NEAR-IR SPECTROSCOPY AND POSSIBLE METEORITE ANALOGS FOR ASTEROID (253) MATHILDE.

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Introduction: Main-belt asteroid (253) Mathilde was discovered November 12, 1885 by J. Palisa at Vienna. It was probably named in honor of Mathilde, née Worms, wife of the astronomer Moritz Loewy (1833-1907), vice-director of the Paris Observatory [1]. Prior to the 1980s Mathilde received little attention aside from astrometric measurements.

The asteroid was included in spectrophotometric surveys in the mid-late 1980s [2-4], and in the IRAS survey [5]. These studies provided albedo and diameter estimates, and sufficient information to classify Mathilde as a C-type asteroid.

Mathilde became the subject of intense interest in the 1990s when it was announced that the asteroid would be the target of a spacecraft flyby. Various studies provided rotation rate, size estimates, and additional spectrophotometric data [6,7]. Based on these newer data, and existing analyses of carbonaceous chondrites, Mathilde was interpreted as having a surface dominated by either strongly heated carbonaceous chondrite materials (to an extent not seen in meteorite collections), or a shock-darkened ordinary chondritic material.

In June 1997 the Near Earth Asteroid Rendezvous (NEAR) spacecraft passed within 1212 kilometers of Mathilde on the way to its primary target, (433) Eros. Due to power constraints only one of NEAR's six instruments, the multispectral imager (MSI), was turned on for this encounter [8].

Present work: Observations of (253) Mathilde were obtained on August 8, 2001 (UTC) using the NASA Infrared Telescope Facility at Mauna Kea Observatories in Hawaii. Near-infrared data were collected using the SpeX medium-resolution spectrograph. The instrument was used in a low-resolution mode (0.5 by 15 arcsec slit) to obtain six spectra of the asteroid over the wavelength range of ~0.75-2.55 microns. Data reduction and analysis methods followed standard procedures described previously (Gaffey et al. 2002 and references therein).

The spectrum of Mathilde exhibits an absorption feature near 0.9 microns that is offset from features caused by solid or liquid water and from telluric water vapor. The spectrum lacks a 2-micron feature, which rules out the CV3 carbonaceous chondrites as analogs for the asteroid. Mathilde provides a good match to carbonaceous chondrites dominated by phyllosilicate minerals and appears to have undergone an alteration process similar to CI1 or CM2 chondrites.

However, some CI1 and CM2 chondrites better match the features of Mathilde. Figures 1 and 2 compare Mathilde to Orgueil (CI1) and an average of Cold Bokkevelt & Murray (CM2). The the ~0.9 µm feature is evident in all of these spectra.

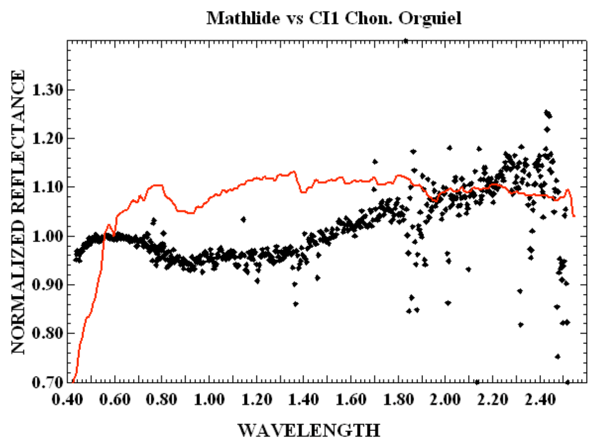

Figure 1 – Normalized reflectance spectrum of Mathilde (SpeX & SMASS data) compared to the CI1 chondrite Orgueil [10] (red line). Note the weak ~0.9 µm absorption feature in both spectra.

