Report for the Joint Use/Research of the Institute for Planetary Materials, Okayama University

2019 fiscal year / period of stay 14/11/2019-24/12/2019

22/01/2020

Category: International Joint Research

Name of the research project: Experimental study of the systems Na_2CO_3-$CaCO_3$, Na_2CO_3-$MgCO_3$, and $CaCO_3$-$MgCO_3$ at 11 GPa.

Principal applicant: Ivan V. PODBORODNIKOV

Position: PhD student (second year)
*(Supervisor): Anton SHATSKIY

Affiliated institution and department: Sobolev Institute of Geology and Mineralogy Siberian Branch of Russian Academy of Science (IGM SB RAS)

Name of the faculty member of IPM : **Takashi YOSHINO** (□ Already consulted)
Must apply after consulting with a faculty member of IPM

List of collaborators (A faculty member of IPM must be included as a collaborator for joint research and workshop)

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Research report:

Background (motivation):

High-pressure phase relations in carbonate systems attract a lot of attention because carbonates participate in various mantle processes connected with deep carbon circle, generation of deep-seated magmas such as kimberlites and magnesiocarbonatites, mantle metasomatism, and diamond formation. Carbonate minerals may enter subduction zones incorporated in hydrothermally altered basaltic crust, overlying marine sediments and underlying mantle lithosphere. Experimental constraints and thermal modeling of subducting slabs indicate that a significant amount of carbonate could survive hydrous melting under forearcs and sink to the deeper mantle as a part of relatively dry eclogites.

Thomson et al. (2016) have shown that decreasing compatibility of Na_2O results in dramatic drop in the solidus temperature of carbonated oceanic crust subducted down to the mantle transition zone. They found that decreasing fraction of clinopyroxene owing its dissolution in garnet structure

yields Na_2O redistribution from silicate to carbonate portion of the system and stabilizes a fusible $Na_2(Ca,Mg)_4(CO_3)_5$ compound, which control the solidus temperature and yields formation of Na-rich carbonatite melt. Similar melts were recently found as inclusions in asthenospheric diamonds from the Juina, Mato Grosso State, Brazil (Kaminsky et al., 2009, 2013, 2016).

It is, therefore, essential to know the phase relations in the Na_2CO_3–$CaCO_3$–$MgCO_3$ and clinopyroxene-carbonate systems under pressure and temperature conditions of the mantle asthenosphere.

Research purpose

The study of subsolidus and melting phase relations in the following binary systems Na_2CO_3–$CaCO_3$, Na_2CO_3–$MgCO_3$, $CaCO_3$–$MgCO_3$ at 14 GPa in order to constrain corresponding T-X phase diagrams. This study is a contribution to the Na_2CO_3–$CaCO_3$–$MgCO_3$ ternary and more complex systems modelling subducting carbonated mid-ocean-ridge basalt.

Actually conducted research and research outcomes

During the last stay on 14/11/2019-24/12/2019, the following experiments were carried out at 14 GPa. ***Each experiment contained 16 samples of different composition.***

Run number, temperature, duration, systems (remarks on troubles if any):

1) 5k3454, 1100 °C, 72 h., Na_2CO_3–$CaCO_3$, Na_2CO_3–$MgCO_3$;

2) 1k3165, 1200 °C, 48 h., Na_2CO_3–$CaCO_3$, Na_2CO_3–$MgCO_3$;

3) 1k3166, 1300 °C, 20 h., Na_2CO_3–$CaCO_3$, Na_2CO_3–$MgCO_3$;

4) 5k3457, 1400 °C, 5 h., Na_2CO_3–$CaCO_3$, Na_2CO_3–$MgCO_3$ (unstable heating);

5) 5k3458, 1500 °C, 2.5 h., Na_2CO_3–$CaCO_3$, Na_2CO_3–$MgCO_3$, $CaCO_3$–$MgCO_3$ (unstable heating);

6) 5k3455, 1600 °C, 2.5 h., Na_2CO_3–$CaCO_3$, Na_2CO_3–$MgCO_3$, $CaCO_3$–$MgCO_3$;

7) 1k3175, 1700 °C, 1 h., Na_2CO_3–$CaCO_3$, Na_2CO_3–$MgCO_3$, $CaCO_3$–$MgCO_3$;

8) 1k3169, 1800 °C, Na_2CO_3–$CaCO_3$, Na_2CO_3–$MgCO_3$, $CaCO_3$–$MgCO_3$ (blowout during compression, before heating).

‘1k…..’ – USSA 1000-ton press, ‘5k….’ – USSA 5000-ton press.

Pressure calibration experiment. Run number, temperature, duration:

9) 5k3450, 1300 °C, 4 h.

Additional experiments in the system $CaCO_3$–$CaSiO_3$–$MgSiO_3$–$MgCO_3$ at 6 GPa using USSA 5000-ton. ***Each experiment contained 16 samples of different composition***:

Run number, temperature, duration:

10) 5k3447, 1350 °C, 24 h.;

11) 5k3443, 1450 °C, 15 h.;

12) 5k3445, 1600 °C, 2 h.;

13) 5k3444, 1700 °C, 1 h.

A total of **13** experiments were conducted. In total, about 190 samples were obtained. Currently we study these samples using a SEM with EDS.