COMPOSITIONAL REGULARITY OF ECLOGITE MINERALS: EXPERIMENTAL AND NATURAL DATA

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Pseudo-ternary eclogitic system omphacite-pyrope (+grossular)-almandine (+grossular) includes information about the pseudo-binary joins omphacite-pyrope, omphacite-almandine, pyrope-almandine, as well as about the general pseudo-binary join omphacite-garnet. The information about some of these joins systems can be taken from papers published previously [1, 2, 3]. These results showed regularity in compositional changes of eclogitic minerals.

A portion of the phase diagram of the join pyrope-almandine (Fig. 1) is constructed on the basis of experimental data at 4.0 GPa. Similar to this system at 6.5 GPa [1], the join pyrope-almandine shows a complete solubility of end-members both in liquids and solids. On the basis of the phase diagrams at 6.5 and 4.0 GPa, a general scheme for formation of a zoning in garnets in dependence on P and T is proposed. Figure 2 shows a scheme for the equilibrium crystallization of pyrope-almandine garnet at decreasing P and T. At constant pressure P_1, cooling down to T_1 results in formation of solid phase S_1 (P_1) from the melt L_1 (P_1). Further cooling ($-\Delta T$) at constant pressure P_1 produces simultaneous increase of iron content both in the solid phase S_3 (P_1) and in the melt L_3 (P_1). In the case of decompression ($-\Delta P$) from P_1 down to P_2 at constant temperature T_1, the simultaneous increase of the Mg content of the melt L_2 (P_2) and garnet S_2 (P_2) is observed. At last, simultaneous cooling and decompression, which geologically corresponds to an intrusion of a magma and its cooling, leads to either the increase, or decrease, or retaining of constant Mg-number of garnet (Fig.2b,c,d). Variation of the garnet composition is determined by relative decrease of temperature and pressure. In the case of the abrupt decompression at slow cooling (Fig.2b), the Mg-number of both garnet and melt increases. Appreciable cooling at slow decompression (Fig.2c) results in the opposite effect: Mg-numbers of garnet and melt decrease. At last, garnet of approximately constant composition crystallizes in the case of slow cooling and decompression (Fig.2d).

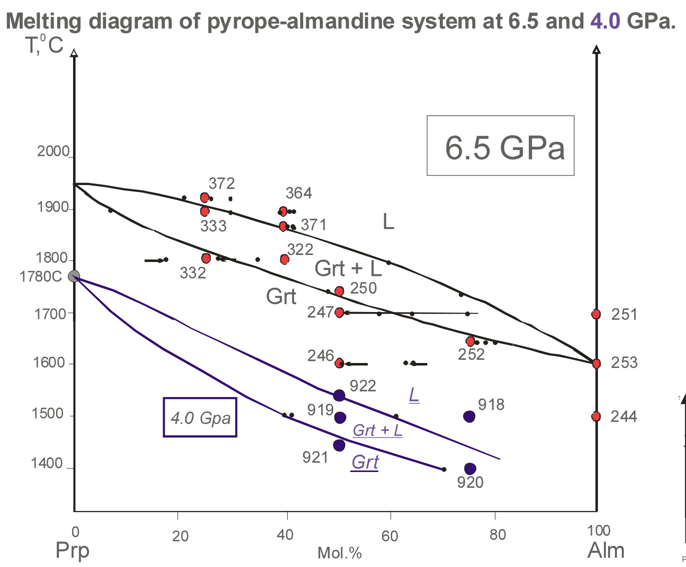

Fig. 1.

