MINERALOGICAL CHARACTERIZATION OF NEAR EARTH AMOR ASTEROID 1036 GANYMED.

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Introduction: 1036 Ganymed is the largest Amor asteroid. Previous investigators have observed 1036 Ganymed, but have not been able to sufficiently characterize the asteroid's surface either due to limited wavelength coverage (0.3 – 0.9 µm) or due to inconsistent data [1,2,3]. We present a mineralogical assessment of data obtained May 18, 2006 UT combined with 24 Color Asteroid Survey data to cover the spectral interval of 0.3 – 2.45 µm.

Observations/Data Reduction: 1036 Ganymed was discovered on October 23, 1924 by Walter Baade. 1036 Ganymed is the largest Amor asteroid with a SIMPS diameter of 31.66±2.8 km, IRAS albedo of 0.2926±0.059, and rotational period of 10.31±0.002 hours [4,5]. Ganymed is a member of the S taxonomic class [6] and the S (VI) compositional subtype [3].

Observations of 1036 Ganymed were obtained on the night of May 18, 2006 UT at the NASA Infrared Telescope Facility located on Mauna Kea, Hawai'i. The spectra were obtained using SpeX in the low-resolution spectrographic mode. A total of sixty spectra were obtained of 1036, of these, forty-four were used in the analysis. The first spectrum of each set was discarded due to persistence, a single spectrum was discarded because it was incomplete, and the last set of ten spectra were discarded due to poor quality because of deteriorating weather conditions.

Asteroid and local standard star spectra were interspersed within the same air mass range to give optimal modeling of atmospheric extinction. 1036 Ganymed's spectral observations were 120 seconds long, standard star SAO 157621 spectral observations were one second long, and solar analog SAO 120107 spectral observations were one second long.

Extraction of spectra, determination of wavelength calibration, and data reduction were done using procedures outlined by [7,8,9]. Each asteroid flux curve was divided by the starpack that most effectively removed the atmospheric water vapor features to produce a final spectrum. Individual spectra were averaged together to produce an average spectrum. Points were deleted that deviated by more than two standard deviations away from the mean. See Figure 1. The average spectrum was then ratioed to an average of the solar analog spectra to correct for any non-solar spectral properties of the standard star. See Figure 2.

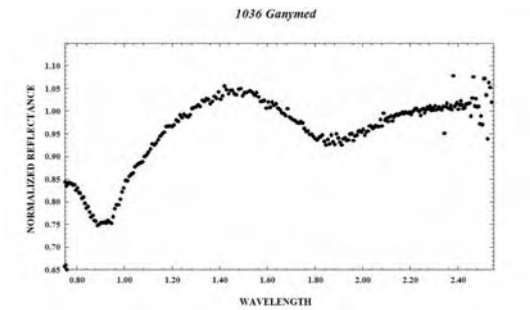

Figure 1: The average spectrum of 1036 Ganymed for the night of May 18, 2006 UT.

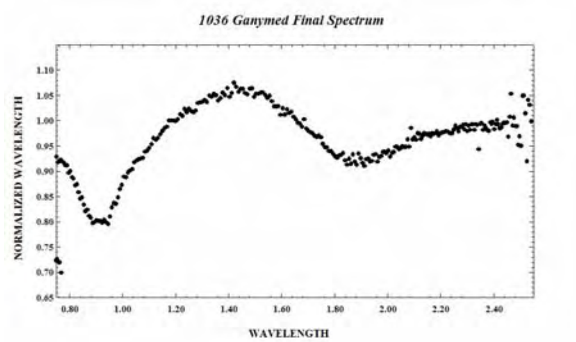

Figure 2: 1036 Ganymed ratioed to the solar analog. There was not a significant difference between the average spectrum in Figure 1 and this one, except for a slight slope variation.

Analysis: The spectrum exhibits two broad absorption features typical of pyroxene-olivine mixtures. After dividing each spectral interval by a straight-line continuum band centers were determined by fitting an n-order polynomial to each feature. The first absorption feature was located in the ~0.9 µm region and was fit with a fifth order polynomial. The band center was calculated at 0.92 ± 0.01 µm, and the feature is ~10% deep. Errors were estimate from the variations of fits of different orders for different spectral intervals around the band center. See Figure 3. The second absorption feature was located in the ~1.9 µm region and was fit with a fifth order polynomial. The band center was calculated at 1.86 ± 0.01 µm, and the feature is ~6% deep. See Figure 4. Due to temperature induced spectral shifts (the mean asteroid surface temperature was ~100 K colder than the lab samples used in the interpretive calibrations) the Band II center was temperature corrected (effectively warmed) by +0.025 µm to yield a Band II center of 1.89 µm. The Band Area Ratio calculated for the features yielded a value of 1.4 ±0.08.

