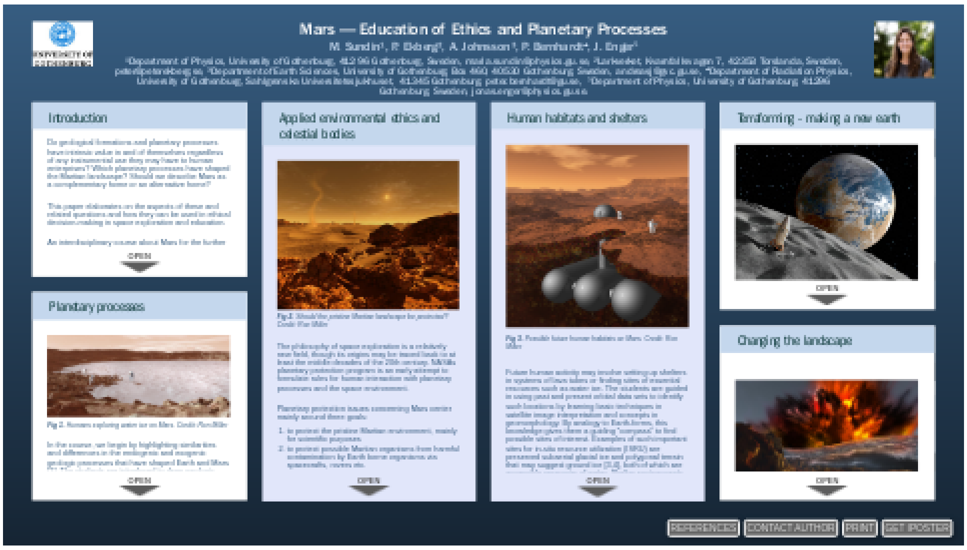
Mars — Education of Ethics and Planetary Processes



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PRESENTED AT:

INTRODUCTION

Do geological formations and planetary processes have intrinsic value in and of themselves regardless of any instrumental use they may have to human enterprises? Which planetary processes have shaped the Martian landscape? Should we describe Mars as a complementary home or an alternative home?

This paper elaborates on the aspects of these and related questions and how they can be used in ethical decision-making in space exploration and education.

An interdisciplinary course about Mars for the further training of teachers and science students was started at the Department of Physics University of Gothenburg, Sweden) in 2015 with lecturers spanning physics, geology, radiation physics and philosophy. A case study of this course is described in [1], and the material in this contribution is inspired by the course.

PLANETARY PROCESSES

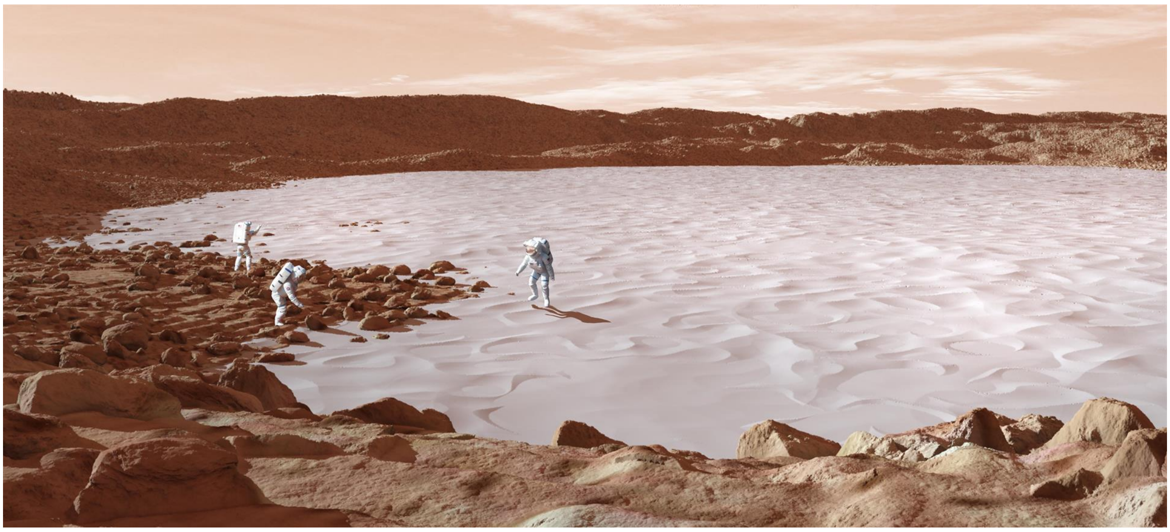

Fig 1. *Humans exploring water ice on Mars. Credit: Ron Miller*

In the course, we begin by highlighting similarities and differences in the endogenic and exogenic geologic processes that have shaped Earth and Mars [2]. The students are introduced to deep geologic time, the preservation potential of surface landforms on Mars compared to Earth, impact cratering and volcanic and tectonic processes, etc.

