A high-pressure polymorph inventory in shocked L type ordinary chondrites

*Masaaki Miyahara[1], Akira Yamaguchi[2], Eiji Ohtani[3], Masato Saitoh[1,4]

1.Graduate School of Science, Hiroshima University, 2.NIPR, 3.Graduate School of Science, Tohoku University, 4.Graduate School of Engineering, Tohoku University

Planetary collision phenomenon is one of fundamental process for planet evolution. So, shock metamorphism is recorded in many meteorites. The existence of high-pressure polymorphs is one of distinct evidences for the planetary collision phenomenon. Many colleagues have worked on high-pressure polymorphs in shocked ordinary chondrites. We could constrain shock pressure conditions, impact velocities and their parent-body sizes using the high-pressure polymorph assemblages in the shocked ordinary chondrites and their kinetics, which will give clues for how the ordinary chondrite parent-bodies were destroyed. Radio-isotope measurements along with such high-pressure mineralogical investigations could date when the parent-body destroys occur in the solar nebula. Ordinary chondrite is classified into H, L and LL based on metallic iron content. Individual ordinary chondrite is further divided into petrologic type 3, 4, 5 and 6 (and 7) based on the differences on thermal metamorphism degree. Most previous investigations working on high-pressure polymorphs have just focused on type 6, especially L6 ordinary chondrite. Few systematic investigations about a high-pressure polymorph in other type ordinary chondrites have not been conducted up to now. A parent-body of an ordinary chondrite is expected to have an onion shell-like structure. The inventories of high-pressure polymorphs included in all type ordinary chondrites are required to depict the destroy process of an ordinary chondrite parent-body. Accordingly, in this study, we described high-pressure polymorphs included in L3, L4 and L5 type ordinary chondrite through a fine textural observation by a FEG-SEM and mineral identification by a laser micro-Raman spectroscopy. Twenty-one Antarctica and one non-Antarctica L-type ordinary chondrite thin sections were used for this study.

Four L3 type ordinary chondrites including shock-induced melting textures were selected through optical microscopic observations. Most chondrules are slightly flattened. The boundaries between the flattened chondrules and surrounding matrices are distinct. Several isolated melting textures (hereafter, a melt-pocket) are observed around the boundaries. High-pressure polymorphs were not identified in and around the melt-pockets although several plagioclase grains become maskelynite. In case of L4 type ordinary chondrites (ten specimens), the boundaries between chondrules and matrices are not so clear compared with L3. The grain-sizes of constituents in the matrices are coarser than L3. Melt-pockets occur around the boundaries like L3. A shock-melt vein occurs only in one specimen. Jadeite was identified in plagioclase grains entrained in and around the melt-pockets or shock-melt veins. Maskelynite was also identified. In case of L5 type ordinary chondrites (five specimens), the boundaries between chondrules and matrices are indistinct. All melting textures occur as a shock-melt vein. Jadeite occurs in plagioclase grains entrained in or around the shock-melt veins. Maskelynite also occurs. The olivine grain entrained in the shock-melt vein partly transforms into wadsleyite.

Our investigations reveal that shock-induced melting occur in L3, L4 and L5 besides L6 ordinary chondrites. Most shock-induced melting occur as a melt-vein in L6 and L5, whereas as a melt-pocket in L3 and L4. Ringwoodite, wadsleyite, akimotoite, majorite, bridgmanite, jadeite, lingunite and tuite occur in and around the shock-melt veins of L6. Only jadeite occurs ubiquitously in and around the shock-melt veins and melt-pockets of L4 and L5. The shock pressure condition can be estimated based on a high-pressure polymorph phase equilibrium diagram deduced from static high-pressure synthetic experiments. The estimated shock pressure conditions are as follows; about

from 13 to 24 GPa for L6, about from 2.5 to 12 GPa for L4 and L5, and less than about 2.5 GPa for L3.

Keywords: High-pressure polymorph, Ordinary chondrite, Shock-induced melting

