Fiscal Year:	FY 2012	**Task Last Updated:**	FY 12/19/2011
PI Name:	Jeevarajan, Antony Ph.D.		
Project Title:	Study of Lunar Dust and Lunar Simulant Activation, Monitoring, Solution and Cellular Toxicity Properties		
Division Name:	Human Research		
Program/Discipline:	HUMAN RESEARCH		
Program/Discipline--Element/Subdiscipline:	HUMAN RESEARCH--Environmental health		
Joint Agency Name:		**TechPort:**	No
Human Research Program Elements:	(1) **SHFH**:Space Human Factors & Habitability (archival in 2017)		
Human Research Program Risks:	(1) **Dust**:Risk of Adverse Health and Performance Effects of Celestial Dust Exposure		
Space Biology Element:	None		
Space Biology Cross-Element Discipline:	None		
Space Biology Special Category:	None		
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City:	Houston	**State:**	TX
Zip Code:	77058	**Congressional District:**	36
Comments:			
Project Type:	GROUND	**Solicitation / Funding Source:**	Directed Research
Start Date:	10/02/2006	**End Date:**	10/01/2011
No. of Post Docs:	0	**No. of PhD Degrees:**	0
No. of PhD Candidates:	0	**No. of Master' Degrees:**	0
No. of Master's Candidates:	0	**No. of Bachelor's Degrees:**	3
No. of Bachelor's Candidates:	7	**Monitoring Center:**	NASA JSC
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Flight Program:			
Flight Assignment:	NOTE: End date changed to 10/1/2011 for reporting purposes (Ed., 9/22/2011) NOTE: End date changed to 9/30/2011 per B. Woolford/JSC (01/2011) NOTE: Start/end dates changed to 10/2/2006-12/31/2010 (previously 4/30/2006-1/31/2011) per B. Woolford/JSC via S. Steinberg-Wright/JSC (9/2009)		
Key Personnel Changes/Previous PI:			
COI Name (Institution):	Wallace, William (Wyle Integrated Science and Engineering Group)		
Grant/Contract No.:	Directed Research		
Performance Goal No.:			
Performance Goal Text:			

Task Description:	With the plan to potentially return humans to the Moon, it is imperative to understand the hazards that may be faced and to determine ways to minimize them. Understanding the effects of lunar dust on both human physiology and mechanical equipment is one of the most pressing concerns, as problems related to lunar dust during the Apollo missions have been well documented. While efforts were made to remove the dust before reentering the lunar module, via brushing of the suits or vacuuming, a significant amount of dust was returned to the spacecraft, causing various problems. For instance, astronaut Harrison Schmitt complained of "hay fever" effects caused by the dust, and the abrasive nature of the material was found to cause problems with various joints and seals of the spacecraft and suits. It is clear that, in order to avoid potential health and performance problems while on the lunar surface, the negative properties of lunar dust must be quenched. Our research will focus on several related areas of research regarding lunar soil: 1) understanding the activation and deactivation processes of lunar soil, as well as how to monitor these processes, 2) understanding the properties of lunar soil in solution (dissolution), and 3) understanding the effects of lunar soil on cellular systems. Initial studies will be carried out using several different materials. Due to the scarcity of pristine lunar soil, tests will be conducted with lunar simulant, JSC-1A-vf, and quartz and titania, which have been used as positive and negative controls, respectively, in toxicological studies. Knowledge of the activation and deactivation processes is important due to the likely passivation of the active surfaces of lunar soils prior to their transfer to long-term storage. In order to determine methods for dust mitigation on the lunar surface, we must first activate the materials and determine the best methods for deactivation. Additionally, the particles themselves may not require activation in order to be toxic. Therefore, dissolution and cellular toxicity studies will be performed to determine if any toxic properties of lunar soil are due simply to their chemical makeup.
Rationale for HRP Directed Research:	
Research Impact/Earth Benefits:	The tests and methods used in these studies on lunar dust are applicable to terrestrial materials, such as mineral dusts and nanomaterials. For instance, a method to monitor the reactivity of ground lunar dust could also be used to measure the ability of quartz, a known fibrogenic material, to produce reactive oxygen species. Our reactivity monitoring method has already been adapted for use in a lunar dust reactivity sensor that could be used in the field to help determine when it may not be safe to enter an area (such as near sandblasting operations).
