Trace element geochemistry of Y000749 (nakhlite) and Dhofar 378(basaltic shergottite).

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It has been widely accepted that shergottites, nakhlites and chassignite (SNC meteorites) are from Mars because of their young crystallization ages (Shih et al., 1982; Chen and Wasserburg, 1986; Jagoutz, 1989) and identical noble gas compositions of EETA79001 (shergottite) and the atmosphere of Mars (Pepin, 1991). Since all of the martian meteorites are igneous rocks formed in Mars subsurface, these meteorites can provide constraints for the magmatic processes in Mars. In fact, many research works have been conducted for the SNC meteorites and have provided valuable information about the chemical differentiation in the planet other than the Earth.

Since the martian meteorites were ejected from Mars, shock metamorphism is one of the essential characteristics of SNC meteorite, in particular, for shergottites. Another notable feature of the martian meteorites, which is suggested by texture, is that they are cumulates (McSween, 1994; Greenwood et al., 2001; Hale et al.,1999). In addition, complex zoning patterns for the chromites in the lherzolitic shergottite (ALH77005) indicate the various degree of reaction with residual melts (McSween et al., 1979) or magma mixing (Ikeda 1994). These facts suggest a complicated magma history of the martian meteorites.

In order to evaluate the chemical evolution of Mars, it is necessary to determine primary magma compositions of martian meteorites. However, bulk rock compositions are not suitable to estimate the primary magma compositions of individual martian meteorites due to the complex magma histories and cumulative origin. To overcome these difficulties, one of the possible geochemical approaches is micro scale analysis which can determine the chemical compositions of primary unaltered phenocrysts in the meteorites, and one of the most powerful tools for the micro scale analyses is the secondary ion mass spectrometry (SIMS). Hence, we improved the analytical procedure for the determination of the trace element compositions of pyroxene which is ubiquitously included in the martian meteorites. Our analytical procedure is based on the method which is reported by Togashi et al. (1998), namely, primary O- ion beam was shaped to 25 um diameter circle with an ion intensity about 2 nA, accelerating voltage 23 kV and the secondary ion was collected with mass resolution power of 4500. Although this analytical procedure can analyze eighteen major and trace elements by resolving molecular interference, this mass resolution power is not enough for the quantitative analyses of the REE. Hence, we adopt energy filtering method (offset voltage = 40 V) along with high resolution method to avoid molecular interference during the REE analyses. Then, we apply this method to recently recovered two martian meteorites, i.e., Y000749 (nakhlite) and Dhofar 378 (basaltic shergottite), with the Cameca IMS-1270 ion microprobe at the Geological Survey of Japan. The major goal of this study is to evaluate the geochemical characteristics of martian meteorites and provide a new insight into the magmatic history of Mars.