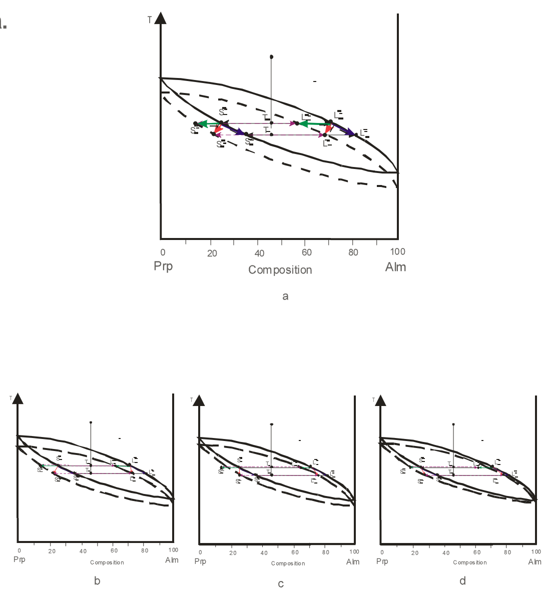

Fig. 2.

Fig. 3 shows phase relations in the pseudobinary system clinopyroxene (omphacite)-garnet at 7.0 GPa. The diagram indicates that the solidus is composed of a single assemblage Cpx+Grt. The field of clinopyroxene enriched in the Ca-Tschermack component is absent in the system. The congruent melting of garnet is also characteristic feature of the system. This feature is a major difference of the above pseudobinary system from similar Na-free systems investigated earlier at lower pressures (Fig. 4) [4,5,6].

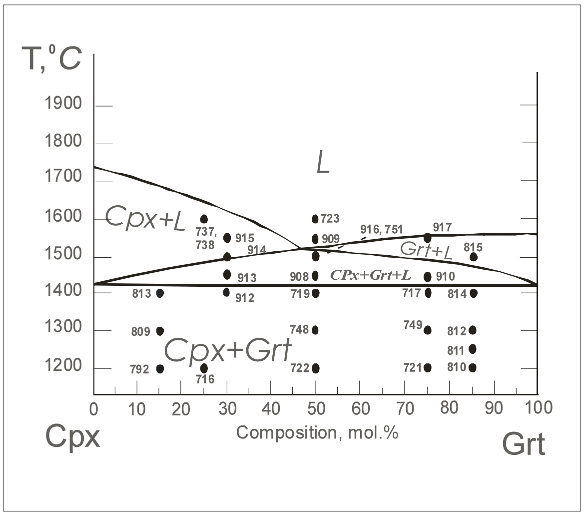

Fig. 3.

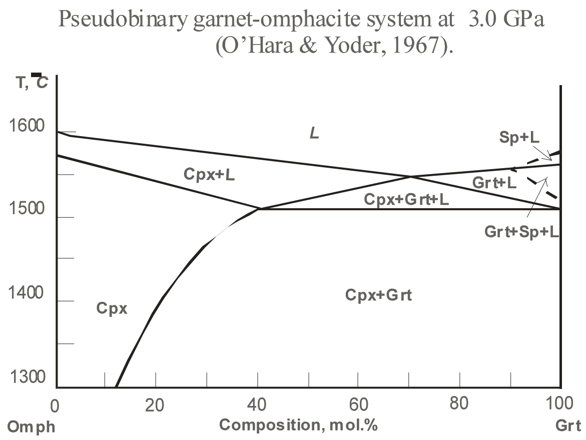

Fig.4.

The absence of the Cpx solid solution field perfectly agrees with natural data, which show that Ca-Tschemack content of is not characteristic for jadeite-rich omphacites. Clinopyroxenes show also some excess of Al2O3 with respect to the jadeite component, which is related to the Ca-Eskola end-member (Fig. 5). This end-member reflects the clinopyroxene formation at very high pressures. Concentration of the Ca-Tschemack molecule is negligible (about 0,1 mol. %).