Task Progress:	During the current reporting period, work has continued on the solubility and dissolution properties of lunar dust. There is no standard protocol for experiments aimed at understanding the solubility and dissolution characteristics of mineral dusts. We have previously developed a protocol using lunar dust simulant (JSC-1A-vf). In this protocol, 0.5 mg/mL mixtures of dust and the solution of interest were placed in sealed containers and rotated for 72 hours in order to ensure consistent mixing. At the completion of this time period, the mixtures were filtered, and the resulting solution was tested using Inductively Coupled Plasma Mass Spectroscopy (ICP-MS) for the presence of metals. These results were compared to tests run concurrently on solutions containing no dust. The current work used jet-milled lunar dust, Apollo sample 14003, and 3 different solutions: distilled water, pH 4.0 buffer (citrate-phosphate), and pH 7.14 buffer (phosphate-buffered saline). After only 2 hours in distilled water, the pH of the lunar dust mixture was significantly higher than that of the control. Over the 30-day testing period, both the control solution and dust mixtures showed increases in pH with respect to the starting pH. While a number of species were measured using ICP-MS after 3, 14, and 30 days, only silicon, calcium, and magnesium were present in quantities above the detection limit of the instrument. While the effects of water on lunar dust are of interest for its possible use as a plant growth medium, studies of dust in the body become more complicated. Fluids in the body are buffered and much more complex in their composition. In an attempt to understand the effects of pH on lunar dust, we performed 3-day dissolution experiments at pH 4.0 and pH 7.14. In contrast to the distilled water testing, many more ions are released into solution in the buffered solutions, especially at lower pH.
Bibliography Type:	Description: (Last Updated: 12/20/2011)
Abstracts for Journals and Proceedings	Tranfield E, Rask JC, McCrossin C, Wallace WT, Kuhlman KR, Taylor L, Jeevarajan AS, Kerschmann R, Loftus DJ. "Chemical Reactivity of Lunar Dust Relevant to Humans." Joint Annual Meeting of LEAG-ICEUM-SRR, Cape Canaveral, FL, October 28-31, 2008. Joint Annual Meeting of LEAG-ICEUM-SRR, Cape Canaveral, FL, October 28-31, 2008. Abstract #4110. http://www.lpi.usra.edu/meetings/leagilewg2008/pdf/4110.pdf , Oct-2008
Abstracts for Journals and Proceedings	Tranfield E, Rask JC, McCrossin C, Wallace WT, Kuhlman KR, Taylor L, Jeevarajan AS, Kerschmann R, Loftus DJ. "Chemical Reactivity of Lunar Dust as it Pertains to Biological Systems." NLSI Lunar Science Conference, Moffett Field, CA, July 20-23, 2008. NLSI Lunar Science Conference, Moffett Field, CA, July 20-23, 2008. Abstract #2158. http://www.lpi.usra.edu/meetings/nlsc2008/pdf/2158.pdf , Jul-2008
Abstracts for Journals and Proceedings	Tranfield E, Rask JC, Wallace WT, Taylor L, Kerschmann R, James JT, Khan-Mayberry N, Loftus DJ, LADTAG Research Working Group. "Lunar Airborne Dust Toxicity Advisory Group (LADTAG) Research Working Group (RWG)." NLSI Lunar Science Conference, Moffett Field, CA, July 20-23, 2008. NLSI Lunar Science Conference, Moffett Field, CA, July 20-23, 2008. Abstract #2125. http://www.lpi.usra.edu/meetings/nlsc2008/pdf/2125.pdf , Jul-2008
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Articles in Peer-reviewed Journals	Rask JC, Zeidler-Erdeley PC, Barger MC, Wallace WT, Porter DW, Tranfield EM, Castranova V, Loftus DJ. "Reactivity of Pulmonary Macrophages in Response to Intratracheally Instilled Lunar Dust." Science 2012. To be submitted. , Jan-2012