VARIATIONS IN KREEP-ENRICHMENT OF NWA 773 CLAN OLIVINE GABBROS AND BRECCIAS BASED ON WHOLE-ROCK COMPOSITIONS

H. Nagaoka[1], Y. Karouji[2], T. J. Fagan[1], M. Ebihara[3], H. Takeda[4] N. Hasebe[1]. [1]Waseda University. E-mail: hiroshi-nagaoka@asagi.waseda.jp. [2]ISAS, JAXA. [3]Tokyo Metropolitan University. [4]University of Tokyo.

Introduction: The lunar meteorites, Northwest Africa (NWA) 773 clan consists of a group of paired meteorites (e.g., NWA 2700, 2727, and 2977 [1]), several containing olivine cumulate gabbro (OC) as clasts in a breccia [e.g., 2,3], and others (e.g., NWA 2977) consisting entirely of OC [4]. Clasts in the NWA 773 clan breccias consist of OC, more differentiated rocks co-magmatic with the OC and independent rocks with variable KREEP enrichment [2,3,5]. In this work, we present whole rock analyses of various NWA 773 clan breccias and OC clasts to infer (1) crystallization sequence of various clasts of OC and (2) extent of KREEP-enrichment in breccia.

Sample Separations and Analytical Methods: The bulk compositions of sub-samples of NWA 2727 and 2977 were analyzed by neutron-induced prompt gamma-ray analysis (PGA), and instrumental neutron activation analysis (INAA) in the Japan Atomic Energy Agency. For NWA 2727, a large chip (835 mg) was used initially for PGA. After PGA, the following portions were plucked from the large chip: Breccia-1 (Br1, 17.2 mg); Br2 (19.1 mg); OC (15.4 mg); and powder residue from plucking of the original chip (37.6 mg). These samples were used for INAA two times with different irradiation periods. The sample separates of NWA 2977 have been reported in [6]. The two powder samples of NWA 2977 (99.8 mg for PGA, 43.3. mg for INAA) were used in this work.

Results and Discussion: As indicated by previous work [2,3], REE compositions from NWA 773 breccia and OC lithologies have similar KREEP-enriched patterns, with the breccias being more enriched. Our analyses of Br1 and Br2 from the NWA 2727 breccia show the lowest and highest REE values reported from NWA 773 clan breccias (La = 40 – 170 × CI chondrite [7]). This wide range probably reflects variable abundances of KREEP-rich clasts in the breccia. The subsample with highest REE (Br2) also has highest Th (5.15 μg/g), consistent with general enrichment of incompatible elements such as KREEP in this portion of the breccia.

Our results indicate that the OC gabbro of NWA 2977 has a similar REE pattern, but lower abundances (La = 15 × CI [7]) compared to other analyses of NWA 773 OC [2,3] and NWA 2727 OC (La = 40 × CI [7]). Relatively magnesian compositions of NWA 2977 mafic minerals [8], combined with the low REE concentrations, suggest that NWA 2977 formed at early stage of crystallization of the OC body on the Moon. Though the OC has been described as a single lithology, clast-to-clast variations of OC probably reflect different stages of crystallization.

References: [1] Bunch T.E.et al. 2006. LPSC 37: Abstract #1375. [2] Fagan T.J. et al. 2003. *M&PS* 38, 529-554. [3] Jolliff B.L. et al. 2003. *GCA* 67, 4857-4879. [4] Zhang A.-C. 2010. *M&PS* 45, 1929-1947. [5] Fagan T.J. et al. 2014. *GCA* 133, 97-127. [6] Nagaoka et al. 2011. LPSC 42: Abstract #1864. [7] Anders E. and Grevesse N. 1989. *GCA* 53, 197-214. [8] Nagaoka H. et al. 2015. *Earth, Planets and Space*, in review.