Cathodoluminescence characterization of shocked plagioclase

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Introduction

Shock-metamorphosed plagioclase in meteorite and impact crater have been less studied in spite of importance of planetary sciences, up to date. In this study, cathodoluminescence (CL) of the shock-induced synthetic plagioclase has been measured to clarify an effect of shock-metamorphism.

Sample and Methods

The unshocked synthetic plagioclase (Andesine-An_{40}) and experimentally shocked samples at 20, 30 and 40 GPa (by rail gun experiment) as well as natural plagioclase (An_{50}) from Ries Crater, Germany (occurred in suevite at shock stage IV< 40 GPa) were selected for the CL measurements.

Result and Discussion

Synthetic plagioclase exhibits four CL peaks: (1) UV peaks at 330 nm related to defect center, (2) blue peaks at around 420 nm attributed to Ti center, (3) yellow peaks at 560 nm assigned to Mn^{2+} center and (4) red peaks at 740 nm assigned to Fe^{3+} center (Fig. 1). Peak positions of blue and yellow peaks respectively shift from 420 to 380 nm and 560 to 630 nm and intensity of all peaks decrease as function of the increasing shock pressure. This indicates that shock wave can cause a change of crystal field and emission procceses leading to peak shift and decrease of intensity. These effects by impact shock are also observed in natural plagioclase samples from Ries Crater except for peak shift of yellow peak, which might be at least partly responsible for heating effect at natural shock event.

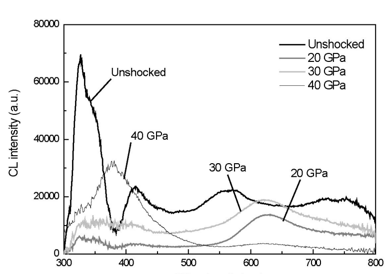

Figure 1: CL spectra of synthetic plagioclase.

Gas chemistry of a hydrothermal plume at 8°18'S on the Mid-Atlantic Ridge

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Plate tectonic processes play an important role in the hydrothermal venting of gases such as helium, methane and hydrogen on mid-ocean ridges. While spreading rate (magma supply) primarilarly determines the rate of mantle helium degassing, venting of methane and hydrogen may be enhanced by extensional tectonics of slow spreading ridges, through the serpentinization of uplifted ultra-mafic rocks. Here we report the deep-water distribution of these gases in the region of a recently discovered hydrothermal vent at 8°17.9'S, 13°30.4'W. The measurements were carried out on Meteor cruises 62/5 and 68/1 in December 2004 and May 2006, as part of the German Priority Program 1144. The vent, a powerful, "odorless" black smoker inside a 2-meter deep crater, is located at the northern end of a narrow ridge within the MAR segment between the Ascension and Bode Verde fracture zones. The methane plume was detectable as far as 12 km from the vent, but the ^3He signal was relatively weak, with clear anomalies only within a 2 km^2 area surrounding the site at the end of the ridge. $^3He/^4He$, hydrogen and methane were observed to be well correlated near the plume, with molar ratios of $H_2/CH_4 \approx 15$ and $CH_4/^3He \approx 4 \times (10)^8$. The latter is one of the highest $CH_4/^3He$ ratios observed in hydrothermal plumes. Measurement of hydrogen and methane in the vent fluid yielded a H_2/CH_4 ratio of 8:1, which is lower than the ratio observed in the plume. The distribution of methane in the region varied temporally, but during the first week of December 2004, it appeared that the plume trended mainly WSW from the vent. LADCP measurements (Stöber, 2005) indicated that currents at the plume depth during the ebb phase of the TPX0.5 tidal model were also in this direction. Excess methane inventories in 3 sections normal to the plume axis appeared to be about 12 to 14 mol m^{-1}. As the the current velocity at this time typically was about 5 cm s^{-1}, it appears that the methane source was about 0.7 mol s^{-1}. From the plume ratios above, it appears that the ^3He and H_2 sources were about 2 nmol s^{-1} and 10 mol s^{-1} respectively. We also use the distribution of these tracers to estimate rates of methane oxidation in the region and of plume dispersion according to a Gaussian model.