INFRARED SPECTROSCOPIC ANALYSIS OF THE BERTHOUD EUCRITE. C. Ertatis[1], O. Unsalan[2], C. Altunayar-Unsalan[3], M. E. Zolensky[4], [1]Ege University, Faculty of Natural and Applied Sciences, Department of Biotechnology, 35100, Bornova, Izmir, Turkey, [2]Ege University, Faculty of Science, Department of Physics, 35100, Bornova, Izmir, Turkey. [3]Ege University, Central Research Testing and Analysis Laboratory Research and Application Center, 35100 Bornova, Izmir, Turkey, [4]Astromaterials Research and Exploration Science, NASA Johnson Space Center, 2101 NASA Parkway, Houston, TX 77058, USA.

Introduction: The Berthoud eucrite was discovered in 2004 at Berthoud, Colorado, U.S.A. Eucrites are achondrite meteorites belonging to the Howardite-Eucrite-Diogenite (HED) meteorite clan. HED meteorites are believed to have originated from the surface of the asteroid 4 Vesta which has key igneous minerals on its surface including olivine, pyroxene group (orthopyroxene and clinopyroxene) and plagioclase [1]. Eucrites are known to consist primarily of plagioclase, pyroxene and minor amounts of ilmenite, silica, clinopyroxene, chromite, plagioclase, and orthopyroxene [2,3]. Determining the minerals in meteorites by spectroscopic techniques supplies important clues on how they formed in and on their parent bodies. Infrared spectrometry (IR) is a vibrational spectroscopic technique often used in astrobiological research to detect mostly organic and inorganic materials in meteorite samples by revealing molecular vibrations. In addition, determination of the chemical compositions of meteorites can give information about the origin of the sample and the asteroid from which it was derived [4]. Hence, in this study, spectroscopic analyzes of the Berthoud meteorite were performed to detect mineralogy.

Material and methods: A 95 mg sample of Berthoud (sample number BRT-001) was ground in an agate mortar and then analyzed by Fourier transform infrared spectroscopy (FTIR). A Perkin Elmer Spectrum Two infrared spectrometer was used for measurements in the 4000-400 cm^{-1} region with a spectral resolution of 2 cm^{-1} and 64 scans. The experiment was performed on the samples with three different sizes (Fig. 1). For the detection of the particle, the sample was magnified 5X Leica MZ 16 stereo microscope [5], and the size of the particles was measured via Image J [6]. IR spectra were visualized by Spectragryph v1.2.15 [7].

Results and discussion: FTIR spectra of three samples of Berthoud with different particle sizes are shown in Figure 2. Past studies showed that eucrites contain olivine, plagioclase, and pyroxene group minerals [2,3]. In Figure 2, IR spectra of different size ground Berthoud samples are presented. The average sizes of the particles were approximately 124 μm, 91 μm, and 56 μm for Berthoud #1, 2 and 3, respectively. The sizes of the ground samples obviously effected the IR spectral intensities. Moreover, reference spectra (dashed lines in Fig. 2) of anorthite and bytownite minerals matched well with our samples. Differences in IR spectra of the sample and reference spectra of minerals are due to their meteoritic origin and are not expected to match peak by peak. Our results demonstrate that spectral intensities are inversely proportional with the grain sizes, with this particular meteorite. These results support the view that the observational reflectance IR spectra obtained by onboard spectrometers used in remote planetary missions and mapping purposes can be complicated by details of actual sample mineralogy and physical characteristics.

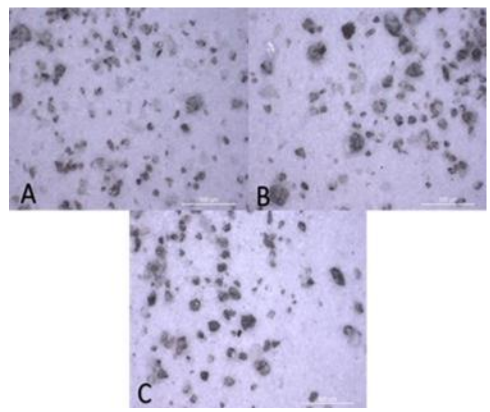

Figure 1. Three different particle sizes of the meteorite visualized by stereo microscope. A) Sample size: ~124 μm (first ground, B) Sample size: ~91 μm (second ground), C) Sample size: ~56 μm (final ground).

Conclusions: The goal of this study was an investigation of the mineralogy of the Berthoud eucrite. As suggested above, HED meteorites, and eucrites, can substantially vary in mineralogy. The study results showed that Berthoud provides matching spectra with typical eucrites, but it also does not contain some minerals typical of eucrites. However, our results are consistent with Berthoud's classification as a eucrite, and derivation from asteroid 4 Vesta.

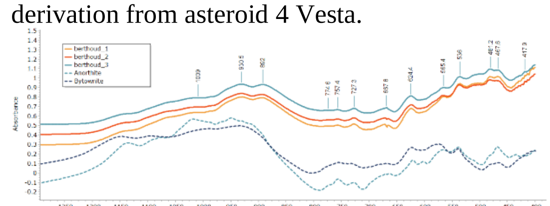

Figure 2. FTIR spectra (1200-400 cm^{-1}) of three Berthoud eucrites samples in comparison with the anorthite and bytownite reference spectra match.

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