GRAVITY STUDIES OF MEAD CRATER, VENUS

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Mead Crater, with an outer ring diameter of 280 km and a depth of about 1 km, is the largest crater identified on Venus [1] (Figure 1). It presents perhaps the only opportunity for investigating the structure of the crust and lithosphere of Venus (and the effects of a large impact upon them) using gravity data, as the altitude of the Magellan spacecraft precludes the detection of gravity signals with spatial wavelengths much less than about two hundred kilometers. In November of 1992 Magellan's periapsis passed over Mead Crater, making it possible to acquire high–quality, high–resolution doppler tracking data. In this abstract we will describe some preliminary analyses of this data.

The gravity data set consists of 13 X–band Doppler radio tracks spanning 21 orbits (6178–6198). The quality of the X–band data was excellent, having an average noise of less than 0.2 mm/sec for 2–second data samples. Ten orbits had a definite signature for the crater, whereas the three orbits at the beginning and end of the span had essentially no crater signature. Figure 3 shows an example the doppler residuals (orbit 6186) relative to GM and to a 36th degree and order field [2]. The orbits crossed the crater (located at 57.5° E. latitude, 12.5° N. longitude) in a north–south direction and the spacecraft was at an altitude of 182 km over the crater. It can be seen that the negative signal from the crater (roughly 5° wide, centered at latitude 12.5) is superimposed on a strong regional signal; only a fraction of the regional signal is absorbed by the 36×36 field. In order to better isolate the crater anomaly, the residuals were reduced relative to a 60th degree and order field [3] (Figure 4). When this is done, the regional "background" becomes less than a milligal, and a negative anomaly of 3 mgal is centered over the crater. However, the 60×60 field itself contains a part (1–2 mgal) of the crater signal (Figure 2). Thus we estimate the total gravity anomaly at spacecraft altitude to be 4–5 mgal.

Several preliminary approaches have been used to interpret the gravity data. By comparing the 60th degree and order field to that computed from a global harmonic representation of the gridded topography, we find that the regional gravity is considerably subdued relative to the predicted gravity from topography, whereas the observed crater signal is relatively more prominent in the observed field. This indicates that the regional topography is considerably more compensated than the crater itself at wavelengths greater than about 600 km. Line of sight (LOS) accelerations were also computed using an orbit simulation program [4]. Topography within two crater radii of the center of Mead was used, tapered at the edges, and a nominal crustal thickness of 20 km was assumed for the compensation depth [5,6]. The best fit to the observed LOS accelerations are obtained from models with 0–30% compensation. This implies either little or no uplift of the moho, much deeper compensation (e.g., thicker crust), or perhaps some sort of low–density fill within the crater.

Considerable uncertainties remain in these models due to incomplete topographic coverage of the area, especially over the topographically rough rim deposits. The models are particularly sensitive to the amount of mass in the rim, as the crater itself is relatively shallow. We are currently working on extending both the spherical harmonic and LOS studies using a more complete representation of the topography derived from specially–processed cycle–3 altimetry data and stereo modeling.

References: [1] Schaber et al., *J. Geophys. Res.*, **97**, 13,257, 1992; [2] Nerem et al., *Geophys. Res. Lett.*, **20**, 599, 1993; [3] Konopliv et al., *Geophys. Res. Lett.*, **20**, 2403, 1993; [4] Phillips et al., *J. Geophys. Res.*, **83**, 5455, 1978; [5] Zuber, *J. Geophys. Res.*, **92** (17th LPSC suppl.), E541, 1987; [6] Banerdt and Golombek, *J. Geophys. Res.*, **93**, 4759, 1988.

