Title: Ready for our trip to Mars? Turning the Red Planet blue

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November 26 last year was an important day for everyone at NASA when the InSight rover landed on Mars, as part of the NASA Mars Exploration Program.

Since then, InSight has been studying the interior of Mars, recording heat flow and analyzing seismic activity.

But InSight is not the only current inhabitant of Mars. It shares the land with three other NASA rovers: Curiosity - that arrived 7 years ago to explore the Martian environmental conditions for small life forms – and two rovers of the Opportunity mission, started in 2004 to screen the Martian surface.

But Mars exploration is not a new thing. In 1964, Mariner 4 spacecraft sent us the really first picture ever taken of the surface of the Red Planet, while in a flyby mode, with a resolution of… 5km! Only 11 years later, NASA's Viking lander was able to achieve the first successful landing on the surface of Mars and send us much better resolved pictures.

A few decades later, NASA's Mars Exploration Program lead to a significant discovery: the building blocks for life – water and salty nutrient – were found by NASA's Phoenix lander. At this time, water was found in the form of huge ice blocks, such as in the huge the Martian Korolev Crater, but in 2015, even liquid water was discovered on the surface of Mars.

These discoveries are definitely the first of a long exciting series. No later than next year, Mars 2020 rover will be sent to seek for life on Mars, but also collect rock and soil samples, put them aside, and potentially bring them back on Earth during a future mission. This study will help to evaluate if the Martian environmental conditions are compatible with future human exploration.

We are laughing today at the first picture of Mars taken 55 years ago, but it's very likely that our kids in 2060 will laugh at us when they'll realize that our travel options were limited to a single planet!

But to reach these perspectives, why are we starting with Mars? Why are we trying so hard to take the first step on this arid, rocky, cold and apparently lifeless land, while traveling to the Moon is so much easier? It's because Mars is more Earth-like than any other planet. 4 billion years ago, Mars is believed to have looked much more like Earth than today…

There is evidence that at this time, Mars was covered in lakes and oceans, and had a thick atmosphere just like Earth. Unfortunately, it burnt away over the millennia because of the lack of global magnetic field and the light Martian gravity. But Mars is not a dead planet, its climate is still actively changing and it is slowly emerging from an ice age that started 400,000 years ago.

Compared to the Moon, Mars has far more vital resources for human body adaptation, in terms of water, temperature, sunlight, gravity, atmosphere, day/night rhythm. Just to give an example, a Moon day takes not less than an Earth month!

We could also think of Venus, that is 30% closer to us than the Red Planet. But Venus is literally like hell, with its acid rains, nights that last for 120 days, average temperatures over 400 degrees and barometric pressures similar to that of 900 meters underwater on Earth. Compared to Venus, Mars is a real paradise.

Mars does not only bring new promises for the future, but it also has the power to tell us about our past. Earth, Mars and Venus formed over 4.5 billion years ago from similar building blocks of minerals and elements. Their transformation over time has then been different, but the deep interior of Mars can still possibly help us understand our own origin. Mars is actually the best laboratory to understand what happened on Earth, for two main reasons: first, there is nobody burning fossil fuels and pumping global warming pollutants into the Martian atmosphere, so the climate on Mars is perfectly preserved compared to the one of our own Planet. Secondly, unlike Earth, Mars has kept evidence of the really earliest days of the solar system because its geology is much less active. The rocks from billion years ago are just sitting on the Martian surface while on Earth it has largely been erased by plate tectonics and mantle convection.

So, exploring Mars actually does not only means exploring **Mars**. It means understanding better our own planet, but also exploring the entire solar system. Mars is the first door to a completely new dimension. Once we get to Mars, the low gravity is ideal to launch other deep space vehicles and eventually become an interstellar humanity.

But even without considering all these potential outcomes, there is no other way but to say that the Martian land is just beautiful, with all its fantastic mountains, canyons and volcanos. Mars has a natural beauty that does not only amaze crazy scientists but also makes the average person think “I wish my next trip could be to Mars”.

Now to make this happen there are still a few technical challenges that need to be solved. The first one is to determine how humans can face the extreme conditions on the surface of Mars, but also during the travel to get there. Going to the Moon took 3 days. Mars is a completely different story. Today it takes at least 6 months just to get there, which means an exciting one-year journey dealing with weightlessness, cosmic radiation and meteorites. And this does not even take into account the dramatic psychological impact that such a long time of isolation and confinement can generate on the human brain.

