TOXICITY OF LUNAR VOLATILES ON HUMAN HEALTH. N. Barnett[1], S. Saydam[2], J. Oh and A. G. Dempster, [1]University of NSW (nicholas.barnett@unsw.edu.au), [2]University of NSW (s.saydam@unsw.edu.au).

Introduction: The detection of water and other volatiles in the Cabeus crater ejecta [1] has provided an opportunity to utilize lunar in-situ resources, as water and oxygen sources for human settlements, building materials and fuel [2-4]. Many of these same volatiles are toxic to humans and exposure to low concentrations can result health implications.

NASA's Artemis III mission is to return humans to the Moon by 2026, landing in the lunar south pole [5]. One of the seven overarching science objectives of this mission is to understand the character and origin of lunar polar volatiles, with humans performing in situ measurements and returning volatile bearing lunar samples to Earth for further scientific analysis [6]. To ensure the safety of all personnel transporting and handling the regolith, the effects of any contaminants within the sample are to be understood with safety protocols established in the event of an accidental release of and human exposure to the lunar volatiles.

Furthermore, technologies to extract drinking water and oxygen from lunar regolith are being explored [7-9]. These technologies are to ensure the contamination of water and oxygen by toxic volatiles in concentrations that exceed safe water and atmospheric guidelines can result in human health implications are not exceeded.

To ensure the safety of all humans in spacecraft, the National Aeronautical and Space Administration's (NASA) Human Health and Performance Directorate have established Spacecraft Water Exposure Guidelines (SMEGs) (JSC 63414) [10] and Spacecraft Maximum Allowable Concentrations (SMACs) for Airborne Contaminants (JSC 20584) [11] for spacecraft environments outlined in Spaceflight Human-system Standard Volume 2: Human Factors, Habitability, and Environmental Health (NASA-STD-3001) [12]. These guidelines provide maximum concentrations of known toxins in drinking water and spacecraft atmospheres where humans could have long-term exposure to the volatiles without a reprieve to expel toxins. Continuous exposure limits are provided for short-, medium- and long-term human exposure.

Using the concentration of lunar volatiles detected in the Cabeus crater ejecta in Table 1 as an example. Assume all of the water within a sample of lunar regolith was to be extracted for human consumption. If from the same lunar regolith 0.87% of ethylene, 0.26% of methanol and/or 0.0083% of ammonia by mass was found to be extracted from the lunar regolith and mixed with the extracted water, the water would exceed SMEGs. Similarly for airborne contaminants, 0.16 grams of lunar regolith containing the same lunar volatiles in Table 1 in 1 cubic metre of atmosphere will exceed SMACs [13], and 0.38 grams of the same lunar regolith in 1 cubic metre of atmosphere will exceed safe working exposure limits on Earth [13].

By identifying and limiting human exposure to lunar regolith from areas on the Moon that could contain volatiles that are toxic to human health, the risk to human health can be minimized.

The same learnings from this study can be used on Earth and on any extra-terrestrial body.

Table 1: Volatiles detected in the Cabeus crater ejecta [1].

Compound	% Relative to H_2O (g)
H_2O	100.00
H_2S	16.75
NH_3	6.03
SO_2	3.19
C_2H_4	3.12
CO_2	2.17
CH_3OH	1.55
CH_4	0.65

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