# Cryo-FIB-SEM-EDX analysis of fluid inclusions reveals the deep fluid chemistry

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Chemical compositions of fluid inclusion have been determined using conventional methods such as microthermometry. Although conventional approaches are powerful, some species in multicomponent aqueous solution can be hardly detected. To test the validity of direct-chemical analysis, we conducted micro-excavation of the fluid inclusion using a scanning electron microscope (SEM) equipped with a focused ion beam (FIB), an energy dispersive X-ray spectrometer (EDX), and a cold stage. Fluid inclusions trapped in the quartz pressure shadow of a UHP talc-garnet-chloritoid schist, collected from the Makbal Complex, Kyrgyz Tien-Shan, show a signature of high-salinity (Raman analysis and microthermometry) and dissolved components other than NaCl (cryo-Raman and microthermometry). Doubly-polished thick section was introduced into the cryo-FIB chamber and micro-excavation was performed after careful determination of the position of target inclusion. In addition to Na, Cl, and Ca inferred from microthermometry, the obtained EDX spectra revealed the presence of K as a solute element, which is hardly identified by conventional techniques.

Petrographic examination of the fluid inclusions indicated the entrapment of fluid during the exhumation stage of the UHP talc-garnet-chloritoid schist, possibly coming from the decomposition of lawsonite inferred by previous study (Orozbaev et al., 2015). Dissolved K and Ca may have been originated from the phengite and lawsonite. Many previous studies assume simple chemical system of the aqueous solution involving only NaCl as a solute component. However, the present result infers the common occurrence of other components such as K as the solute species of deep fluids. Misidentification of solute species introduces errors into salinity estimation, resulting in error propagation in other quantitative analyses such as LA-ICP-MS. As we show in this study, FIB-based sample preparation and cryo-SEM-EDS analysis can help the precise characterization of the complex chemical system of fluid inclusion.