DERIVING THE DISTRIBUTION OF ORDINARY CHONDRITE (H, L, LL)-LIKE MATERIALS IN ASTEROIDS FROM THEIR VISIBLE AND NEAR-INFRARED REFLECTANCE SPECTROSCOPY.
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Introduction: It has been an important question whether the high abundance of ordinary chondrites really reflects their abundance in the main asteroid belt. The abundant S-type asteroids and less abundant Q-type asteroids could contain significant amount of ordinary chondrite materials of different degrees of thermal metamorphism and space weathering [1]. On the other hand, there is a study that indicates only about 25 % of the main-belt S asteroids could be made of ordinary chondrite materials [2]. This issue is highly related to the nature of space weathering on pyroxene, olivine, and metallic iron. Here, we have attempted to identify asteroid surface materials similar to ordinary chondrite types by examining reflectance spectra of the S, A, R, and V asteroids over the 1-μm band range, and derive their distributions.

Experimental: Visible and near-infrared telescopic reflectance spectra of 53 S/A/R/V asteroids were taken from the 24-color [3], eight-color [4], and 52-color surveys [5]. Eighteen powder samples and three pellet samples ordinary chondrites were prepared, and the pellet samples were irradiated with pulse laser at 5-mJ energy for simulating a space weathering process [6, 7]. Bidirectional reflectance spectra of the above samples were measured at 30° incidence and 0° emergence angles.

Data Analysis: Reflectance spectra of ordinary chondrites and many brighter asteroids are known to show a 1-μm absorption band which is characteristic of 3d-electron transitions of Fe^{2+} ions in common geologic silicates, mainly pyroxene and olivine. Because ordinary chondrite types have each different modal abundances of pyroxene and olivine, this 1-μm band feature can be used to distinguish them. Shown in Fig. 1 is such a scheme. Each reflectance spectrum is divided by a tangential continuum curve (linear to wavenumber) over the 1-μm band, of which the natural logarithm is taken, and the absorption strength at 0.95, 1.05, and 1.25 μm are calculated. These wavelengths represent absorption band centers of pyroxene and olivine. As shown in Fig. 2, ratios of these band strengths of ordinary chondrites show a good correlation and well define the range of each ordinary chondrite type. Three pellet samples irradiated with pulse laser still stayed in the same type range in the plot. It is believed that while space weathering affects the band strengths, the relative strengths of nearly bands tend to stay the same. For that reason, this scheme is believed to be less influence by space weathering than the other, more common scheme [*e.g.*, 8] which utilizes the 2-μm absorption band of pyroxene.

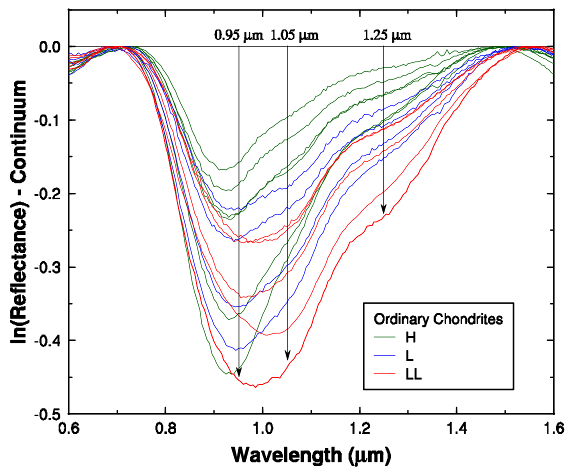

Fig. 1. Continuum-removed natural log reflectance spectra of ordinary chondrite samples. Absorption band strengths at key wavelength positions are indicated with arrows.

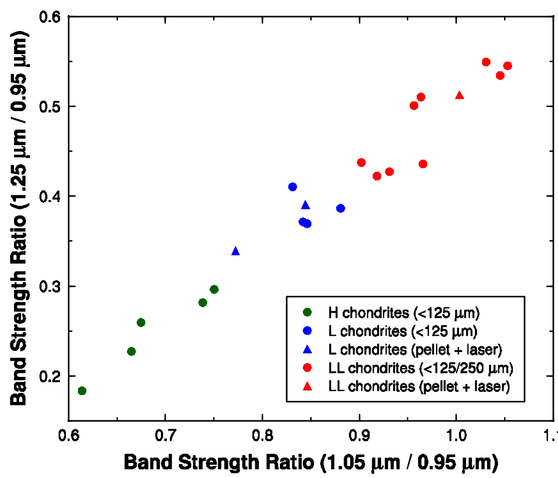

Fig. 2. Three band strength ratio plot of ordinary chondrite samples, including pellet sample irradiated with pulse laser to simulate space weathering.

