

## Shock pressure estimation by high-pressure polymorphs and cathodoluminescence spectra of maskelynite in Yamato-790729 L6 chondrite and their significance for collisional condition

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Most asteroidal meteorites have experienced impact events that occurred on their parent-bodies because shock-induced features (e.g., melting textures, high-pressure polymorphs and vitrification) provide clear evidences for impact events. L6 type ordinary chondrite frequently has a vein-like shock-induced melting texture (a shock-melt vein or shock vein). Furthermore, they may contain high-pressure polymorphs and shock-induced glasses (e.g., maskelynite) that were transformed from the constituent minerals (e.g., olivine, pyroxene and plagioclase) due to high-pressure and -temperature conditions induced by impact events. Such high-pressure polymorphs and shock-induced glasses provide constraints on the asteroidal impact history. In this study, Yamato (Y)-790729, which is classified as heavily shocked L6 type ordinary chondrites, was investigated to estimate the shock-pressure, temperature and size of the parent body, based on high-pressure polymorph assemblage and cathodoluminescence (CL) spectroscopy of maskelynite. The shock pressure conditions estimated by these two methods were also compared each other to evaluate the validity of the methods.

Y-790729 is a typical L6 ordinary chondrite with remnants of chondritic textures, and has a shock-melt vein. The host-rock of Y-790729 consists mainly of olivine, low-Ca pyroxene, feldspar, metallic Fe-Ni, and iron-sulfide with minor phosphate and chromite. Undulatory extinction was recognized in some plagioclase and pyroxene grains under the optical microscope. A scanning electron microscope (SEM), laser micro-Raman spectroscopy and transmission electron microscope (TEM) equipped with an X-ray energy dispersive spectrometer (EDS) were carried out for this meteorite to determine the chemical composition, observe the petrological features and identify the high-pressure phases. Another SEM with a CL spectrometer was also conducted to characterize the shock metamorphic effects of the feldspar and maskelynite.

A shock-melt vein with a width of  $< \sim 620 \mu\text{m}$  exists in Y-790729. TEM observations and micro-Raman spectroscopy of this meteorites demonstrated that ringwoodite, majorite, akimotoite, lingunite, tuite, and xieite occurred in and around the shock-melt vein. The ringwoodite is polycrystalline assemblages under the TEM observations, where the individual grain reaches from  $\sim 0.1$  to  $\sim 1.3 \mu\text{m}$  across. According to the phase equilibrium diagrams of these high-pressure polymorphs, the shock pressure in the shock-melt vein is about 14-23 GPa.

Part of plagioclase grains in the host-rock occurred as maskelynite under the optical microscope and Raman spectroscopy. Sixteen different CL spectra from maskelynite portions of Y-790729 showed characteristic emission bands at  $\sim 330$  and  $380 \text{ nm}$ . The obtained CL spectral data of maskelynite portions were deconvoluted into three emission components at 2.95, 3.26, and 3.88 eV. The intensity of emission component at 2.95 eV was selected as a calibrated barometer to estimate shock pressure, and the results indicate shock pressures of about 11-19 GPa. The difference in pressure between the shock-melt vein and host-rock might suggest heterogeneous shock conditions.

Assuming an average shock pressure of 18 GPa, the impact velocity of parent-body of Y-790729 is calculated to be  $\sim 1.90$  km/s. The melting temperature of the shock vein could be about 2173 K at 18 GPa, according to previous data obtained from the KLB-1 peridotite and Allende meteorite. It is likely that the duration of high-pressure and -temperature conditions recorded in the shock-melt veins of Y-790729 is several seconds, implying that the parent-body size is  $\sim 10$  km in diameter at least, based on the incoherent formation mechanism of ringwoodite in Y-790729.

Keywords: L6 type ordinary chondrite, Yamato-790729, high-pressure polymorphs, cathodoluminescence