An unambiguous regularity in variation of the Fe/Mg ratio in garnets in dependence on temperature is not found. However, garnet at liquidus in the system omphacite-garnet (Fig. 3) is more Mg-rich than garnets crystallized in the sub-solidus (Fig. 3). Therefore, the tie-lines of the garnet-clinopyroxene assemblages are steeper on the diagram CaO-MgO-FeO. Totally, garnets become more Mg-rich with respect to the initial composition and correspond to composition of garnets of the eclogite xenoliths from the Unachnaya and Mir kimberlite pipes (Fig. 6). There is a slight increase of the Mg-number of clinopyroxenes at the liquidus in comparison to the sub-solidus clinopyroxenes. On the diagram CaO-MgO-FeO, this is expressed in simultaneous change of Mg-numbers of garnets and clinopyroxenes and in the slope of the tie-lines, which reflects the temperature of the eclogite formation (Fig. 6).

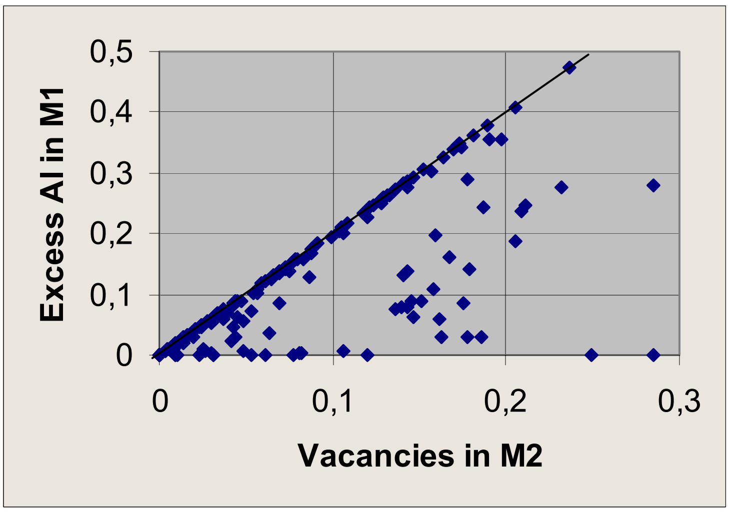

Fig. 5.

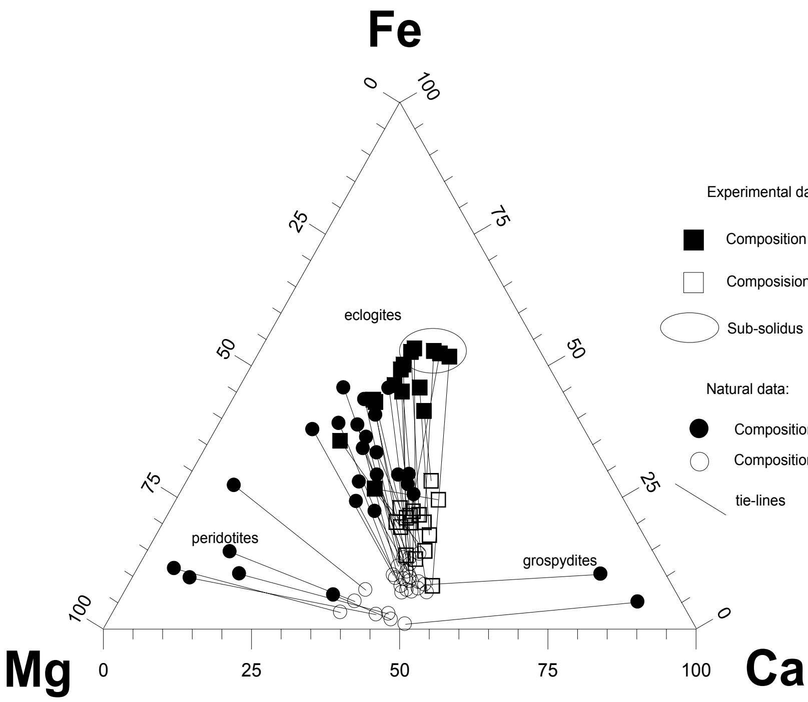

Fig. 6.

Thus, the experimental study of variations of compositions in eclogite minerals combined with the natural data allowed determination of some compositional regularity, which can be used in the study of eclogite formation and evolution.

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