan to get a sample back that would be restricted-Earth-return. So, starting that process is a rather large investment, and with all the budgetary constraints and the other constraints that are imposed on us at the moment, we do not really expect to have any rapid progress in building a sample-return facility" [9].

It is logical then that groups like the ICAMSR object this, and demand that this mission be blocked until what they consider a safe four-step plan (commented in the next chapter) is implemented by NASA [10]. It is hence important to consider if now is the moment to develop a SRM to Mars.

**Different views, many conflicts**

Throughout the previous section, a few actors have been briefly mentioned. In the following, the most important ones will be presented in detail together with some argumentations.

**COSPAR**

COSPAR defines itself as an international scientific organization that "ignores political considerations and views all questions solely from the scientific standpoint" [17]. COSPAR focuses on guaranteeing international cooperation on scientific research in space and is open for discussion of
problems related to space research. Regarding its PPP, COSPAR maintains the standards on procedure of the UN Space Treaty [18].

However, by further analyzing COSPAR's PPP, one may indeed think that this approach is a sort of a soft law rather than a binding law and, delving into details from the text, vague normative statements can be found [19] and [20]. In other words, COSPAR states clearly what should be done (the end), but does not say how things should be approached (the means).

**Space Agencies**

This is why the labour of the management and directorate team within space agencies is very important. In such organizations a hierarchical model of accountability attribution is typical. Hence, any responsibilities fall on managers and directors in case of undesired consequences, and for that, planetary protection is a challenge for them. It is their task to search for a trade off between risks and benefits.

By benefits they include the interest of the scientific community; technological development; to get good press and media relevance (let the public know their agency is the best); to achieve milestones; and last but not least, economical profits. All of these, of course, assuming a successful mission. This success would allow for future mission developments, even more challenging, requiring more manpower, therefore offering new jobs for engineers and scientists.

Regarding the possible risks, managers usually put more care about risks concerning technical or scientific issues rather than risks concerning ethical issues, in this case, planetary contamination. The reality gives us evidences as obvious as the previously cited words from Dr. Cassie Conley (chapter 2), which make crystal clear that budgetary constraints put a barrier in the choice of ethical issues as the main driver in interplanetary mission design.

When defining the requirements on the mission, managers have the last word on the planetary protection approach (whether it is accepted or it needs improvement). They are aware of the increase in costs that a more exhaustive PPP can cause on the mission, specially on a SRM to Mars. So, it is not easy to make a decision on this matter. In an utilitarian approach the manager would tip the balance in favour of the benefits, not caring about the contamination issues, and could even give biased feedback to COSPAR (due to its softness) and to the government.
However, he or she would not be following the "no harm principle", since the lives of others would be put at stake. Furthermore, he or she would be committing fraud, with the advantage that no one would notice it if the mission is successful and no physical harm results in the end.

As long as the requirements on planetary protection for a SRM to Mars do not change, one could argue that the morally acceptable action (not to give green light to the project) does not create any pleasure, whereas the morally unacceptable action (give green light to the project assuming risks but for my own pleasure) maximizes pleasure. Moreover, since the negative consequences are unexpected (Earth contamination by extraterrestrial life is not documented to have happened before, so there are no precedents and it is not known what can happen), utilitarianism results insufficient to work with.

Instead, a virtuous manager with the virtues of expertise, professionalism, compromise, objectivity, being honest, integer and just, would try to find a morally correct solution.

Governments

Space agencies have the last word on their mission approval, but it is the task of governing authorities to give launch authorizations and certifications. Their interest lies on ethical aspects and, to a lesser degree nowadays, on a space race (notice for instance the sudden interest of U.S. President George W. Bush on planning a return to the Moon and later to Mars [21]; or the claims from ESA and NASA on who has been the first to discover life on Mars [24]).

Also, COSPAR, for instance, gathers the documentation received from its members and delivers a report to the Secretary General of the United Nations. This report includes information about the planetary protection procedures of the different agencies.

\[\text{1} \] There is an interesting, fictional example on how a politician follows an ethical approach, whereas scientists focus on facts and commit rash generalization fallacies [25]. One scientist believes there are no reasons to prevent a SRM to Mars, based on the negative results from the Viking lander. He is thus basing his assessment on one experiment only, therefore committing a fallacy. It cannot be confirmed if the experiment did not succeed because the sensitivity of the instrument was not as good as that of present space instruments.
Public

COSPAR's report is also made available to the public. However, society as a whole is not concerned about the fatal consequences that Martian contamination on Earth could have. People naïvely believe that it is about time that we put a man or a woman on Mars, since we were already on the Moon long ago, although they are not aware of the relevant differences and requirements for both missions. This is mainly due to typical misinterpretation of the press about space matters or hype from blockbuster science fiction movies and novels.

