Cathodoluminescence and Raman spectroscopic study of maskelynite in shergottite (Dhofar 019) and experimentally shocked plagioclase

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Introduction

Dhofar 019 classified as an olivine-bearing basaltic shergottite consists of subhedral grain (0.2-0.5 mm) of pyroxene (pigeonite and augite), olivine and feldspar mostly converted to maskelynite and minor K-feldspar, merrillite, chromite, ilmenite and pyrrhotite, associated with terrestrial secondary phases. An estimation of shock pressure for this meteorite has been an important subject under discussion, whereas it was qualitatively presumed in the range of 30-35 GPa judging from the formation of maskelynite (An_{36-68}) [1, 2]. In this study, we evaluate the shock pressure by quantitative comparison with experimentally shocked plagioclase using cathodoluminescence (CL) and micro-Raman spectroscopy.

Sample and methods

Two polished thin sections of Dhofar 019 meteorite were employed for CL and Raman measurements. Experimentally shocked plagioclase (Ab_{40}) at 20, 30 and 40 GPa were used as a reference sample for known shock pressure. CL measurements were carried on in the range from 300 to 800 nm using a SEM-CL system, which is comprised of a secondary electron microscope (JEOL: JSM-5410) combined with a grating monochromator (OXFORD: Mono CL2). The Laser Raman spectroscopy is carried out using a NRS-2100 (JASCO CO.) with an Ar laser of 514.5 nm wavelength.

Results and discussion

CL spectra of maskelynite in Dhofar 019 exhibit two broad band peaks at around 400 and 600 nm, which can be assigned to self-trapped exciton (STE) and Mn^{2+} impurity center, respectively. Similar blue emission at around 400 nm is observed in plagioclase shocked at 40 GPa, whereas it has not been recognized in the plagioclase at 0, 20 and 30 GPa (Fig. 1). The wavelength of the peak in yellow region shifts from 560 nm for unshocked plagioclase to 630 nm for maskelynite and shocked plagioclase at 20, 30 and 40 GPa. Maskelynite in Dhofar 019 and experimentally shocked plagioclase at 40 GPa show a weak and broad Raman spectral peak at around 450 cm^{-1}, which can be assigned to T-O-T symmetrical stretching vibration, suggesting the alteration of the crystal field related to Mn^{2+} activator (Fig.2). Raman spectral analysis indicates that lower shocked plagioclase at 20 and 30 GPa have their high crystallinity without any change of framework configuration. These facts imply that shock pressure induced on this meteorite is relatively high at approximately 40 GPa.

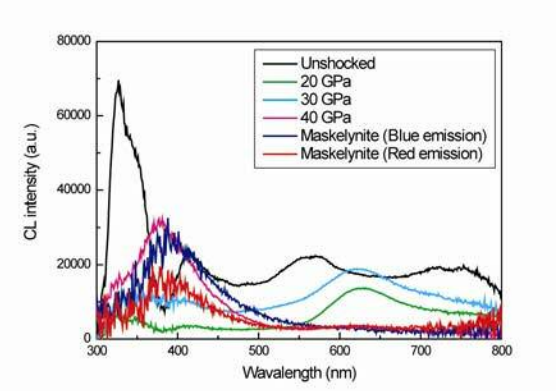

Fig. 1 CL spectra of unshocked and experimentally shocked plagioclase at 20, 30 and 40 GPa and maskelynite in Dhofar 019

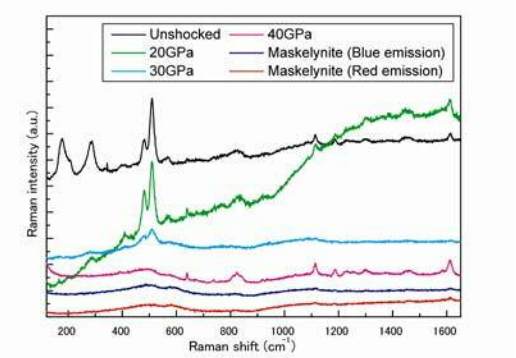

Fig. 2 Raman spectra of unshocked and experimentally shocked plagioclase at 20, 30 and 40 GPa and maskelynite in Dhofar 019

References

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[2] Taylor L. A et al. 2002. Meteoritics & Planetary Science 37:1107–1128.