SURVEY OF GRAVITY ADMITTANCE FOR MARS FROM THE HIGH-RESOLUTION MARS RECONNAISSANCE ORBITER DATA. D. C. Nunes[1], S. E. Smrekar[1], and A. Konopliv[1], [1]Jet Propulsion Laboratory, California Institute of Technology, Pasadena CA 91109 (Daniel.Nunes@jpl.nasa.gov).

Introduction: The Mars Global Surveyor (MGS) provided the first high-resolution global view of the martian shape and potential field, which are dominated by the hemispherical dichotomy, the Tharsis volcanic province, and major impact basins [1,2]. The analysis of gravity and topography data is a common approach to understanding the interior structure of terrestrial planets, and has led to the broad characterization of crustal and elastic thicknesses on that planet [e.g., 3]. While spectral approaches are useful in determining different contributions to loading according to spatial scale, they suffer from their inability to handle geographic variations in how topography and gravity relate to each other, especially at regional scales.

The application of spatio-spectral localization schemes to planetary data [4], in turn, allows spectral analysis techniques to be used more effectively with regionally limited features. For Mars, [5] and [6] applied such schemes to obtain the admittance, or transfer function, and the correlation between gravity and topography for the major volcanoes. These were modeled with thin elastic shell flexure formulations and, in the majority of cases, the resulting elastic thickness estimates are large, ranging between 50 and 100 km. Such results are used in conjunction with cratering-derived surface ages to constrain thermal models for Mars.

These two studies, however, utilized the spherical harmonic expansion jgm85h02 of [7], which has a resolution of 125 km or 85 degree and order (D&O). Due to coefficient uncertainties, geophysical analyses are limited to D&O ~60 (175 km). While additional tracking data from the Mars Odyssey further improved the MGS gravity solution, the similarity between the orbits of the two spacecraft limited gains in spatial resolution to about ~180 km, with errors limiting geophysical studies to harmonic degree ~70 (150 km) [8]. Another aspect of the work of [5] and [6] is that they choose a single admittance spectrum to represent a given region.

Our goal with this work is to incorporate the much higher resolution gravity data from the Mars Reconnaissance Orbiter (MRO) in obtaining admittance spectra via a spatio-spectral localization approach and assess whether local variations in admittance spectra are sufficiently noticeable to alter estimates of lithospheric properties.

Gravity and Topography Data: The MRO Radio Science (RS) experiment was expected to improve the solution of the potential field of Mars to ~100 km because of better signal strength, lower noise, and a lower spacecraft altitude [9]. Here we adopt the preliminary solution MRO110B, which extends to degree and order 110 (97-km resolution). Globally, the degree strength, where power of the unconstrained uncertainties matches the power of the coefficients, occurs at D&O 90 (118 km).

For topography, we use a spherical harmonic expansion of the MOLA 128 pixel/degree gridded data, truncated to 110 D&O to match the gravity field. For their common bandwidth, coefficient power in this expansion matches those in the topographic expansion gtm090aa furnished by the Planetary Data System (PDS).

Approach to Admittance: We adopt the localization approach of [4], which consists of a spatially windowing data that is then transformed into spherical harmonic domain via a convolution and applied to a localization transform. The adopted window consists of a spherical cap that is centered at a desired location, is isotropic, and scales according to the wavelength (or harmonic degree). The spectral bandwidth of the window, L_{win}, is set to 16.

We conduct the localization over the entire globe of Mars at every degree of latitude and longitude, and the output consists of 64,800 admittance spectra.

Spectral Classification: Due to the challenging nature of modeling such a large number of spectra with a relatively wide parameter space for load, crustal and lithospheric properties, [10] applied an interative self-organizing spectral classification technique (ISODATA) that identifies spectral classes according to their similarity (albeit for Venus). Each class is then iteratively mapped onto the globe using minimum distance techniques. Each spectral class can be represented by an average spectrum and its standard deviation.

With the goal of preventing noisy data from affecting our classification, we have limited the ISOSDATA scheme to the bandwidth from 2 to 90 degree and order, thus conforming to the global degree strength of the MRO110B gravity field.

Results:

Overall Highland-Lowland Dichotomy: The predominant characteristic to arise in our analysis is a strong dichotomy in admittance spectral signature between the southern highlands and the northern lowlands. In a spectral classification exercise limited to 20 classes, the southern highlands are almost exclusively dominated by only four classes, which contain ~70% of all spectra. In each of these four classes, spectra are predominantly smooth, tending to be flat (<300 mGal/km) across the spectral bandwidth and remaining within 2 standard deviations from the mean. Instances of these four classes occur in the northern lowlands, but they generally have substantial oscillation in value (at least several 10's of mGal/km) from degree to degree and exceed 3 standard deviations from the mean. Of the remaining 16 spectral classes, 15 occur almost entirely in the northern lowlands and they are characterized by large admittance values (>500 mGal/km) and display large oscillations (>50 mGal/km) from degree to degree. The last remaining spectral class characterizes most of the large volcanoes, a portion of Isidis basin, and a portion of the northern polar region.