It would therefore be necessary to concern people about the health risks of a SRM to Mars. This is a question of informed consent: if people are asked whether they want to take the risk of bringing samples from Mars, and that suddenly an alien microbe develops and results extremely hazardous and causes our extinction, our common sense says no to this, so another solution ought to be found. In reality this will not happen because it would cause worldwide panic and rejection of further space exploration, being fatal for the business. The approach is instead either to take the risk not voluntarily or to lower the risk, such that people accept it anyway (as they do with nuclear energy). Unfortunately, this sheer size fallacy turns informed consent into a minor issue and leaves the awareness and responsibility of this matter to space institutions, international committees and governments.

ICAMSR

Probably the most important stakeholder in this case, ICAMSR, is an international committee of scientists and engineers that are currently against a SRM to Mars [11]. Let us make clear that they do not oppose to it. What they request is a series of changes to be made in the mission planning involving four steps to be taken to ensure safe containment of Martian samples and safe return to Earth [10]. The steps involve first performing experiments in Mars with many landers; then doing tests in Martian orbit on an hypothetical orbiting laboratory; later on, when the return of samples has been warranted, more analysis must be made on Earth orbit (e.g., at the International Space Station, ISS) and then finally bring them back to Earth.

It looks like they want to make use of any single test/analysis facilities available in space. It seems as if performing as many tests in space as possible (before risking Earth’s contamination) would allow to induce
general results. The question in this inductive argumentation is how many experiments are needed, and ICAMSR does not state that. It could be one, ten, one thousand. They should be more clear on this matter. In any case, ICAMSR’s approach would increase the costs of the mission considerably, and that is the major objection agencies have against ICAMSR.

However, ICAMSR is doing a morally desirable task: it does not want to stop the project, but make it equitable for everyone. It wants to increase the public awareness of the SRM to Mars as well, but without making it all widely public\(^2\).

It must also be mentioned that the character of their website is quite sensationalist: they blame humanity for previous mission failures, "loss of Mars Climate Orbiter and the Mars Polar Lander spacecraft (...) due to human failure" [10]; and there are analogies from cases of worldwide contamination that happened centuries ago [12].

Moreover, there are documents on their website about the Genesis\(^3\) SRM's crash [6], a failed sample return mission from which they profit in quite a pessimistic and direct way: "Genesis sample return mission crash news. Will a Mars Sample Return capsule end up the same way?" [13]. It is apparently a good statement, but one can soon realize that it is unsound. The scientific community and space agencies could argue that since the return capsule from Genesis crashed on Earth and the samples made contact with Earth's microbes and organisms but nothing happened, if the same happened to a return capsule coming from Mars (having kept the same planetary protection standards), nothing dangerous would happen either. ICAMSR would be left with the only option of saying that this is because samples from Mars are from a completely different nature than solar wind samples, thus ruining its own argument (because it would become a case of false analogy).

However, what about the meteorites coming from Mars that impact on Earth? For millions of years, we have received yearly impacts from rocky Martian stones, and nothing evidently harmful has happened on Earth. By 2004, thirty Martian meteorites were reported to have been found on Earth [26]. It is true that there are only few clear evidences on whether these

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\(^2\) 25000 people in 7 years have visited their website. It is not a considerable value to raise the alarm worldwide

\(^3\) Genesis was a mission from NASA attempting to collect samples from solar wind and bring them back to Earth [5]
meteorites contain any remnants of Martian life [23], albeit the dubious case where an Australian scientist found supposed Martian sediments [27].

Engineers

Other relevant actors are engineers. They rely on the success of space missions in order to have a job to do in the future. Some of them will also become managers and directors of space agencies in the future, so they must follow an ethical conduct to do their job well and be able to lead the projects of tomorrow in an impartial, objective and professional way.

