CONSTRAINTS ON THE MAGMATISM OF MARS INFERRED FROM CHEMICAL COMPOSITIONS AND RADIOGENITC ISOTOPIC COMPOSITIONS OF SHERGOTTITES

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Introduction: A wide range of Zr/Hf ratios was previously reported among shergottites [1,2]. Based on chemical compositions for shergottites and assembled partition coefficients for Zr and Hf for several phases, Shirai and Ebihara [2] concluded that clinopyroxene and majorite are responsible for the fractionation of Zr and Hf in shergottites. Shirai and Ebihara [2] suggested that the Mars and Moon must have experienced different magmatism. However, timing of the fractionation of Zr and Hf in shergottites is still not established.

Recently, improved analytical techniques represented by MC-ICP-MS and TIMS increased our knowledge concerning the timescale of the core formation and early differentiation on Mars [e.g., 3]. Foley et al. [3] reported that the silicate differentiation which formed the shergottites' mantle source occurred 4.525 Ga. In this study, we conducted a chemical study of shergottites and combined chemical compositions with isotopic compositions to elucidate the timing of the fractionation of Zr and Hf in shergottites.

Analytical procedures: NWA 856 (basaltic shergottite), Y 000097 (lherzolitic shergottite) and NWA 1068 (olivine-phyric shergottite) were analyzed for bulk major, minor and trace element compositions by using three nuclear analytical methods (PGA, INAA and IPAA).

Results and Discussions: Zr/Hf ratio of NWA 856 (36.6±1.4) is chondritic and is agreement with that for basaltic shergottites represented by Shergotty and Zagami. Some olivine-phyric shergottites (EETA 79001A, DaG 476, SaU 005 and Y 980459) were reported to have subcondritic Zr/Hf ratios [1,2], while the olivine-phyric shergottite NWA 1068 has a chondritic Zr/Hf ratio (39.0±2.1). Zr/Hf ratio of Y 000097 is subchondritic (26.5±1.8) and consistent with those for other lherzolitic shergottites and olivine-phyric shergottites (EETA 79001A, DaG 476, SaU 005 and Y 980459). Three shergottites (NWA 856, NWA 1068 and Y 000097) analyzed in this study fall on a positive line in the plot of Zr abundances vs. Zr/Hf ratios.

Shergottites were reported to have a large variation of ε^{142}Nd [3]. Zr/Hf ratios are found to decrease with increasing of ε^{142}Nd among shergottites, indicating that the fractionation of Zr and Hf and Sm and Nd in shergottites occurred contemporaneously and during early silicate differentiation. It was previously suggested that shergottites were formed by different degrees of mixing of components derived from depleted and enriched parent magmas, implying that the correlation trend between Zr/Hf ratios and ε^{142}Nd presents a mixing line. Lherzolitic shergottites and olivine-phyric shergottites (EETA 79001A) do not fall on the correlation line of Zr/Hf ratios and ε^{142}Nd. Lherzolitic shergottites and EETA 79001A must have experienced the different petrogenesis from that for the other shergottites.

References: [1] Münker C. et al. 2003. *Science* 301:84-87. [2] Shirai N. and Ebihara M. 2006. Abstract #1917. 37th Lunar and Planetary Science Conference. [3] Foley C. N. et al. 2005. *Geochimica et Cosmochimica Acta* 69:4557-4571.