Japan Geoscience Union Meeting 2015
(May 24th - 28th at Makuhari, Chiba, Japan)

SIT06-P02 Room:Convention Hall Time:May 25 18:15-19:30

Jadeite in shocked meteorites: various textures and formation processes

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Introduction

Collision of materials is one of the most fundamental processes in planet formation of the early solar system. Heavily-shocked meteorites sometimes contain high-pressure minerals, which provide important constraints on the nature of the impact events. Jadeite is a high-pressure mineral identified in various types of meteorites such as H, L and LL chondrites, and Martian meteorites [1-8]. Here, we show various occurrences of jadeite observed in shocked meteorites, and discuss the conditions and mechanisms of jadeite formation.

Results and Discussions

Heavily-shocked ordinary chondrites (H, L and LL) were mainly observed in our studies. They consist of chondritic host-rock and pervasive shock-induced melt veins (SMVs). Jadeite is usually identified in fragments of the host-rock entrained to the SMVs. Albitic feldspar grains in these fragments have been replaced by jadeite plus amorphous material.

A variety of texture was observed in jadeite-bearing grains of Sahara 98222 L6 chondrite, such as “particle-like” , “stringer-like” , and “polycrystalline-like” phases [4]. Similar textures were also reported in jadeite-bearing grains of other L and H ordinary chondrites [5], and shocked rocks from Ries crater, Germany [7]. Detailed TEM observations by Miyahara et al. [5] clarified that these jadeite-bearing grains consist of massive or network-like assemblages of jadeite crystals and interstitial amorphous (or poorly-crystallized) materials. Bulk chemical compositions of the jadeite-bearing grains are almost identical to that of albitic feldspar in the host-rocks. Therefore, the jadeite described above is considered to have formed by solid-state reactions.

On the other hand, we recently found a new occurrence of jadeite in Chelyabinsk LL5 chondrite [8]. Needle-like or skeletal-rhombic crystals of jadeite coexist with amorphous material. The bulk chemical compositions of the jadeite-bearing grains are different (more K-rich) from that of albitic feldspar in the host-rock. In addition, jadeite-rich part is enriched in Na, whereas the amorphous part is highly enriched in K. The significant element migrations appear to be difficult in solid-state reactions during a short duration of an impact. Thus, jadeite in Chelyabinsk meteorite is considered to have crystallized from feldspathic melt.

It is experimentally revealed that albite dissociate into jadeite plus silica phase over 3 GPa, and jadeite can be stable at 3-19 GPa as a liquidus or subsolidus phase [9-14]. The two types of jadeite formation (from solid or melt) were probably caused by different temperature conditions. For the jadeite formed by solid-state reactions, the temperature is considered to have been lower than at least 1400 ℃, the melting temperature of albite at 3 GPa [10,11]. For the jadeite formed from melt, the temperature could have been higher than 1400 ℃. The different textures and chemical compositions of the jadeite-bearing grains reflect different P-T-t (Pressure-Temperature-time) conditions during the impact events on different parent bodies of the meteorites.

References

[1] Kimura et al. (2000) Meteorit. Planet. Sci. 35, A87-A88.
[2] Kimura et al. (2001) Meteorit. Planet. Sci. 36, A99.
[3] Ohtani et al. (2004) Earth Planet. Sci. Lett. 227, 505-515.
[4] Ozawa et al. (2009) Meteorit. Planet. Sci. 44, 1771-1786.
[5] Miyahara et al. (2013) Earth Planet. Sci. Lett. 373, 102-108.
[6] El Goresy et al. (2013) Lunar Planet. Sci. Conf. 44, 1037.
[7] James (1969) Science 165, 1006-1008.
[8] Ozawa et al. (2014) Sci. Rep. 4, 5033.
[9] Birch & LeCompte (1960) Am. J. Sci. 258, 209-217.
[10] Boyd & England (1963) J. Geophys. Res. 68, 311-323.
[11] Bell & Roseboom, Jr (1969) in Pyroxenes and Amphiboles: Crystal Chemistry and Phase Petrology,151-161.
[12] Liu (1978) Earth Planet. Sci. Lett. 37, 438-444.
[13] Yagi et al. (1994) Phys. Chem. Min. 21, 12-17.

[14] Tutti (2007) Phys. Earth Planet. Int. 161, 143-149.

Keywords: jadeite, meteorite, impact, high-pressure mineral, shock melt vein, formation mechanism