SHOCK METAMORPHISM HISTORY OF H-TYPE ORDINARY CHONDRITE PARENT-BODY BASED ON THE HIGH-PRESSURE POLYMORPHS.

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Introduction: Most meteorites have experienced a shock metamorphism induced by a planetesimal collision. Pervasive shock-melt veins occur in the heavily shocked meteorites. Constituents in the shocked meteorites transform into their high-pressure polymorphs under ultra-high pressure and -high temperature conditions induced by the planetesimal. High-pressure polymorphs are one of clues for estimating impact pressure and temperature conditions. Ordinary chondrite is collision divided into from petrological type 3 to type 6 based on the difference of thermal metamorphism degree. Ordinary chondrite parent-bodies are expected to be composed of from type 3 to type 6 (from center to outside). Many kinds of high-pressure polymorphs occur in shocked ordinary chondrite, especially in type 6. Accordingly, most previous studies have worked on high-pressure polymorphs in type 6. However, high-pressure polymorphs in from type 3 to type 5 have hardly investigated so far. High-pressure polymorphs not only in type 6 but also in from type 3 to type 5 should be investigated to understand the destruction process of the ordinary chondrite parent-body. In this study, we will conduct the systematic investigation of high-pressure polymorphs in H4, H5 and H6 ordinary chondrites.

Materials and experimental methods: The petrologic thin sections of Yamato 792764 (Y-792764) H4, Yamato 75262 (Y-75262) H5, Yamato 790215 (Y-790215) H5, Yamato 790254 (Y-790254) H5, Yamato 790746 (Y-790746) H6, Yamato 792770 (Y-792770) H6, Yamato 793535 (Y-793535) H6, Yamato 793537 (Y-793537) H6, NWA 2546 H5, Dar el Kahal H5,and Peekskill H6 were prepared for this study.

Fine textural observations were conducted using a field emission scanning electron microscope (FE-SEM; JEOL JSM-7000F) at Geodynamics Research Center (GRC), Ehime University. Raman spectra of constituent minerals in the meteorites were measured by a JASCO NRS-5100gr spectrometer at GRC. The chemical compositions of minerals were determined by an electron probe micro-analyzer (EPMA; JEOL JXA-8200) at N-BIRD, Hiroshima University.

Results and discussion: All H4, H5, and H6 ordinary chondrites studied here included shock-melt veins (a width 30-500 µm), which is suggestive of a heavy shock metamorphism. Although olivine, pyroxene and feldspar grains next to or entrained in the shock-melt veins were meticulously investigated by FE-SEM and Raman spectroscopy, their high-pressure polymorphs were not identified. Only plagioclase glass (maskelynite) was confirmed in some cases. Considering previous studies [1], it’s likely that the presences of high-pressure polymorphs and maskelynite are rare in H chondrite compared with L chondrite although shock-melt veins occur ubiquitously in shocked H chondrites. We will raise three possible reasons few high-pressure polymorphs occur in shocked H chondrites; i.e., 1) The limited duration of ultra-high pressure condition, 2) High content of metallic iron and 3) Back-transformation. First, the duration of ultra-high pressure condition induced by a planetesimal collision depend on the size [2]. The estimated diameter of ordinary chondrite parent-bodies is from 150 to 260 km [3]. The diameter of H-chondrite parent-body (75-130 km) is about 0.6 times as large as that of L-chondrite parent-body (125-215 km) [4]. In case of H-chondrite parent-body, the duration of shock may be too short for high-pressure polymorph formation. Second, fayalite content in the olivine of H-chondrite is lower than those of L- and LL-chondrites. Considering pressure-composition diagram for the Mg_2SiO_4- Fe_2SiO_4 system, forstelitic olivine transforms into wadsleyite or ringwoodite at higher pressure condition compared with fayalitic olivine. It is likely that the shock pressure condition recorded in H-chondrites does not achieve region where the phase transformation occurs. Third, although high-pressure polymorphs formed around 18-23 GPa they back-transformed into their original phases during adiabatic decompression stage. Both H- and L-type chondrites have shock-melt veins. Although, L-chondrites include high-pressure polymorphs H-chondrites hardly include them. It is expected that there is a difference on thermal histories between H- and L-chondrites after dynamic events [5].

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