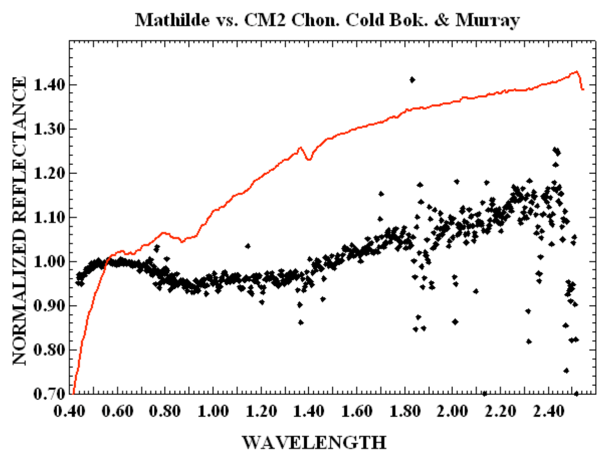

Figure 2 – Normalized reflectance spectrum of Mathilde (SpeX & SMASS data) compared to the CM2 chondrites Cold Bokkeveld & Murray (averaged). The ~0.9 µm is somewhat weaker in these two meteorites.

By contrast Figures 3 & 4 compare Mathilde to an average of Murchison & Meghei (CM2) and Nogoya (CM2) which were altered under different parent body conditions. These do not exhibit the ~0.9 µm feature seen in the Mathilde spectrum and exhibit an ~0.7 µm feature not seen in Mathilde.

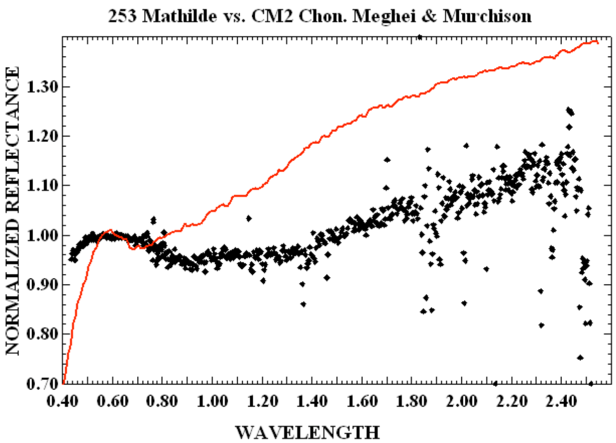

Figure 3 – Normalized reflectance spectrum of Mathilde (SpeX & SMASS data) compared to the CM2 chondrites Meghei & Murchison (averaged). The ~0.9 µm is essentially absent in these two meteorites, but a feature is present near 0.7 µm.

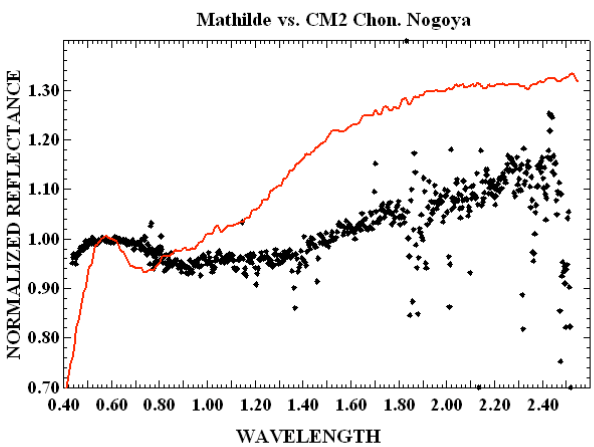

Figure 4 – Normalized reflectance spectrum of Mathilde (SpeX & SMASS data) compared to the CM2 chondrite Nogoya. The ~0.9 µm is very weak in this meteorite, but a strong feature is present near 0.7 µm.

Understanding the nature of these features will require additional work, but the present results indicate that C-type asteroid spectra contain considerably more compositional information than is commonly supposed. Careful observations and data reduction combined with detailed data analysis should open a clear window onto the diversity of materials subsumed within the generic C-classification.

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