DENSITY AND ELASTIC THICKNESS CONSTRAINTS AT LUNAR VOLCANIC PROVINCES: IMPLICATIONS FOR GRAIL. Qian Huang and Long Xiao, Planetary Science Institute, China University of Geosciences (388 Lumo Road, Wuhan, 430074, China, qianhuang.83@gmail.com)

Introduction: The volcanic provinces of Wilhelms [1], such as the Aristarchus Plateau, Marius Hills, Rümker Hills, and west region of Copernicus (Tab. 1) are likely sites of intense and sustained magmatic activity, and it is conceivable that a large portion of the basalts within Oceanus Procellarum may have originated from within them [2]. These volcanic provinces are located at regionally high elevations (Fig.1). The Aristarchus Plateau has a diameter of 250 km and about 3 km above its surrounding area. It is a distinctive geologically complex volcanic highland, abundant with pyroxene, olivine and feldspar minerals [3]. Marius Hills are the largest volcanic dome complex on the Moon. The dome field is around 200 by 250 km across and 2 km regionally high [4], with a well central high radial free-air gravity anomaly. Mons Rümker has a diameter of about 65 km and the height of about 1km. Localized positive free-air gravity anomalies are associated with these volcanic complex and with relative high gravity/topography correlations.

Here we use the newly derived 200 degree and order gravity filed model LPE200 [5] and LOLA topography [6] to carry out spectral admittance analyses on these regions, and try to constrain the density of the volcanic load as well as the elastic lithosphere thickness at the time of load emplacement. The new gravity field model has a spatial resolution about 27 km over the nearside, allowing for the analysis and interpretation of small-scale volcanic features.

Method: Localized spectral admittances of the volcanic provinces were calculated by windowing the free-air gravity and surface topography with the band-limited localization windows of Wieczorek and Simons (2005) [7]. The localization windows are constructed to minimize the signal arising exterior to the region of interest (a spherical cap of angular radius θ_0) for a given spectral bandwidth. We chose a single localized window with bandwidth L_w such that 99% of its power was concentrated in the region of interest. In order to neglect possible rotational and tidal contributions, localized admittances were analyzed between degrees L_w+3 and L_{data}-L_w, where L_{data} = 200 corresponding to the maximum degree of the LPE200 gravity model.

In describing the relation between gravity and topography at these volcanic provinces we calculate the linear transfer function between gravity and topography coefficients in the spherical harmonics domain using a forward model appropriate for top loading of the lithosphere [8, 9].

Table 1. Lunar volcanic complex regions

Name	Region	θ_o	$\rho_{l\_bestfit}$, (kg m^{-3})	$T_{e\_bestfit}$, (km)
Aristarchus	309°E, 26°N	3°	1380	12.0
Compton-Belkovith	99.8°E, 60.2°N	3°	1870	8.0
Marius Hills	307.5°E, 14°N	3°	3130	1.0
Rümker	301°E, 40.5°N	3°	2760	0.0
West Copernics	333°E, 16.5°N	3°	1960	6.0

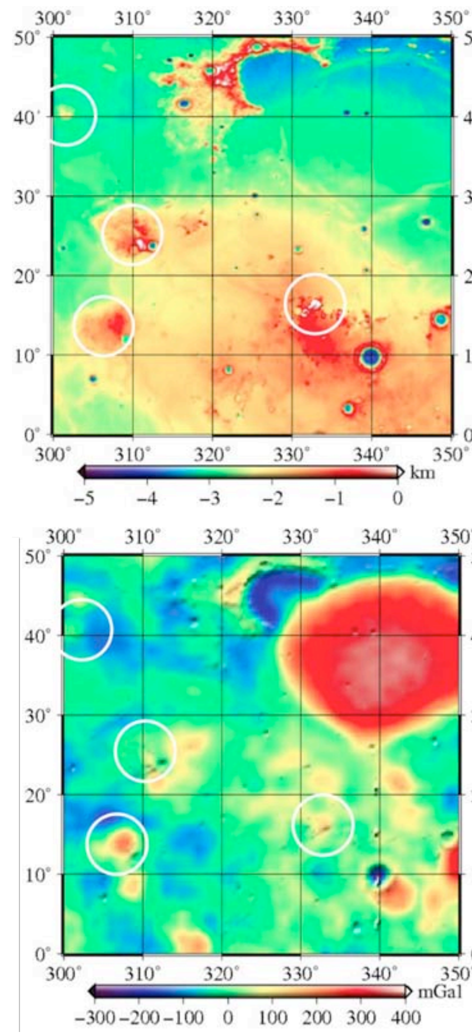

Figure 1: Topography (Lola1439.sh) and radial free-air gravity anomaly (LPE200) of Lunar nearside volcanic provinces. The white-circled localization windows here have an angular radius of 3°.

