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A novel micro-XRD technique for the selected area in petrographic thin section using FIB and high-sensitive XRD

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Powder X-ray diffraction (XRD) is the most common and convenient technique for determining mineral compositions in rock or crystal structure of minerals. However, they can be heterogeneous within a rock or petrographic thin section and conventional XRD is often useless because it requires a considerable volume of the specimens. To overcome this problem, so called micro-XRD instruments have been developed and applied. Especially recent confocal X-ray mirror can generate a convergent X-ray source whose brightness close to synchrotron radiation. Two-dimensional X-ray detectors such as CCD camera and imaging plate (IP) are also useful to acquire diffracted X-ray efficiently. On the other hand, micro-sampling techniques using a focused-ion-beam (FIB) developed mainly to prepare TEM specimens can select and pick up minute mineral fragments from interested areas in petrographic thin section. Although the maximum size to pick up using FIB micro-sampling is rather limited, it can be compensated by the bright X-ray source and efficient XRD detectors. We will report the application of these techniques assembled to determine the crystal structures of chlorite and related minerals in petrographic thin section.

Chlorite, one of the most abundant phyllosilicates found in variety of geological environment, has six polytypic groups. Like other phyllosilicates, the detailed investigation of its crystal or stacking structure is crucial. 'Chlorite-like minerals' (chlorite, serpentine, and their interstratification) from Toyoha geothermal system, southwestern Hokkaido, Japan was investigated using this novel micro-XRD, as well as electron diffraction and high-resolution imaging in TEM. We found that chlorite-like minerals in veins and matrices are different (mainly serpentine in the veins and chlorite in the matrices) from micro-XRD pattern. Polytypic groups of chlorites in the matrices seem to be dependent on their chemical compositions.

Keywords: XRD, FIB, petrographic thin section, HRTEM, phyllosilicate, chlorite