Redox states of lunar mare basalts as inferred from micro Fe-XANES analysis of plagioclase/maskelynite

T. MIKOUCHI1*, N. OKOI1 AND T. ARAI2

1University Museum, University of Tokyo, Hongo, Bunkyo-ku, Tokyo 113-0033, Japan, mikouchi@um.u-tokyo.ac.jp
2Planetary Exploration Research Center, Chiba Inst. of Technology, Tsudanuma, Chiba 275-0016, Japan

Introduction: Fe-XANES analysis of plagioclase in extraterrestrial samples provides a promising indicator of oxygen fugacity (fO2) during their magmatic formation [e.g., 1]. We applied this method to plagioclase/maskelynite in lunar mare basalts to see the relationship between the obtained redox states and reported water contents [e.g., 2].

Samples and Methods: We newly analyzed 3 Antarctic unbrecciated lunar meteorites (LAP 02205, Y-793169 and Asuka-881757) and compared results with our earlier studies on 5 returned mare basalts (Apollo: 10019 (HT), 12010 (LT), 14321 (LT), 15459 (LT), and Luna: 24088 (VLT)) [3]. The Fe-XANES analysis was performed at BL-4A, Photon Factory, KEK, Japan [e.g., 1] and Fe valence states (Fe3+/6Fe) were estimated using a procedure in [3].

Results and Discussions: The analyzed lunar meteorites are LT/VLT [e.g., 4] and the obtained Fe3+/6Fe of plagioclase/maskelynite are 3-4% for LAP 02205, 2% for Y-793169 and 2% for Asuka-881757. Y-793169/Asuka-881757 show slightly lower Fe3+/6Fe indicative of lower fO2 and may be consistent with primitive nature with only little KREEP components [4]. However, all of these ratios are similarly low and close to those of Apollo/Luna HT (2-3%), LT (2-5%) and VLT (3-4%) basalts [3], suggesting formation under reducing conditions (perhaps log fO2~IW-1) consistent with earlier works [e.g., 5]. It should be noted that micro XANES analysis is more relevant to the early magmatic fO2 because plagioclase is one of early crystallizing phases from basaltic magma and can avoid the influence by Fe-rich inclusions due to ~5 µm beam size. The reported water contents of apatite are higher in the order of VLT, LT and HT [e.g., 2], but the Fe3+/6Fe ratios of plagioclase/maskelynite are not related. This is probably because some other factors (e.g., degree of degassing) were involved and the relationship between redox states and water abundance is not straightforward.