Using the known topography, theoretical gravity fields were then calculated as a function of load density ρ_l, elastic thickness T_e. Young's modulus E was set to 10^{11}Pa, Poisson's ratio ν was set to 0.25, and the crustal density was set to be 2550 kg m^{-3} from GRAIL gravity analyses [10], mantle density was assumed to be 3360 kg/m^{-3}, and T_c was set to 35 km from average thickness obtained by GRAIL [10]. By varying the parameters ρ_l and T_e, the best-fitting model to the observed admittance can be obtained. Figure 1 shows the chosen localization window with an angular radius of $\theta_0=3^o$ and a spherical harmonic bandwidth of L_{win}= 86.

Results: Figures 2 shows the observed localized and modeled admittances and correlations for these regions. As an interest, we also studied the non-mare silicic volcanism on the lunar farside at Compton–Belkovich [11]. The best-fit loading density ρ_l of Aristarchus, Compton-Belkovith and West Copernics are less than 2000 kg m^{-3}, which is much lower than Marius Hills and Rümker (Tab.1). The loading density of Marius Hills is extremely high, with a crustal density contrast of 580 kg m^{-3}. This contrast is consistent with the results obtained from Kiefer [12], indicating high density materials presented at a certain depth. Small loading density of Aristarchus maybe only presents the porous density of the ejecta carpet from young Aristarchus impact crater. The west Copernices region with low density (higher than Aristarchus) is conceivable part of the ejecta from Imbrium. Rümker Hills has a load with density of 2760 kg m^{-3}, 210 kg m^{-3} higher than the crust, indicating a magma basalt intrusion or buried subsurface load. The constrained elastic thicknesses are as small as 0 km in those regions.

Discussion: By using newly analyzed global models of the Moon's topography and gravity field, we applied admittance analyses on the lunar volcanic complex provinces. The localized admittance and correlation functions were interpreted using a geophysical model that treated the lithosphere as a thin elastic spherical shell with a load on the surface of the crust. Constrained loading density and elastic thickness indicates that Marius Hills and Rümker Hills maybe original volcanic centers, with shield volcano characteristics. Since Our admittance analyses are sensitive to the gravitational field, we believe that higher resolution (~7km) gravity from the Gravity Recovery and Interior Laboratory (GRAIL) will make further contributions to the density and elastic thickness of these volcanic provinces.

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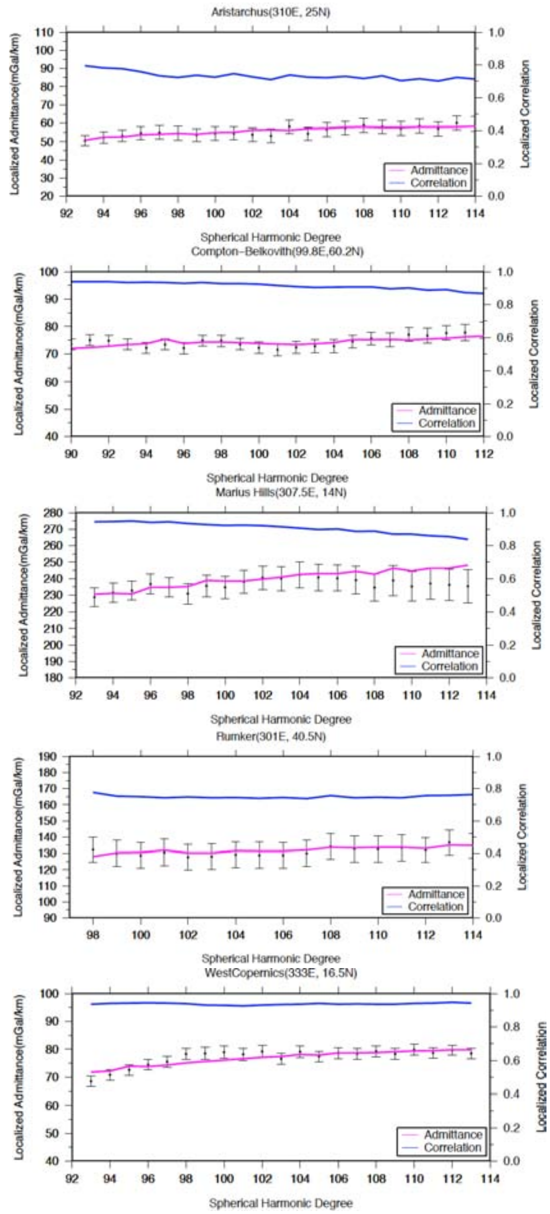

Figure 2. Localized admittance and correlation for the lunar volcanic provinces. Black data points and the blue curve represent the observed admittance and correlation, respectively, whereas the magenta curves are for the model that best fits the admittance.

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