3D structural analysis using X-ray Computed Tomography technique: a case study for fault rocks from the Nojima Fault, southwest Japan

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Fault rock structures in active fault shear zone can contain important information of seismic slip mechanism (e.g. Lin et al, 2013; Lin and Nishiwaki, 2019). The micro- to macro-structural characteristics of fault rocks formed pass entirely throughout faulting periods, resulting in a broad suite of deformation processes being recorded by deformation structures and textures in spatial within the fault zone (Lin, 2008). Therefore, to understand the spatial variation of meso- and microstructures of fault shear zones, it is important to analyze the three dimensional (3D) images of fault rocks.
In this study, we conducted the 3D structural analysis using X-ray computed tomography (XCT) technique for the cataclastic rock samples including fault gouge obtained from the scientific drilling project “Drilling into Fault Damage Zone (DFDZ)” penetrated throughout the Nojima Fault (NF) Zone that triggered the 1995 M_w 6.9 Kobe earthquake. XCT technique is a non-destructive imaging analysis using CT-value, a function of density and chemical composition. Drilling investigations and 3D structural analyses of drill cores reveal that a ~60 m wide fault damage zone containing a 10–30 cm thick fault gouge zone developed along NF (Nishiwaki et al., 2018; Lin and Nishiwaki, 2019). The fault gouge zone consists of many different color gouge layers 1-2 mm to ~10 cm thick in both sides of the fault plane. In the gouge layer, there is foliations oriented parallel or sub-parallel to the boundaries of each gouge layer. XCT analysis shows the 3D structural features as followings: 1) the main fault plane shows a sharp boundary between two fault gouge layers and cut or offset all other fault gouge layers and fragments, 2) foliations developed within individual fault gouge layers defining the composite planer structures on the X-Z section which show a right-lateral shear sense as that inferred from the topographical and geological evidence, and 3) fine-grained materials were injected into the cataclastic rocks and formed veinlet network structures with complicated spatial variation. These results indicate that the XCT imaging technique is a powerful tool to study 3D deformational structures and textures of fault rocks combining with conventional structural analysis.
References:
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