Khodorevskaya L.I. Attempts at experimental modeling of infiltrational granitization of amphibolite at T=750^{o}C and P=5 kbar.

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Presented below are the experimental results on the amphibolite-granite transformation (the process of granitization [1]) occurring upon directed infiltration of fluids saturated in granite components.

Experiments were carried out in gold capsules 50mm long with the outer diameter of 5 mm and wall 0.2mm thick. A sample of grounded synthesized glass of granite composition was placed on the bottom of the capsule and 0.12 cm^3 of 1N solution of HCl was added. After that a cylindrical amphibolite sample 4.6 ±0.01mm in diameter and 15 mm long was tightly inserted into the capsule. A thick walled microchamber was placed above the sample for gathering the solution. Then the capsule was sealed and placed into the high pressure apparatus. In the beginning of the experiment at room temperature, the bottom part of the capsule with solution was compressed up to 2 kbar. As a result a fluid pressure (Pfl =2 kbar) was set up on the one side of the capsule. At the same time the sample itself was compressed from the sides (P_{eff}= 2kbar) which prevented the filtration of the solution between the capsule and sample. There was no solution in the upper part of the capsule i.e. in the microchamber (P_{fl}=0) which provided the filtration of the fluid through the vapor space of the sample. After that the heating was switched on. Amphibolite permeability in the beginning of the experiment at room temperature and an effective pressure of 2.0 kbar is about $1x10^{-21}$ m^2 [2]. At the given size of the capsule one can expect the filtration through amphibolite with the rate $1.7x10^{-5}$cm^3/sec. Taking account of the rate of heating (5oC/min) and pressure increase (25bar/min), while the apparatus is being brought into the experimental mode the permeability is expected to decrease to $1x10^{-23}$ m^2 [2] and not more than 0.020 mm^3 of the solution is filtered through the sample. Experimental parameters were reached in 2 hours, the temperature being increased up to 750^{o}C and pressure up to 5 kbar. Duration time within experimental conditions was 3 days. At the end of the experiment the isobaric quenching up to 200^{o}C was carried out after which temperature and pressure were decreased simultaneously.

Chemical composition of the starting granite glass, amphibolite, and the analyses of the samples after the experiments are given in [3].

The microprobe analysis showed that the only dark colored mineral remaining in amphibolite after the experiment was biotite. Amphibole completely decomposed and to yield the aggregations of ilmenite. Biotite was represented by coarse (100-250μm) crystals slightly oriented along the pressure gradient (Fig.1). The composition of biotites somewhat differed from the starting one. It had higher content of Ti, Fe, and alumina in the six fold coordination. Three plagioclase compositions were found: Pl30-32 – restites of the starting one, Pl51 and Pl27 – formed in the course of the experiment.

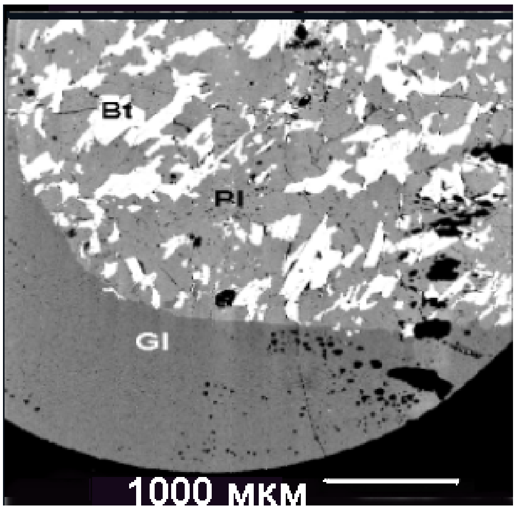

Fig.1.

The zone of melted glass Gleutec.1000-2000μm in size forms in the lower part of amphibolite facing the solution.

Since at experimental temperatures the degree of amphibolite melting is 10-20wt%, glass formation immediately at the amphibolite-granite contact is due to the partial melting of the alkalized and debasified part of amphibolite in the zone which is most intensively affected by the flow of silicon-alkali fluid ascending from the bottom part of the capsule. The average composition of the glass is $Na_{0.67}K_{0.32}Ca_{0.13}Fe_{0.08}Mg_{0.03}Al_{1.47}Si_{6.53}O_{16}$ – Gleutec. It corresponds to the composition of trondhjemite, and in quartz-albite-orthoclase coordinates is close to the eutectic one at P_{H2O}=1kbar [4].

Several balls of quenched glass $Na_{0.22}K_{0.29}Ca_{0.16}Fe_{0.09}Mg_{0.04}Al_{1.59}Si_{6.51}O_{16}$ – Gl3 several microns in size were observed on the sample walls. They were crystallized from the fluid phase.

Besides the glasses Gleut. and Gl3 there were noted intergranular (first tens of microns) glass regions (between plagioclase grains or at the ilmenite crystals interfaces (Gl3)) – $Na_{0.11}K_{0.24}Ca_{0.23}Fe_{0.09}Mg_{0.04}Al_{1.52}Si_{0.57}O_{16}$.This glass probably forms upon amphibole and plagioclase decomposition.

As it was noted during field investigations [5,6] the melt originating in rear zones of the column in the course of granitization substitutes first rear and then outer zones of the column to form the saturation zones of host rocks and then to substitute them up to the complete assimilation. Our experiments model the stage of feldspathization (rock lightening) and that of the melt origination. Formation of granite melt on amphibolite in experiments lowers essentially the rate of fluid infiltration and actually at the duration of our experiments means the corking of the rock. Therefore, we failed to perform the next stage of host rocks saturation with the melt so far.

The investigation of chemical bulk composition of amphibolite determined on the area 800x800 μm along the pressure gradient showed that a) at the distance 1000-2000 mm of the newly formed amphibolite edge alongside with the gain of silica there occurs an intensive loss of Fe and Mg, Ca content remaining close to that in the starting amphibolite, i.e. Ca solubility in silica-alkali fluid is essentially lower than that of Mg and Fe. The change in amphibolite composition in this area of the sample imitates formation of “lightening” zones [6], which are observed in natural metabasites in the course of their granitization; b) the loss of Fe and Mg from the newly formed area of amphibolite is accompanied by their redeposition in the range 4-8 mm far from the edge, where the amount of Mg and Fe increases by a factor of 1.5 compared to their content in the starting amphibolite. Herewith, the content of K increases and that of Si and Ca decreases as compared with that in the starting sample. This leads to an increase of biotite amount in this area of the sample i.e. to the biotisation of amphibolite. Appearing of microscopic regions (veins) of essentially granodiorite and even quartz-monzonite composition was also observed in the mentioned zone.

Conclusions.

1. The processes taking place in real natural complexes and being one of the major elements of granitization as an infiltration magmatic substitution have been reproduced experimentally.

2. It has been shown experimentally that amphibole undergoes debasification and alkalization upon the action of a filtrating fluid.

3. It has been proved experimentally that a “lightened”[5,6] biotite-bearing leucocratic zone forms due to the gain of silica and alkalis and loss of Mg and Fe, herewith the degree of melting in the lightened areas increases.

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