BULK DENSITY ESTIMATION ON VENUS FROM A MODIFIED NETTLETON METHOD. R. H. Dame[1] and P. B. James[1], [1]Baylor University Department of Geosciences, (Rudger_Dame1@baylor.edu).

Introduction: One of the three main science goals identified in the 2019 VEXAG "Goals, Objectives, and Investigations for Venus Exploration" document is to "Understand the geologic history preserved on the surface of Venus…". One objective pertaining to this goal is answering the question of "what geological processes have shaped the surface of Venus?". Determining the composition of the surface will hint at geological processes that has shaped Venus.

One promising way to identify the composition of the surface is through calculating bulk density. Higher bulk densities could imply a more mafic surface while a lower bulk density could imply a more felsic surface. If the tesserae were shown to be more felsic in composition than the plains because of a lower density, this might hint at an ancient hydrosphere and plate recycling mechanism [1]. Bulk density of localized regions could be calculated using a modified Nettleton Method.

Venus geophysical data: The degree and order 180 *MGNP180U* data product was based on Magellan data and augmented with observations from Pioneer Venus Orbiter [2]. The gravity degree strength l_s is the spherical harmonic degree at which the power of the gravity uncertainty surpasses the signal power (this can be thought of as the maximum data resolution). The power spectrum of the error in the MGNP180U gravity surpasses the power of the coefficients above degree 70 (spatial block size 270 km), so this is the nominal degree strength of the data set. The actual degree strength varies considerably, with a resolution as high as degree 100 near the equator and as low as degree 40 elsewhere on the planet (Fig. 1).

Nettleton's method: It has been known for 80 years that the bulk density of a terrain may be estimated using gravity measurements [3]. While the initial implementation of Nettleton's method was flawed in the presence of large terrain variations, recent advancements in mathematical techniques enable us to precisely estimate the gravitational attraction of finite-amplitude terrains on other planets [4]. As a result, we can estimate the bulk density of Venus' crust in various locations through a simple least-squares regression between the observed gravity and the gravity expected from a crust with a density of 1 kg/m^3.

Expected gravity: The gravity from Venus's topography can be estimated for a density of 1 kg/m^3 using the calculation described in [4]. The crust–mantle boundary also contributes to the observed gravity field, and this contribution may be estimated either by using an existing crustal thickness model (e.g., [5]) or by assuming a state of Airy isostasy. The bulk density may be estimated with and without relief on the crust–mantle boundary, and the difference between those two densities provides a plausible estimate of the uncertainty.

Ideal spectral filtering: Unlike spatio-spectral estimates of Venus' crustal density [6], our new method is capable of inferring density on relatively short scales. The downside of Nettleton's method is that it is influenced by gravity anomalies at all wavelengths. The gravity data at low spherical harmonic degrees are sensitive to the presence of crustal roots and the deeper mantle, which can sometimes artificially decrease the interpreted density. Therefore, we apply a filter to the observed and predicted gravity data: we suppress the lowest spherical harmonic degrees and also suppress the spherical harmonic degrees higher than the local degree strength (Fig. 1).

References: [1] Gilmore, M. S. et. al. (2015) *Icarus, 254,* 350-361. [2] Konopliv, A. S. et al. (1999) *Icarus, 139,* 3-18. [3] Nettleton L. L. (1939) *Geophysics, 90,* 1151–1154. [4] Wieczorek M. A. and Phillilps R. J. (1998) *JGR, 103,* 1715-1724. [5] James, P. B. et al. (2013) *JGR-Planets, 118,* 859–875. [6] Dahlen, F. A. and F. J. Simons (2008).

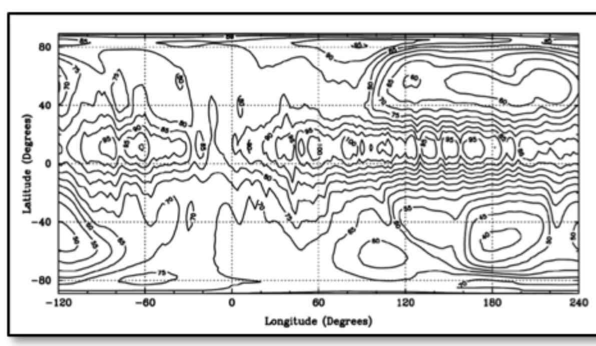

Figure 1. Map of the "degree strength" l_s of Venus's gravity field (from [1]). The degree strength indicates the spherical harmonic degree at which the power of data noise surpasses that of the signal.