At the two machanism of garnets allocation

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Under the mechanism of allocation of minerals is a chemical reaction, leading to the deposition of mineral. The solution of this problem helps identify the conditions of the formation of garnets, and, hence, and host mineral rock. Thus, the problem of the mechanism of allocation of mineral is one of the inverse problems of geology, directed to the establishment of conditions for the formation of rocks (ores).

Base solving the problem are the laws of chemistry and physical chemistry. Considerable information about the mechanism of allocation of minerals represent a variety of experiments, carried out by domestic and foreign researchers practically for all time of existence of geology, as a branch of scientific knowledge. These studies include a wide range of minerals, both soluble in water (fluid) in a wide interval of temperatures (T) and pressure (P), as well as minerals, spun off from the magmatic melts.

Solution of the problem is based on the axiom: 1) in the reactions of the natural mineral formation is always maintained the state of thermodynamic isotope and geochemical equilibria between the explored mineral M and some connection $\dot{C}$. It is generalization of the point of view of E.M. Galimov [*Galimov*, 1973).]. 2) geochemical system M–$\dot{C}$ is formed as a result of the collapse of some initial parent substance.

In general solution of the problem is divided into two stages: 1) determination of the composition of connection $\dot{C}$, equilibrium studied mineral; 2) on the basis of the determination of the composition of the parent compounds, decomposition of which formed compounds M and $\dot{C}$.

Procedure for solving tasks of the first stage is an analysis of the isotherms of the relations of elements in a mineral or minerals. For these minerals methods of the analysis of gas–liquid or melt inclusions determine taken for the standard temperature (T_{et}) education of these minerals. That are prepared pairwise relations of the three elements. Method of culling for the selection of sampling is described in [*Makarov*, 2006[b]]. According to this new charts of isotopes (elements) in one or more minerals, having the angular coefficient of S$_{watch}$ [*Makarov*, 1987; 2005[a]].

According to literary data the isotopic composition of quartz *Qw*, biotite *Bio*, and muscovite *Mus*, feldspars *Kf*, albite *Al*, adularia, plagioclase Pl_{40}, garnet *Grn*, diopside, hornblende. Set the sequence of allocation of minerals in the form of sequences [*Makarov,* 1991; 2004]

$(Qw, Bio) > (Mt, Il) > Al_1 > Mus > Al_2 > Grn,$ (A, magmatites)

$(Qw, Bio) > (Mt, Il) > Pl_{40} > Mus > Grn.$ (B, metamorphites)

This is the most rich in the number of silicate analyses mineral. He is from the granites, peridotites, pyroxenite, lherzolites, kimberlite, gneisses, schists, enderbites, eclogites different regions of the world. On it are the chemical exchange reactions elements of Ca, Mg, Fe and Mn between connections *Grn*–$\dot{C}$. As a $\dot{C}$ taken: Ca, Mg, Fe, Ca^{+2}, Mg^{+2}, Fe^{+2}, CaO, MgO, Fe, Fe_2O_3, Al_2O_3, pyroxenes, biotite, olivines, cordierites, sillimanites (for a couple of Fe^{+3}-Al^{+3}), spinels (including maghetites), corundum, hematite. In terms of education all sample garnets are conditionally divided into two parts.

A. Garnets of a) kimberlite; b) ultrabasic rocks (mafic, pyroxenite, peridotites, lamproites) and c) of eclogite. In the group of kimberlites sample garnets in the vast majority are selected from the diamond-bearing tubes of Yakutia. From melt inclusions single definition T_{form} garnets range from 1150°C (kimberlite, tube Berry) to 1230°C (eclogite, Mugojari). The same T_{form} a garnets on geochemical barothermometers: *Pyr* 1000–1200°C, Cpx – 980–1400; P= 40–75 kbar. The average T_{form} of pyroxenes, olivine and plagioclase is approximately 1250°C, it is taken as a reference; minerals are in equilibrium CO_2 and together with it stand out [*Makarov*, 1987]. On garnets isotopic data are not available. According to geological data *Grt* (*Pyr* – pyrope) are together with clino-(*Cpx*, diopside) and ortopiroxenes (*Opx*, enstatite), rarely – kyanite [*Makarov*, 2002[b], 2005[c], 2006[a]].

