EXPERIMENTAL MODELING OF GLAUCOPHANE SCHIST - OLIVINE INERACTION UNDER P-T CONDITIONS OF SUBDUCTION ZONE

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Key words: *subduction, experiment, dehydration, fluid, melt*

Introduction

Modern high-pressure apparatus permit to carry out experimental studies at P-T conditions which correspond to the lower mantle of the Earth (30 GPa and more). The experimental runs commonly carry out at constant temperatures and pressures [2], which not always appropriate to the type of the processes under consideration. For example, subduction zones are characterized by valuable thermal gradients owing to descend of cold oceanic plate into the hot mantle [5]. For studies of the interaction between subducted plate and mantle in most realistic conditions we propose to apply high-gradient zones of the piston-cylinder apparatus [1]. In this contribution, we present peculiar features of the glaucophane schist-olivine interaction as analogs of crust and mantle, respectively.

Experimental conditions

The glaucophane-phengite schist is from the Maksytov complex, Southern Urals (courtesy of V.S. Shatsky), the olivine is collected from the quarry Ahaim, Norway. P-T conditions of the run correspond to so-called “hot” geotherm which is typical for slowly subducted young lithosphere [3]. The run was carried out during was 91 hr at pressure of 2.5 GPa and temperature of 1150^{o}C at the upper end of the capsule. Temperature of the lower edge of the 3 mm capsule was inferred from the numerical modeling of the thermal structure of the pressure cell based on the real sizes of the materials after the run. The numerical modeling using method by Schiling and Wuender [4] reveals that when the temperature at the upper edge (side of the olivine) is fixed at 1150^{o}C, the temperature of the lower edge (side of the glaucophane schist) drops to ~900^{o}C.

Run products and results

Phase transformations during the run were controlled by the temperature and chemical composition of the local domains (fig.1). Glaucophane (Gl) breakdown and formation of barroisitic amphibole (Brz) and albite (Ab) sometimes in association with biotite (Bt) is a common feature of the lower domain of the capsule. The breakdown products occur as symplectites in the grain boundaries, but also form microchannels within the grains pointing at the migration of hydrous (Na, K-bearing) fluid. Degree of transformation dramatically increases in the upper portion of the schist where primary minerals are almost totally replaced by the barroisite-orthopyroxene (Opx, X_{Mg}~0.7; Al_2O_3~4 wt.%) – albite and albite-corundum (Cor) – biotite symplectites (fig.1c). Triangular diagram reveals that the symplectites replace either glaucophane or phengite (fig. 2). Note that fusion phenomena in this domain are lacking. The uppermost portion of the former glaucophane schist is composed of the biotite (X_{Mg}~0.81), garnet (X_{Mg}=0.6; X_{Ca}=0.1) and melt of trachidacite-riodacite composition. In the areas of abandon melting, the liquid ascends and forms small diapirs (fig. 1c, d). The melts in the olivine matrix have dacitic composition and contain abundant orthopyroxene (X_{Mg}~0.9, Al_2O_3<3.5 wt.%). Orthopyroxene developed after olivine in contact with the melt is enriched by Al_2O_3 (X_{Mg}~0.9, Al_2O_3<6.9 wt.%).

Conclusions

Experimental study of the glaucophane schist-forsterite interaction as analogs of subducting crust and mantle, respectively, reveal breakdown of the minerals of the glaucophane schist which was resulted in:

- formation of the orthopyroxene-plagioclase-quarz symplectites after glaucophane;
- formation of the plagioclase-corundum-orthopyroxene symplectites after phengite;
- production of the K, Na-saturated aqueous fluid, which migrates towards the most heated areas along the grain boundaries as well as through the crystals;
- ascending acid melt reacts with the olivine producing orthopyroxene in different structural positions.

The study demonstrated that high-gradient zones of the “piston-cylinder” apparatus are very effective for study mantle-crust interaction in the subduction zones.

