

SCANNING ELECTRON MICROSCOPE-CATHODOLUMINESCENCE AND MICRO-RAMAN PROPERTIES OF KABA CV3 CHONDRITE. A. Gucsik¹, Sz. Bérczi², T. Okumura³, H. Nishido³, K. Ninagawa⁴, Sz. Nagy², ¹Max Planck Institute for Chemistry, Dept. of Geochemistry, Joh.-J.-Becherweg 27, D-55128, Mainz, Germany (E-mail: gucsik@mpch-mainz.mpg.de); ²Eötvös University, Institute of Physics, Dept. Materials Physics, Cosmic Materials Space R. Group, H-1117 Budapest, Hungary; ³Research Institute of Natural Sciences, Okayama University of Science, 1-1 Ridai-cho, Okayama, 700-0005, Japan; ⁴Department of Applied Physics, Okayama University of Science, 1-1 Ridai-cho, Okayama, 700-0005, Japan;

Introduction: Previous petrologic studies [1,2] suggest that Kaba (kept in Reform College of Debrecen, Hungary) is the most primitive unshocked CV fall. It is therefore of great interest to us because it will: (1) give us a better understanding of the effects of parent body processing on the mineralogy of CVs and allow comparison of these effects with other meteorite groups, (2) help in determining mineralogy of Interplanetary Dust Particles.

Early classification alternately changed from the original Wiik type III (1956) [3], to Wood type II, (1967) [4], to Van Schmus-Wood C2, (1967) [5], to Van Schmus and Hayes type C(V)3 (1974) [6], and finally to CV3 oxidized and Bali-type (Krot et al., 1998) [7]. Its characteristics is also the presence of two endtype olivines: forsterite (Mg_2SiO_4) and fayalite ($\text{Fe}^{2+}_2\text{SiO}_4$), too.

In this study, we discuss potentials of use of cathodoluminescence and micro-Raman techniques to study of Kaba meteorite focusing on applications to study of the Interplanetary Dust Particles (IDPs) and macromolecular meteoritic organic material.

Application to IDPs: It is believed that IDPs were derived from comets and asteroids. However, to date the formation mechanism of the IDPs is poorly understood. Studies of IDPs provide understandings about grain dynamics in the early Solar System and presolar interstellar and circumstellar environments, grain condensation, chemical and physical evolution, and grain density distribution in the proto-planetary disk. Gucsik et al. [8] suggested cathodoluminescence would be a means of quickly surveying Stardust particles to get a first order indication of their mineralogy and petrology. In their CL study, they used Semarkona chondrules for the implications for studies of IDPs. According to Bérczi et al. [9] in the CL images of fayalite from Kaba shows CL-dark characters and forsterite exhibits CL-bright area in the otherwise CL-dark environment. CL spectra of the Kaba fine grained samples (powdered) are characterized by a dominant broad band, which is centered at around 630 nm. An additional shoulder peak is centered at around 720 nm (Fig. 1).

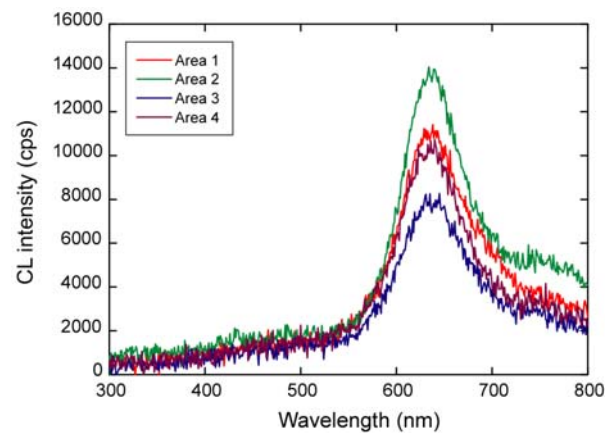


Figure 1. CL spectra of four area containing a dominant broad band centered at around 630 nm. SEM-CL spectral analyses (at Okayama University of Science, Okayama, Japan) were performed using a Scanning Electron Microscope (SEM), JEOL 5410LV, equipped with a CL detector, Oxford Mono CL2, which comprises an integral 1200 grooves/mm grating monochromator attached to reflecting light guide with a retractable paraboloidal mirror. The operating conditions for measuring BSE (backscattered electron) images, CL images, and CL spectra were accelerating voltage: 15 kV, and 2.0 nA at room and liquid nitrogen temperature (data from Bérczi et al. [9]).

Their [9] CL spectral and imaging features are in a good agreement with previous studies. The peak at 630 nm is assigned as Mn^{2+} -activator element-related band, and the shoulder peak at 720 nm might be related to Cr^{3+} [10,11]. These activator elements can cause relatively high CL intensity parts (CL-bright areas) in the CL images of forsterite. On the other hand, there is a relatively high Fe-content as a major quencher element of fayalite, which can produce CL-dark parts of the sample. A further micro-Raman spectroscopical characterization will be carried out on these samples to yield more data on the crystallinity of forsterite and fayalite.

Implication for study of macromolecular organic material in chondrites: The following chapter has been based on the personal communication with Conel M. O'D. Alexander at Carnegie Institution of Washington (2004, 2006). The macromolecular organic material is the most abundant organic material in chondrites, but remains poorly understood. It is thought to be largely interstellar in origin [12]. However, a solar system origin for some of the macromolecular material can't be ruled out, and it has been modified by processes in the meteorite parent bodies and, possibly, in the solar nebula (e.g. Alexander et al., [13]). It may also have been the source of the soluble organic material in meteorites that include amino acids and nucleic acids (e.g. Cronin et al., [14]). It has been shown that some optically active soluble compounds, including amino acids, have slight L-enantiomer excesses [15,16]. Meteorites and interplanetary dust (IDPs) would have been a significant source of complex organic material on early Earth. Given the L-enantiomer excesses in meteorites and in all living organisms, it has been suggested that extraterrestrial organic matter may have played a role in the origin of life.

Thus, the organic matter in meteorites potentially retains a record of processes that occurred in the interstellar medium, in the solar nebula and in meteorite parent bodies. Unraveling this history is of considerable interest to astronomers and meteoriticists. Since it would have been a significant source of complex organic material on the early Earth, understanding what the products of its weathering were under early Earth conditions is also an important goal for Astrobiology.

Based on noble gas abundances in presolar components, Huss et al. [17] suggest that the volatile element fractionations are the result of modest heating in the nebula prior to chondrule formation and chondrite accretion. This heating would have significantly modified the organic material. They based their conclusions in part on data from the CVs Vigarano and Leoville. If, as expected, we find that the organic matter in Kaba is more primitive than in Vigarano and Leoville, this will show that they have underestimated the role of parent body processing in modifying the noble gas abundances, and would go some way to disproving their model. After the organic analyses, we will also attempt to measure presolar noble gas abundances in the Kaba residue to further test their model. A multiple technological approach of cathodoluminescence and micro-Raman spectroscopy can aid to understand more about these models.

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