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Detection of past frictional heating on fault from Raman spectra of carbonaceous material

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Raman spectra of carbonaceous material (RSCM) systematically change with increases in temperature and thus have been used as a geothermometer in sedimentary and metamorphic rocks. We examined whether RSCM can be useful to detect increased temperatures associated with frictional heating on fault. The studied fault constitutes the thrust sheet boundary in the coherent chert-clastic sequence of the Jurassic accretionary complex in central Japan. The fault includes a few millimeters-thick, chert-derived pseudotachylyte and the 50-cm-thick cataclasite defined by the fragments of black chert in the carbonaceous clay matrix. We analyzed RSCM with a 514.5 nm Ar^{+} laser across these fault rocks and obtained characteristic Raman bands. The results show that the intensity ratio of D1-band and D2-band (I_{D1}/I_{D2}) and the full width at half maximum (FWHM) of the D1-band markedly decrease in the pseudotachylyte and the host rocks (gray chert) of less than ˜2 mm from upper and lower boundaries of the pseudotachylyte, representing the localized progress in carbonization. In contrast, there are no changes in I_{D1}/I_{D2} and FWHM of the D1-band across the boundaries of the cataclasite. The spatial distribution of the decreased I_{D1}/I_{D2} and FWHM of the D1-band and the presence of pseudotachylyte are consistent with the localized heating during frictional melting along a few millimeters-thick slip zone. We conclude that RSCM is useful to detect increased heating associated with seismic slip on faults.

Keywords: carbonaceous material, Raman spectra, pseudotachylyte, cataclasite, chert-clastic sequence