SYNTHESIS OF VENERA 13 ANALOG BASALT SAMPLES FOR OXIDATION AND DEGASSING EXPERIMENTS. J. A. Edmond[1], J. Filiberto[1], V. Tu[1], B. A. Anzures[1], F. M. McCubbin[1], K. Iacovino[1], and E. Kohler[2], [1]ARES Division, NASA Johnson Space Center, Houston, TX 77058, USA, [2]Solar System Exploration Division, NASA Goddard Space Flight Center, Greenbelt, MD 20771

Introduction: Experimental studies on the redox behaviors of Venus surface materials are important for preparing instrumentation and landing gear for upcoming NASA Venus missions DAVINCI and VERITAS, and ESA's EnVision mission. The exact surface composition and mineralogy is unknown, but measurements from prior missions Venera 13 and Vega 1 & 2 are consistent with alkali basalt and basalt, respectively, and orbital remote sensing is consistent with basaltic lava flows [1-2]. Venus's inferred volcanically active state [3-5] also motivates the desire to understand the degassing behavior of a cooling Venus basalt, which could lend insight into the formation of the Venus atmosphere and surface mineralogy. Therefore, in order to further our knowledge of Venus' surface mineralogy, this study focuses on two surface characterization aspects: 1) The oxidation and alteration behavior of a Venera 13 basalt with prolonged surface exposure, on the order of 2-3 days, and 2) The degassing of a cooling Venera 13 basalt representative of Venus' crust. We explore the effect of fO_2 and particle surface area on reaction rate by performing oxidation experiments using samples with a range of starting fO_2 and two different particle sizes exposed to a Venus atmosphere (e.g., a $CO_{2(g)}$-$N_{2(g)}$-$SO_{2(g)}$) at pressure-temperature conditions of the Venusian surface [6-7].

Methods: *Venera 13 Sample Synthesis*. Two Venera 13 samples have been synthesized for the alteration/oxidation and the degassing experiments (Figures 1A and 1B) based on the same Venera 13 analysis. For the alteration/oxidation experiments, a 40 gram volatile-free sample was mixed from powdered reagent grade oxides. This will be split into six batches and the fO_2 of each batch will be equilibrated at FMQ +2, FMQ, or IW using a 1-bar CO-CO_2 gas-mixing furnace and quenched to a homogenous glass.

For the degassing experiments, a 3g mix of the same composition has been made but includes sulfur and chlorine [8-9]. This sample will not be glassed at 1-bar to avoid loss of volatiles prior to the degassing experiments.

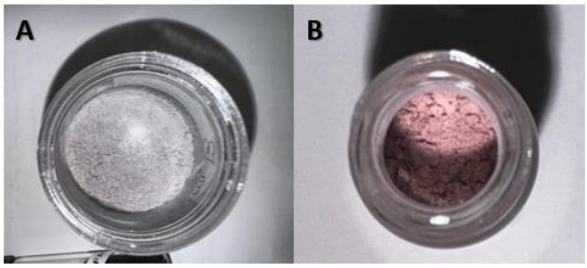

Figure 1A (left) and 1B (right). 1A) Image of synthetic Venera 13 sample for oxidation experiments. 1B) Image of synthetic Venera 13 sample for basalt degassing experiments.

VICI Chamber Oxidation Experiments. Alteration experiments will be performed on the six redox-equilibrated Venera 13 basalt analog samples in NASA Goddard's Lil'VICI (Venus In-Situ Chamber) at Venus surface conditions, 96 bars and 470 ˚C in a Venus two-gas mixture atmosphere (155ppm SO_2 and the rest CO_2) as shown in Figure 2. Lil'VICI is a small 300mL pressure vessel composed on Inconel capable of reproducing a range of Venus-like temperatures and pressures. This vessel is primarily used for short-term experiments that require Venus-like high temperatures and pressures and/or gases.

