The monitoring of heterogenetic two-phase flow in porous geological material by elastic wave velocities.

CO_2 storage division
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We will try to reveal the two-phase flow mechanisms in porous geo-materials. It is essential to monitor the CO_2 flow in the deep reservoir for safety assessment of CCS project. In this study, we try to monitor the two-phase flow (CO_2 and water) in porous geo-material by compressional wave velocity (V_p). This is an analogue experiment to demonstrate the CO_2 flow in the reservoir. In general, the reservoir of CO_2 is deep saline aquifer with complex sedimentary structure (e.g., bedding structure), while we use sandstone with bedded thin iron-oxide laminae (bedded sandstone). This sample has high average porosity (ca.24 %) with several flat and oblique laminae (porosity is 10%). First, we observe an internal structure of specimen by using an X-ray CT scanner. It is illustrated that several oblique laminae in upper part of specimen (Fig.1). Next, we conducted mulch-channel V_p and V_p-anisotropy measurement under super critical CO_2 conditions during CO_2 injection (drainage) and water re-injection (imbibition) processes. In drainage, V_p shows large reduction (around 10 %) in all channels and changes from bottom channel to upper channels. It is considered that V_p reduction reflects the CO_2 movement in the specimen. V_p-anisotropy of upper two planes indicates clear increase (Fig. 2). These results also suggest the formation of a heterogenic CO_2-flow in upper part of this specimen during drainage. In imbibition, V_p shows slow recovery in all channels, but V_p-anisotropy doesn't change. It implies the uniform-water flow in the whole sample. These results indicate the strong effect of laminae on fluid flow. Water can pass easily these laminae, however CO_2 is not able to go through these laminae. This may be caused by the difference heterogenetic of capillary pressure between laminae zone and surrounding porous zone.

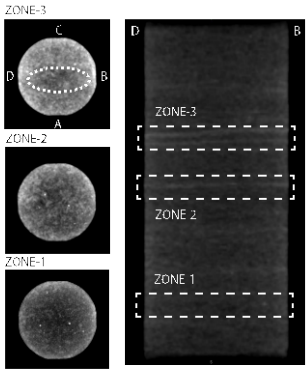

Fig. 1. Internal structure of bedded sandstone

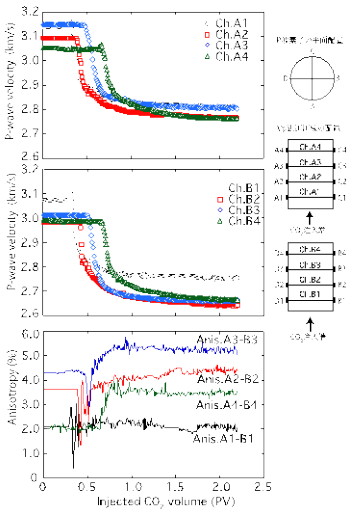

Fig. 2. V_p and V_p-Anisotropy change during CO_2 injection