SPECTRAL CHARACTERIZATION OF PIPLIA-KALAN METEORITE IN VISIBLE/NEAR INFRARED SPECTRAL REGION., S. Bhattacharya[1], A. B. Sarbadhikari[2], M. Chauhan[1], M. S. Sisodia[2], L. Le Corre[3], V. Reddy[3] and P. Chauhan[1], [1] Space Applications Centre, Indian Space Research Organisation, Ahmedabad – 380 015, India (satadru@sac.isro.gov.in); [2]Physical Research Laboratory, Navrangpura, Ahmedabad – 380 009, India; [3]Planetary Science Institute, 1700 East Fort Lowell, Suite 106, Tucson, AZ 85719, USA.

Introduction: The Piplia Kalan meteorite is an eucrite [1, 2] fell in the Pali district of Rajasthan, India in 1996. It belongs to the howardite, eucrite and diogenite (HED) family of achondrites, which are considered as the extraterrestrial analogs of basalts. Eucrites show unique characteristics depending on the variations in their thermal history as well as chemical and mineral compositions [1-3]. Based on their spectral reflectance characteristics, it has been proposed that the parent body of the HED family of achondrites is an asteroid, 4 Vesta [4, 5]. Here we report the spectral characterization of Piplia Kalan meteorite in Visble/Near Infrared (VNIR) domain of EM spectrum (350-2500 nm).

Methods: We used a Visible/Near Infrared (VNIR) FieldSpec® 4 Hi-Res spectroradiometer (Analytical Spectral Devices (ASD), Boulder, CO, USA) with spectral resolutions of 3 nm for VNIR and 8 nm for SWIR-1 and SWIR-2 and spectral range of 350-2500 nm. Data were acquired by using 1° FOV supplied with the ASD instrument with 45° incidence angle and 0° emission angle. 70W, 15V illuminator with a fan cooled 12V Quartz-Tungsten-Halogen lamp was used for indoor diffuse reflectance measurement having 12° beam angle and 3100K color temperature.

We have performed band parameter analysis to derive the central wavelengths of the 1000- and 2000-nm pyroxene absorption features designated as Band I and Band II respectively and the ratio of Band II area to Band I area known as Band Area Ratio (BAR) [6, 7]. In order to compute the band center, band strength and band area values precisely, we have performed continuum removal by fitting a straight line continuum tangent on both side of the absorption band for the Bands I and II separately and dividing the spectra by the respective continuum.

The points of ‘‘highest reflectance’’ on either side of the absorption minimum have been considered to be the tangent points. Band center is calculated by fitting a 3rd order polynomial to the bottom of the continuum-removed absorption feature and the minimum point on the polynomial fit is considered as the band center. The errors associated with the band center computation have been determined through an iterative process whereby the number of points on either side of the visually determined band minima are changed three to four times and band center values are computed each time. The average error associated with the band center estimation is found to be ±0.01 µm. Band area is calculated as the area between the continuum slopes and the data points. The spectral band parameters, thus computed, allow quantification of the surface mineralogy, relative mafic mineral abundances (olivine/ortho- and/or clinopyroxene) and pyroxene chemistry.

Results and discussions: Figure 1 shows the photograph presenting macroscopic features of Piplia-Kalan meteorite [2]. Figure 2 presents the VNIR spectra of the same. We have taken multiple spectral measurements from the bulk rock (a total of 5 spectra).

Figure 1. Photograph showing macroscopic image of Piplia Kalan [2].

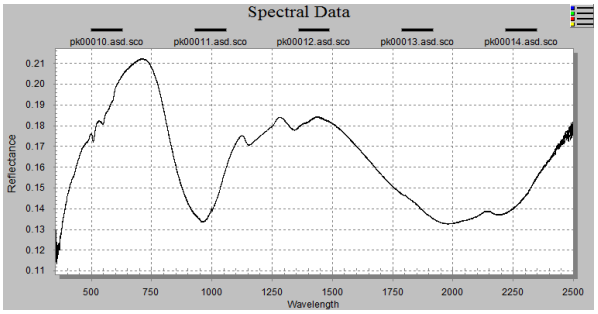


Figure 2. VNIR spectra of Piplia-Kalan meteorite showing characteristic absorption features of pyroxenes at around 1000 and 2000 nm, respectively.

