PRESSURE AND TIMING OF THE SHOCK EVENTS RECORDED IN L6 CHONDRITES. S. Ozawa[1], E. Ohtani[1] and K. Terada[2], [1]Institute of Mineralogy, Petrology and Economic Geology, Graduate School of Science, Tohoku University, Sendai 980-8578, Japan (ozawasin@ganko.tohoku.ac.jp), [2]Department of Earth and Planetary Sciences, Hiroshima University, Higashi-Hiroshima 739-8526, Japan (terada@sci.hiroshima-u.ac.jp).

Introduction: Collision of planetesimals is a fundamental process of formation and evolution of planets. Shocked meteorites are the unique and important samples that provide us some information about collision histories in the solar system. Based on the shock metamorphic features, several studies estimated shock conditions of meteorites such as pressure, temperature and shock duration [e.g., 1-4]. Other works reported impact ages of shocked meteorites using radiometric methods [e.g., 5-8]. However, there are few studies to estimate both of the shock conditions and the impact ages for the same meteorites. In order to understand the impact histories in the solar system, we need both of the two information, i.e., what is the magnitude of the impact and when the impact occurred. In this study, we estimated the shock pressure of two L6 chondrites (Sahara 98222 and Yamato 74445) based on the mineralogy of shock melt veins (SMVs) and the stability field of observed high-pressure phases determined by static high-pressure and –temperature experiments. At the same time, we also estimate the impact age of Sahara 98222 based on U-Pb dating of phosphates in and around the SMVs.

Analytical Procedures: Several petrographic thin sections of Samples (Sahara 98222 and Yamato 74445) were investigated, which contain SMVs. We identified mineral phases in the SMVs using micro-Raman spectroscopy. Fine textures of minerals were observed by using a FE-SEM. Chemical compositions of minerals were analyzed by using an EPMA-WDS.

For U-Pb dating, we first identified phosphate minerals in or around the SMVs of Sahara 98222 by conducting chemical mappings of P and Ca. After the phase identifications and chemical composition analyses of the phosphates, we measured the concentrations and isotopic ratios of U and Pb in the phosphates by using a Sensitive High-Resolution Ion Microprobe (SHRIMP II).

Results and Discussions: Both of the samples consist of chondritic host rock and black SMVs. Major constituent minerals in the samples are olivine, enstatite, diopside, plagioclase, Fe-Ni-S metal and minor amounts of phosphates. There were two lithology in the SMVs: one is a coarse-grained polymineralic fragments of host rock entrained into the SMVs and another is fine-grained silicates or metallic phases that fill the inside of the SMVs. In this study, we mainly examined the coarse-grained lithology:

Shock Pressures of the samples. Olivine and plagioclase in coarse-grained fragments within the SMVs of Sahara 98222 are partially or totally transformed to their high-pressure phase, wadsleyite and jadeite, respectively. This would indicate that Sahara 98222 experienced high-pressure conditions corresponding to the stability fields of wadsleyite (13-16 GPa) and jadeite (2.5-22 GPa) [9- 13]. In addition, we could not identify any high-pressure polymorph of enstatite. It suggests that shock pressure in the SMVs of Sahara 98222 would be lower than enstatite-majorite phase boundary (<16 GPa) [14]. Therefore, the shock pressure of Sahara 98222 would be 13-16 GPa. In case of Yamato 74445, several high-pressure minerals were identified in coarse-grained fragments within the SMVs or host rock adjacent to the SMVs, such as ringwoodite (with trace amounts of wadsleyite), majorite, akimotoite and lingunite coexisting with jadeite. The stability pressure of ringwoodite (+ minor wadsleyite), majorite, akimotoite and lingunite (with jadeite) are 14-24 GPa, 17-22, 23-24 GPa, and 17-24 GPa, respectively [9-14]. Therefore, we estimated the shock pressure of Yamato 74445 is 17-24 GPa.

The estimated shock pressure of Yamato 74445 (17-24 GPa) is consistent with those of other L6 chondrites previously reported: e.g., 18-23 GPa for Yamato 791384, ~23 GPa for Sixiangkou, ~23 GPa for Suizhou and ~ 25 GPa for Tenham [2-4, 15, 16]. On the other hand, that of Sahara 98222 (13-16 GPa) is relatively lower than those of other L6 chondrites. Theoretically, shock pressure could be proportional to impact velocity during the collision [17]. The difference in shock pressure could suggests that Sahara 98222 experienced a relatively weaker collision than that of the other L6 chondrites.

The impact age of Sahara 98222. In Sahara98222, we identified five apatite and six merrillite in host rocks adjacent to the SMVs or as coarse-grained fragments within the SMVs. Among them, four merrillite entrained to the SMVs as fragments was completely converted its high-pressure polymorph, tuite. Plotting the obtained Pb and U isotopic ratios of each phosphates in $^{238}U/^{206}Pb$-$^{207}Pb/^{206}Pb$-$^{204}Pb/^{206}Pb$ plane, we calculated the "total isochron age" as 4467 ± 22 Ma. This age is slightly younger than that of previously reported U-Pb ages of unshocked L6 chondrites (e. g., 4566 Ma for Harleton (L6), 4546 Ma for Modoc (L6), 4535 Ma for Bruderheim (L6), 4511 Ma for Marion

(L6)) [18, 19]. Therefore, we considered that Sahara 98222 have experienced a thermal event, probably an impact, at 4467 Ma and U-Pb radiometric system was reset. However, several studies have reported that many L chondrite have impact ages around 500 Ma [e.g., 5-8]. Presented age of Sahara 98222 is inconsistent with these reports and the reason of this discrepancy have not been clarified yet. Sahara 98222 may have recorded an different impact on the L chondrite parent body occurred in the early solar system.

References:

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