Evidence for Silicate Regoliths on 27 Main-belt M-type Asteroids

Z. A. Landsman[1], J. P. Emery[2], H. Campins[3], L. Lim[4], D. Cruikshank[5]

[1] *University of Central Florida/Florida Space Institute, Orlando, FL, United States*
E-mail: zoe.landsman@ucf.edu
[2] *University of Tennessee, Knoxville, United States*
[3] *University of Central Florida, United States*
[4] *NASA Goddard Space Flight Center, United States*
[5] *NASA Ames Research Center, United States*

Introduction: The Tholen "M"-type asteroids are characterized by moderate albedos and red, relatively featureless visible-wavelength spectra [1]. Radar data (e.g., [2]) and comparisons with iron meteorites suggest that some M-types have high metal content, and a few may be remnant iron cores. Among these is (16) Psyche, the target of an upcoming NASA mission [3].

Intriguingly, there is also spectroscopic evidence for both mafic minerals (especially pyroxene) (e.g., [4]) and hydroxyl (attributed to hydrated minerals) [5,6] on the surfaces of many M-type asteroids, including some of those thought to be metallic.

Methodology: We have analyzed mid-infrared (5-35 µm) spectra of 27 M-type asteroids. These data [7,8] were collected using the Spitzer Space Telescope's Infrared Spectrograph during its cryogenic mission. We fit a simple thermal model, the NEATM [9], to constrain the thermal properties of the asteroids. In particular, we are interested in the beaming parameter (η), which is a rough proxy for the asteroid's thermal inertia. In future work, we will model a subset of the larger sample using a thermophysical model to derive thermal inertias.

We then remove the modeled thermal contribution from each spectrum to reveal emissivity features, and interpret these residual spectra to constrain the surface composition of each asteroid.

Preliminary Results: The beaming parameters for the sample range from $\eta = 0.84$ (±0.03) to $\eta = 1.4$ (± 0.1). There is a slight positive correlation (Pearson's r ~ 0.4) between beaming parameters and radar albedos (Figure 1). This suggests that the elevated regolith density at the depths probed by radar (~1m) may also be present at the more superficial depths probed by thermal emission studies of main-belt M-types (the thermal skin depth, ~1mm-1cm).

We also found that the emissivity spectra of all 27 asteroids in the sample show excess emission from ~9-12 µm. This is attributed to the Si-O stretch and bend fundamental band in silicates and is associated with fine-grained (<75 µm particles) and/or under-dense silicate regolith [10,11].

Conclusions: There is a slight correlation between the beaming parameter and radar albedo in our sample (N=27), consistent with elevated metal content in the high-radar albedo M-types. However, the emissivity spectra are consistent with the presence of fine-grained silicates for the whole sample.

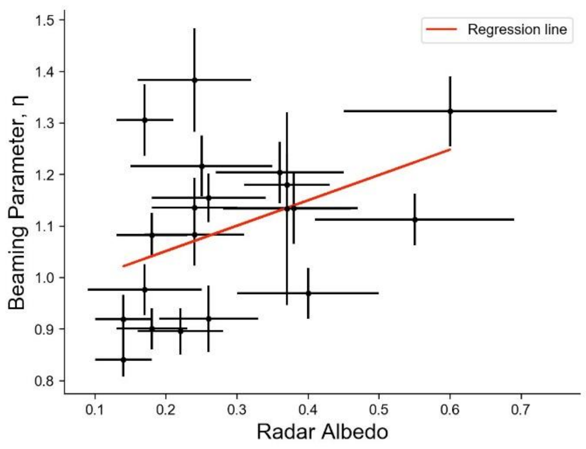

Figure 1: Beaming parameter vs. radar albedo

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