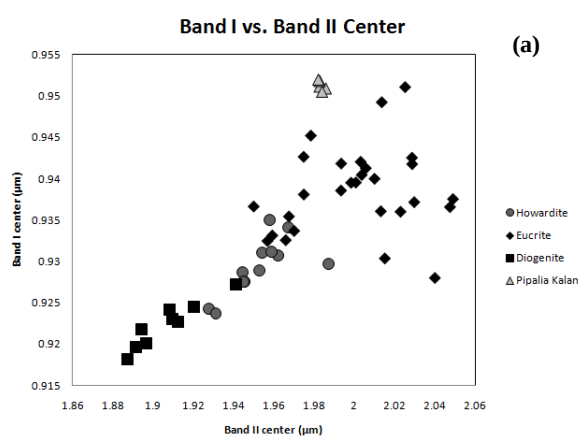
The spectral band parameters for Band I center and Band II center of pyroxene are obtained as mentioned earlier. The Band-I center of the bulk rock sample varies from ~950.4-951.9 nm having a mean value of 951.2 nm, whereas the Band II center varies from ~1982.1-1985.8 nm with an average Band II center of ~1983.5 nm. The BAR value of Piplia-Kalan meteorite

varies from ~1.86-2.02 against a mean value of ~1.956. A plot of Band I center versus Band II center for the HEDs is shown in Figure 3a [8].

The Band I center vs. Band II center plot of Piplia-Kalan falls little away from the zone defined by the Band I vs. Band II plot of all other eucrites as can be seen in Figure 3a. On the other hand, when plotted against Band II Center vs. BAR, the band parameters of Piplia-Kalan falls exclusively within the eucrite zone (Figure 3b). This difference possibly has important implications. It is also evident from Figure 3a that the three HED subgroups occupy three distinct zones in the Band I vs. Band II scatter plot with a common overlapping region [8]. Eucrites are generally characterized by band centers at longer wavelengths than the diogenites implying that they are more Fe rich. Also eucrites have Ca/Mg abundance ratios much greater than diogenites [9].

The howardites being the brecciated mixtures of eucrites and diogenites, have band centers that are intermediate to that of the eucrites and diogenites [8]. The band center-based compositional trend is found to be consistent with the origin of the diogenites at greater depths within the HED parent body, i.e. low-Ca diogenites crystallized and settled before high-Ca eucrites as the HED parent body cooled [8, 10]. A plot of BAR versus Band II center is shown in Figure 3b. The BARs do not clearly separate out the three HED subgroups. The eucrites show the maximum variability in terms of BAR values and also tend towards larger values.

Future Work: We intend to compare the spectral band parameters of Piplia-Kalan with those of Vesta derived from the Dawn visible and near-IR spectrometer data to identify specific terrains that have similar characteristics. Identifying specific regions on Vesta from which Piplia-Kalan was derived would enable us to bettern understand the origin and nature of the parent body.



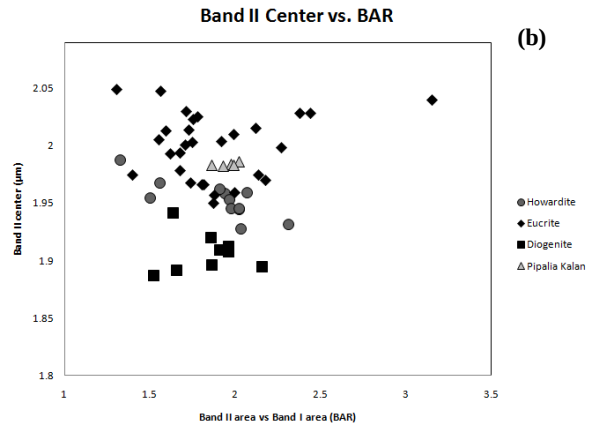


Figure 3. a. Plot showing Band I center vs. Band II center of howardites (blue diamonds), eucrites (red squares), Piplia-Kalan eucrite (orange circle) and diogenites (green triangles). The eucrites and diogenites are very clearly separated out in this scatter plot; **b.** BAR vs. Band II center for HED meteorites. The symbols are same as in **a**. The Piplia-Kalan eucrite spectral band parameters clearly fall within the eucrite zone.

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