

Development of an apparatus for simultaneous modeling of geological structure and fluid flow

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Understanding the effects of geological evolution on hydraulic properties of geological media is very important for evaluating the long-term stability of the facilities associated with disposal of radioactive nuclear wastes. This paper introduces a newly developed large-scale testing apparatus that is capable for simultaneous modeling of geological structure and fluid flow.

The characteristics of the apparatus are as follows:

- 1) A large-sized box, measuring 100cm in length by 60 cm in height by 12 cm in width, is constructed with dismountable plates and a movable loading plate that can horizontally shorten a modeled stratum or composed strata to the maximum of about 50% of initial length. Deformation rate can be controlled at any desired level ranging from 1cm/hr to 10 cm/hr.
- 2) The box is leak-free that permits to investigate the effect of fluid on strata deformation and/or fault evolution.
- 3) Side plates of the box are transparent. Deformation and fault evolution in the strata can be observed and recorded.
- 4) The box is equipped with necessary parts for permeation tests. An in-situ permeation test, either in horizontal or in vertical direction, can be performed.
- 5) The box can be inclined to the maximum angle of 45 degree. By removing the front plate of the box, sampling at any desired places can be easily conducted. Spatial distributions of permeability in the deformed strata can be evaluated from independent tests on the samples.

The basic functions of this new apparatus have been verified through a couple of tests on simulated sedimentary strata. The results illustrated that:

- 1) The apparatus can be effectively used to simulate fault evolution in dry, wet, or fully saturated condition.
- 2) Permeation test combined with tracer technology can be used to image the fluid flow in the model strata.
- 3) Faults can be regarded as boundaries for different geological units. Hydraulic properties of geological units across a fault may be quite different.
- 4) Faults developed in shallow depth are generally with high permeability whereas faults developed in deep earth can be less permeable or even become sealing bands of fluid flow. This decrease in permeability may be due to the re-arrangement and orientation of micro particles such as clay in the strata.