EXPERIMENTAL STUDY OF QUARTZ SOLUBILITY IN HF-H$_2$O SOLUTIONS AT 400°C and 50-150 MPa

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Fluorine after H$_2$O, CO$_2$, and Cl is one of essential components of natural fluids. F-bearing solutions play important role in transfer of silica and formation of quartz veins and near-vein metasomatites on greisen and rare-metal deposits. For pegmatite, greisen and the hydrothermal processes connected to formation of such deposits, moving the big amount of silica, formation of veins and large crystals of quartz which occur to participation of the water fluids enriched with fluorine is typical. Experimentally solubility of quartz in HF-H$_2$O solutions was earlier studied at 500-1000°C and pressure of 100-500 MPa [1,2,3]. The research carried out by us earlier [1] has shown, that at temperatures 500-700°C and pressure 100 MPa the relation between concentrations of SiO$_2$ and HF in a solution can be described by expression log m_{SiO2} = 0.6083 log m_{HF} - 0.2027 (±0.098). On all isotherms sharp growth of quartz solubility was observed at concentration HF at which in the solution started to prevail fluoride-silica complexes. For 500°C and 100 MPa the concentration was higher 0.05m. Here experimental data on solubility of quartz in water-hydrogen fluoride solutions are submitted at temperature 400°C and pressure 50, 100 and 150 MPa.

Experimental Method

Experiments were carried out in autoclave vessel and electric resistance furnace with automatic support of temperature and set of required pressure in an autoclave by filling calculated amount of water. Runs were made in tight by electric arch gold ampoules. Solubility of quartz was determined on loss of weight of a mono-crystal. In experiments were used cylinders of transparent natural quartz from pegmatite. The sample of quartz in weight 0.2–0.6 g was placed in the ampoule together with 1.7 - 3 ml of the H$_2$O-HF solution. The initial HF concentrations were used: H$_2$O, 0.001; 0.01; 0.05; 0.1; 0.5; 1 and 2 mole of HF on 1 kg of H$_2$O. Concentration dissolved silica in a solution after experiment was calculated by the relation: $m_{SiO2(aq)}$ = ΔSiO$_2$/60.0843 V$_{aq}$, where $m_{SiO2(aq)}$ is concentration of SiO$_2$ in the solution, mole/kg of H$_2$O; ΔSiO$_2$ is losses of weight of a quartz crystal, mg; V$_{aq}$ is the weight of a solution. There are accepted, that the molecular weight of silica is equal 60.0843 and the density of the diluted solutions is close to density of the pure water and equal 1 g/cm^3 under room conditions. Change of the density during experiment was not taken into account.
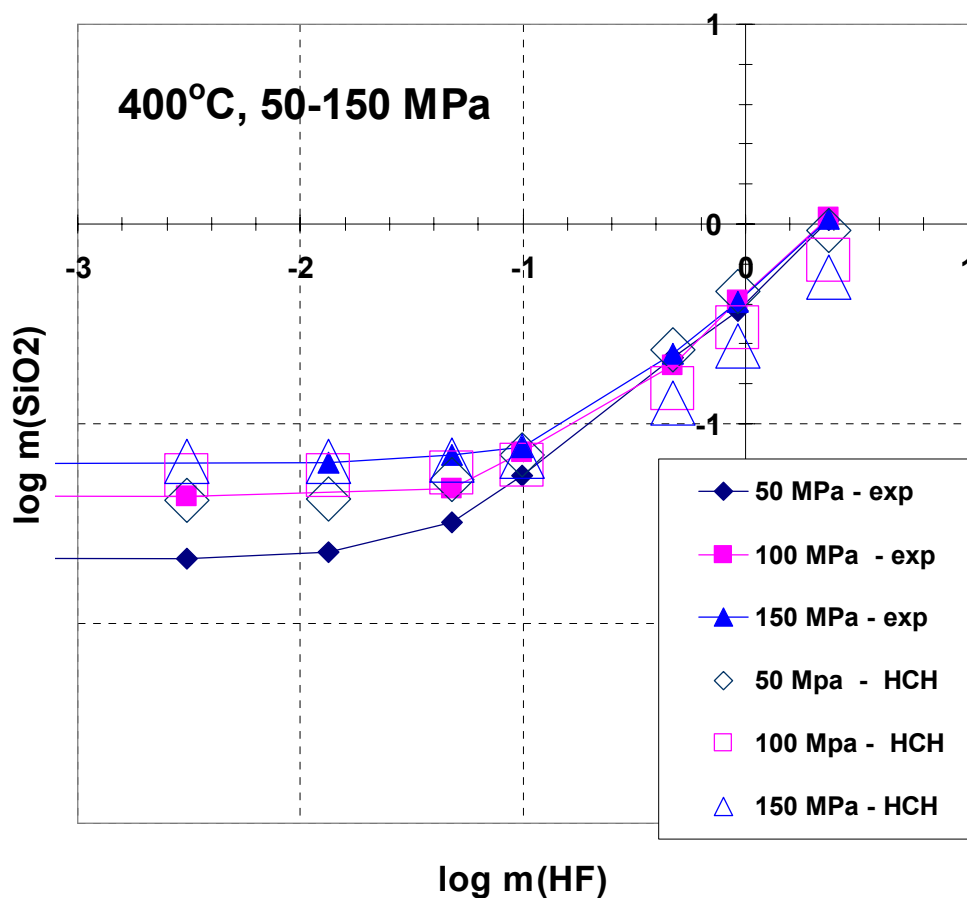
Results of Experiments and Discussion of Results

Results of experiments are presented on Fig.1 and shown, that the quartz solubility at low HF concentration HF (up to 0.01m HF) remains at a level of solubility in water. The bend of an isotherm is observed from above 0.01m HF. It is related with increase of fluoride-silica complexes in the solutions. At growth of pressure, solubility raises. Up to 50 MPa it is noticeable, and after 100 MPa it is less expressed.

At concentration HF near 0.1m there is a very much growth of the solubility and already at near 0.5m HF all three isotherms have very close value. The difference between solubility at various pressures becomes unimportant. At 400°C and 100 MPa at 1.0m HF solubility of quartz has increased up to 0.42m, i.e. up to 25 g/kg of water.

Preliminary comparison of results of experiments with results of calculation by Yu. Shvarov's code shows that in dilute solution calculated quartz solubility is higher as in experiment. At high HF concentration on the contrary that is lower in comparison with the experimental data. The analysis of the data should be continued.

Solubility of quartz in HF-H2O solutions.
Experimental and calculated by HCH code.

400°C, 50-150 MPa

log m(SiO2)

log m(HF)

Legend:
- 50 MPa - exp
- 100 MPa - exp
- 150 MPa - exp
- 50 Mpa - HCH
- 100 Mpa - HCH
- 150 MPa - HCH

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