And when you get there, the nightmare continues with intense radiation passing the thin Martian atmosphere, extreme temperature variations from -120 to 20 degrees and giant dust storms that cover the entire planet for months.

This means that we need to invent deep-space habitations that will be self-sustaining, sealed and made of local materials (mainly dust). Thus, Martian houses will strongly rely on 3D printers and nanotechnologies to create lightweight super-strong buildings.

Then we will also need to establish food and medicine sources. Making plants grow in the Martian environment is more than challenging and we will probably use protective greenhouses supplied with water from the ice poles.

But even if we make the Red Planet completely self-sustainable and we travel light – which means bringing nothing but ourselves – we’ll still have to improve our landing skills. Right now, NASA is able to land a 1-ton vehicle on the surface of Mars. But for human exploration, we’ll need to be able to land at least 10 tons on the surface of Mars, and with a much better precision, to avoid mountains, hills and rocks.

While landing needs to be improved, taking off from Mars needs to be invented: today, we only have one-way tickets, which might not be a very appealing travel…

Once we’ll be able to come back from the Red Planet, we will definitely want to bring back Martian samples and use our advanced analysis techniques on Earth to study them. This can sound really cool

but also pretty scaring… What if life on Mars is actually not compatible with life on Earth? It's a potential risk that we totally need to consider. Returning samples could endanger the whole humanity and it's actually hard to anticipate these threats. Life on Mars could be completely different from what we know about DNA-based life on Earth. It could be encoded by a completely different building block. And while it could lead to the discovery of the really fundamental form of life, it could also lead to our own ending.

Now let's assume that we know how to protect humans against this new form of life, we should also turn the issue the other way around: what if human footprint impacts Martian life? How can we explore without contaminating the Red Planet and run the risk of destroying everything in our way?

For that question, it's important to remember the dreadful damage that was caused to colonized populations in the past. I hope we learnt from the history of culture contacts on Earth to make informed choices about our future in space.

Exploration and scientific innovation are in human's nature. We are an unsatisfied species and each technological achievement makes us want to go even further. But are we sure to know where we want to go? Yuval Noah Harari in Sapiens' epilogue said "We have advanced from canoes to galleys to steamships to space shuttles – but nobody knows where we're going. We are more powerful than ever before, but have very little idea what to do with all that power. Is there anything more dangerous than dissatisfied and irresponsible gods who don't know what they want?"

We are approaching the time when we'll be able to park to another planet. According to Michio Kaku in "The future of Humanity", we are entering the "fourth wave of science" that will open the doors to Mars colonization based on our progress in artificial intelligence, biotech and nanotech. But does that mean that we will forget about our good old Earth as soon as we'll be able to escape global warming and nuclear proliferation? For what? Destroying a new planet?

We should definitely not use Mars exploration as an excuse to give up on Earth. Space exploration has the potential to bring outstanding impacts in terms of commercial applications, education and inspiration to youth, scientific progress and philosophical outcomes. But this is under the condition that we consider Mars exploration as an insurance policy, rather than a Plan A.

As the astronomer Carl Sagan said, "We live in the middle of a shooting gallery with thousands of asteroids in our path that we haven't even discovered yet. So, let's be at least a two-planet species, as a backup plan". And indeed, if dinosaurs had had a space program, they would certainly still be here today.

Mars exploration brings tons of new questions that absolutely need to be addressed: how to implement protection protocols to preserve life on both planets, but also how will we share the land there. Is it fair to share it based on technological contribution of countries on Earth, while 99.9% of the inhabitants have nothing to do with scientific advances of their country? How can we avoid to maintain the gap between the rich and poor? Will the Martian humanity suffer from power changes on Earth?

If we take all these questions seriously and early enough, Mars exploration could be considered as a new chance to reinvent our humanity. I deeply hope that nations will be united on that matter to avoid competition and reverse the existing inequalities on Earth. When we see how much joy and fraternity the landing of InSight brought in the entire NASA community last year, we can only hope that our upcoming Martian generation will share the same feelings once up there.