Pressure-temperature conditions and age of shock events recorded in L6 chondrites

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Impact phenomena are the fundamental processes of accretion of the terrestrial planets. Shocked meteorites have recorded impact events occurred in the solar system. Therefore, investigations of meteorites that experienced shock events are useful for understanding mechanisms of planetary impact events and formation of terrestrial planets. In this study, constituent mineral assemblages in shock melt veins of two L6 chondrites (Sahara 98222 and Yamato 74445) were investigated to estimate the pressure-temperature conditions during their impact events.

In the shock melt veins of these meteorites, several high-pressure minerals ware found such as wadsleyite (beta-Mg_2SiO_4), jadeite ($NaAlSi_2O_6$) and tuite ($Ca_9MgNa(PO_4)_7$) for Sahara 98222 and ringwoodite (gamma-Mg_2SiO_4) (+ wadsleyite), akimotoite ($MgSiO_3$-ilmenite) and lingunite ($NaAlSi_3O_8$-hollandite) for Yamato 74445. Based on constituent mineral assemblage in the shock veins, the pressure and temperature conditions during their impact events were estimated: 13-15 GPa, more than 1900 degrees C for Sahara 98222 and 23-24 GPa, more than 2100 degrees C for Yamato 74445, respectively.

In addition, a U-Pb dating of phosphates in and around the shock melt veins of Sahara 98222 was conducted to reveal when this shock event occurred, using a Sensitive High Resolution Ion MicroProbe (SHRIMP II) at Hiroshima University. Sahara 98222 contains apatite ($Ca_5(PO_4)_3$(Cl, OH)) and whitlockite ($Ca_9MgNa(PO_4)_7$) as phosphate minerals and whitlockite in the shock melt vein were transformed to a high-pressure polymorph, tuite ($Ca_9MgNa(PO_4)_7$).

As a results, following radioactive ages were obtrained; a Pb-Pb isochron age: 4466 (31) Ma, an U-Pb isochron age: 4498 (150) Ma, a total U-Pb isochron age: 4467 (22) Ma. These ages are slightly younger than the previously reported ages of chondrites, which are usually older than 4500 Ma. This could suggest that Sahara 98222 have recorded a shock event in the very early stage of the solar system.