

# INHALATION TOXICITY OF GROUND LUNAR DUST PREPARED FROM APOLLO-14 SOIL

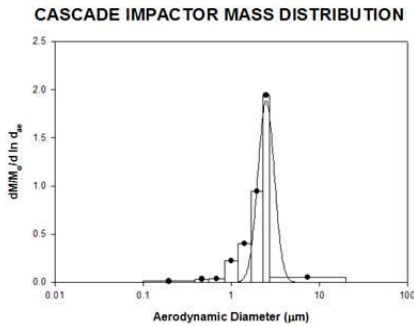
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## INTRODUCTION

Within the decade one or more space-faring nations intend to return humans to the moon for more in depth exploration of the lunar surface and subsurface than was conducted during the Apollo days. The lunar surface is blanketed with fine dust, much of it in the respirable size range (<10µm). Eventually, there is likely to be a habitable base and rovers available to reach distant targets for sample acquisition. Despite designs that could minimize the entry of dust into habitats and rovers, it is reasonable to expect lunar dust to pollute both as operations progress. Apollo astronauts were exposed briefly to dust at nuisance levels, but stays of up to 6 months on the lunar surface are envisioned. Will repeated episodic exposures to lunar dust present a health hazard to those engaged in lunar exploration? Using rats exposed to lunar dust by nose-only inhalation, we set out to investigate that question.

## METHODS

Male F344 rats were exposed for 20 days over a 1-month period by nose-only inhalation to concentrations of 0, 20, and 60 mg/m<sup>3</sup>. Daily exposures lasted 6 hours and each group consisted of 22 rats. The dust was prepared by jet mill grinding in ultrapure nitrogen of soil from an Apollo 14 sample (14003,96).



The typical size distribution of the particles to which the rats were exposed is given in the figure. A cyclone particle separator was operated at a flow condition that allowed only particles in the respirable size range to reach the rats. Approximately 22 g of ground lunar dust was used to conduct the entire experiment. In addition, positive end-point controls were prepared by intra-pharyngeal instillation of 3 mg of quartz. Five rats per group were euthanized 1 day, 1 week, 1 month, and 3 months after the last inhalation exposure. Blood, lung lavage fluid (right lung, cellular and soluble portions), and tissue samples (left lung) were harvested. Limited lavage fluid data from the 1 day and 1-week harvest were available at this writing.

## RESULTS

The table shows findings for selected endpoints obtained 1 day and 7 days after the end of exposures.

Parameter	Air controls		20 mg/m <sup>3</sup>		60 mg/m <sup>3</sup>		Quartz controls
	1 day	1 week	1 day	1 week	1 day	1 week	6 days (instillation)
Lavage fluid LDH	+	+	++++	+++	+++++	+++++	+++
Lavage fluid protein	+	+	+++	++++	++++	+++++	+++
Cell counts	+	+	++++	+++	+++++	+++++	+++

## DISCUSSION AND CONCLUSION

Our target concentrations were selected from results of the previous intra-pharyngeal instillations to elicit no adverse effect (low concentration) and moderate adverse effect (high concentration). Thus, we were surprised by the effects that were clearly present at the lowest lunar dust concentration, especially compared to the effects of the instilled quartz. The effect of this result on the safe exposure level estimated by comparative benchmark dose modeling from instillation data is unclear. That value was 1 mg/m<sup>3</sup> for 6 months of episodic exposure.