Their relevance on planetary protection issues is limited to cleaning and sterilizing tasks. It is a task that needs the uttermost care. They do what they can with what they have [28]. They also do what they are told to do. For instance, Viking standards are used\(^4\), as COSPAR recommends. These standards yield a low probability of having microorganisms left on and inside the spacecraft. However, research studies from 2003 concerning NASA’s SRM programme show that the PPO believes that only some parts of the spacecraft need to be sterilized (underestimating even more the risks of the mission) instead of taking into account that these standards are old and therefore precautions must be taken [3]. Considering that these old standards have been used during three decades, it is visible that previous missions have not succeeded in terms of planetary protection. So far, nothing has happened. But, so far, we have not brought anything back from Mars.

Scientists

Two types of scientists can be distinguished: those concerned about the dangers of the mission, which were already included in ICAMSR’s point of view; and the rest, who ICAMSR defectively defines as arrogant scientists.

The main argument used by the second type of scientists is that they want to explore, detect and study life in space. Under this pretext, actually, the majority of space missions are approved, developed and launched towards outer celestial bodies. One of the arguments from scientists is that it would be interesting to discover new life, study it and even find out that this new life has different biochemical reactions and that does not even have a DNA or RNA, but rather a new structure that we cannot even imagine [30].

\(^4\) Viking standards require less than 100000 particles per cubic meter. These particles are half a micron size at least.
The thing is: is it really necessary to send a SRM to Mars to study that? Would not it be better to send landers to Mars with the capability to make these analysis in-situ? Scientists could say that humans on Earth have countless ways to perform analysis and experiments, whereas a probe on Mars would have limited choices for analysis. A proposal could be to send more missions to Mars, with better payloads. Since there is a tendency to reduce the size (and therefore the cost) of spacecrafts, this could be feasible within a decade. But the urge of scientists to find something on Mars and bringing it back to Earth, plus the urge of society to send a manned crew to Mars, make it difficult to brake this hunger for "immediate" space exploration. In addition to this, this need to hurry leads to unavoidable forward contamination that could make us lose the chance of discovering new life on Mars, not to mention the backward contamination issues as well. This, presumably, is therefore an immoral attitude.

My view on the stakeholders' conflict of interests

I wonder why we humans are so obsessed with manned missions to other celestial bodies, being cheaper, safer, faster and even logical to maintain unmanned missions as a priority. Our interests are ahead of our technology, the risks today are higher than the benefits, and being obsessive can only cause problems. Of course, there are business and political interests, which only make it difficult to act with good sense.

I will therefore assume the premise "a manned mission to Mars is expected from fifty years from now" (instead of the twenty-five years envisioned by space agencies [22]), and will argue the means (a SRM) needed to achieve this end (human beings to Mars, the next step in Martian exploration).

It is hard to see whether it is too soon for a SRM to Mars or not. As it has been shown in previous sections, it depends on the interests of the stakeholders. Space agencies, engineers and scientists are in favour of such a mission albeit their PPP. On the other hand, ICAMSR and to a lesser degree governments are not against, but reject such a mission if not enough care is taken.
Concerning the SRM to Mars, which belongs to a "category V\(^5\) - Restricted Earth Return type", the following norm can be found in the COSPAR's PPP text: "if any sign of the existence of a non-terrestrial replicating entity is found, the returned sample must remain contained unless treated by an effective sterilizing procedure" [19]. This is not clear. What do they mean by "effective sterilizing procedure"? Do they have a standard that defines what is an effective method and what is not? Apparently they do not. Furthermore, do we have the means to study in-situ this entity and even determine if it is self-replicating? In addition to this, "the concerns for these missions is the protection of the Earth, and the Moon". Why does COSPAR only consider protection of the terrestrial system? The answer is because "scientific opinion" states that the rest of the solar system bodies do not contain life forms. Such an assertion ought not to be made until enough evidence is found, since scientific opinion could be biased due to the shortage of empirical proof. It is therefore logical that managers from space agencies can almost feel free to approve interplanetary missions with these low planetary protection standards.

Also, only mission types II, III and IV explicitly require some sort of documentation to be submitted. Of course, it can be read from the text that "category V concerns are reflected in requirements that encompass those of Category IV plus a continuing monitoring of project activities, studies and research", meaning that the difference between these type of missions lies on the quality of the monitoring.

