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Experiments for exploring flow pass in hard rocks by acoustic tomography

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Hard rocks are considered to be promising areas of high-level nuclear wastes disposal. One of the major issues in disposal of nuclear wastes is that the behavior of groundwater flow near the wastes. Presence of the fractures is one of the most important factors to interpret the characteristics of groundwater flow because these zones can become flow pass of the wastes. Therefore, it is very important to explore fractures, groundwater flow pass way, in hard rocks. There is a possibility to map the fractures by using geophysical exploration methods. It is considered that P-wave velocity and electrical resistivity in and near the fractures are almost same because fracture zone are too narrow. So there is less possibility to map the fractures. Amplitude of wave can be attenuated when wave is propagated in the fractures. Acoustic tomography is thought to be mapped the fractures in the rock mass because attenuation data can be acquired and high frequency acoustic wave can be used. So we have conducted laboratory and field measurements of acoustic tomography in the fractured hard rock area.
In the laboratory experiments, we made the granite rock sample of 2.5m scales including a horizontal fracture. The fracture was made by stacking two blocks of granites, whose width was 0.5mm. Acoustic tomography was conducted by using two boreholes in the two boreholes in the rock sample whose distance was 1.78m. As a result, P-wave velocity was almost same in and around the fracture. On the other hand, amplitude attenuation was appeared in the fracture zone. This suggests that there is a possibility to map the fractures by measuring attenuation of acoustic waves.
In the field experiments, we conducted acoustic tomography measurements in the fractured granite area in the Grimsel Test Site (GTS), Switzerland. We used three boreholes in the test site, and P-wave velocity and attenuation of two cross-sections data were acquired. Distance of each borehole was about 1.5m, respectively. As a result, attenuation was more sensitive than P-wave velocity to the presence of the fractures. This also suggests that fractures can be mapped by measuring amplitude attenuation of acoustic wave.
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Keywords: High-level nuclear wastes disposal, Hard rocks, Groundwater flow pass way, Geophysical exploration, Acoustic tomography, Amplitude attenuation