GROUNDWATER RECHARGE STUDY USING NOBLE GAS AND H-3 TRACER

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Tritium is a component of the water molecule, it is the most conservative tracer for groundwater study. And dissolved atmospheric noble gases in groundwater provide information on the conditions during groundwater recharge, in particular the recharge or noble gas temperature. Therefore, these isotopes are used natural tracer for the study of groundwater recharge of protected cultivation with water curtain greenhouse area. The study area used groundwater for warming tool of greenhouse during the winter, and is associated with issues of groundwater shortage. During the winter time, groundwater recharge were studied by using noble gas and ^{3}H.The content of ^{3}H was ranged <0.5 – 5.9 TU and noble gas was ranged 9.1×10^{-8}-5.8×10^{-8} ccSTP/g for ^{4}He.

I. Study Area

The study area was located middle west side of Korean peninsula and groundwater was used for agriculture as a water curtain for greenhouse heating during the winter. Therefore, there is a lack of groundwater at this location, along with an associated decrease in water level during the winter. Due to water level variations, near-surface water was introduced through base flow.

II. Experiment

Groundwater was sampled at the study site well before protected cultivation with water curtain greenhouse start. Before sampling, about three well volumes of groundwater were purged using a low-rate peristaltic pump. During the purging process, field parameters including water temperature, electrical conductivity (EC), dissolved oxygen (DO), pH and oxidation–reduction potential (ORP) were measured using portable meters (HORIBA D-50, ES5-1, Horiba Ltd., Kyoto, Japan). Once the values of these parameters had stabilized, water samples were collected. For the analysis of noble gas, groundwater was sampled with Cu tube and sealed with clamp and 1 L was sampled in PE bottle for ^{3}H analysis. H-3 was analyzed using LSC after electrolysis enrichment and noble gas analyzer was used after noble gas extraction.

III. Results

The groundwater and surface water interaction was studied with H-3 and noble gas for the protected cultivation with water curtain greenhouse area. H-3 was a good natural tracer to know residence time of the groundwater and dissolved noble gas concentrations potentially provide an excellent tool for identifying subsurface inflow because of their dependence on the ground temperature at the point of recharge. The study area recharge was different with the well position. From the ^{3}H analysis data, A2-2 and A2-3 well were recharged very fast and the other wells recharge very slowly. And calculated noble gas recharge temperature data showed different recharge patterns with each well and it did not correlated recharge residence time.

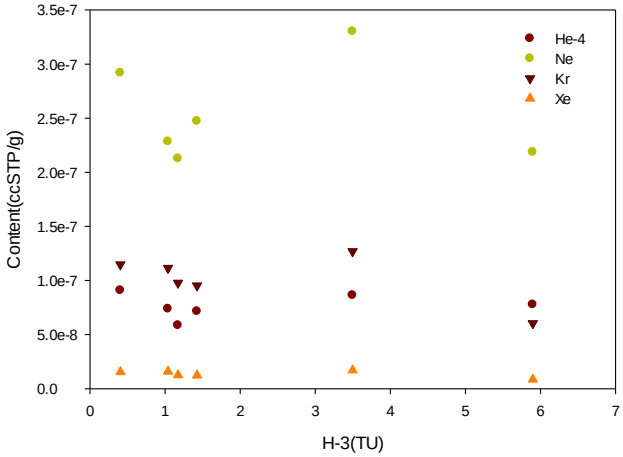

Fig. 1. Noble gas and H-3 relation.

TABLE I. Noble gas and ^{3}H amount and calculated recharge temperature.

Well	^{4}He(ccSTP/g)	Ne/He	NGT(℃)	^{3}H(TU)
A2-1	6.14×10^{-8}	3.69	3.4	<0.5
A2-2	7.77×10^{-8}	2.81	24.4	5.90
A2-3	8.63×10^{-8}	3.83	4.4	3.50
AA1-1	5.85×10^{-8}	3.64	10.8	1.17
AA1-2	7.37×10^{-8}	3.10	5.0	1.04
B2-2	7.15×10^{-8}	3.46	15.5	1.42
BB1-1	9.08×10^{-8}	3.21	10.7	<0.5

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REFERENCES

1. Andrew H. Manning, D. Kip Solomon, “Using noble gases to investigate mountain-front recharge”, *J. Hydrol*, 275 194(2003).
2. A. Visser , J.E. Moran, Darren Hillegonds, M.J. Singleton, Justin T. Kulongoski, Kenneth Belitz, B.K. Esser, “Geostatistical analysis of tritium, groundwater age and other noble gas derived parameters in California”, *Water Research*, 314(2016).
3. Tillmann Kaudse, Refaat Bani-Khalaf, Randa Tuffaha, Florian Freundt,Werner Aeschbach-Hertig, “Noble gases reveal the complex groundwater mixing pattern and origin of salinization in the Azraq Oasis, Jordan, *Appl. Geochem.*, 114(2016).4.