SEARCHING FOR LARGE BURIED CRATERS ON VENUS. S. Karimi[1], L. Ojha[1], K. Lewis[1]. [1]Department of Earth and Planetary Sciences. Johns Hopkins University, 301 Olin Hall, 3400 N. Charles St. Baltimore, MD, 21218. (saman@jhu.edu)

Introduction: Unlike the Moon or Mars, the surface of Venus has relatively few impact craters [1, 2, 3], indicating that the surface of Venus is very young (less than 500Myr). Various geologic processes likely continue to play a role on the surface of Venus including volcanism, tectonism and relaxation, among which volcanism is theorized to have played the major role in reshaping the surface and resetting its cratering age [3,4,5,6]. Over the history of the System, Venus would have been impacted by a comparable number of impacts to other terrestrial planets, including large basin forming events. Due to resurfacing, these large basins, are not visible in the topography or in radar images of the surface [7].

Previous studies have identified buried craters on Mars [8 -11], particularly in the resurfaced Northern Lowlands. A number of Quasi-Circular Depressions (QCDs) discernable in Mars Orbiter Laser Altimeter (MOLA) topography are hypothesized to be buried craters [8-10]. A recent study of the Moon [11] has identified ~100 quasi-circular mass anomalies using GRAIL gravity data, interpreting them to be buried impact craters.

Here, we attempt to identify candidate buried impact structures on Venus (potentially overlain by volcanic material). Although the nature of the resurfacing of Venus is uncertain, it is plausible that traces of large preexisting structures could have been preserved at depth. Due to the relatively low resolution of the gravity and topography data on Venus, we only sought evidence of impact craters larger than 1000 km. A basin of this size would be similar to Hellas on Mars or Oriental on the Moon, and would likely have a large mantle uplift. By implementing the relaxation model of [12], we have determined that a large crater on Venus preserves part of its topographic relief at surface and subsurface even after 0.5 Gyr of relaxation. Due to the relatively large crust-mantle density contrast hypothesized for Venus ($\Delta\rho$= 400-500 kg/m^3) [5, 13], a moderate mantle uplift causes a positive Bouguer gravity anomaly that should be resolvable in the current gravity model of Venus. By investigating the Bouguer gravity anomaly we aim to find large ancient craters mainly preserved at the crust-mantle boundary. A successful detection would indicate that it is possible to maintain the shape of a large impact structure (even though partially) through geologic time, providing insight into the rheology and tectonic and resurfacing history of our sister planet.

Methodology: We analyze topography and gravity data of Venus obtained from the Magellan mission. The gravity model of Venus is available nominally up to degree and order 180, equivalent to a spatial resolution of ~250km [14]. However, Magellan mission data do not have uniform spatial resolution across the planet, making the higher degree and order spherical harmonic coefficients less reliable [14]. We truncate the higher degrees and use spherical harmonic coefficients up to degree and order 110 (with an associated resolution of ~400 km). The Bouguer gravity anomaly is calculated based on an average crustal density of 2900 kg/m^3. In our study we search for any positive Bouguer gravity anomaly with circular (or pseudo-circular) shape. Concurrently, we examine the surface topography associated with each positive Bouguer anomaly to ensure that the surface possesses either negative or zero topographic expression. This simple approach yielded 18 locations that fit in our criteria. Following the methodology of [11, 15], we searched for these candidate locations in the constructed map of 2nd derivatives of the Bouguer anomaly.

We note that the gravity signature alone resulting from mantle uplift associated with large basins is almost unrecognizable from that of mantle plumes. In order to discern between these two gravity signals, we examine the corresponding surface topography of each candidate location, searching for coronae (the possible surface expression of a warm mantle plume). Locations associated with large coronae are not considered as potential hidden craters.

Results and Discussion: After applying the described methodology, we have identified the two most likely locations on the surface of Venus demonstrating a quasi-circular mass anomaly, with their locations listed in Table 1. Although it is impossible to prove an impact origin given the current data for Venus, we view these as the most promising candidates for future study. Both locations exhibit positive Bouguer anomaly with minimal surface expression (Figure 1). Moreover, the plots of geoid to topography ratio (GTR) of these regions reveal shallow depth of compensation. The degree strength map of the gravity field [14] demonstrates that for the suggested locations of 1 and 2 (Table 1), the gravity data are reliable up to degree of 90 and 60, respectively.

