

Permeability measurements on the deformed layers formed in sandstone using dodecane and water as fluids

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To evaluate the entrapment capacity of petroleum fluid with the faults, the knowledge of the permeability in the deformed layer is quite important. Here we made measurements of the permeability in the deformation layer using dodecane as a mock petroleum fluid. We paid our attention on the permeation feature in gauge layer specifically, as that layer considered to act as sealing layer.

The permeability values were obtained by measuring the pressure loss values as a function of flow rate of fluid. All the measurements performed in this study were made at room temperature. Prior to the application of dodecane to the sample, distilled water was applied to fill the throat in the sample.

We first carried out the evaluation of the permeability of the sandstone. We extracted 3 kind of samples from the same matrix; the sample from neighbor to the deformation layer (sample 1), that from separated area (sample 2), and that from the area between the two deformation layers (sample 3). The permeability evaluated from the dodecane experiment of the sample 1 was about 5 md, whereas the sample 2 and 3 showed ca. 50 md. This result reflected that the sample 1 contained fine grain, which originated in the deformation.

The two types of deformation layers were extracted from the matrix; one consisted of gauge layer only (sample 4), and the other consisted of smear and gauge layers. On the permeability measurement, the fluid was applied in the direction perpendicular to the layer. The permeability of the sample 4 and 5 were in the order of sub-md, and their values were small compared with those of the sandstone samples, due to the existence of fine grain. However, the permeability difference between the sample 4 and the sample 5 was little in spite of the sample 5 contains smear layer. The optical microscope observation revealed that the smear layer had defects, which made the layer discontinuous and acted as shortcut channel.

Among this series of experiments, we found that the pressure loss values measured with water were larger than those measured with dodecane at the same flow rate. This is somewhat queer result, as the highly viscose fluid brings high pressure loss at the same flow rate in general. In addition to this, in the gauge sample, we found a successive pressure loss increase up to 100 hr during the water experiment. Similar feature could be observed when the applied fluid was dodecane, although the successive pressure loss increase finished within 60 hr. Those results suggested that the dynamic variation of the throat properties, such as throat diameter and the porosity, took place during the application of the water to the gauge layer sample. One of the characteristic feature in gauge layer associated with such phenomenon observed was that the gauge layer expanded when the sample dipped in water, whereas the expansion did not occur in dodecane. This expansion is considered to be of the fine grain existing in the crevice between the sand of quartz.