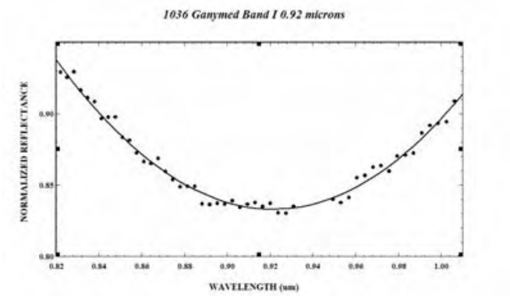

Figure 3: 1036 Ganymed's Band I center shown with the associated polynomial fit to the feature.

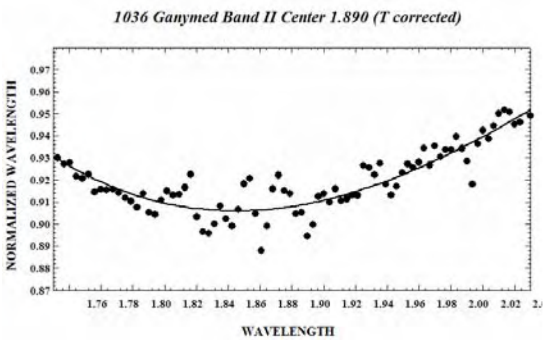

Figure 4: 1036 Ganymed's Band II center with the polynomial fit to the feature. The value of the Band II center was shifted by +0.025 µm to account for temperature induced spectral effects.

1036 Ganymed's band centers were plotted on the Band I vs. Band II plot [10,11]. 1036 Ganymed falls on the trend line between the orthopyroxene/clinopyroxene border suggesting that the silicate component on the asteroid surface is primarily pyroxene. Using equations outlined by [12] the chemical composition of the average pyroxene was calculated to be Fs_{23}(±5)Wo_3(±3). Using the BAR of 1.4 and plotting it on the S-Asteroid sub-type plot derived by [3], 1036 Ganymed plots within the S (VI) subtype region. See Figure 5. This suggests an orthopyroxene-rich surface composition possibly with metal. The slope of Ganymed is not as red as would be expected if there were a significant metal component on the surface. However, the possibility cannot be ruled out because there may be a component of wüstite (FeO) coating the metal grains optically masking the metal [13].

Conclusions: Results of the analysis indicate 1036 Ganymed is an S (VI) asteroid with a surface silicate assemblage consisting of opx and cpx, (Fs_{23}(±5)Wo_3(±3) average of both phases), which is consistent with band centers and band area ratios. Figure 6 is the complete spectrum covering the 0.30-2.45 µm interval. A meteorite affinity is currently under investigation and will follow with the geologic history of the asteroid.

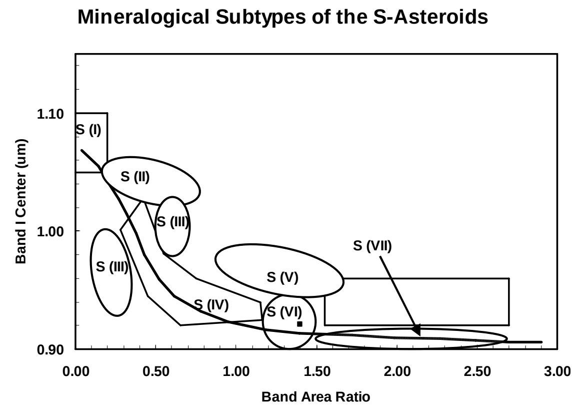

Figure 5: 1036 Ganymed (solid black square) plotted on the S Subtype plot. Ganymed plots within the S (VI) region indicating a surface assemblage consisting of opx-rich silicate possibly with metal.

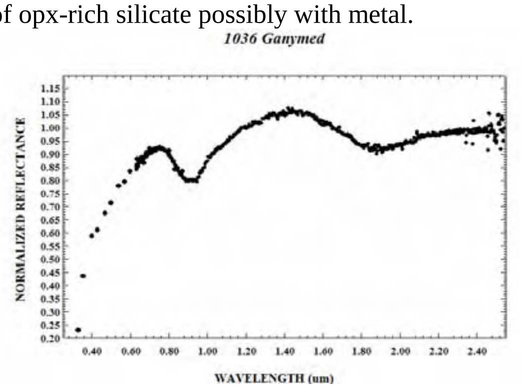

Figure 6: 1036 Ganymed's May 18, 2006 UT spectrum plotted together with the visible spectrum from [1].

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