Strain-induced amorphization and assimilation process of graphite in fault zone of the Hidaka metamorphic belt, Hokkaido, Japan
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We report the characteristic occurrences of graphite and its amorphization by deformation in Hidaka metamorphic rocks, Hokkaido, Japan. The crystallinity of graphite and microstructural observations by micro-Raman spectroscopy, XRD, SEM and HRTEM revealed the presence of two stages of deformation process; delamination stage and size reduction stage of La and Lc during low to high strain fields.

In graphite-bearing mylonite, graphite mainly glide along the (001) plane in graphitic structures and show the layer separation, kink band and bending structures to the shared axis of (101) plane. The rupture energy is used for the layer delamination of graphite because the weakest bonding is perpendicular to the c-axis. Subsequent increase in deformation, such as those in graphite-bearing cataclasite, ultracataclasite and pseudotachylyte, the rupture energy causes not only the delamination in stacking but also crushing of carbon sheets, reflected in the decrease of crystal size La and Lc. The layer separation during mylonitization does not change the crystallinity of graphite, whereas size reduction stage reveals significant decrease of crystallinity of graphite as a result of interlayer delamination and crushing by HRTEM observations. These microstructures indicate strong modification from well-crystallized graphite to increase in crystal edge planes. Figure 1 suggests that strain-induced amorphization of graphite has different trend from host graphite. In addition, the deformed graphite is accumulated within shear bands with other oxide minerals, and slip surface and striation was observed in the graphite aggregates. The carbon isotopic composition of graphite in host rocks, cataclasite, ultracataclasite and pseudotachylyte revealed that all samples show light $\delta^{13}C$ signatures. Thus, these data suggest that the low crystalline graphite is accumulated by assimilation and remobilization of pre-existing disseminated host graphite.

The graphite uses the rupture energy for amorphization resulting from delamination and crushing process, and these processes especially delamination stage may induce a lubrication effect in fault zone. In particular, our data suggest a possibility that the degree of amorphization can be an indicator for the strain rate or shear strain in deformation process.

Figure 1 Relationship between Raman spectroscopic parameters of R1 ratio and G band FWHM in fault and host metamorphic rocks.