THE GEODYNAMICS SEMINAR №629

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Keywords:
1. Acoustic emission (AE)
2. AE cluster
3. Spatial distribution of fault

In situ deformation experiments on olivine under the pressure-temperature condition of shallow subducting slabs: microseismicity and spatial distribution of faults

To understand the process triggering intraslab earthquakes occurring at depths greater than ~40 km, many experimental studies have been conducted using a D-DIA apparatus combined with an acoustic emission (AE) monitoring system (e.g., Schubnel et al., 2013). As supported by scaling laws, AEs radiated from propagating microcracks are good simulation of natural earthquakes. Wang et al., (2017) applied a double-difference earthquake location algorithm (Waldhauser and Ellsworth, 2000) to relocate the hypocenters of AEs radiated at high pressures. They reported that the number of AE events usable for hypocenter determination increased by ~10 times and the location uncertainty decreased down to $\pm 10\,\mu m$ as a result of relocation using the algorithm. They successfully showed that spatial distributions of faults and AE hypocenters are correlated with each other in the stage of rupture process.

In this study, we conducted in situ deformation experiments on olivine aggregates using a D-DIA apparatus combined with an AE monitoring system at BL04B1/SPring-8. Our experimental conditions correspond to those of the interior of subducting slabs (500-900°C, ~3 GPa). To improve the accuracy in AE hypocenter location, we evaluated waveform cross-correlation for each AE event based on a source relocation algorithm (template-matching method: Lei et al., 2022). Recovered samples were observed by X-ray micro CT at BL20B2/SPring-8 to analyze spatial distribution of faults.

Throughout the deformation runs, semi-brittle flow associating AE radiation was observed. At 700-900℃, throughgoing faulting associating strong AEs occurred after yielding. Comparison with spatial distributions of AE hypocenters and fault planes showed that distribution of AE hypocenters was random in the early stage of deformation, while AEs preferentially distributed around the faults around/after the timing of faulting. Our results suggest that clustering of AEs (i.e., localization of damage) is mandatory for the formation of faults.

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