This lets us infer, on the one hand, that either category IV missions present very strict requirements, or that category V requirements are smoother than required. Since category IV mission requirements use old, Viking-like standards, it looks more like the latter. On the other hand, the monitoring documentation delivered to COSPAR might be full of speculations, since fraud is possible in any sort of documentation. Furthermore, it is not understood why category V missions, which require the highest degree of ethical, scientific and technological concern, just need requirements covering those of category IV missions plus some monitoring of the activities, which, by the way, ought to be better defined.

\(^5\) COSPAR defines five categories of missions, where category I missions are the less restringent ones (includes Mercury, Venus, the Sun, i.e., celestial bodies without astrobiological interest) and category V missions are the ones requiring the utmost concern (this category comprises all Earth return missions). Regarding category V missions, if there is evidence of indigenous life forms they are also labeled "restricted Earth return" missions.
Obviously, the poorly defined COSPAR’s PPP has let space agencies to rely on old standards for planetary protection under the premise that nothing has been found on Mars with the Viking probes. Assuming that since nothing survives there, no harm is done and hence there is no need to sterilize, is a rash generalization fallacy. Life should not be underestimated. We did this on Earth and then found microorganisms living under extreme conditions (extremophiles in permafrost; microorganisms in nuclear reactors, ...) [30]. The risk of cross-contamination is therefore present. Also, an important question arises at this point: how do we know whether the samples from Mars actually contain terrestrial organisms? A typical solution is to make an inventory of the remaining spores and microorganisms remaining on the spacecraft before launch [29]. This way, in the case that a microorganism is found on Mars, it would be compared with the inventory to avoid false detections of Martian life.

The ambiguity of COSPAR statements and the advantage that space agencies presumably have over COSPAR’s PPP make understandable that ICAMSR demands higher standards for planetary protection. The problem is that COSPAR does not suggest any new standards, so it is up to the agencies to change them and satisfy members from ICAMSR. And another matter is that ICAMSR can be quite rigorous. Assuming that ICAMSR’s recommendations must be followed, if the technical requirements cannot be attained (e.g., very high levels of cleanliness and containment that cannot be achieved by present technology), then a SRM to Mars cannot be developed. If the maxim "I tell you to do X, otherwise you cannot do Y, even though I know beforehand you will not be able to fulfil X" becomes universal, then there is no possible interplanetary mission. However, and as seen in their curricula, most of ICAMSR members have experience on sterilization issues, [14]. Thus, ICAMSR knows that it must be flexible in order to gain some credibility and authority, and it also knows that by pushing agencies it can be possible to build high-level containment facilities, such that then it is possible to achieve better standards. It is a matter of trading-off between its chances to get what it wants.

Of course, ICAMSR has its flaws. I commented before their taste for sensationalism. Such an attitude usually leads to incongruities, and this is no exception, namely: the comparison between the crash of the Genesis ERC and a possible accident of the ERC from the SRM to Mars does not hold water, as it was discussed before. Moreover, the analogies used at their website from previous European explorers can be considered as deficient arguments. In those cases, people did not have enough
knowledge on medicine and biology, unlike nowadays. We have had the recent example of the avian influenza (virus H5N1). A pandemic was feared, but actions were taken and now the threat is lesser.

Finally, proof that space agencies' ethical considerations have been falling apart and need a push from someone to rise again (or for the first time) can be inferred from the interview with Dr. Cassie Conley, where she says that NASA was prepared twenty years ago to build a high-level containment facility, but did not do so because of the high costs [9]. NASA had the idea in mind, but did not carry it out. Thus it is justifiable that ICAMSR puts so much pressure, because if it were not for ICAMSR concern, NASA would probably have maintained a lower cost mission at the expense of safety hazards.

So, balancing the prons and cons of ICAMSR, the balance tips, from my point of view, in its favour. This is why my final recommendation, presented in the next section, follows a similar approach to that of ICAMSR.

**Possible solutions towards both a mitigation of the ethical dilemma and an optimized mission approach**

I would like to consider two approaches. The first one would be to do a mission together with international collaboration in order to reduce costs. This way, building a high-level containment facility could be feasible, and iterating the sterilization process would optimize the level of cleanliness beyond the Viking standards used nowadays. In addition to this, the inventory approach commented on chapter 4 would be followed. Then, a spacecraft could be sent to Mars fulfilling excellent (but never perfect) sterilization requirements. It would analyze and collect Martian samples (during this phase the chain of contact with Mars must be broken\(^6\)) and then would launch a MAV to put the ERC into orbit around Mars. This ERC containing the sample container would rendez-vous with an orbiter in Martian orbit that would help it to transfer to Earth’s orbit, where it would rendez-vous with the ISS or any other similar facility that could allow for further testing (since the mission is performed with international collaboration, the different agencies would have agreed on using an international orbiting facility for keeping and testing the samples). Astronauts would extract the samples from the ERC and analyze them (the

