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Seasonal Variation of Rare Earth Element Concentrations and Eu Anomaly in Groundwater and Surface Water from Jeonju-Wanju Area, Jeonnam Province, Korea

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1. Introduction

The rare earth elements (REE) signatures in groundwater are complicated by the fractionation processes including complex formation, ion exchange, absorption/desorption, and colloid transport. It leads most of the research to focus on the interpretation of the REE signatures in terrestrial water in terms of such fractionation processes.

There have been few reports on the seasonal variation of the REE signatures in terrestrial water. This study is 1) to examine the seasonal variation of REE concentration in groundwater and surface water and 2) to test the possibility of utilizing REE as a tracer in groundwater flow.

2. Geological and hydrogeologic Settings, and Sampling Methods

Jeonju is the capital city of Jollabukdo Province, located southwestern part of the Korean peninsula, and Wanju is a district surrounding the city. Majority of the area consists of the Jurassic granite and the Cretaceous volcanic rocks and dykes which intruded the Precambrian orthogneisses and the early Paleozoic metasediments.

Groundwater samples were collected from 8 different wells from April 2002 till May 2004 in Jeonju-Wanju area (6 times). Surface water (stream water) samples in the vicinity of the sampling wells also were collected. The water quality parameters including pH, Eh, conductivity, and temperature of groundwater were measured on the outflow from the submersible wellpump at the depth of 60m from the surface.

3. Results and Discussions

Electric conductivities (EC) of groundwater and surface waters vary with sampling site and time. A most of the sampling sites, pH of groundwater is higher than that of nearby surface water. The temperature of groundwater shows relatively constant value regardless of sampling site and time.

The REE concentrations (∑REE) in surface and ground water in the study area vary from site to site and from time to time. Particularly, ∑REE in most of the water samples is very high before and after rainy season (June and August, 2003), which suggests that the cycle between surface water and groundwater may be relatively fast.

In the study area, the characteristics of the REE patterns in groundwater and surface waters can be summarized as follows;

1) The groundwater samples collected in April, 2002 and February, 2004 show slightly enriched HREE patterns with positive Eu anomaly. The most groundwater samples except a few in June, 2003 and May, 2004 show relatively flattened features with Eu positive anomalies. The groundwater samples except one in August, 2003 are relatively flattened with Eu negative anomalies.
2) The REE patterns of surface waters collected in April 2002 to May 2004 are very similar to those of the groundwaters collected at the same day and site. Particularly, the surface water samples collected after rainy season (August and November 2003) show very similar REE patterns in Eu anomalies with the groundwater samples.
3) One of the characteristics in PAAS-normalized REE patterns of groundwater and surface water is the existence of Ce negative anomaly. The surface water samples collected in November 2003 show relatively strong Ce negative and very strong positive anomalies. Negative Ce anomaly in seawater is produced from the change of redox condition because cerium fractionates from the other REE^{3+} in oxidizing environments.

Our data shows that the precipitation during the rainy season dominantly controls the REE signatures of groundwater and surface water in the study area.