

**DIVERSITY IN THE VISIBLE-NIR ABSORPTION BAND CHARACTERISTICS OF LUNAR AND ASTEROIDAL PLAGIOCLASE.** T. Hiroi<sup>1,2</sup>, H. Kaiden<sup>2</sup>, K. Misawa<sup>2</sup>, H. Kojima<sup>2</sup>, K. Uemoto<sup>3</sup>, M. Ohtake<sup>4</sup>, T. Arai<sup>5</sup>, S. Sasaki<sup>6</sup>, H. Takeda<sup>5</sup>, L. E. Nyquist<sup>7</sup>, and C.-Y. Shih<sup>7</sup>, <sup>1</sup>Dept. of Geological Sci., Brown Univ., Providence, RI 02912, USA (takahiro\_hiroi@brown.edu), <sup>2</sup>Natl. Inst. of Polar Res., 10-3 Midori-cho, Tachikawa, Tokyo 190-8518, Japan, <sup>3</sup>Dept. Earth & Planet. Sci., Univ. of Tokyo, 7-3-1 Hongo, Bunkyo-ku, Tokyo 113-0033, Japan, <sup>4</sup>JAXA Inst. of Space and Astronaut. Sci., Sagami-hara, Kanagawa 229-8510, Japan, <sup>5</sup>Chiba Inst. of Tech., 2-17-1 Tsudanuma, Narashino, Chiba 275-0016, Japan, <sup>6</sup>RISE Project, Natl. Obs. of Japan, Mizusawa-ku, Oshu, Iwate 023-0861, Japan, <sup>7</sup>KR111, NASA Johnson Space Center, Houston, TX 77058, USA.

**Introduction:** Studying the visible and near-infrared (VNIR) spectral properties of plagioclase has been challenging because of the difficulty in obtaining good plagioclase separates from pristine planetary materials such as meteorites and returned lunar samples. After an early study indicated that the 1.25  $\mu\text{m}$  band position of plagioclase spectrum might be correlated with the molar percentage of anorthite (An#) [1], there have been few studies which dealt with the band center behavior. In this study, the VNIR absorption band parameters of plagioclase samples have been derived using the modified Gaussian model (MGM) [2] following a pioneering study by [3].

**Method:** As a part of VNIR spectral survey of the Antarctic lunar and HED meteorites stored at the National Institute of Polar Research (NIPR), anorthositic clasts showing on subsamples of a lunar meteorite Yamato (Y)-86032, and eucrites Y-74450, Y-794002, and Y-794043 were chosen for this study. An incident light beam of about 2 mm in size was shone on each clast and the VNIR reflectance spectrum was measured. Details of the measurement method can be found in our previous work [4].

In addition, a coarse plagioclase crystal phase showing on a chip of Asuka (A)-881394 eucrite and a powder sample (75-150  $\mu\text{m}$ ) from Apollo lunar anorthosite 60015 were measured through a similar procedure at RELAB [5]. VNIR spectra of a powder sample (<250  $\mu\text{m}$ ) of lunar anorthosite 15415 (“genesis rock”) and plagioclase separates from other Apollo rocks (15058, 15555, 70017, and 70035) [6] were taken from the RELAB database.

**Results of spectral measurements:** Shown in Figs. 1 and 2 are the obtained VNIR reflectance spectra of plagioclase in lunar and eucrite samples chosen for this study. While Apollo samples naturally show very clean plagioclase features, meteorite samples show signs of terrestrial weathering at around 1.95, 2.2, beyond 2.5  $\mu\text{m}$ , and possibly 0.4, 0.5, and 0.85  $\mu\text{m}$ . The negative overall spectral slopes of Y-86032 and eucrites are typical of most chip samples.