Prior to the alteration experiments, the glassy samples will be powdered or crushed into small chips/fragments of glass to understand the effects of different surface areas on the alteration process. The VICI will be run for 2 days, and then quenched by shutting off the power, which will take approximately 45 minutes to reach room temperature while still exposed to the Venus two-gas mixture. Quench effects will be considered when evaluating samples post-experiment and interpreting results. Samples are then removed and also analyzed via scanning electron microscopy (SEM) to observe alteration products and associated elements and by X-ray diffraction (XRD) to determine phases present and mineral abundances.

Figure 2. Image of the small Venus In-Situ Chamber (Lil'VICI) at NASA Goddard [10].

Basalt Degassing Experiments. Basalt degassing experiments will use a synthetic Venera 13 basalt with added S and Cl in evacuated sealed silica-glass tubes to identify the components partitioning out of a degassing basalt under Venus conditions. Models simulating degassing of a Venus crust have been performed [11-15]; however, this is one the first sets of experiments testing these conditions. First, we ensure the water content in the sample is minimal because of the lack of H_2O in the current Venus atmosphere [16] by dehydrating the sample in an open-ended silica glass tube under continuously pumping vacuum at a lower temperature (~800 ˚C). After about 20 minutes of dehydration, the tube is sealed with the sample inside. The sample is then heated to 1200 ˚C in a 1-bar tube furnace and held at temperature for 2-3 days in order to allow the sample to fully degas. The sample is quenched by removing the tube from the furnace and dipping into room-temperature water. Confocal Raman spectroscopy is used to analyze the inner walls of the sealed tube and measure the sample before exposure to the atmosphere. The solid residual material on the side of the tube are then removed and analyzed using SEM/EDS and WDS to further identify reacted phases.

Results: Currently the two Venera analog samples have been synthesized (Figure 1). The first set of samples are in the process of being melted and equilibrated to desired fO_2 states. A preliminary experiment adding sulfur and chlorine to the degassing experiment sample is underway. Phase purity of all samples is being confirmed using XRD and EPMA before the initial experiments.

Discussion: The next step is to take the S and Cl bearing sample for the degassing experiments and sinter it in the piston cylinder. Then, we will be ready to perform the dehydration step just prior to performing the degassing experiment. We will also continue to prepare for the Lil'VICI chamber experiments by melting and equilibrating the samples at designated fO_2 conditions and grinding half of each sample mass into a powder.

Acknowledgments: This work is supported by the ORAU NASA Postdoctoral Program. VT, BAA, and KI acknowledge support from the JETSII #80JSC022DA035 contract.

References: [1] Filiberto J. (2014) Icarus, 231, 131-136. [2] Gilmore M., Treiman A., Helbert J., Smrekar S. (2017) Space Sci. Rev., 212, 1511–1540. [3] Smrekar S. E., Stofan E. R., Mueller N., Treiman A., Elkins-Tanton L., Helbert J., Piccioni G. and Drossart P. (2010) Science, 328(5978), 605-608. [4] Filiberto J., Trang D., Treiman A. H. and Gilmore M. S. (2020) Science Advances, 6(1), 7445. [5] Herrick R. R. and Hensley S. (2023) Science, 379(6638), 1205-1208. [6] Lodders K. and Fegley B. (1998) Oxford University Press. [7] Ivanov M. A. and Head J. W. (2013) Planetary and Space Science, 84, 66-92. [8] Treiman A. H. (2007) Geophysical Monograph-American Geophysical Union, 176(7). [9] Filiberto et al. (In prep). [10] Johnson N. M. and Kohler E. (2016) In 47th Annual Lunar and Planetary Sci-ence Conference, 1903, 2267.5 [11] Gillmann C. and Tackley P. (2014) JGR: Planets, 119(6), 1189-1217. [12] Mikhail S. and Heap M. J. (2017) Physics of the Earth and Planetary Interiors, 268, 18-34. [13] Wetzel D. T., Rutherford M. J., Jacobsen S. D., Hauri E. H. and Saal A. E. (2013) PNAS, 110(20), 8010-8013. [14] Warren A. and Kite E. (2021) AAAS Abstract. [15] Namiki N. and Solomon S. C. (1998) JGR: Planets, 103(E2), 3655-3677. [16] Johnson N. M. and de Oliveira M. R. (2019) Earth and Space Science, 6(7), 1299-1318.