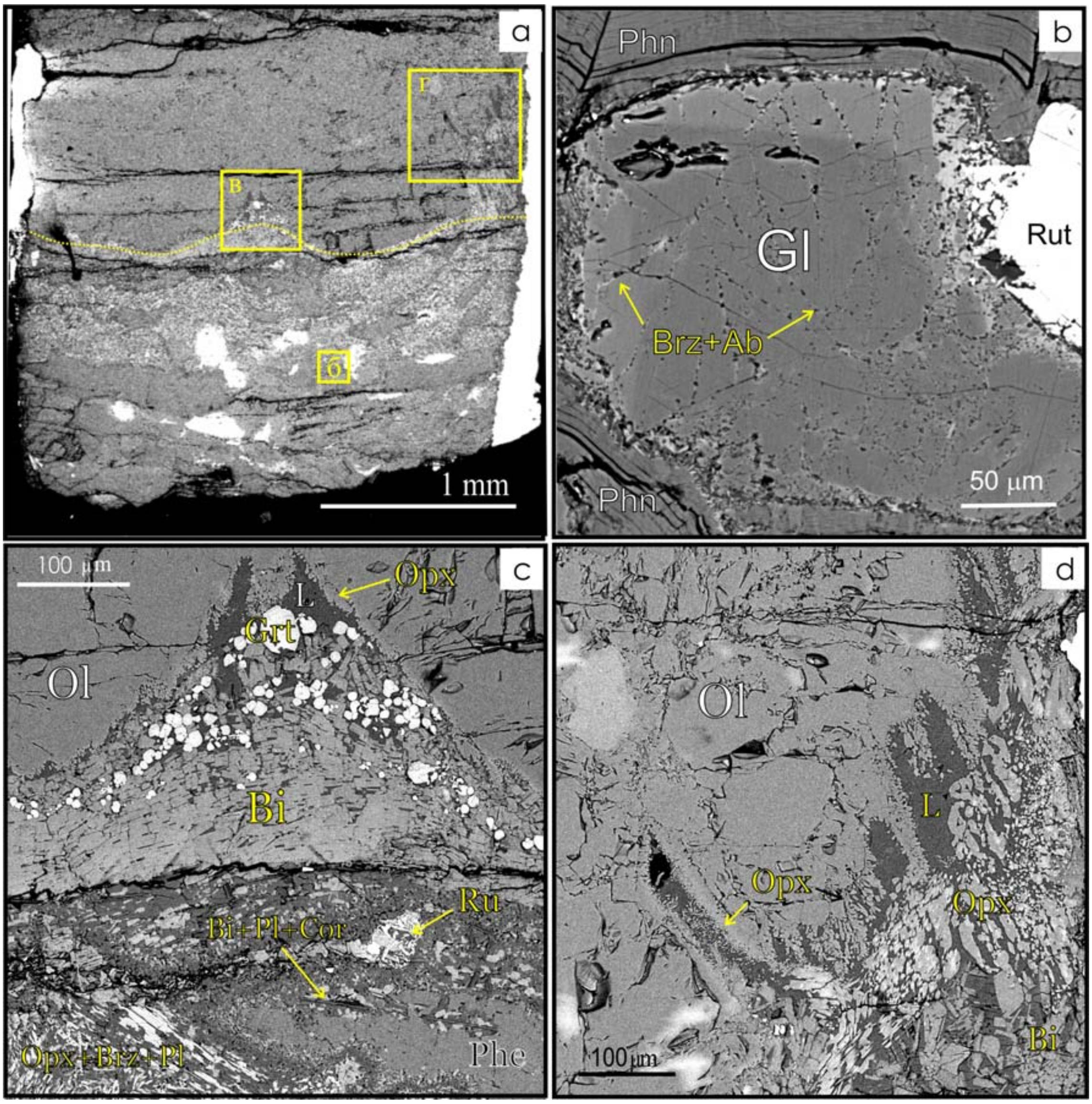

Fig.1. Run products at P=2.5 GPa, T= 900(bottom)-1150 (top) ^{o}C, duration 48 hrs: a) capsule after the run (bottom - glaucophane schist, top – olivine). Yellow boxes – domains corresponding to figs.1 b-d, dotted line - boundary between the starting materials; b) replacement of glaucophane at the grain boundaries and via the microchannels; c) symplectites after phengite and glaucophane, growth of biotite and garnet triggered by melt; d) ascend of melt in the olivine domain and growth of orthopyroxene. BSE images

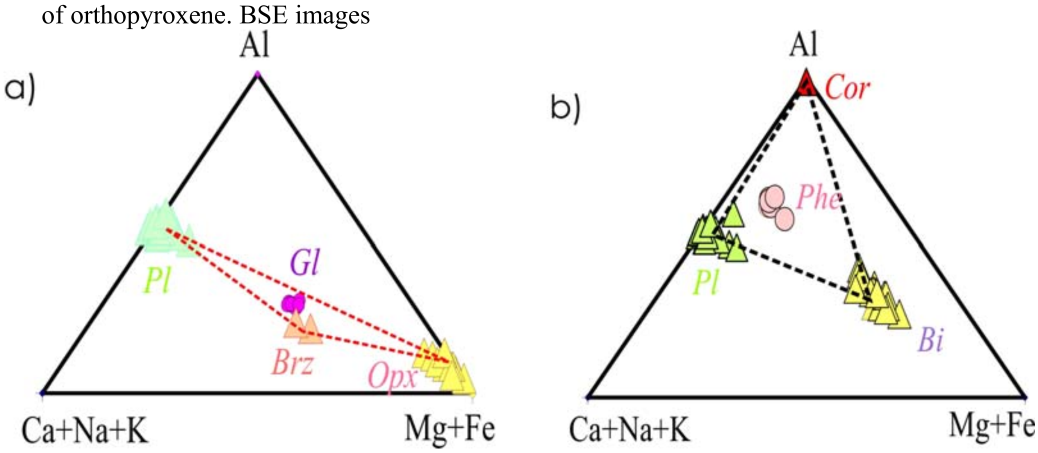

Fig.2. Compositional diagrams illustrating development of symplectites after (a) glaucophane and (b) phengite

Financial support by RFBR grants N 09-05-01217 and 09-05-0099

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Electronic Scientific Information Journal "Vestnik Otdelenia nauk o Zemle RAN" № 1(27)′2009
ISSN 1819 – 6586
Informational Bulletin of the Annual Seminar of Experimental Mineralogy, Petrology and Geochemistry – 2009
URL: http://www.scgis.ru/russian/cp1251/h_dgggms/1-2009/informbul-1_2009/term-11e.pdf

Published on July, 1, 2009