Venus Surveyor for Planetary Exploration Research (VeSPER)

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Introduction:
The surface of Venus has only ever been imaged six times by four different landers [1-2]. The final image was obtained by Venera 14 in 1982, nearly 40 years ago [2]. These low-resolution images provided researchers with the first evidence of weathering on Venus [1-2]. Such evidence included fine particles on the surface and rocks with pitting and rounded edges [1-2]. Venera 9's images showed the presence of mass wasting [1]. However, many details may have been lost due to the low-resolution of these cameras [1-3].

Over the past 40 years advances in technology have allowed researchers to send multiple landers equipped with high-resolution cameras to Mars, including the Mars Science Laboratory mission's Curiosity rover which can take images with a resolution as high as 150 micron/pixel at 2 meters [4]. For Venus, new, higher resolution images are essential in order to characterize different rock types and identify chemical and mechanical weathering processes that may have been unobservable by past landers. This data could be obtained using a more advanced imager system with a resolution higher than the original Venera cameras encapsulated inside a vessel able to survive for several minutes at Venus surface conditions. Such a concept is the core of this paper.

Instrument:
The Venus Surveyor for Planetary Exploration Research (VeSPER) camera system is a short-lived imaging system that can be attached to a Venus lander. The camera was originally designed to be externally attached to the Seismic and Atmospheric Exploration of Venus (SAEVe), a mission concept involving two Venus landers. However, due to its small size, VeSPER can be attached to any future lander. VeSPER is designed to withstand Venus surface conditions for 90 minutes. To date, VeSPER has only been tested in a furnace at Venus temperature (460°C), but ambient pressure and in air. In the future, VeSPER will undergo further testing under Venus conditions, including possible testing in the Glenn Extreme Environment Rig (GEER) at Venus temperature, pressure, and atmospheric chemical composition.

Mission overview:
VeSPER was designed relevant to SAEVe to obtain five images of Venus at wavelengths between 550-1020 nm. These images include two images taken during descent (~5 km and 400 m from the surface) and three images from the surface. The motive behind the two images during descent is to ascertain the landing site morphology. One of the instruments onboard SAEVe is a seismometer. Thus, the next two images taken by VeSPER will be of the ground before and after the deployment of the seismometer to check instrument coupling. These images will be used not only to observe where the seismometer has landed, but to also take higher quality images of the surface than the images obtained by the Venera landers. These images can be used to further understand the composition and mechanical and chemical

weathering processes occurring on Venus. The last image taken by VeSPER will be of the horizon. This image will be used to study the topography and morphology of the surface.

Future Work:

As mentioned previously, VeSPER has not been exposed to Venus pressure or atmospheric chemical composition. Future experiments at these conditions will be completed with possible testing in the GEER located at NASA Glenn Research Center. Further advancements are planned to extend the lifetime and the performance of the system (such as improvements in image compression and transfer). These advancements would allow for the acquisition of additional images of the surface of Venus.

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