Major volcanoes: We have surveyed admittance spectra of ten of the martian volcanoes (Alba, Amphitrites, Apollinaris, Arsia, Ascraeus, Elysium, Malea, Olympus, Pavonis, and Syrtis). Except for Alba, all of the volcanoes fall into one of two groups. The high-admittance group (Amphitrites, Apollinaris, Arsia, Ascraeus, Elysium, Olympus, and Pavonis) has spectra that, on average, increase in admittance to between 100 and 150 mGal/km up to degree 30, and remain near that level all the way to degree 90. The low-admittance group (Malea and Syrtis) also increases in admittance over degrees 2 to ~25, but reaches only ~50 mGal/km. Beyond degree 25, average admittance values for these volcanoes drop to zero or negative values. The spectral signature of the Alba edifice is less clear, encompassing three spectral classes.

Olympus Mons: To better illustrate our analysis, we here focus on Olympus Mons and its surroundings. Fig. 1 contains all the spectra in a 16° box centered at 18°N, 227°E. The green curves correspond to spectral class 7 that dominates the volcanic edifice. On average, admittance values increase from 110 to 150 mGal/km between degrees 15 and 50, then drop back to 110 mGal/km at degree 90. A noticeable variation in behavior is seen in some spectra beyond degree 50, however. A second spectral class (5), blue curves, is observed at the northwestern scarp of Olympus and over the immediate portion of the aureole deposits. Although similar to class 7 up to degree 45, admittance values drop to 80 mGal/km and remain flat beyond degree 70.

We have also included in Fig. 1 the Olympus Mons panel of Figure 4 from [6]. The inset contains the admittance spectrum (grey curve with error bars) used by [6] to interpret elastic flexure models. Although their admittance values are slightly higher than ours, perhaps due to their window being more efficient, their spectrum is not necessarily representative of the area.

Discussion: The dichotomy in spectral behavior between the northern lowlands and southern highlands is notable and remains to be properly explained. The fact that admittance values can reach very high values (1000 mGal/km) may possibly derive from the very weak spectral power in the topographic field due to the smoothness of the NL caused by infilling.

The major volcanoes on Mars fall into two distinct categories: high-admittance and low-admittance. We are currently implementing a thin spherical-shell flexure model to interpret these results and will soon report on our findings. However, as shown here, interpretation should take into consideration all of the spectra occurring in a given region of interest, as a single spectrum may not capture all of the regional processes.

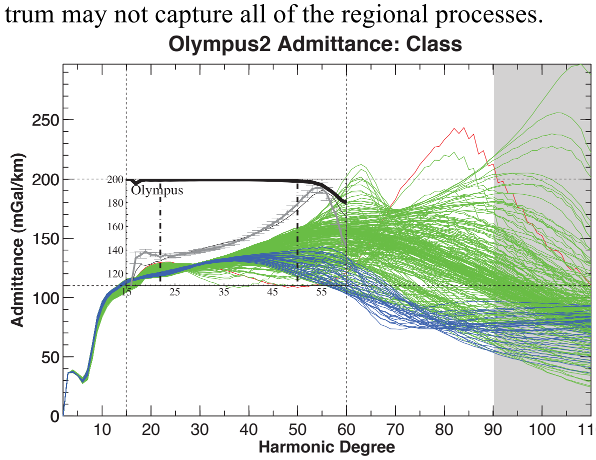

Fig. 1 - Colored curves depict admittance obtained for Mount Olympus, where tint represents different spectral types. Inset corresponds to the Olympus panel of Figure 4 from [4], containing admittance (grey) and correlation (black) curves. Harmonic degrees beyond 90 (shaded area) are not considered for spectral classification purposes.

References: **[1]** Smith D. E. et al. (1999), *Science*, *284*, 1495-1503.**[2]** Smith, D. E. et al. (1999), *Science*, *286*, 94-97. **[3]** Zuber M. T. et al. (2000), *Science*, *287*, 1788-1793. **[4]** Simons M. et al. (1997), *GJI*, *131*, 24-44. **[5]** McGovern P. J. et al. (2002), *JGR*, *107*, doi:5110.1029/2002JE001854. **[6]** Belleguic V. et al. (2005), *JGR*, 110, doi: 11010.11029/12005JE002437. **[7]** Lemoine F. G. et al. (2001), *JGR*, *106*, 23359-23376. **[8]** Konopliv A. S. et al. (2006), *Icarus*, *182*, 23-50. **[9]** Zuber M. T. et al. (2007), *JGR*, *112*, doi:10.1029/2006JE002833. **[10]** Anderson F. S. and S. E. Smrekar (2006), *JGR*, *111*, doi:08010.01029/02004JE002395.