Fiscal Year:	FY 2023	**Task Last Updated:**	FY 02/17/2023
PI Name:	Lybrand, Rebecca Ph.D.		
Project Title:	Growing Food on Mars: Determining the Impact of Radiation, Atmospheric Composition, and Rock Substrate on Plant Growth in a Space Rock Garden Experiment		
Division Name:	Space Biology		
Program/Discipline:			
Program/Discipline--Element/Subdiscipline:			
Joint Agency Name:		**TechPort:**	No
Human Research Program Elements:	None		
Human Research Program Risks:	None		
Space Biology Element:	(1) Plant Biology		
Space Biology Cross-Element Discipline:	None		
Space Biology Special Category:	(1) Bioregenerative Life Support		
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Zip Code:	95616-5270	**Congressional District:**	4
Comments:			
Project Type:	GROUND	**Solicitation / Funding Source:**	2021 Space Biology NNH21ZDA001N-SBPS E.9: Plant Studies
Start Date:	12/15/2022	**End Date:**	12/14/2023
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No. of PhD Candidates:		**No. of Master' Degrees:**	
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No. of Bachelor's Candidates:		**Monitoring Center:**	NASA ARC
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Flight Program:			
Flight Assignment:			
Key Personnel Changes/Previous PI:			
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Task Description:	1. SCIENCE GOALS AND OBJECTIVES. As human civilization expands outside of its terrestrial cradle to explore the Moon and Mars, the sources and delivery of nutrients for long-duration missions must be identified and refined. The importance of using local mineral resources for sustaining life, and the bioengineering of such environments remain at the vanguard of sustainable human space exploration. Our overarching goal is to test how ionizing radiation, atmospheric composition, and rock substrate constrain and influence plant growth in deep space exploration, specifically the maintenance of plants in Lunar and Martian environments. This Early Career Investigation (ECI) will produce new publishable findings that integrate how food plants interactively respond to spaceflight stressors (carbon dioxide / CO2 and radiation) and environmental constraints imparted by basalt rocks containing different morphological and elemental arrangements that serve as nutrient sources for plants and microbes in Mars-relevant environments. Once constructed, the Space Rock Garden Experiment (SRGE) will serve as the framework for performing additional plant studies experiments to be proposed through full-ground based proposals and future International Space Station (ISS) flight experiments. We will achieve three objectives: 1) Develop and construct the SRGE, an integrated experimental system capable of controlling the mineral substrate, water, atmospheric and ultraviolet (UV) radiative conditions, and the presence of plants and microbes; 2) Identify how the flux of short wavelength (UV-B) radiation and atmospheric composition influence the rock weathering environment (e.g., nutrient elements compartmentalization), therefore assessing how coupled atmospheric and stellar energy sources influence the formation and habitability of incipient soils; 3) Integrate tomato and N-fixing plant genotypes, arbuscular mycorrhiza, and associated microbiota into the SRGE to assess how rock properties affect the growth and development of plants as viable crops for deep space exploration under increased CO2 and UV-B radiation. 2. METHODOLOGY. We will design, construct, and test the SRGE to simulate plant growth and microbe-mineral interactions under atmospheric and radiation scenarios relevant to Martian landscape. We will assess plant and microbial stress indicators in combination with biogeochemical analyses of major and trace elements in mineral, water and biomass pools. Micro-XCT (X-Ray Computed Tomography) will be used to assess plant root architecture, pore space morphology, and the biogeochemical indicators required to support complex plant life. We performed a pilot study using basalt rock substrates sampled from Mars analog sites in Iceland and confirmed that: i) tomato and lentil plants successfully co-germinated and grew together in basalt rock substrates under ambient conditions; ii) DNA was can be extracted from fresh basalt rock substrates, indicating that the rock materials are capable of hosting microbial life; and iii) a microXCT approach successfully differentiated dense mineral particles, water-filled pores, air-filled pores, and roots from tomato plants grown in the basalt rock substrates.
Rationale for HRP Directed Research:	
Research Impact/Earth Benefits:	
Task Progress:	New project for FY2023.
Bibliography Type:	Description: (Last Updated: 10/17/2023)