Geophysical Research Abstracts,
Vol. 11, EGU2009-3238, 2009
EGU General Assembly 2009

Phase relations in the forsterite-diopside-jadeite system.

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Peridotites and eclogites, including diamond-bearing ones, are the basic ultra-basic and basic rocks of the upper mantle (Ringwood, 1969, 1975; Sobolev, 1974; Marakushev, 1985; Taylor & Anand, 2004). These rocks are presented in the assemblage of mantle xenolyths in kimberlites, but the basic minerals of peridotite paragenesis, olivine, orthopyroxene, garnet and clinopyroxene as well as of an eclogite paragenesis, garnet and omphacite are wide-spread synthetic inclusions in diamonds. The cases of finding minerals and peridotite and eclogite parageneses in diamond are described. It implies that these parageneses can have a single mantle source. However, the formation of peridotite and eclogite mineral parageneses at differentiation of the primary ultrabasite melt during physico-chemical single process is possible only at overcoming the "eclogite" thermal barrier (O'Hara, 1968; Litvin, 1991).

Eclogite genesis is one of the most difficult and discussional problems of modern petrology. Among investigators there is an opinion about eclogite heterogeneity not only on conditions of formation (crust, mantle), but also by composition of the initial rocks (para-, orthoeclogites) as well as by the way of their formation (magmatic, metamorphic, metasomatic). In literature diamond-bearing eclogite nodules of kimberlite pipes are often considered as metamorphic, which are formed at subduction of the Archean or of the Proterozoic oceanic crust (MacGregor & Manton, 1986; McCandless & Gurney, 1986, 1997 et al.]. Only the presence of Na2O in garnet and K2O in clinopyroxene is a criterion of their participation in mantle magmatic processes.

Together with the hypotheses considered on eclogite origin there exists a version suggested in papers (Kushiro, 1972; Kushiro & Yoder, 1974), according to which mantle eclogites could be formed due to peridotite substance in the processes of fractional crystallization of ultrabasite magmas. The present paper is devoted to the experimental study of this problem.

Due to this fact the main purpose of this paper is an experimental study of phase relationships in the model system forsterite-dioside-jadeite at pressure of 7 GPa and foundation of possible physico-chemical correct transitions between peridotite and eclogite parageneses with overcoming liquidus "eclogite" thermal barrier. To construct a diagram of a ternary system forsterite-diopside-jadeite it is necessary to study its boundary binary sections forsterite-jadeite and fosterite-diopside as well as a number of internal polythermic sections. The section jadeite-diopside at 7 GPa has been studied earlier (Bobrov, Litvin, Kojitani, Akaogi, 2006; 2008) and it is characterized by the unlimited miscibility of jadeite and diopside components in solid and liquid states.

The first experimental results obtained at the initial stage of the investigation of this problem can be characterized as follows.

Forsterite-jadeite section.

The experiments in this section have been done in the temperature range of 1100-18000C on which basis the construction of fusibility diagram of the system forsterite-jadeite at 7 GPa has been started. The obtained experimental data testify to the existence in the system of the liquidus fields Fo + L, GrtSS + L and CpxSS (on the basis of jadeite phase) +L, as well as show indirectly a possible appearance of orthopyroxene as a liquidus phase. In subsolidus experiments olivine-bearing assemblages on the basis of the paragenesis Ol+Grt+Opx+Cpx are found. Garnet there is not a pure pyrope, but has the molecule Na2MgSi5O12 (Na-majorite) what manifests itself in the direct correlation of Na and Si in the equations of this phase. OpxSS is not a pure enstatite, but forms a complicated solid solution En+Jd+Mg-Ts. With jadeite content increase in the system olivine-bearing assemblages transfer into non-olivine ones, up to the assemblage Cpx + Grt (jadeite-clinopyroxene has also enstatite component) being indirect evidence of a peritectic character of solidus in this system). Due to this

fact forsterite vanishes in subsolidus in the region of compositions rather enriched by jadeite component. The performed experimental investigations testify to complex topological relations of phases in this system at close solidus temperatures what needs further studies. The experimental investigations done earlier and referring to this system (Gasparik & Litvin, 1997) testify to the appearance of a new phase of the composition Na2Mg2Si2O7, which role in the formation of subliquidus and subsolidus assemblages must be more studied.
Nevertheless, the obtained preliminary experimental data contain constructive data that make it possible to consider the basic problem of this work and start experimental investigations of liquidus phase relations of the system forsterite-diopside-jadeite.

The system forsterite-diopside.
The experiments in this section are given at pressure of 7 GPa in the range of temperatures 1600-17000C. The system is pseudobinary due to the appearance of orthopyroxene component that forms an independent phase. According to the preliminary data liquidus assemblages of this system at 7 GPa are Fo + L DiSS + L, but the type of melting is eutectic. It agrees with the above investigations at pressure of 3 GP (Davis, 1963) where some pseudobinarity of the system forsterite-diopside caused by the appearance of orthopyroxene minal in clinopyroxene solid solution can be also seen.

The system forsterite-jadeite-diopside.
The experimental data and conclusions obtained for the boundary systems make it possible to start investigating liquidus surface for fusibility diagram of the ternary system forsterite-jadeite-diopside at P 7 GPa. For the experimental study polythermic sections of forsterite-(jadeite50diopside50) and forsterite-(jadeite25diopside75) have been chosen. The obtained data testify to the fact that olivine vanishing and garnet formation are realized in both sections. The problem of further investigations is to search minimum concentrations of jadeite in the composition of this system where a total olivine vanishing takes place.
Thus, the performed experimental investigations of the model system forsterite-diospside-jadeite at pressure 7 GPa testify to the fact that forsterite (olivine) is a stable phase in the boundary system forsterite-diopside (olivine-clinopyroxene). While introducing rather low contents of jadeite component into the composition of this system the reaction of jadeite component with forsterite takes place in the melt. As a result, garnet appears as liquidus phase.
With the increase of the jadeite component concentration in the system the field of liquidus garnet expands, but a physico-chemical control of crystallization differentiation of the remnant melts transforms from the monovariant cotectics Fo + DiSS + L through the invariant peritectic point Fo + DiSS + Grt + L to the monovariant cotectics Grt + Cpx + L, which is responsible for crystallization of bimineral garnet-omphazite eclogite parageneses. The obtained experimental results testify unambiguously to the fact that in the system Fo-Di-Jd a physico-chemical mechanism of overcoming liquidus peridotite-eclogite barrier at mantle magma differentiation is realized. Thus, a gradual transition from olivine-bearing assemblages to those close by their characteristics to bimineral eclogites is provided.

Support RFBR: grants 07-05-00499, 08-05-00110, grant to the leading scientific school 5367.2008.5 (A.A. Marakushev), President grant MK-194.2008.5.