Both of the candidate regions exhibit a smooth surface at the resolution of global topography, consistent with volcanic infilling. As shown in Table 1, the size of these two geologic features are comparable with Argyre basin on Mars.

To examine the potential for relaxation of large basins on Venus, following [12, 5], we have applied both hydrous and anhydrous rheologies. Using a hydrous rheology (terrestrial level of water content) leads to complete relaxation of the topography at the surface and subsurface for craters of this scale. This is inconsistent with the current topography on the surface of Venus, requiring an anhydrous rheology for the Venusian interior in the case that these features represent the traces of buried impact basins. Further assessment of the origin of these candidate basins will require higher-resolution gravity data from a future mission, such as the proposed VERITAS orbiter.

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Table 1. Locations of the proposed buried basins.

Basin No.	Longitude	Latitude	Diameter (km)
Basin # 1	347° E	41° N	~2000
Basin # 2	145° E	57° S	~2100

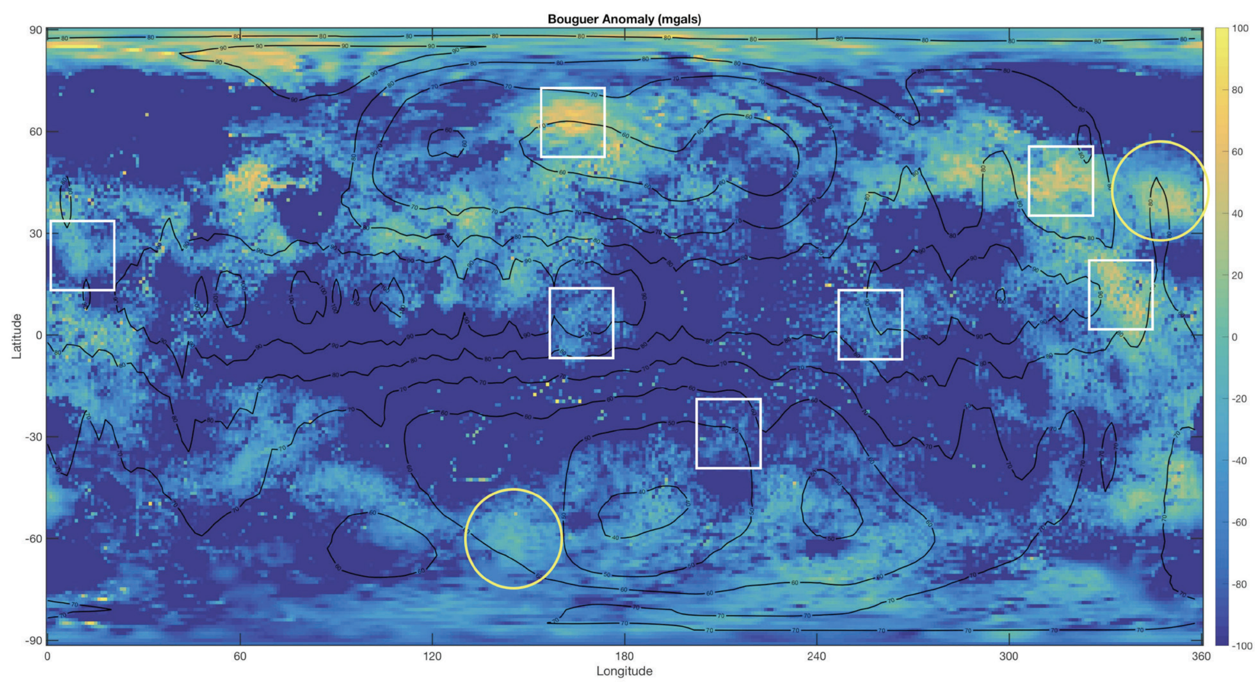

Figure 1. The circles show the location of two large buried basins, suggested by this study, on Bouguer gravity map of Venus. The degree strength of the gravity field as determined by Konopliv et al. [14] is demonstrated on the map. The squares show seven other locations that demonstrate similar Bouguer gravity anomaly but cannot be considered as buried basins because of their proximity to coronae and their surface topography.