TRACE ELEMENT GEOCHEMISTRY AND U-PB CHRONOLOGY OF THE BASALTIC SHERGOTTITE NORTHWEST AFRICA 8653.

Y. Wu[1] and W.Hsu[1,2], [1]CAS Center for Excellence in Comparative Planetology, Purple Mountain Observatory, Nanjing, China, yhwu@pmo.ac.cn, [2]The State Key Laboratory of Lunar and Planetary Science, Macau University of Science and Technology, Taipa, Macau, wbxu@pmo.ac.cn.

Introduction: Northwest Africa (NWA) 8653 is a basaltic shergottite mainly composed of pyroxene, maskelynite, and other minor phases [1]. The crystallization age of shergottites is highly controversial as whole-rock and non-radiogenic mineral Pb-Pb isochrons imply ancient ages [2], while mineral isochrons and *in situ* U-Pb analyses reveal much younger ages [3-4]. Detailed geochemical and chronological analyses are carried out in this study to set additional constraints on the formation of NWA 8653 shergottite.

Analytical Methods: Rare earth element (REE) concentrations of individual minerals and feldspathic intergrowths were analyzed *in situ* with an LA-ICP-MS at the State Key Laboratory of Geological Processes and Mineral Resources, China University of Geosciences, Wuhan. *In situ* U-Pb and Pb-Pb analyses of fine baddeleyite grains (≥ 5*5 μm) were conducted using the Cameca IMS-1280HR secondary ion mass spectrometer at the Institute of Geology and Geophysics, Chinese Academy of Sciences, Beijing. *In situ* Pb-Pb analyses of phosphate, feldspathic intergrowth and maskelynite were also conducted using the SHRIMP at the Beijing SHRIMP Center, Chinese Academy of Geological Sciences.

Rare Earth Elements: Pyroxene exhibits an LREE-depleted pattern with La varying from 0.1 to 2.1×CI, and Lu from 1.6 to 9.1×CI. Maskelynite exhibits a positive Eu anomaly (Eu=~11×CI) with HREE ranges from below detection limits to ~0.6×CI. Merrillite is rich in REEs (La=~780×CI) with a subtle negative Eu anomaly (Eu/Eu*=0.7). And HREEs gradually decrease from Gd (~840×CI) to Lu (~410×CI). Apatite has a similar REE pattern to that of merrillite at a much lower level (La=~40×CI). The calculated bulk REEs from the average REE concentrations of individual minerals and their modal abundances are consistent with those of enriched shergottites with a $(La/Yb)_{CI}$ value around 1.1 [5].

The feldspathic intergrowths also displays a positive Eu anomaly, but the concentrations are varying. The analyzed intergrowth with lower SiO_2 (65.3 wt %) and higher CaO (6.79 wt %) exhibits a similar REE pattern to that of maskelynite, while others (SiO_2 73.3-78.6 wt %, CaO 1.0-4.42 wt %) have slightly higher LREEs and HREEs with variable Eu. The correlation of REEs and major element contents is not obvious. Overall, the average REE contents of intergrowth areas are slightly higher than maskelynite.

Chronology: U concentrations of baddeleyite varies from 25 to 207 ppm with an average of ~ 72 ppm. The majority has a $^{206}Pb/^{204}Pb$ ratio below 500 and about half of them are below 100. Only one grain has a $^{206}Pb/^{204}Pb$ ratio above 1000. The Pb-Pb isotopic composition of baddeleyite concides with the 0.2 Ga isochron. The uncorrected $^{207}Pb/^{206}Pb$ and $^{238}U/^{206}Pb$ plotted on a Tera-Wasserburg diagram reveals a young age of 190.5 ± 6.4 Ma (MSWD = 1.7). The Raman spectra reveals characteristic for monoclinic baddeleyite [1]. Thus, the age is likely to represent the crystallization age of NWA 8653. This is consistent with young crystallization ages of some other shergottites in previous studies [3-4].

The uncorrected Pb-Pb isotopic composition of phosphate, feldspathic intergrowth and maskelynite exhibits overlaps lying near the 4.1 Ga isochron while maskelynite leans towards the most primitive value of shergottite as suggested in [6]. The common Pb level of these phases is significantly higher than that of baddeleyite with measured $^{206}Pb/^{204}Pb$ ratios below 20, which may result from mixing of modern terrestrial Pb and primitive Martian Pb [6].

Conclusion: NWA 8653 is a young enriched basaltic shergottite. The feldspathic intergrowth presenting within maskelynite represents an evolved end with slightly elevated REEs and minor Fe-rich minerals such as fayalite and ilmenite. *In situ* Pb-Pb analyses suggest that both phosphate and maskelynite (including feldspathic intergrowth) may provide misleading chronological information. Unshocked baddeleyite grains with less common Pb is more likely to record the crystallization age.

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