DETERMINING PRODUCTION RATES OF COSMOGENIC RADIOISOTOPES ON MARS. Y. Kashiv[1,2,*], M. Paul[2] and P. Collon[1], [1]Department of Physics, The University of Notre Dame (*ykashiv@nd.edu), [2]Racah Institute of Physics, The Hebrew University of Jerusalem.

Introduction: Cosmogenic isotopes are produced by nuclear reactions of cosmic rays with atoms in rocks, atmospheres, and the interstellar and interplanetary media. Cosmogenic isotopes produced in rocks on Earth are used mainly to determine erosion rates and rock exposure ages, while those produced in the atmosphere are used in dating, studies of large-scale air circulation, hydrology, geophysics, etc. [1].

Most studies in this area are done with radioactive cosmogenic nuclides, which are measured by the technique of Accelerator Mass Spectrometry (AMS). The choice of isotope to study depends on (*a*) the problem to study, (*b*) its half-life, (*c*) chemical behavior and (*d*) expected concentration in the samples. Table 1 lists some of the frequently studied cosmogenic radioisotopes, their half-lives and the main elemental targets from which they are produced in rocks.

Table 1: Some frequently studied cosmogenic radioisotopes, their half-lives and main targets in rocks [1,2].

Isotope	Half-life (10^6 yr)	Targets
^{10}Be	1.6	O, Mg, Si, Fe
^{14}C	0.00573	O, Mg, Si, Ge
^{26}Al	0.71	Si, Al, Fe
^{36}Cl	0.3	Fe, Ca, K, Cl
^{41}Ca	0.1	Ca, Fe
^{53}Mn	3.7	Fe
^{129}I	16	Te, Ba, La, Ce

Production rates for a number of cosmogenic radionuclides were measured in terrestrial rocks and in the atmosphere (e.g., [2,3,4]), lunar rocks (e.g., [5,6]) and meteorites (e.g., [5]), and exposure ages were deduced under various models. Models applicable to Martian samples may be simpler due to possibly very long exposure ages and very low erosion rates [7], leading to saturation values for the concentrations of cosmogenic radionuclides (i.e., steady state concentrations, in which production is balanced by decay).

The different composition and pressure of the Martian atmosphere, the lack of current magnetic field on Mars, and the fact that Mars is located farther from the Sun, will result in different cosmogenic production rates in both Martian surface rocks and the Martian atmosphere.

We propose to measure the production rates of a number of cosmogenic radionuclides in surface rocks, both igneous and sedimentary, and possibly in the atmosphere as well. These production rates will then serve as the reference values for any study using these nuclides in Martian samples.

Studies of the physics and/or chemistry of Mars that could benefit from knowledge of cosmogenic production rates are, for instance, sand transport by winds (aided by determining the exposure ages of rock surfaces that were exposed after long burial times under thick layers of sand), and condensation of atmospheric gasses.

The proposed measurements will be done at the new AMS laboratory at The University of Notre Dame.

Production Rates in Martian Surface Rock:

1. *Igneous rocks.* Both the basaltic rocks of the southern highlands and the andesitic rocks of the northern lowlands [8] offer plenty of elemental targets for the production of all the isotopes in Table 1, with possibly the exception of ^{129}I.

2. *Sedimentary rocks.* In terms of elemental targets for the production of the cosmogenic radioisotopes in Table 1, Fe-rich sandstones [9] are similar to the basaltic and andesitic rocks.

3. *Samples.* There are two main requirements for samples of both types of rocks: (*a*) that they will be of surface layers of rocks, assumed to have been exposed to the atmosphere for a period of time of the order of the measured isotope's half-life, (*b*) show evidence for as little erosion as possible. The lack of tectonic activity, volcanism and surface liquid water in the recent geologic history of Mars (on the order of the half-lives of the isotopes in Table 1) means that it should be possible to find samples that satisfy the two requirements above.

The required sample size varies from about one milligram of rock for ^{10}Be and ^{26}Al to a few grams for ^{129}I.

Production Rates in the Martian Atmosphere: Atmospherically produced cosmogenic isotopes on Earth precipitate on the surface with the aerosols they attach to. The lack of liquid water on the surface of Mars (wet sedimentation) and as rain makes measuring atmospherically produced cosmogenic radioisotopes on Mars a challenging task.

Three possible ways that may enable one to determine the atmospheric production rates are: (*a*) collect samples of atmospheric aerosols [4], (*b*) sample the ice in the poles, and (*c*) leaching of surface-deposited aerosols on rocks (if such an environment is found). These types of samples are expected to collect atmospherically produced cosmogenic radioisotopes.

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