

QUARTZ MAY BE A HAZARD TO HUMAN EXPLORATION OF MARS. T. P. Meloy, West Virginia University

The Mars Environmental Compatibility Assessment (MECA) payload on the MSP '01 Lander has been selected to evaluate hazards to future astronauts associated with Martian soil and dust.

Of the possible hazards, cumulative inhalation of fine quartz particles stands out as the most threatening. This paper evaluates the implications of as little as 0.1% of the soil consisting of such particles. The high filtration rates required to remove respirable quartz dust from the martian habitat could call into question the very feasibility of human exploration of Mars.

To estimate the dust transported into a human habitat, it is assumed that:

- Each astronaut averages one EVA a day.
- During each EVA, 5 grams of Martian surface soil enters the habitat.
- 10% of the soil entering the habitat is of respirable size.
- 0.1% of the soil entering the habitat is quartz.
- All the dust entering the habitat can only be removed by filtration.
- During each filtration pass half ($k = 0.5$) the respirable particles are removed
- For a 168 hour exposure per week, NIOSH will recommend 10μ ($Ca = 10 \mu$) grams per cubic meter.
- The 30 grams of the dust entering the habitat becomes airborne at a uniform rate over a 24 hour period.
- A typical habitat volume is 250 m^3

During periods when no new dust is added, the dust removal follows an exponential decay law:

$$dC/dt = -kC$$

To balance the incoming weight of respirable quartz dust, W , at steady state, the amount removed is:

$$kCV = W$$

where C is the concentration of dust (grams per cubic meter), k is the decay constant, V is the volume of air in the habitat filtered (processed) in a give time and W is the amount of quartz entering the habitat atmosphere in that same time period.

With the above assumptions, the following values may be calculated:

- Daily dust intake = 30 grams, or 0.12 gm/m^3 .
- A complete air change is required every 6 minutes.
- The required filtration rate is 42 cubic meters per minute.
- The total mass of material removed by filtration during the mission is fifteen kilograms.

An air change every six minutes is high, especially since the quartz loading is low and there are no safety factors. Thus, even a modest amount of quartz in the Martian surface soil requires either high filtration rates and power requirements, or well designed showering and scrubbing procedures to prevent intrusion of dust into the habitat.

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