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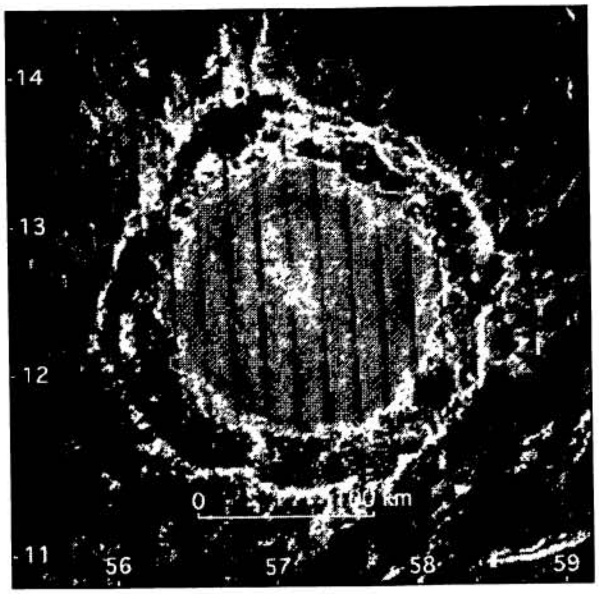

Figure 1: Radar image of Mead Crater. Image is 350 km across (C1MIDR–15N060).

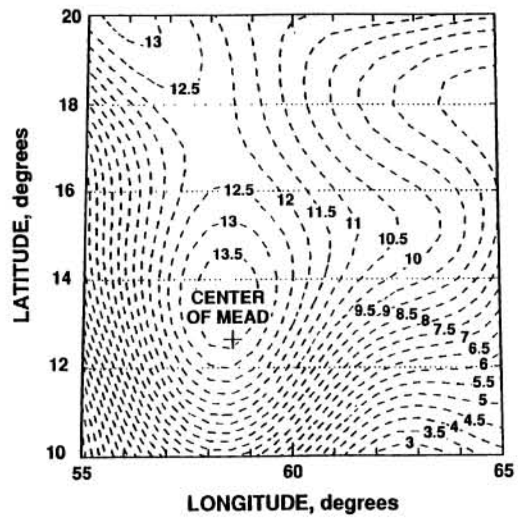

Figure 2: Radial acceleration at 182 km from PMGN60J. Contour interval is –0.5 mgal.

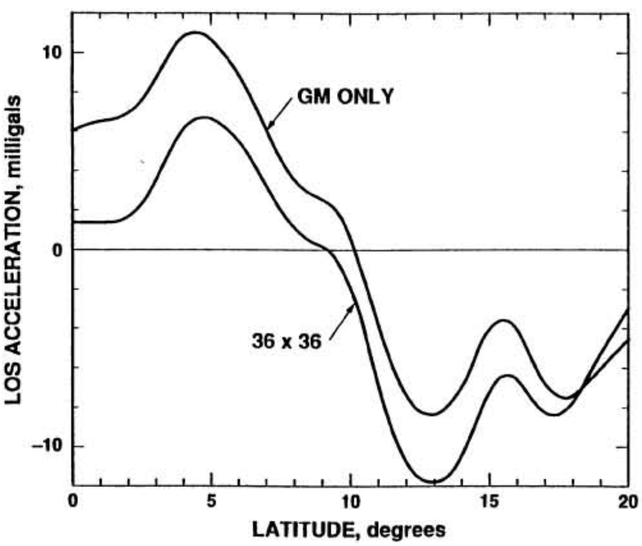

Figure 3: Magellan LOS acceleration profiles over Mead Crater derived from doppler residual relative to GM only, and to a 36 × 36 field [2]. Orbit number 6186.

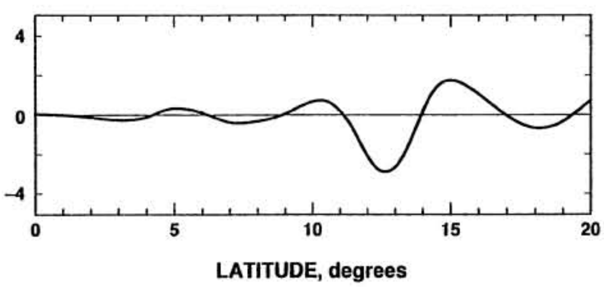

Figure 4: Magellan LOS acceleration profiles over Mead Crater derived from doppler residual relative to a 60th degree and order field (PMGN60J). Orbit number 6186.