The same calculation is applied to 53 S/A/R/V asteroid spectra, and the results are plotted in Fig. 3 together with ordinary chondrites. Based on this plot, those asteroids can be classified into pyroxence-rich (lower-left), H-like, L-like, LL-like, and olivine-rich (upper-right) asteroids. Their number populations are compared with those of meteorites in Fig. 4. Fewer than 50 % of these asteroids are consistent with ordinary chondrites in mineral assemblage, meteorites seem to overrepresent L and underrepresents LL chondrites, and there is the "dunite shortage". The semimajor axes and eccentricities of the classified asteroids are plotted in Fig. 5. A notable trend is that H-like asteroids seem to be concentrated around the 3:1 Kirkwood Gap at 2.5 AU.

Discussion: Although this study may not have statistically significant number of samples, there is a clear sign that the ordinary chondrite population is different between meteorites and asteroids. The overrepresentation of L and underrepresentation of LL chondrite meteorites cannot be explained by their physical weakness in comparison with the H chondrites. Shortage of olivine meteorites is too clear to deny. We plan to increase the number of asteroids by utilizing other surveys by the time of our presentation.

References: [1] Binzel R. P. et al. (2004) *Icarus, 170*, 259-294. [2] Gaffey M. J. et al. (1993) *Icarus*, *106*, 573-602. [3] Chapman C. R. and Gaffey M. J. (1979) In *Asteroids*, 655-687. [4] Zellner B. et al. (1985) *Icarus*, *61*, 355-416. [5] Bell J. F. et al. (1988) *LPS*, *XIX*, 57-58. [6] Yamada M. et al. (1999) *EPS*, *51*, 1255-1265. [7] Sasaki S. et al. (2001) *Nature, 410*, 555-557. [8] Gaffey M. J. et al. (1993) *Icarus*, *106*, 573-602. [9] Grady M. M. et al. (1999) *Catalogue of Meteorites*, pp. 7-8.

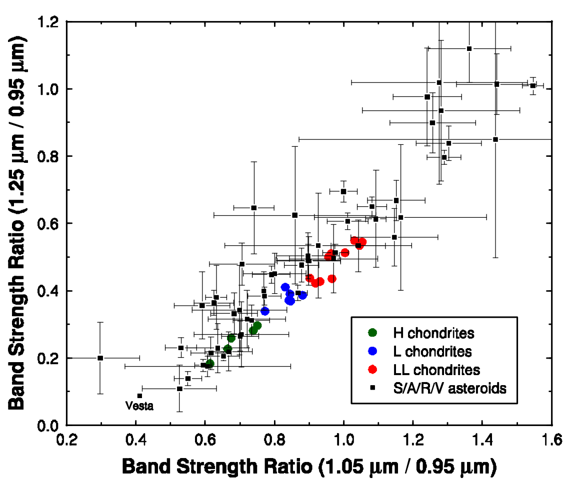

Fig. 3. Similar three band strength ratio plot to Fig. 2 which includes 53 S/A/R/V asteroids.

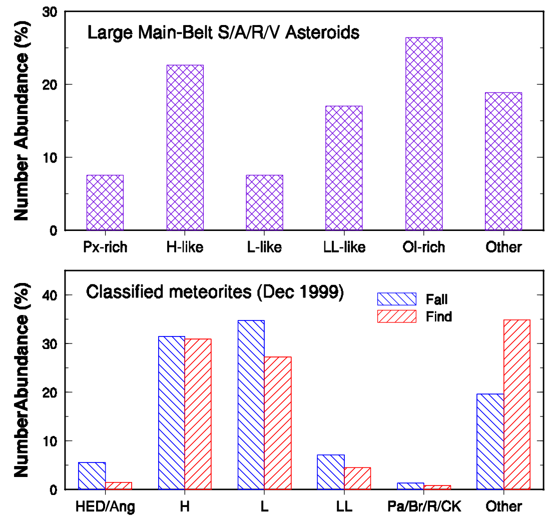

Fig. 4. Comparison of number abundances of large main-belt S/A/R/V asteroids and meteorites [9].

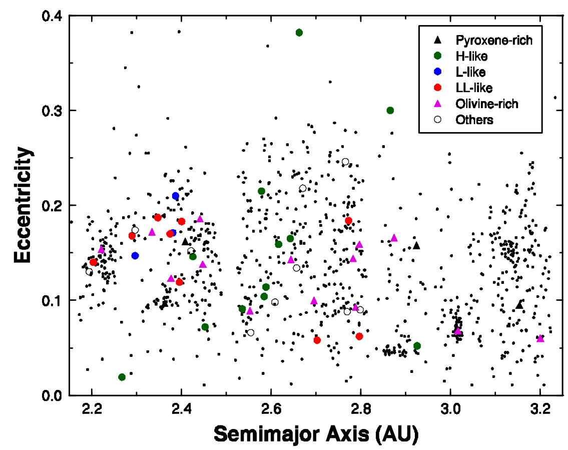

Fig. 5. Distribution of H/L/LL-like and pyroxene/olivine-rich asteroids in the semimajor axis and eccentricity plot of the main-belt asteroids.

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