SHOCK METAMORPHIC DEGREE OF EURITES BASED ON THE TEXTUAL AND XRD ANALYSES.

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Introduction: Most of the eucrites are considered to have experienced shock metamorphism after their solidification. The evidence of the shock metamorphism in eucrites is recognized from the petrographic textures. However, the systematical classification of shock degrees for eucrites has not been established. Recently, Imae et al. [1] used X-ray diffraction (XRD) technique to the semi-quantitative determination of the shock stage of ordinary chondrites. We applied this method for 13 basaltic and 3 cumulate eucrites. We recently defined the shock degrees of studied eucrites from A to D by the petrographic and mineralogical features of thin sections [2]. The criterion is similar to the shock stages of enstatite chondrites [3] and other achondrites [4]. The comparative study of the petrographic and XRD data can provides better interpretations for shock metamorphism on the eucrite parent body (probably asteroid 4 Vesta). We thus further examined the features more quantitatively in the present study.

Measurement methods and samples: We performed the X-ray measurements by an X-ray difractometer, SmartLab (RIGAKU) at the National Institute of Polar Research (NIPR), on the condition of Cu Kα with 40 kV and 40 mA through the slit of 10 x 5 mm in size with the divergence angle of (1/6)°. The measured 2θ range was 8-75°. We performed petrological and mineralogical studies using an optical microscope, a field emission scanning electron microscope (FE-SEM: JEOL JSM-7100) with an energy dispersive spectrometer (EDS) (Oxford AZtec Energy) and cathodoluminescence system (GATAN Chroma CL), an electron probe microanalyzer (EPMA: JEOL JXA-8200), and a micro-Raman spectroscopy (JASCO NRS-1000), at NIPR. For identification of maskelynite or plagioclase, we also used a luminoscope (ELM-3) at the Okayama University of Science.

Results: Agoult, EET 90020 and Moama, are unbrecciated eucrite, showing sharp optical extinction of plagioclase and pyroxenes. These eucrites do not have any shock textures (which is defined shock degree A). Juvinas and Y-791195 are recrystallized breccias showing a mosaic texture (shock degree B). Pyroxene and plagioclase in Camel Donga, Millbillillie, Stannern, NWA 5356, Y-792510 and Y 983366 show weak undulatory extinction and mosaic texture (shock degree B). A-881747, Cachari, Y-790266, Y 980433 have maskelynite with various modal abundance (< 40vol%) (shock degree C). Most plagioclase (>70-80 vol.%) in A-87272 is converted to maskelynite (shock degree D).

XRD patterns mainly consist of diffractions of plagioclase, pigeonite, and augite. The macro XRD data has several correlations for shock degrees. The full width at half maximum (FWHM) values (for both average and total) shows a positive correlation for the shock degrees. The XRD peaks become weaker and broader by increasing the shock degrees. On the other hand, the number of peak in the XRD pattern shows a negative correlation for the increase of shock degrees. Unshocked eucrites, Agoult, EET 90020, and Moama, show the total number of the peak as 163, 159, 148, respectively. Shocked eucrites, A-87272, Cachari, and Y 980433, show the total number of the peak at 35, 70, 64, respectively. The decrease of the diffraction peak is remarkable for plagioclase rather than pyroxene. Based on the Williamson–Hall plot [5] of pigeonite, the lattice strain value positively correlate with the shock degrees. The specific peaks of plagioclase (especially -202) show the decreasing peak intensity and increasing FWHM values for the increase shock degree. The pyroxene peaks (pigeonite 310 and augite -311) show a positive correlation between the FWHM values and shock degrees, whereas there is no correlation between the peak intensities and shock degrees.

Discussion: The shock degrees from A to D in the eucrites studied here are cleary distingished from the averaged FWHM value (total FWHM value / the total number of peak). The averaged FWHM value is composed of two correlations, 1) a positive correlation between the FWHM values (of specific peaks) and shock degrees and 2) a negative correlation between the total number of the peaks in diffraction patterns and shock degrees. The broadening of diffraction peak is observed in plagioclase and pyroxene. A positive correlation between the lattice strain values and shock degrees indicates that the increase of FWHM value is due to the increase of disturbed crystal lattice. The decrease of the total peak number is mainly due to the maskelynization of plagioclase. In particular, most of the plagioclase peaks in A-87272, the strongest shocked sample (D) studied here, have disappeared. Instead, the shock metamorphism produces the strain in pyroxenes. We plan to examine the shock pressure from the lattice strain value.

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