CURRENT LABORATORY RESEARCH AND VENUS IN-SITU CHAMBER INVESTIGATIONS.

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Introduction: Historically, although Venus is similar in size and mass with the Earth and is Earth's nearest planetary neighbor, it has not been the target of many recent missions, especially those that can land on the surface. In fact, only the USSR's Venera and Vega programs designed landers to specifically target and survive on the surface of Venus. The challenge most often cited for this scarcity of surface probes is the workability/survivability of instruments and equipment in Venus' harsh environment. As noted in a presentation to the scientific community by the Venus Science and Technology Definition Team (VSTDT), "[The] key to enabling a Venus Flagship mission is the ability to conduct investigations and tests in Venus simulation chambers."[1]. In fact, it is of utmost importance to maintain current Venus facilities in an effort to assess the development of high temperature electronics and to gauge high temperature and pressure technologies for their respective technology readiness levels.

In order to meet these needs, VICI (Venus In-Situ Chamber Investigations) is available for use at NASA Goddard Space Flight Center in Maryland. It is available for testing of small flight components/instruments and short-term experiments that require Venus-like high temperatures and pressures.

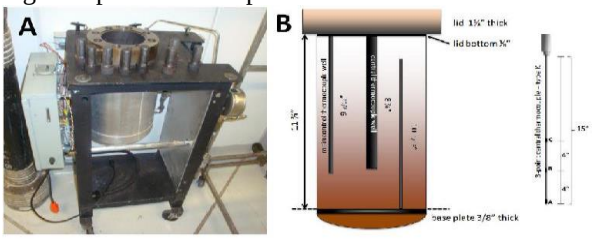

Figure 1: *Venus simulation chamber at Goddard Space Flight Center. (A) Chamber image. (B) Cartoon of chamber interior with dimensions and relative positions of the thermowells.*

Previous Work: Radar mapping of the surface of Venus shows areas of high reflectivity in the Venusian highlands at altitudes between 2.5-4.75 kilometers [4]. While theoretical studies have been beneficial, the origins remain unclear and few experimental investigations have been completed. Recently, experiments were conducted in the chamber in an effort to determine the source of the Venusian radar anomalies [2,3].

Several minerals thought to exist on Venus, and suggested as potential sources for the anomalies, were tested for stability. One gram of each sample was heated, and pressurized in VICI to average Venusian surface conditions, and separately to highland conditions (460°C and 90 bar, 380°C and 55 bar, respectively) under CO_2 as well as a simulated Venusian atmosphere of 96.5% CO_2, 3.5% N_2 and 150 ppm SO_2. After each run, the samples were weighed and then analyzed using X-Ray Diffraction (XRD). Results of the gas mixture experiments are presented in Table 1.

Table 1: *Results of XRD analysis on each sample tested in VICI. Percentages show how much of the sample identified as each compound.*

	Mixed Atmosphere			
	460°C, 95 bar		380°C, 55 bar	
Te	Te TeO_2	83% 17%	Te TeO_2	78% 22%
Bi_2S_3	Bi_2S_3	100%	Bi_2S_3	100%
FeS_2	N/A	N/A	FeS_2 S	85% 15%
Bi_2Te_3	Bi_2Te_3	100%	Bi_2Te_3 BiTe	91% 9%
HgTe	HgTe Te	41% 59%	HgTe Te	61% 39%

Specifications: VICI is constructed of 316 stainless steel and can maintain a steady temperature of 740K and pressure of 95.6 bar for ~48 hours (or longer depending on leak rate) under CO_2. Gas mixtures that include N_2 and SO_2 (at ppm levels) are also possible. The interior dimensions are five inches in diameter and twelve inches deep. The actual working space is slightly smaller because of volume taken up by thermowells that contain the temperature control and monitoring thermocouples. Options include viewports and/or throughputs for data and power as well as running at temperatures and pressures lower than those found at the surface of Venus. The software used with the chamber is LabVIEW and records simultaneous temperature and pressure readings.

In order to obtain time for VICI, please contact Natasha Johnson (phone: 301-286-3919 or email: natasha.m.johnson@nasa.gov). Discussions will be held to make the most of the chamber's abilities and the proposed project in both design and outcome. If there is a project or experiment that could benefit, do not hesitate to call or email. This facility is meant to further our collective knowledge of Venus and its exploration. Through discussions and carefully planned projects we will all be steps closer in accomplishing these goals.

References: [1] Bullock M. A. (2009) *LPS XL*, Abstract #2410. [2] Kohler, et al., (2013), *LPSC XLIV*, abs. #2951. [3] Kohler, et al., (2014), *LPSC XLV*, abs. #2321. [4] Rogers, A. and Ingalls, R., (1970) *Radio Science, 5*, 425-433.

Acknowledgments: *The availability of this chamber would not be possible without the support of NASA, the Goddard Space Flight Center, and especially to Dr. William Byrd who built the chamber.*