The 421th Geodynamics Seminar

Technical developments on acoustic emissions monitoring at high pressures

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Abstract

The subduction zone produces a major fraction of the Earth's seismic activity. Intermediate-depth earthquakes within the subducting slab form a double seismic zone. The cause of intraslab seismicity have been attributed to dehydration of hydrous minerals (*e.g.*, Peacock, 2001). Brittle fracture associating dilatancy is difficult at high pressures (*i.e.*, depths at which intermediate-depth and deep-focus earthquakes occur), although dilatancy prior to failure usually occurs in the case of shallow-depth earthquakes.

At deeper depths, dehydration embrittlement (*i.e.*, hydrofracturing) is expected to play an important role in failure of rocks because the overall volume change of the dehydration reaction is positive and thus pore pressure can be increased (*e.g.*, Raleigh and Paterson, 1965). However, experimental results on dehydration embrittlement of antigorite are controversial. Dobson *et al.* (2002) conducted a series of experiments on dehydration of antigorite, and they reported that dehydration of antigorite associates acoustic emission (AE) when the dehydration reaction is positive. Even though the volume change becomes strongly negative above 2 GPa, Jung *et al.* (2004) reported that brittle failure of antigorite occurs at pressures up to 6 GPa. Recently, Gasc *et al.* (2011) reported that no detectable AEs through dehydration of antigorite-rich serpentinite. Therefore, the cause of intermediate-depth earthquakes is still unclear.

In some of subduction zones, a significant activity of deep-focus earthquakes has been reported (*e.g.*, Kirby *et al.*, 1996). It has been proposed that deep-focus earthquakes are triggered by an instability faulting caused by olivine phase transformations (Kirby *et al.*, 1991; Green *et al.*, 1992). Schubnel *et al.* (2013) conducted deformation experiments on germanium olivine (Mg_2GeO_4) at 2-5 GPa and 1000-1250 K, and they observed many AEs generated in the sample. Schubnel *et al.* (2013) discussed that fractures nucleated at the onset of the olivine-to-spinel transition.

To investigate the brittle properties of rocks, determination of AE source is critical. In the community of high-pressure rock physics, Green *et al.* (1992) conducted AE monitoring by using a Griggs apparatus combined with an AE sensor. Dobson *et al.* (2002, 2004) and Jung *et al.* (2006) adopted 2 or 4 AE sensors to a multianvil apparatus. However, the position of AE source has not been determined in the experiments because of not enough number of sensors used in the experiments. De Ronde *et al.* (2007) adopted 8 AE sensors to a multianvil apparatus and they succeeded to determine the position of AE sources. Recently, Gasc *et al.* (2011) succeeded to develop an experimental setup that allows determining the position of AE source by using DIA-type multianvil apparatus combined with 6 AE sensors. Schubnel *et al.* (2013) adopted the experimental setup reported by Gasc *et al.* (2011) to a D-DIA apparatus installed at a synchrotron facility, and they succeeded to measure strain and stress of the sample and AE signals. We have developed an experimental setup that is optimized for the determination of the position of AE source in a synchrotron D-DIA apparatus. We will report some preliminary experimental results on AE monitoring under the upper mantle conditions.