

Mars – Education of Ethics and Planetary Processes. M. Sundin¹, P. Ekberg², A. Johnsson³, P. Bernhardt⁴, J. Enger⁵ ¹Department of Physics, University of Gothenburg, 412 96 Gothenburg, Sweden, maria.sundin@physics.gu.se, ²Larkverket, Kvarnfallsvagen 7, 42353 Torslanda, Sweden, peter@peterekberg.se, ³Department of Earth Sciences, University of Gothenburg, Box 460, 40530 Gothenburg, Sweden, andreasj@gvc.gu.se, ⁴Department of Radiation Physics, University of Gothenburg, Sahlgrenska Universitetssjukhuset, 41345 Gothenburg, peter.bernhardt@gu.se, ⁵Department of Physics, University of Gothenburg, 41296 Gothenburg, Sweden, jonas.enger@physics.gu.se.

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? This paper elaborates on the aspects of these and related questions and how they can be used in 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].

Planetary processes creating possible human shelters: In the course we highlight similarities and differences in the geologic processes that have shaped Earth and Mars and explore the dynamic Martian landscape of today. Future human activity may involve finding shelter in such as vast systems of lava tubes, or locations of essential resources such as preserved glacial ice etc. 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. We now embellish on the part of the course concerning the ethical questions connected to planetary processes.

Ethical questions: 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 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 called 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.

Changing the landscape 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. It might also be protected as a celestial wilderness area as suggested by [2]. Should space mining be allowed? If it suited our anthropocentric needs, would it be advisable to tear down Olympus Mons? What is the value of pristine planetary processes and landscapes? Which space environments and processes, if not all, ought to be preserved? Suggestions range from places worthy of a proper name, exotic places in the solar system, places of aesthetic value, etc [3].

References:

- [1] Sundin M. et al. (2020) *IAU 367S, Education and Heritage in the Era of Big Data in Astronomy*, Poster in Session #6
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- [3] Rolston H (1986) *Beyond Spaceship Earth: Environmental Ethics and the Solar System*, Ed Hargrove E, p 140-182, San Fransisco: Sierra Club Books