FORMATION OF A MELT ON A REACTIONARY INTERACTION BETWEEN AN AMPHIBOLITE AND A GRANITE MAGMA

Shchekina T.I., Batanova A.M., Gramenitskiy E.N., Kurbyko T.A.
tishchek@geol.msu.ru

Herald of the Earth Sciences Department RAS, № 1(20)′2002
URL: *http://www.scgis.ru/russian/cp1251/h_dgggms/1-2002/informbul-1.htm#magm-17.engl*

The great petrological importance is attached to processes of an interaction between magma and country rocks (an assimilation, a contamination, a magmatic substitution); however, a notion of them does not meet model requirements of the process. Essentially, there are no experimental data for understanding of specific mechanisms, of scales and of the petological importance of these processes. From the point of view of the essence of the magmatic substitution and the assimilation as accordingly infiltration and diffusion processes of the interaction between a magma with a substrate it is reasonable the consideration of the all rock complex as a column of simultaneously formed zones. The approach to reactionary phenomena in magmatic process, thus, is methodically joined with the theory of metasomatic zoning developed by D.S.Korzhinskii. The revealing of columns formed by the laws of metasomatism, for that, one of phases along with minerals is melt, it is offered as a specification and a development of this model. A set of experiments has been made by the authors on study of an interaction of a model granite melt with rocks of various basicity in "dry" and hydrothermal conditions. Specificity of our approach is the fixed attention to a formed zoning, study of behaviour of both main rock forming components and trace elements in these processes. In the earlier works of the authors on modelling interaction between granite melt and olivine pyroxenite [1,2] and dolerite [3,4] formed columns were typified on scales of manifestation (type1 - the interaction with separate grains, type II – the interaction with rock as a whole) and on a state of substance: the rock remains in a solid state (type A); in reactionary zones occurs a melt, which is formed by the mechanism of the substitution (type B). The case is especially allocated, when the rock is subjected to partial melting independent from a reaction with the granite melt (type C**)**.

The results of an interaction study between the granite melt and epidote bearing amphibolite in "«dry" (1150^0 c, 1атм.), and hydrothermal (800^0 C, P_{H2O}=1000 bar) conditions are presented in this paper.

In the hydrothermal experiment outside of an area of the interaction between the grinding amphibolite and the granite melt (L_0) the amphibole is kept without changes, the plagioclase becomes more basic (An_{50}) in comparison with initial (An_{45}), the most basic (An_{60-100}) plagioclase, zoisite and garnet (andradite-grossular) develop on the primary epidote. Formation of the anatectic melt does not occur. This zone (0) is shown only in "«idle" experiment (carried out at the same conditions, but without the granite melt). At an interaction of amphibolite with a granite melt a reactionary column appears. The rhyolite melt (L_2) containing up to 0,7 % CaO and up to 0, 4% Fe0 is formed in first three zones (4, 3, 2) located near the contact. The schematised column structure is next:

00. L0 | 01. L1 || 4. L2 | 3. L2+Pl | 2. L2+Pl+Bi | 1. Pl+Hb+Px | 0. Pl+Hb+Zo+Gr.

By double feature are divided exocontact (1, 2, 3, 4) and endocontact (01) zones. The general widths of the zones with melt formed on the amphibolite makes up 300 microns. The composition of the plagioclase in them is more acid (An_{27-35}) then in the zone 0, the amphibole is replaced by the phlogopite, forming needle crystals. The composition of all minerals and melt of the 1, 2 and 3 zones contain Ga, which was injected in initial granite melt. The melt is not formed in the zone 1 (300 - 7000 microns) more removed from the contact. The composition of minerals gradually changes. Ferruginosity of the amphibole and basicity of the plagioclase decrease as the contact with the granite melt is approached. Contrary to zone 0 in hydrothermal runs and the "idle" experiment in a reactionary column anortite with inclusions of melilite and pyroxene develops on the epidote and the garnet. At grain boundaries of the plagioclase and the amphibole there is augite, quite often formed edged crystals of a 10-15 micron size. The considered column of interaction concerns to a type II Б.

