Laue microdiffraction and you: Phase maps and strain measurements in rocks and minerals

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The study of geological materials has focused to a great degree on phase distribution mapping and on calculation of stress/strain relationships in rocks and minerals. At beamline 12.3.2 of the Advanced Light Source, we have the capability to perform direct strain measurements and elemental and phase mapping in two-dimensions at a 2 µm scale using a combination of wavelength and energy dispersive diffraction and x-ray fluorescence. The layout of the beamline allows for quick data collection without the need for sample rotation, and enables use of multiple types of stages including the diamond anvil cell. Here we present some recent applications of the beamline to the field of geoscience, including crystallographic mapping of twin phases, direct strain measurements in quartz, and fine-grained phase mapping in high-temperature tuff. In the first case, energy-dispersive (Laue) diffraction was used to determine crystallographic orientation in a natural moissanite (SiC) sample, which presented plastically deformed Si crystals grown from melt within twin boundaries. In the second case, a long-standing quandary regarding the formation of boudinage was addressed by mapping strain ellipsoid orientation in single-crystalline and twinned quartz veining. In the last case, nanocrystalline clays in naturally-forming seawater concretes were mapped, leading to a grater understanding of natural and anthropogenic concrete formation. Overall, the techniques developed at beamline 12.3.2 have the potential to address a wide range of research topics within the geoscience and high-pressure community.