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\(^6\) "breaking the chain of contact with Mars" means that the exterior of the sample container cannot make contact with Martian entities (rocks, dust, ...).
ERC would be left as space debris or be disposed, and since it does not need to withstand Earth's reentry conditions because the samples are left on the ISS, it would disintegrate, eliminating any hypothetical hazardous microorganisms on it\(^7\). If it is proven after the analyses that there is no risk of planetary contamination, or if the samples do not contain microorganisms at all, the samples could be brought back to Earth on a shuttle, together with the astronauts.

The second approach that I propose is similar: the ERC, instead of docking with the ISS, would dock with a permanent manned laboratory orbiting Mars. The problem is that such a mission would require a delay of at least a decade or more, until, on the one hand, faster propulsion systems are developed and, on the other hand, a laboratory can remotely be set up on Mars' orbit. One advantage, however, would be the need to develop useful technologies allowing manned interplanetary flight (but without landing on another celestial body). Plus, there is no need to bother landing humans on Mars. As I assumed in my premise from chapter 4, there should be no urge on doing that.

There are obviously more options, but I tried to be concise and therefore considered the two options that, in my opinion, present technological, economical and scientific benefits, as well as ensuring that the contamination is minimum. The question now is: which one is better? Or rather: is there actually a best option? A personal answer might be subjective or biased, hence I believe that, to obtain an objective answer, both technical assessment and a trade-off, preferably based on multi-criteria analysis, are required.

One important shared feature of both options is the fact that it is guaranteed that humans can analyze the samples, (which, according to current SRM research, is basically the purpose of bringing the samples back to Earth) but they are analyzed outside of the Earth. This also implies health and contamination risks (albeit lesser than in the initial case, because the sample container must have broken the chain of contact with

\(^{7}\) In fact, the ERC would not be an Earth Return Capsule since its purpose is not to re-enter Earth's atmosphere, but to dock with a space station/laboratory. It would rather be something like a Docking Return Vehicle, i.e., a small vehicle containing the sample container and which mission would be to bring the container back to Earth's orbit and to dock with the ISS or any other similar facility orbiting Earth. It would not need any re-entry shield or parachute/airbag system, unlike an actual ERC does [3]. The acronym ERC has been used throughout the essay, therefore it is kept here, in my opinion, to make my recommendation easier to understand for the average reader.
Mars, meaning it is clean): astronauts can be contaminated, and they must go back to Earth, which means that it would get contaminated as well. Hence, cleanliness and containment must also be ensured during this phase.

Considering my first proposal, the risk of an ERC Earth crash is eliminated thanks to the docking maneuver. This is suitable, since once the docking is successfully completed, it is very unlikely that the sample container breaks. But in case that the docking did not succeed, the ERC with the container would be lost in space (in a low Earth orbit). Nevertheless, it would not cause contamination on Earth because the ERC and the samples would eventually disintegrate upon re-entering the atmosphere. Compared to the typical, current approach where the ERC is designed to withstand Earth's reentry, meaning that if the ERC re-enters Earth but crashes (because the parachute/airbag system fails) the samples would be exposed to our biosphere, my recommendation avoids this scenario at any cost. From my point of view, if we are to lose the samples, let them be lost in space, but not on Earth.

Last but not least, in any of both cases it is recommended that COSPAR's policy be better defined to avoid vagueness and improve standards.

In the end, planetary protection is just a step, not towards new frontiers, worlds or horizons, but instead a step towards a safe and fair space colonization that will make us a better race, the one to uncover the secrets of life in the universe.
Glossary

COSPAR  COmmittee on SPAce Research
DNA    DeoxyriboNucleic Acid
ERC    Earth Return Capsule
ESA    European Space Agency
ICAMSR International Committee Against Mars Sample Return
ISS    International Space Station
MAV    Mars Ascent Vehicle
NASA   National Aeronautics and Space Administration
PPO    Planetary Protection Officer
PPP    Planetary Protection Policy
RNA    RiboNucleic Acid
SRM    Sample Return Mission
UN     United Nations

Bibliography


