Paleo-stress analysis of fault gouges using Raman spectroscopy and rock magnetic methods

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Paleo-stress analysis is important for estimating ancient activities of faults only from the information of fault gouge. Mishima et al. (2006) and Fukuzawa et al. (2017) determined the layers of high-temperature slip zone by magnetic methods. Although these studies are powerful to detect slip layers, paleo-stress is not determined. Chou et al. (2002) identified the presence of irregular-shaped pyrite crystals and the absence of framboidal pyrite within the 1999 Chi-Chi principal slip zone. It is thought that such pyrite is associated with alteration of iron sulphide minerals into pyrite at hydrothermal conditions due to coseismic frictional heating during earthquakes. Such pyrite has the potential to record accumulated stress as structural distortions in fault gouge after earthquakes. Therefore, we measured pyrite crystals in the Nojima fault gouge by Raman spectroscopy and analyzed the distortion. We found that systematic shifts of Raman double peak spectrum (Ag, Eg modes) to increase the wavenumber. Non-hydrostatic pressure causes such wavenumber shift according to laboratory pressure experiments. As a result, it is estimated that the maximum magnitude of stress from pyrite is estimated at 600 ~ 1000 MPa, resulting in long-duration after the last earthquake. After determining slip zones by magnetic methods, Raman analysis offers a practical method that could derive paleo-stress to reveal fault activities only from the information of fault gouge.

Keywords: Fault gouge, Raman, Scanning magnetic imaging

