HEATING EXPERIMENTS OF MASKELYNITE IN ZAGAMI AND ELEPHANT MORAINE A79001: IMPLICATIONS FOR THEIR RELATIVE SHOCK DEGREES.

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Introduction: Maskelynite is understood as a diaplectic plagioclase glass that has been transformed from plagioclase in solid-state transformation by strong impact and is commonly found in martian meteorites [e.g., 1]. The shock pressure of martian meteorites has been quantitatively estimated from the refractive index of plagioclase by comparing with the recovered shocked plagioclase by dynamic high-pressure experiments [1]. However, the time scale of the impact is significantly different between natural events and laboratory experiments [2-3], and it has been pointed out that the shock pressure may be overestimated [4]. In this study, we performed heating experiments of maskelynite in martian meteorites because it is known that maskelynite is easily converted to crystalline plagioclase by reheating and the degree of recrystallization depends upon shock pressure [5]. We tried to evaluate the shock pressures of two shergottites (Zagami and EETA 79001) because they are reported to have experienced different degrees of shock [1].

Experiments: Small slices (~5 mm in size) of Zagami and EETA 79001 were heated at 900 °C (1, 8, 24 and 168 hours) and 1000 °C (1 hour) in a CO_2-H_2 gas mixing furnace at the oxygen fugacity of two log units above the iron-wüstite buffer ($\log fO_2$=IW+2). The heated samples were observed with an optical microscope to estimate the degree of plagioclase recrystallization and mineral compositions were analyzed by electron microprobe (JEOL JXA 8530F and JXA 8900L at Univ. of Tokyo).

Results: As reported in [6], Zagami did not show clear evidence of recrystallization in the experiment heated at 900 °C for 1 hour, but fibrous crystalline plagioclase was observed in the experiments heated at 900 °C for 8, 24, and 168 hours. Zagami maskelynites heated at 900 °C for 24 and 168 hours were almost completely converted to polycrystalline plagioclase. In maskelynites heated at 900 °C for 8 hours and heated at 1000 °C for 1 hour, fibrous crystalline plagioclase was observed only along the cracks and edges of the original grains. Although maskelynites appear to have a smooth surface through optical microscopy, the recrystallised plagioclase shows a dirty devitrified texture. Electron microprobe analysis revealed that Na and K are reduced, but Ca is enriched in the recrystallized plagioclase of the samples showing partial recrystallization (900 °C for 8 and 24 hours and 1000 °C for 1 hour). In the maskelynite grains heated at 900 °C for 168 hours, small glass regions enriched in Na and K are present (Na_2O: 6.5 wt%, K_2O: 2.5 wt%), suggesting that Na and K concentrate in areas where recrystallization did not start yet.

Similar to Zagami, EETA 79001 did not show clear evidence of recrystallization in the experiment heated at 900 °C for 1 hour, but fibrous crystalline plagioclase was observed in samples heated at 900 °C for 8, 24, and 168 hours. Maskelynites heated at 1000 °C for 1 hour also showed fibrous crystalline plagioclase. The sample heated at 900 °C for 24 hours shows concentration of Na and K in glass areas (Na_2O: ~5.0 wt%, K_2O: ~ 2.0 wt%), which resembles Zagami maskelynites heated at 900 °C for 24 and 168 hours.

In EETA 79001 maskelynites heated at 900 °C for 24 hours and at 1000 °C for 1 hour, the degree of recrystallization in one grain was similar compared to the samples under the same heating conditions of Zagami. However, there was a difference that EETA 79001 had lower volumes of the recrystallized regions compared to Zagami. This is probably because the grain size of maskelynites in EETA 79001 are smaller (~300 μm) compared to those of maskelynites in Zagami (500-800 μm).

Discussion and Conclusion: The degree of recrystallization of maskelynite is reported to be related to the original shock degree of plagioclase as experimentally demonstrated [5]. The results of [5] showed that the higher the degree of impact, the lower the recrystallization rate, as compared for the samples with the same heating time. The shock pressure of Zagami and EETA 79001 are estimated to be 29.5 ± 0.5 GPa and 36 ± 5 GPa, respectively [1]. Comparing our Zagami experiments with those of EETA 79001, in the heating experiments at 900 °C and 1000°C, the degree of recrystallization was similar, but EETA 79001 samples showed smaller volumes of recrystallization areas because of there differences in grain sizes. Therefore, we consider our experimental results are consistent with the higher shock degree of EETA 79001 than Zagami.

References: [1] Fritz J. et al. (2011) Meteoritics and Planetary Science 40:1393-1411. [2] Xie X. et al. (2001) European Journal of Mineralogy 13:1177-1190. [3] Ohtani E. et al. (2004) Earth and Planetary Science Letters 227:505-515. [4] Tomioka N. et al. (2010) Geophys. Res. Lett. 37:L21301. [5] Ostertag R. and Stöffler D. (1982) Proceedings of 13th Lunar and Planetary Science Conference:A457-A463. [6] Mikouchi T. et al. (2002) Meteoritics and Planetary Science 37:Suppl. A100.