CO_2 注入試料の光ファイバーによるひずみ検出
Strain detection by optical fiber for CO_2 injected core specimen

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In order to detect strain of rock specimen during CO_2 injection using optical fiber, a laboratory experiment was carried out using porous sandstone. Spiral direction strain of core specimen was detected by optical fiber. We compared the strain profiles in the case of one-phase flow (water only) and the case of two-phase flow (CO_2 in water saturated specimen). CT image analysis was also used to determine the internal state of the specimen. Sarukawa sandstone (diameter: 34.83mm, length: 179.50mm) was used in this study. Porosity of the specimen determined by X-ray CT imaging is 23.38%. This specimen is homogeneous overall, but there are some gravels in some places. The permeability is about 7 mDarcy. The experiment was conducted under the pressure and temperature conditions that simulate underground environments; pore pressure: 10MPa, temperature: 40 degrees Celsius. The confining pressure selected in this study is 12MPa. The specimen was first saturated with KI aqueous solution (11.5 wt%). The permeability was confirmed using the KI aqueous solution. The upstream pump was prepared at 10.5 MPa for differential pressure of 0.5MPa. The CO_2 flooding was carried out until the total fluid injection reaches about 7.6PV (pore volume). Optical fiber measurement and X-ray CT imaging were performed in all experimental steps. In the case of one-phase flow (water only), as soon as the water injection started, the strain profile was completed. And the strain profile was almost constant until the test ended. In the case of two-phase flow (CO_2 flooding in water saturated specimen), there was a small strain increase up to CO_2 breakthrough and there was a sudden strain increase after the breakthrough. In this study, it was possible to measure the spiral direction strain of 180mm long core specimen. At the same time, we could visualize the process of CO_2 flooding by X-ray CT image analysis. It has become possible to measure distortion of a long distance under the ground with a single optical fiber. It reveals that the optical fiber sensing is a potential tool for future CO_2 storage industries.

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