CCD REFLECTANCE SPECTRA OF SELECTED ASTEROIDS; F. Vilas, NASA Johnson Space Center/SN3, Houston, TX 77058; L. A. McFadden, California Space Institute, University of California, San Diego, La Jolla, CA 92093.

Studies of the surface mineralogical composition of asteroids have been conducted using broadband and narrowband photometry of diffusely reflected sunlight from an asteroid's surface (e.g., Chapman and Gaffey, 1979; Zellner et al., 1985). Recent advances in instrumentation have allowed scientists to obtain relative reflectance spectra of asteroids with increased spectral resolution (e.g. Vilas and Smith, 1985). This higher resolution should improve asteroid studies by delineating subtle absorption features masked by the smearing effect of broad passband filters; refining the measurement of changes in spectral shape; and clearly demonstrating the presence of telluric water absorption and other atmospheric effects still apparent following the reduction of the data. Reflectance spectra of 35 asteroids were acquired during the years 1984 - 1987 to address various problems related to the composition and origin of asteroids (e.g. Vilas and Gaffey, 1989; McFadden and Vilas, 1987). Collectively, these spectra will be used in studies of the surface composition of primitive asteroids, statistical studies of slope differences among outer-belt asteroids, searches for ordinary chondrite sources among small-diameter asteroids in the 3:1 Kirkwood Gap chaotic zone, and studies of near-Earth asteroids.

Observations

Observations were made in 1984, 1985, and 1987 using the1.5-m telescope at the Cerro Tololo Inter-American Observatory, Chile, with the facility Cassegrain spectrograph coupled to a General Electric epitaxial CCD. During the 1984 and 1987 observing runs, a Schott GG 495 filter was used to limit the spectral range to 0.495 - 0.990 μm. A Schott OG 530 filter was used in 1985 to limit the spectral range to 0.53 - 1.00 μm. The range shown in each spectrum depends upon the quality of the spectrum, and data point which were obviously spurious were deleted. The data acquisition and reduction procedures are described extensively in Vilas and Smith (1985). All spectra and photometry have been scaled to a reflectance of 1.00 for the wavelength of 0.7 μm. All dates discussed are Universal Time.

1 Ceres

This spectrum of 1 Ceres is a composite of 31 spectra obtained at an air mass equal to 1.00 over a 30-min time interval. This composite spectrum of Ceres shows two weak absorption features centered at 0.60 μm and 0.67 μm. These features do not correlate with any of the weak features identified by Golubeva et al. (1983) in their spectrum of Ceres. In addition, the weak features identified by Golubeva et al. in the wavelength range common to both spectra (0.48 - 0.75 μm) are noticably absent from this new Ceres spectrum.

Near-Earth Asteroids

Three near-Earth asteroids have been observed. Spectra of 433 Eros and 1036 Ganymed, the two largest planet-crossing asteroids, confirm previous observations. Asteroid 1866 Sisyphus was observed on two nights in June, 1985. The spectrum shows that it is an S-type asteroid. A 3% variation in the depth of the 1-μm silicate absorption feature between the spectra taken on the two different nights was noted by Vilas and McFadden (1985), however, the noise apparent in the 6/09/85 spectrum renders this determination cautionary. Kresak (1979) cites 1866 as a candidate for cometary origin based upon its librating argument of perihelion. Hahn and Lagervist (1988) integrated the orbit of Sisyphus showing that it will evolve into the Flora region of the main asteroid belt in 30,000 years. This orbit could also have evolved from that region. Based upon the predominance of S-class asteroids in the inner regions of the main belt, 1866 Sisyphus is not likely to be an extinct cometary nucleus.

Asteroids Near the 3:1 Kirkwood Gap Not in the Chaotic Zone

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Spectra of three S-class asteroids which are located near the 3:1 Kirkwood Gap, but not in the chaotic zone defined by Wisdom (1985) were obtained. Asteroid 695 Bella was observed on the nights of 6/07/85 and 6/09/85. Assuming a period of 14.222 hrs (Dermott et al., 1984), these spectra represent opposite sides of the asteroid. No variation in depth of the 1-μm silicate absorption feature to within 1% is apparent.

Asteroids in the 3:1 Kirkwood Gap Chaotic Zone

Wisdom (1985) proposed that the chaotic zone near the 3:1 Kirkwood Gap could be the source region for the ordinary chondrite meteorites. As part of a search for ordinary chondrite analogues among small-diameter asteroids, CCD reflectance spectra were obtained of seven asteroids located in this zone ($2.47 \leq a \leq 2.53$ AU). Asteroids 877 Walkure and 495 Eulalia have flat spectra. Asteroids 292 Ludovica, 908 Buda, 1368 Numidia, 1722 Goffin, and 2113 Ehrdni have spectra with prominent UV and 1.0-μm absorptions, indicating the presence of mafic silicates, and belong to the S class. The spectrum of 908 Buda is affected by the incomplete removal of telluric H_2O, partly masking the 1.0-μm absorption.

Main-Belt Primitive Asteroids

In order to compare the surface mineralogy of main-belt and outer-belt asteroids, efforts to obtain spectra of asteroids classified as P or D but located in the main asteroid belt have resulted in spectra of 102 Miriam (P) and 368 Haidea (D). These high-resolution reflectance spectra are not similar to spectra of asteroids from the same classes located in the outer part of the solar system.

Cybeles

Spectra of 11 asteroids in the Cybele zone (outside the main asteroid belt between the 2:1 and 5:3 resonances with Jupiter's orbit) were obtained as part of an effort to study the outer belt asteroids. No previous spectral information on asteroids 528 Rezia and 940 Kordula is available. Asteroid 528 Rezia has a flat spectrum and the IRAS albedo value of 0.054 ± 0.004, consistent with the C-class asteroids. The spectrum of 940 Kordula shows a slightly positive slope similar to the EMP classes. Spectra of the only two S-class asteroids identified in the outer belt, 483 Seppina and 692 Hippodamia, were obtained. Both asteroids have very shallow 1.0-μm absorptions. No turnover suggesting a silicate absorption band near 1.0 μm is present in the reflectance spectrum of 570 Kythera, which has previously been classified as ST. The spectrum is more reddened than a D-class asteroid spectrum. Asteroid 1467 Mashona has a flat spectrum until 0.75 μm, where it increases sharply in slope. Asteroid 566 Stereoskopia has a slight positively -sloped spectrum similar to the P-class asteroids. No infrared turnover was apparent in the spectrum of 733 Mocia (F). The spectra of 76 Freia (P), 121 Hermione (C), and 1167 Dubiago (D) were consistent with their classifications.

Hildas

Three P-class asteroids in the Hilda zone (the 3:2 resonance with Jupiter's orbit) were observed in this program. The spectra of 748 Simeisa, 1162 Larissa, and 1512 Oulu are consistent with their classifications.

Trojans

D-class asteroids comprise the majority of the Trojan asteroids. One objective of this observing program was to obtain high quality spectra of D-class asteroids, in particular those among the Trojans. Spectra of 884 Priamus (D), 1172 Aneas (D), 2357 Phereclos (D), 2674 Pandarus (D) and 1208 Troilus (P) were obtained.

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