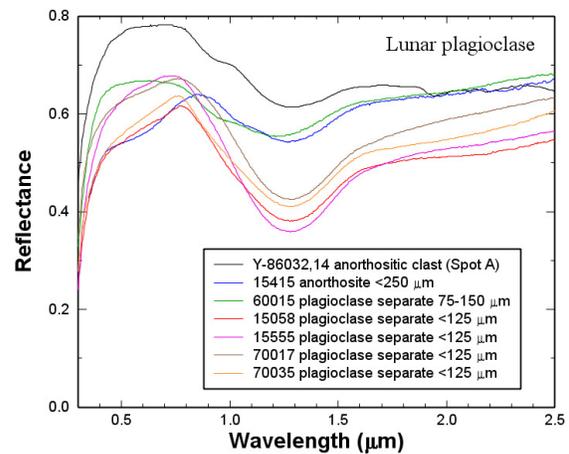


Fig. 1. VNIR reflectance spectra of plagioclase from a lunar meteorite and Apollo returned rocks.

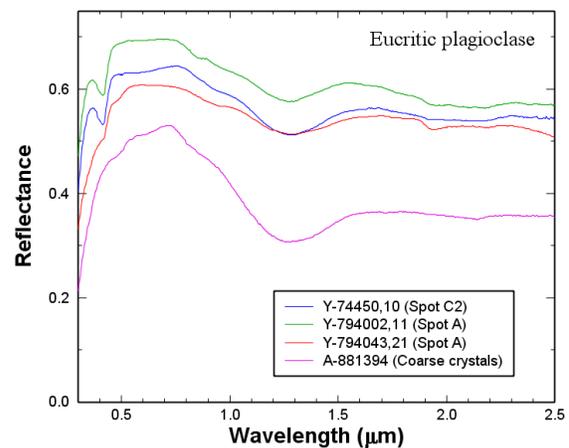


Fig. 2. VNIR reflectance spectra of anorthositic clasts of eucrite chips.

**MGM analysis:** Shown in Figs. 3 and 4 are two examples of the MGM fits of plagioclase spectra in Figs. 1 and 2. The plagioclase separate from Apollo 60015 represents the simplest case, requiring only four modified Gaussians in Fig. 1. On the other hand, the lunar meteorite Y-86032 represents a more complex case, requiring a negative continuum slope and many absorption bands including those due to terrestrial weathering.

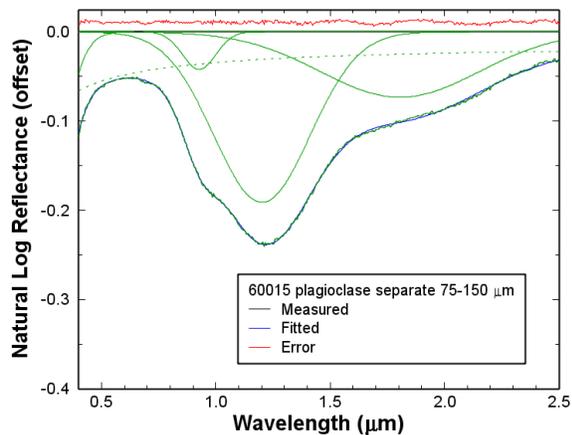


Fig. 3. The MGM fit of a plagioclase separate of the Apollo lunar sample 60015.

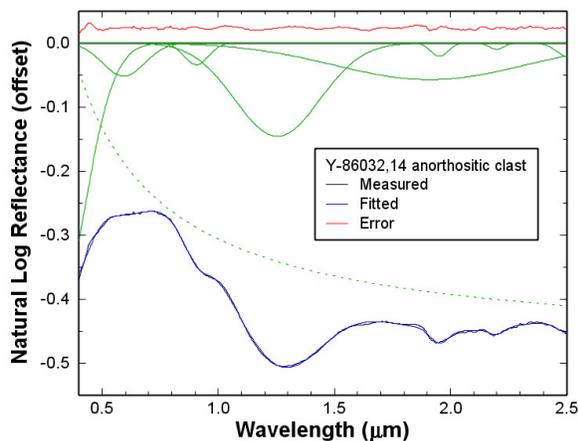


Fig. 4. The MGM fit of an anorthositic clast of the lunar meteorite Y-86032.

