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# Amorphization and crystallization kinetics of plagioclase at high pressure and temperature

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## Introduction

High-pressure phases of plagioclase and amorphous plagioclase are often observed in shocked meteorites. These can be important constraints on the history of shock events. Equilibrium phase relations of plagioclase have been well studied at high pressure, however the processes of plagioclase breakdown are poorly known. In additon, experimental studies on amorphization of plagioclase have been rather limited to very short time scales (~$10^{-6}$ sec) by laboratory shock experiments, or to room temperature by using DAC. Here we report new experimental results on amorphization and crystalization kinetics of plagioclase examined by in-situ X-ray observations at high pressure and temperature.

## Results and discussion

Two kinds of plagioclase, natural labradorite (Ab45.0An51.8Or3.2) and natural albite (Ab98.0An0.4Or1.6), were used in the present study. Pressure was generated by the double stage system using the high-pressure apparatus of MAX-80 and MAX-III installed at PF. Cold compressions of these powdered and sintered polycrystalline plagioclase caused broadening of X-ray diffraction peaks, however fully amorphization was not observed at room temperature up to 20 GPa. The X-ray peak broadening became more significant with increasing temperatures after the cold compression. We observed that plagioclase amorphizations occurred by heating at high pressure. The amorphization pressure decreases with increasing temperature (Fig. 1).

We found that crystallization kinetics from amorphous plagioclases, which was examined by time-resolved X-ray diffraction measurements with energy dispersive method, is rather different among minerals (Fig. 2). Jadeite first appears from amorphous plagioclases of both chemical compositions. Nucleation of other minerals such as grossular, stishovite, and Ca ferrite-type $NaAlSiO_4$ is significantly delayed. Preliminary analysis of kinetic data based on Avrami rate equation indicates that the n-value for the formation of Jadeite is around 0.5, whereas the n-values for other phases are relatively large 3~4. This may suggest that fast nucleation and diffusion-controlled growth of jadeite, and slow nucleation rates of other phases.

These findings and further quantitative analysis of kinetic data make it possible to constrain P-T-t conditions during shock events based on the plagioclase breakdown.

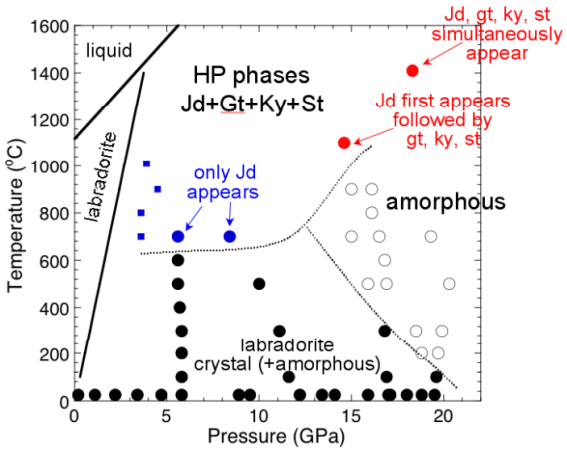


Fig. 1 P-T conditions for amorphization and high-pressure phase crystallization in the starting material of labradorite (Jd: jadeite, Gt: grossular, Ky: kyanite, St: stishovite)

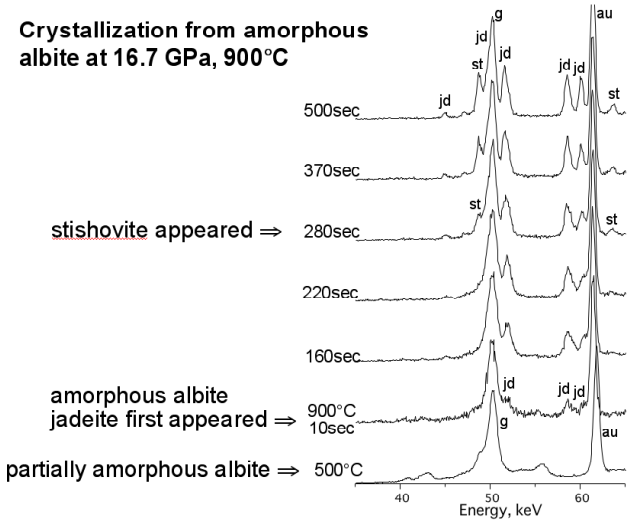


Fig. 2 Changes of X-ray diffraction patterns during crystallization of jadeite and stishovite from amorphous albite. Nucleation of jadeite is much faster than that of stishovite.

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