Questions addressed are;

- What happened to the Martian atmosphere and water?
- Why are the volcanoes so large on Mars?
- What evidence do we have for an ancient watery Mars?

We move on to explore the dynamic present-day land-surface processes on Mars.

In summary, the students are introduced to the concepts of geologic time and planetary evolution of the Earth-Mars system. Furthermore, they are introduced to remote sensing tools and basic geomorphological concepts to be able to assess the current conditions on Mars.

Possible radiation protection strategies are discussed in connection to in situ landforms. Any other planet or moon could be used in a similar course or lecture.

APPLIED ENVIRONMENTAL ETHICS AND CELESTIAL BODIES

Fig 2. *Should the pristine Martian landscape be protected? Credit: Ron Miller*

The philosophy of space exploration is a relatively new field, though its origins may be traced back to at least the middle decades of the 20th century. NASAs planetary protection program is an early attempt to formulate rules for human interaction with planetary processes and the space environment.

Planetary protection issues concerning Mars center mainly around three goals:

1. to protect the pristine Martian environment, mainly for scientific purposes
2. to protect possible Martian organisms from harmful contamination by Earth borne organisms via spacecrafts, rovers etc.
3. to protect the Earths biosphere from possible harmful effects of sample-return contamination.

The planetary protection program is largely anthropocentric in its conception. These goals could, however, be expanded from a strictly anthropocentric view. One way to do this is by applying concepts and ideas from environmental ethics. For instance, we acknowledge the possibility that non-human life forms have intrinsic value (biocentric ethics). More importantly for the present discussion is that the space environments we encounter, i.e. geological formations and planetary processes may also have intrinsic value in and of themselves regardless of any instrumental use they may have to human enterprises. This view is named ecocentric ethics. In this sense planetary landscapes and processes should perhaps not be viewed primarily as a resource for humans. The philosophy of space exploration is, as these questions suggests, mainly ethical in its conception. It carries questions of both legality and law as well as psychological and physiological questions concerning astronaut welfare during short-and long term space flight, as well as colonization attempts.