The available geochemical data pyrope thermodynamically is equilibrium pyroxenes. Communication

Grt with pyroxene is genetic: they are formed from the decomposition of protomatter. Assessment of its composition is based on data for quantitative measurements of the *Pyr/Cpx* in real objects, often *Pyr/Cpx* ≈ 1.0. Then $Mg_3Al_2Si_3O_{12} + CaMgSi_2O_6 = CaMg_4Al_2Si_5O_{18}$ is cordierite, initially formed, perhaps, by the reaction of $(An) = (Mg\text{-}Ol) + 2(Mg\text{-}Opx)$.

For pyroxenes (diopsides) together with olivine and plagioclase on the isotope data set equilibrium with CO_2 to oxygen. Then the equation of garnet and pyroxene should has the form

$$... = ... \{Gr + [Px\} + CO_2] + ...$$

Here brackets reflect: [...] - isotope; {...} - geochemical equilibrium.

Thus, the supplier ^{18}O in minerals is CO_2, consistent with good solubility of CO_2 in the ultrabasic melts of high pressures. When analyzing the impact of CO_2 on the melting of the silicates in the literature were considered reaction carbonatization pyroxenes (enstatites *Ens*) and olivine under pressure: (1) *Ol + Dio* +CO_2 → *Ens + Dol*; (2) *Ol + Dol* + CO_2 → *Ens + Mgt* (magnesite). The obtained results show doubtfulness of these equations. These data can be understood, if we consider, for example, the equation (1) in the form of *Ens + Dol* → *Ol + Dio* +CO_2. This leads to the hypothesis that the ultrabasic rocks – transformation product of the pyroxene (enstatite) – dolomite (or magnesite) rocks.

B. On the isotope data all biotites are formed at $T ≈ 700^oC$, plagioclases ≈ 500^oC. On the isotope data [*Makarov,* 2002[a], 2004, 2005[a]] and the analysis of gase-liquid inclusions garnet is allocated at 300–450^oC. On the official point of view – ≈ 700^oC, but it relies heavily on the geochemical thermometers, the use of which there are significant errors [*Makarov,* 2005[b]]. Biotite and garnets are in equilibrium with water. About cordierite information is not available. In experiments of L.L. Perchuk et al. (1983) at T= 550–1000^oC ion exchange between garnet and cordierite at joint crystallization is absent.

The results of calculations and comparisons have shown that the best agreement is observed in equilibrium of garner with cordierite, biotite, and pyroxene. According to geological data in the studied rocks pyroxene is not identified. Biotite also under suspicion, as between it and pomegranate there is a significant difference in T_{form}. The basic version is equilibrium with cordierite, often present in gneisses in association with a garnets. Thus, the probable equation of education garnets has the form

$$... = \{Cor + [Grn \} + H_2O] + ...$$

The results of interpretation of the obtained results are based on the work [*Eliseev,*1963]. Transition of rocks of green-schist facies, rocks epidote amphibolites is carried out on the basis of reaction *Chl + Qw* → *Grn* + H_2O (*Chl*- chlorite). But, explaining isotopic equilibrium garnet with water, this reaction does not reflect the geochemical equilibrium of mineral with other components of gneisses. In describing the origin of garnets, N.A. Eliseev [*Eliseev,*1963] also writes about the reaction of *Chl + Qw* → *Cor + Ant* + H_2O (*Ant* - anthophyllite). These reactions occur at different *P–T* conditions. But their unification in the central areas of *P–T* conditions leads to the reaction of formation of minerals: *Chl + Qw* → {*Cor* + [*Grn*} + H_2O], the scheme of allocation received by isotope-geochemical data.

Thus, in the history of the formation of garnets are two different mechanism of its formation. In the acidic rocks garnet is in equilibrium with water and cordierite, corresponding conditions, characteristic facies of epidote amphibolites.

In ultrabasic rocks, forming at high values of *T* and *P*, the garnets are together with pyroxene in equilibrium with CO_2. Here already protomatter substance, perhaps, is the cordierite; the primary products can also be pyroxene (enstatites) - dolomite (or magnesite) rock (marbles or skarns).

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