IMPACT OF ANELASTICITY ON MARS' DISSIPATIVE PROPERTIES – APPLICATION TO THE *INSIGHT* MISSION.

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Introduction: We revisit the interpretation of Mars' dissipation factor inferred from the secular acceleration of Phobos. The low value of that parameter has been interpreted as evidence for the existence of a highly dissipative region within Mars' mantle or crust.

While previous approaches have relied on the assumption that Mars' mantle behavior can be described by a viscoelastic model [e.g., 1], we demonstrate that material anelasticity is likely responsible for the observed dissipation, consistently with experimental measurements, and deemphasize the need for a highly dissipative region.

Modeling Approach: Material attenuation is a complex phenomenon determined by the density, geometry, and mobility of defects in the material [e.g., 2]. Per analogy with Earth, Mars' mantle deformation is believed to deform in the dislocation creep regime, and this even at the low stress exerted by Phobos. Attenuation measurements of silicate materials deformed in that regime at a forcing period of a few hours [e.g., 3] are consistent with the general description of the Andrade model. That model associates a Maxwell element representing material viscoelasticity and a term describing material anelasticity, as a function of a parameter α that represents the degree of heterogeneity of the material and β, a function of the density of defects in the material [4].

We model the interior of Mars following the approach considered in previous studies [e.g., 5] assuming that the primary source of dissipation stems from the mantle. The contribution of the elastic crust to the global dissipation budget of the planet is negligible.

Results and Discussion: In the case of the Maxwell model, the observed k_2^{pho}/Q^{pho} matches a mantle viscosity of ~2×10^{16} Pa s (Fig. 1). If one accounts for the attenuation due to anelasticity, then the mantle viscosity required to explain k_2^{pho}/Q^{pho} ranges from 10^{18} to 10^{22} Pa s. The uncertainty is due to the broad range of values for the parameter α considered in this study. Indirect constraints on the value of that parameter suggest it is closer to 0.15-0.2 [2]. That lower bound corresponds to a mean mantle viscosity of 10^{22} Pa s, which in turn suggests an average mantle temperature of ~1700 K [6] and is consistent with geophysical evolution models [e.g., 7]. In the continuation of this work we will compute the attenuation spectrum of Mars for a broad range of input parameters and in the prospect of the SEIS and RISE experiments proposed as part of the *InSight* mission (under review).

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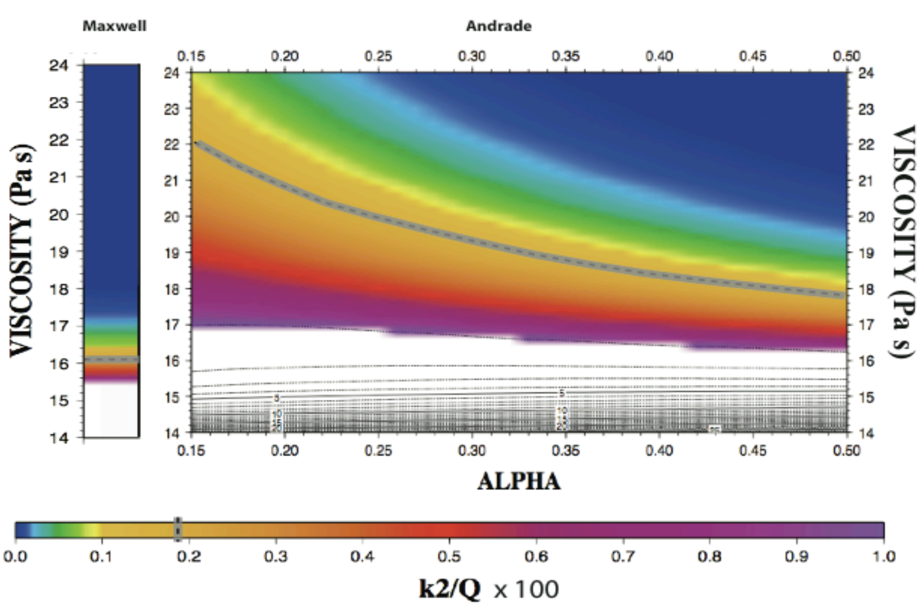

Figure 1. k_2^{pho}/Q^{pho} computed for two dissipation models, Maxwell and Andrade, as a function of the viscosity assumed for Mars' mantle and the Andrade parameter α. This model includes a core radius of 1700 km, an inner solid core of 1100 km, and a crust thickness of 50 km, consistently with the observed moment of inertia [8]. The space of results matching the observed k_2^{pho}/Q^{pho} is marked by the thick dotted line.