The obtained band center and width values of plagioclase are plotted in Figs. 5 and 6. In spite of large scatters in the band centers of some bands, the strongest absorption band at around 1.25  $\mu\text{m}$  plots over a wavelength range of 1.24-1.27  $\mu\text{m}$  in Fig. 5, consistent with the An# of 50 or 80 according to [1]. However, as can be seen in Fig. 6, plagioclase in 60015 has the primary band at around 1.20  $\mu\text{m}$ , which is unusual and indicates the An# 40, which is contradictory with the actual composition (98%). Therefore, this may indicate that the trend in [1] continues down to 1.20  $\mu\text{m}$  for nearly pure anorthite compositions, which is the case of plagioclase in 60015. However, the fact that 15415 having a similarly high An# does not show such a short band center position suggests that the accuracy of the MGM analysis may have to be evaluated.

**Summary:** This preliminary study shows a potential to elucidate a way to detect plagioclase composi-

tion by VNIR spectroscopy of lunar and asteroidal anorthosites or anorthositic clasts. However, the exact correlation between the 1.25- $\mu\text{m}$  band center wavelength and the An# must be further studied using more samples.

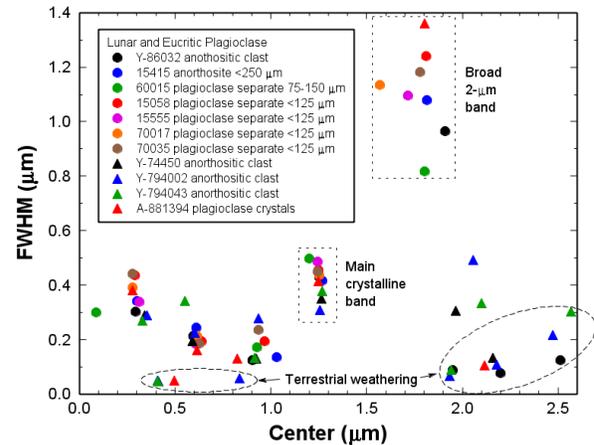


Fig. 5. A plot of the band center vs. width of all the absorption bands of all the studied plagioclase.

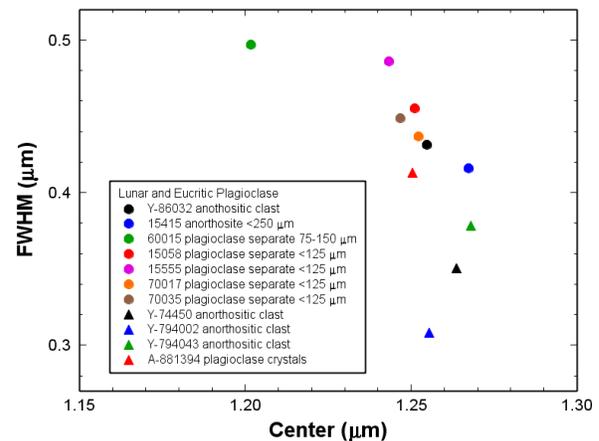


Fig. 6. An expanded view of Fig. 5, showing the band center and width values of the primary crystalline band of plagioclase.

**Acknowledgment:** Lunar and eucrite meteorite samples and Apollo lunar samples were kindly loaned from the NIPR and NASA Johnson Space Center. Their reflectance spectra were measured either at RELAB or NAOJ Mizusawa campus.

**References:** [1] Adams J. B. and Goulland L. H. (1978) *Proc. LPSC, 9th*, 2901. [2] Sunshine J. M. et al. (1990) *JGR*, 95, 6955. [3] Pieters C. M. (1996) *LPS, XXVII*, 1031. [4] Hiroi T. et al. (2011) *Polar Sci.*, 5, 337. [5] Pieters C. M. and Hiroi T. (2004) *Lunar Planet. Sci. XXXV*, Abstract #1720. [6] Isaacson P. J. et al. (2011) *M&PS*, 46, 228.