The initial phase composition of the rock is subjected to essential changes in "dry" experiments. Interstitual basalt melt (L_3) develops without an influence of the granite melts to the amphibolite. The partial melting is accompanied by a decomposition of the amphibole and the epidote to the clinopyroxene and the magnesioferrite, by a formation the more basic plagioclase and the magnesian olivine. The new formed clinopyroxene (pseudomorph on amphibole) has an augite composition: $Ca_{0,85}$ $Mg_{0,83}$ $Fe_{0,29}$ $Ti_{0,03}$ $Si_{1,76}$ $Al_{0,29}O_6$. The magnesioferrite ($Mg_{1,08}Fe_{1,99}Mn_{0,02}Ti_{0,05}Al_{0,47}0_4$) is evolved abundantly as very fine skeletal crystals (3-5 microns) of the octahedral, frequently of the square (in sections) forms. The plagioclase has needle forms, its size comprises no more than 10 microns, and its composition is An_{50} in the centre and An_{47} in the edge. The magnesian olivine ($Mg_{1,94}Fe_{0,04}Si_{1,00}O_4$) is evolved as separate fine crystals of isometrical forms. At the interaction with the granite melt crystal phases consistently disappear in reactionary zones and an amount of the glass grows, thus, at first the olivine, then the plagioclase, the magnesioferrite and the clinopyroxene are dissolved. The plagioclase is settled in the glass between crystals of the pyroxene at the distance 1000 microns from the granite contact and further. Its composition became more acid (centre An_{42}, edge An_{28}) in comparison with initial. Contents of SiO_2, MgO, CaO decrease (within the limits of 3-5 %), and contents of FeO, Al_2O_3, TiO_2 increase in the clinopyroxene in the contact zone. The composition of the glass in the rock changes from basalt in the most removed zone of a sample up to trachyte in the zone closed to the contact. Schematically structure of the reactionary column can be presented as follows:

00. L_0 | 01. L_1 || 4. L_2 | 3.L_2 +Cpx | 2. L_2 +Cpx+Mf | 1. L_2 +Cpx+Pl+Ol+Mf | 0. L3+Cpx+Pl+Ol+Mf.

The interaction concerns to the type II B.

The granite glass in the area close to the contact becomes contaminated by components of the rock CaO, FeO, MgO, TiO_2 in both types of experiments, while the glass formed on amphibolite is enriched by SiO_2, Na_2O and K_2O. The place of the sharpest change of their contents divides endo- and exocontacts. A thickness of the zone 01 of the contaminated glass (L_1) in "dry" experiments is 50 microns; in hydrothermal it is about 4000 microns, and of zone 4 (L_2) in "«dry" experiments is 30-50 microns, in hydrothermal is 5-7 microns**.** An occurrence of the melt in the hydrothermal experiments is caused by the mechanism of substitution owing to diffusion introdution of components from the granite melt and contrary carring out of substance from the rock. In dry experiments the melt arose not only at the cost of a diffusion interaction, but also owing to partial melting (anatexis) of the rock. The results of experiments allow not only to open new features of natural processes of the assimilation and the magmatic substitution, but their differences from the anatetic melting. The revealed regularities are applicable to similar processes of a technical mineral formation at the interaction of the refractory material with the glassforming and others silicate melts.

References

1. *E.N. Gramenitskiy, T.I. Shchekina, A.M.Batanova, T.A.Kurbyko.* Formation of the zoning at an interaction of the granite melt and the pyroxenite // Vestnik. Mosk.Univ., Ser. 4. Geology. 2001. N3, P.27-37.
2. *E.N. Gramenitskiy, T.I. Shchekina, I.M.Romanenko.* Behaviour of Ga and Ge at an interaction of the granite melt and the pyroxenite // Vestnik. Mosk.Univ., Ser. 4. Geology. 2001. N6. P.21-24.
3. *E.N. Gramenitskiy, T.I. Shchekina, A.M.Batanova, T.A. Kurbyko.* An interaction of the granite melt with the dolerite. Part 1. Experiments in hydrothermal conditions // Bul. Mos. soc. of nature. Geology ser. 2002. N3.
4. *E.N. Gramenitskiy, T.I. Shchekina, A.M.Batanova, T.A.Kurbyko.* An interaction of the granite melt with the dolerite. Part 2. Experiments at atmospheric pressure // Bul. Mos. soc. of nature. Geology ser. 2002 (in the press).