

## Principal Research Results

### Development of analytical method for ground water - Estimation of isotopic composition of pore water -

#### Background

Estimation of characteristics (flow rate, direction, origin, residence time) of groundwater is very important for safety assessment of high level radioactive wastes, because radionuclides migrate with groundwater. Isotopic composition of groundwater provides very important information to estimate such characteristics of groundwater. However in low permeable bedrocks estimating isotopic composition is very hard because pore water has to be extracted from rock while such extraction procedure changes the isotopic composition of pore water. Thus development of methodology to estimate the isotopic composition accurately is required.

#### Objectives

Development of “isotopic exchange method” for putting the method to practical use.

#### Principal Results

##### 1. Determination of experimental condition to carry out isotopic exchange method appropriately

(1) Making and verification of vessel for experiment:

Vessels for isotopic exchange method were made from stainless steel. These vessels can contain vapor for 2 weeks without leakage of vapor.

(2) Specification of effective parameter for isotopic exchange method:

Standard samples were obtained by replacing the original pore water to simulated pore water that has known isotopic composition. Applicability of isotopic method to rocks can be discussed estimating the difference between isotopic composition of standard samples and estimated values by isotopic method. Thus the amount of pore water is found to be a most effective parameter.

(3) Appropriate amount of pore water:

Over 5g of pore water is required to estimate the isotopic composition by using the isotopic exchange method, in the case of 1.5L vessel.

##### 2. Verification of applicability of isotopic exchange method

Isotopic exchange method was applied to boring core obtained in Horonobe, Hokkaido, Japan and the depth profile of isotopic composition of H was estimated. The depth profile obtained by isotopic exchange method was compared with that obtained by squeezing method or from pumped groundwater. The depth profiles obtained by the 3 methods showed good agreement with each other. This result showed propriety of the isotopic exchange method. Thus we have obtained the new method that can be applied to nearly all kind of rocks.

#### Future Developments

The isotopic exchange method will be applied to rocks that have low permeability to estimate the isotopic composition of groundwater.

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**Fig.1** Vessel used for isotopic exchange method

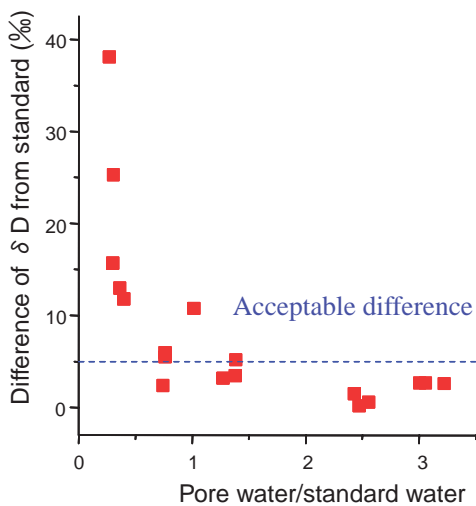
Rock sample and standard water (that has known isotopic composition) are enclosed in the vessel. Then isotopic exchange reaction takes place through vapor. After exchange reaction reaches to equilibrium, isotopic composition of pore water in rock sample and standard is the same. Thus the information of isotopic composition of pore water is extracted to standard water.



| Rock type      | Porosity | permeability              |
|----------------|----------|---------------------------|
| Horonobe-shale | 37%      | $1 \times 10^{-11}$ (m/s) |

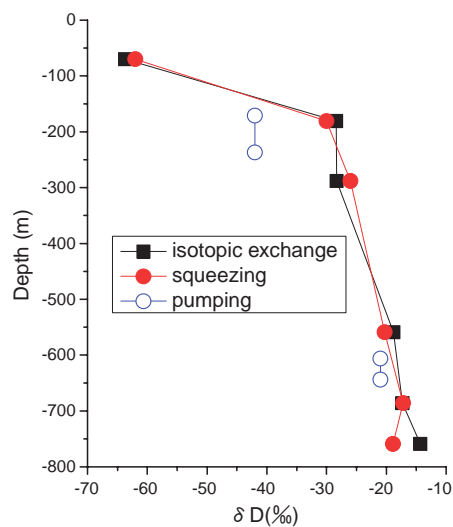
**Fig.2** Boring core obtained in Horonobe (picture) and characteristics (table)

Just after boring core appeared from subsurface, it was vacuum-packed to prevent the change of isotopic composition of pore water in the boring core.



**Fig.3** Estimation of applicability of isotopic exchange method to Izumi sand rock

The results showed isotopic exchange method can be applied to the all kinds of rocks in the case of (pore water)/(standard water) > 2.5.



**Fig.4** Application of isotopic exchange method : squeezing, pumping and isotopic exchange were applied to boring core in Horonobe

The depth profiles obtained by the 3 methods showed good agreement with each other. This result showed propriety of the isotopic exchange method