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An evaluation of synthetic fluid inclusions for the purpose of trapping equilibrated, coexisting, immiscible fluid phases at magmatic conditions

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Abstract

We report data that allow us to evaluate the method of trapping immiscible, saline aqueous fluids (i.e., vapor and brine in the $NaCl$-KCl-HCl-$FeCl_2$-$AuHCl_2$-H_2O system) as synthetic fluid inclusions in pre-fractured quartz cores in order to quantify the concentrations of Au, Fe, K, and Na, among coexisting three-phase, immiscible fluids (i.e., haplogranite melt, brine, and vapor) at magmatic conditions. Coexisting vapor and brine were trapped experimentally at 800 °C and 100–110 MPa as synthetic fluid inclusions in both quartz microfractures and quenched silicate melt (i.e., glass), and also sampled indirectly using the recovered quenched aqueous fluid. Quartz-hosted and glass-hosted brine inclusions were analyzed by laser-ablation inductively-coupled-plasma mass spectrometry (LA-ICPMS) and instrumental neutron activation analysis (INAA), respectively. Quenched aqueous fluid from each experiment containing a quartz core was recovered and analyzed by atomic absorption spectrophotometry (AAS). The composition of aqueous fluids trapped as quartz-hosted inclusions, glass-hosted inclusions, and those recovered after quench yield consistent and precise data, at the 2σ uncertainty level, for the elements of interest. The overlapping Au, Fe, K, and Na concentrations in aqueous fluids trapped and analyzed via three entirely different instrumental techniques (i.e., LA-ICPMS, INAA, and AAS) suggest strongly that quartz microfractures heal on a slow enough time scale to permit entrapment of fully equilibrated aqueous fluids at our experimental *PTX* conditions. The data evince clearly that the chemical composition of fluids in quartz microfractures at the time of self-healing represents equilibrium conditions; hence, synthetic fluid inclusions in experiments with low thermal gradients across the charge provide a reasonable estimate of fluid composition at least at the experimental conditions examined in this study.

Keywords: Analysis (chemical), fluid inclusions, experimental petrology, magmatic-hydrothermal fluids, element partitioning, immiscible fluids, igneous petrology, vapor, brine