SYNTHESIS OF B-F-CONTAINING FLUID INCLUSIONS

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F and B are important components of natural fluids and elements - mineralizators. Ore genesis is often connected with these components. As it was studied before, there are immiscible regions with the equilibria of water-rich and silica-rich (heavy fluid) liquids and vapor or solid in the system quartz-NaF-water. The synthesis of B- F- containing inclusions give us the possibility to study: (a) the P-T-conditions of the "heavy fluid" appearing if B is at fluid with the F, (b) the compositions of phases in inclusions.

Synthesis of fluid inclusions by the healing of the cracks was carried out at P=2 kbar and T=800, 700^{o}C at hydrothermal vessels with external heating and cold seal; at P=1 kbar and T=350-450^{o}C – at autoclaves. Run duration was 19-38 days.

Results

The re-crystallization of the surface part of the quartz samples results in appearance of solution and growth zones. Synthetic fluid inclusions were located along healing cracks and sometimes – at new growth quartz blocks or along their boundaries. Inclusions forms were various degrees of the perfection; many of them were in form of the negative crystal; sizes were up to n*10 mkm. Optical study resulted in the following features:

1. Two-phase inclusions with vapor and liquid are presented in the samples from the run at 350 and 450^{o}C. The fluid existed at homogeneous conditions.
2. Inclusions with "glassy" phase (or "heavy fluid") are presented in the samples from runs at 800^{o}C and P=2 kbar and B-F-containing solutions. At lower temperatures and absent of F in solutions this phase has not generated.
3. If F was absent, fluid was homogeneous at all parameters of our experiments. Addition of F results on heterogeneity at 700-800^{o}C.

Microthermometry of fluid inclusions

It was carried out at the stage THMSG-600 "Linkam" (interval of temperature: –196 -+600^{o}C, magnification of the "Olimpus"objective 80^x). Homogenization temperatures were: near 370^{o}C (for 700^{o}C runs) and near 400^{o}C (for 800^{o}C runs).

Cryometry has shown that if only bornic acid presents in fluid, there are good correspondence between composition of synthetic inclusions (measured at Linkham stage) and starting run compositions of solutions. For example, if starting concentration of the H_3BO_3 was 12, 0 mas. %, cryometry of inclusions has shown 11, 8 mas. % (run 5411: 800^{o}C, 2 kbar).

If some F was added there are deflections of the results of cryometry from initial compositions. So with increasing F content in starting mixing the deflections increased too. For example, if starting composition was: 12 mas% H_3BO_3 and 8 mas% NaF, in inclusions one has measured 4,3 mas% H_3BO_3; if starting composition was: 25 mas% H_3BO_3 and 2 mas% NaF, in inclusions one has measured 14,5 mas% H_3BO_3. Probably, at relatively low temperatures, boron was reacted with fluorine and produced complicate complexes. Unfortunately, we cannot indicate the stability of these complexes at higher temperatures.

Microprobe analysis

The "glassy" phase from inclusions of the run 5407 was analyzed by microprobe "CAMEBAX Micro". The possible lost of the Na_2O was near 20 %. "Glassy" phase was consisted of: 61-66 mas% SiO_2; 3-4% Na_2O; near 1,5% F; up to 1,5% CaO; near 0,2% K_2O. Glasses had not uniform compositions: tiny crystalline phases were included into glass. Largest deviations of concentrations were for F and Na. Small inclusions sizes had no possibility to study the glass heterogeneity by wider electron beam method. Deficit of sum was determined by B and H_2O presence. Analysis of hardened glass on the surface of the quartz example was carried out. This phase was characterized by a complicate structure: on the quartz mineral plate was the hardened glass, with content of the Si, Al, Na, trace Ca (F was not detected). Outer zone of hardened glass is represented by: 1) debris of glass and partly crystallized phase which content the F (near 1 mas %) and Al, Na, Ca; 2) fine dispersed phase, composition of which was not investigated yet. The conclusions are as following: the quench was realized from heterogeneous fluid and F-rich phase attended at more low temperature and this F-rich phase did not quench as the glass, but crystallized.

Heavy fluid attends as a transparent glassy phase in inclusions and contents 10-50 vol% of the inclusions. It is silica-rich phase with high quantity of water. The high water content was confirmed by behavior of fluid inclusions under high temperatures: some bubbles started to appear in the glassy phase; bubbles slowly stuck together and the volume of the liquid increased. Under cooling inclusions came back at initial state. We believe this glass is consisted of hydrosilicates which loose water under heating.

Conclusions

1. The presence of B in fluids does not produce radical changes of fluids phase state relatively to the pure F-system. The present of F leads to reaction between fluid and quartz and phase equilibrium reflect features of the systems of P-Q-type.

2. A good agreement between fluid inclusion composition and composition of initial solution is observed when the fluid system contents the mixture of $H_3BO_3 + H_20$ only.

3. The lower concentrations of H_3BO_3 in fluid inclusions relatively to initial solutions were observed in the system $NaF + H_3BO_3 + H_2O$. This phenomenon may be explained by the presence of the boron – fluorine complexes.

4. “Heavy fluid” phase is characterized by the high extracting capability, and all minor components of admixtures were extracted by this phase.

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