Fiscal Year:	FY 2011	**Task Last Updated:**	FY 01/24/2011
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
Contact Monitor:	Woolford, Barbara	**Contact Phone:**	218-483-3701
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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 in place to 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:	Work has progressed on one of the three aims described in our task description. Aim 2: Solution properties Tests aimed at determining the behavior of lunar dust simulant in solution provided a protocol for dissolution studies that was determined to be sufficient for testing of lunar soil. Previous tests on lunar dust simulant showed an increase in solution pH when the dust was added to water. Therefore, it was decided to use buffer solutions in order to remove a variable in the testing process. A citrate-phosphate buffer (pH 4.0) and phosphate-buffered saline (pH 7.14) were prepared for testing. Additionally, distilled water was used in order to determine the behavior of the dust in an unbuffered solution for comparison to the results of lunar simulant dissolution. The lunar dust used for the testing was prepared from a larger sample of Apollo 14 dust, 14003, by a jet-milling process. Dust concentrations of 0.5 mg/mL were added to the solutions and agitated at regular intervals for 3-30 days to ensure consistent mixing. After filtering the mixtures, Inductively Coupled Plasma Mass Spectroscopy (ICP-MS) was used to determine the concentration of various elements leached into the solution during the dissolution tests (aluminum, antimony, barium, beryllium, cadmium, chromium, cobalt, copper, iron, lead, manganese, molybdenum, nickel, selenium, silicon, silver, titanium, and zinc, as well sodium, potassium, magnesium, and calcium). A lower pH was found to lead to higher levels of dissolution in the buffer solutions, as seen previously in the tests using lunar dust simulant. However, there were significantly lower levels of dissolution seen in the distilled water, even though its pH (6.7) was somewhat lower than that of the phosphate-buffered saline (7.14). This indicates that the solubilization of many of these elements requires the presence of Na^+, which is indicative of cation exchange phenomena. For each of the tests, the major constituent released into solution was silicon, followed by aluminum (low pH) and iron (high pH). The testing of the dust in distilled water also included the measurement of pH and oxidation-reduction potential. Addition of the dust to water led to an immediate increase in the pH compared to the control solution. Throughout the testing period, a gradual increase in the pH was seen for both the dust sample and control. The behavior of the oxidation-reduction potential was not as clear. Addition of the dust to the water led to an immediate decrease in the potential. However, over the testing period, this potential oscillated, though, once again, this oscillation mirrored the control solution. Future work will include testing of the jet-milled lunar dust in solutions used for intratracheal instillation of the dust in rats. This will help to determine if there is any significant change in the dust after it is placed in solution but before it is instilled in the animals.
Bibliography Type:	Description: (Last Updated: 12/20/2011)
Articles in Peer-reviewed Journals	Wallace WT, Phillips CJ, Jeevarajan AS, Chen B, Taylor LA. "Nanophase iron-enhanced chemical reactivity of ground lunar soil." Earth Planet Sci Lett. 2010 Jul 1;295(3-4):571-7. http://dx.doi.org/10.1016/j.epsl.2010.04.042 , Jul-2010