Study of deformation mechanism(s) of sandstones by parallel AE signal measurement and neutron diffraction technique

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Understanding the mechanical behavior of rock materials is essential if we are to utilize an underground environment as storage space (e.g., geological isolation of high-level nuclear waste). The macroscopic strain of rock samples may be associated with strains accumulated in mineral grains and a structural change caused by slip of mineral grains and /or crack initiation. Neutron diffraction technique can evaluate the lattice strain of crystal grains. AE (Acoustic Emission) signal measurements are useful way to identify dynamic phenomena, such as mineral grain slip and crack initiation. Therefore, to investigate deformation mechanism(s) of rock materials under uniaxial compression, measurements of neutron diffraction patterns have been undertaken in parallel with measurements of AE signal.
In situ neutron diffraction measurements were undertaken using the Engineering Materials Diffractometer “TAKUMI” at J-PARC (Japan Proton Accelerator Research Complex). AE signals were measured using a PCI-2 (PHYSICAL ACOUSTIC CORP.). Three types of sandstone were tested: Berea, Tomita, and Izumi. Macroscopic strain values were recorded using a strain gauge.
The macroscopic strain of each sandstone was larger than the lattice strain. The macroscopic strain exhibited plastic deformation behavior, whereas the lattice strain exhibited elastic deformation behavior. AE signals were detected as the applied load was increased. These AE events might be related to internal structural changes. These dynamic phenomena may also explain the discrepancy between the macroscopic and lattice strain values. The characteristics of the measured AE signals varied with rock type, indicating that the deformation mechanism is a function of rock type.
In this presentation, I will provide further details of the experimental methods and present some of the more interesting data obtained from these measurements.

Keywords: neutron diffraction, acoustic emission, rock, strain

