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Heterogeneity of chemical and mineral compositions of Bensour meteorite (LL6) in relation to Hayabusa sample analysis.

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The Hayabusa spacecraft returned to the earth last June. ”Hayabusa” succeeded in observation of the asteroid Itokawa, and samples on the surface of Itokawa were recovered. Asteroids are considered to have information when they were formed in the early stage of the solar system, and it is expected that the clue to the information can be obtained by analyzing their samples. However, the maximum size of the sample particles recovered by ”Hayabusa” is the order of 100 micro meters, and most of them are smaller than ten micro meters [1]. The chemical composition and mineral composition obtained from these small particles doesn’t represent the material on the Itokawa surface. Then, it is necessary to examine how the chemical composition and the mineral composition change compared with the bulk when the sample becomes smaller in connection to the texture of meteorites.

It is proposed that the surface material of Itokawa is similar to LL5 or LL6 ordinary chondrite based on the infrared spectroscopic observation by” Hayabusa” [2]. In this study, heterogeneity of the chemical and mineral compositions was quantitatively examined by obtaining elemental mapping of the Bensour meteorite (LL6 chondrite). 13 elements (Al, Ca, Cr, Fe, K, Mg, Mn, Na, Ni, P, S, Si, Ti) were measured for two areas of about 4mmx4mm in a polished thin section, and elemental maps (images of 1024x1024 pixels) were obtained. In addition, mineral maps were made from the obtained elemental maps. The minerals contained in those ranges ware olivine, Ca-poor pyroxene, Ca-rich pyroxene, plagioclase, apatite, whitlockite, taenite, kamacite, and chromite.

The elemental and mineral maps were divided into smaller areas by four, sixteen, and so on in the images. The standard deviations of the characteristic X-ray intensities of the elements and of the mineral modes were calculated as a function of the number of the division. The characteristic X-ray intensities and the mineral modes and changes of their standard deviations by increasing the number of the division were not greatly different among the two measured areas. This indicates that these areas roughly represent an average feature of this meteorite. The standard deviation of the characteristic X-ray intensity normalized its intensity increases with increasing the number of the division. The normalized standard deviations at the same number of the division for elements of low abundances, such as P, Ni and Cr, are larger than those of elements with high abundances, such as Si and Mg. This is due to the concentration of the elements with low abundances in specific accessory minerals, such as Ca phosphates, taenite, chromite for P, Ni and Cr, respectively, which are distributed locally. On the other hand, there is a different group of elements with low abundances, such as K, Mn and Ti. These normalized standard deviations are relatively small. These elements are included as minor elements in major minerals, such as plagioclase of K and pyroxenes for man and Ti. Based on the present study, if the Hayabusa sample is an LL6 chondrite, we can quantitatively expect deviations of the element and mineral compositions obtained from limited size of the sample by preliminary examination.

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[1] Nakamura T. et al. (2011) abstract in 42nd LPSC. [2] Abe M. et al. Science, 312, 1334-1338. [3] Tsuchiyama A. et al. (2011) abstract in this conference.

Keywords: Hayabusa, chondrite meteorite, compositon