HUMAN HABITATS AND SHELTERS

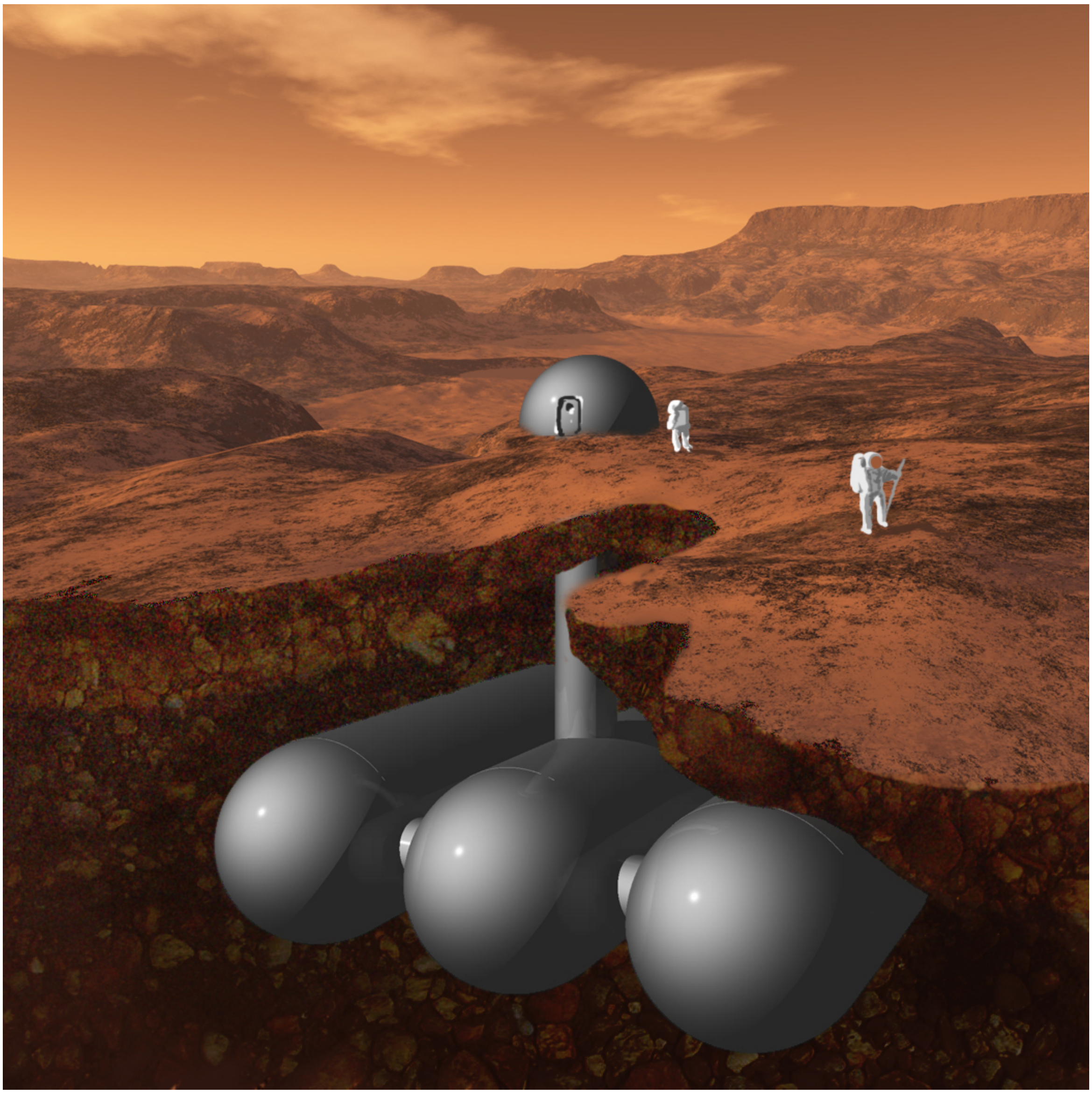

Fig 3. *Possible future human habitats on Mars. Credit: Ron Miller*

Future human activity may involve setting up shelters in systems of lava tubes or finding sites of essential resources such as water ice. The students are guided in using past and present orbital data sets to identify such locations by learning basic techniques in satellite image interpretation and concepts in geomorphology. By analogy to Earth-forms, this knowledge gives them a guiding "compass" to find possible sites of interest. Examples of such important sites for in-situ resource utilization (ISRU) are preserved subaerial glacial ice and polygonal terrain that may suggest ground ice [3,4], both of which are accessible reservoirs of water. Shelter environments may include systems of lava tubes. Here it is, for example, essential for the students to know the difference between an impact crater and a collapsed roof of a lava system.

Present-day atmospheric processes may also pose challenges to future manned expeditions. These include regional and global dust storms that may hamper solar energy production. Also, the long-term impact of fine dust particles on health and mechanical parts is not fully understood.

TERRAFORMING - MAKING A NEW EARTH

Fig 4. *Should Mars be terraformed? Credit: Ron Miller*

Terraforming is a potential project, aimed at modifying the Martian atmosphere, temperature, topography and ecology to duplicate Earths environment. Hence making Mars able to sustain humans and other species.

The four main transformations required are:

1. Increasing the temperature
2. Increasing the air-pressure
3. Creating a breathable atmosphere
4. Lessening the impact of radiation on the surface

Terraforming planets to make them habitable for humans is another issue for ethical consideration. Do we really have the right to terraform Mars and interrupt its natural evolution? Should nuclear bombing of Mars polar caps be accepted as a means of accelerating the warming of the Martian atmosphere? What values are violated by such a strategy? Mars has unique features both above and below ground, and could be viewed as a ”museum” with clues to the history of our solar system. What is the value of pristine planetary processes and landscapes? This question we turn to next.

CHANGING THE LANDSCAPE

Fig 5. *An explosion causing water to flow on the Martian surface. Credit: Ron Miller*

Should space mining be allowed? If it suited our anthropocentric needs, would it be advisable to tear down Olympus Mons and mine it for resources, build tunnels etc? Humans, undoubtly, have the ability to alter the Martian landscape in varying degrees.There are at least four main reasons for preserving the Martian landscape principically untouched.

1. For scientific purposes
2. To protect possible Martian organisms as well as ourselves from "Virgin soil epidemics".
3. Because of uniqueness and being intrinsically valuable
4. For aesthetic and existential reasons

Mars might, for instance, be protected within the framework of a celestial wilderness area as suggested by [5]. This modelsuggest that Mars should be preserved to 99,999%. The remaining part should be devoted to science, observatories, hotels for space tourism, biospheres, hiking treks etc. The existential aspect of experiencing the untouched wilderness of Mars could give rise to a radical sense of wonder benefitting humans and preparing us for a new and expanded narrative for our species.

We may of course also ask, which particular space environments and processes, if not all, ought to be preserved? Suggestions range from places worthy of a proper name, for instance Olympus Mons and Valles Marineris, exotic places in the solar system, places of aesthetic and historic value, etc [6].

Lastly a distinction made by [7]: Mars as a
complementary home to humans and other species, would perhaps be advisable, rendering humans multi-planetary and thus less vulnerable to pandemics and environmental collapse as well as making an effor tto preserving life, which is so rare in the solar system. Mars as an *alternative*
home - a go to planet - when Earth has been made inhabitable by disuse, might be a naive conception.

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