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A preliminary study of water quality and hydrogeochemistry of the major rivers in South Korea

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1. Introduction

The chemical composition of the rivers is generally affected by three major controlling factors such as chemical weathering of minerals, atmospheric input and anthropogenic activities. Especially, Cl^-, NO_3^- and SO_4^{2-} are known to associate with anthropogenic sources, and these anions have been widely used as useful indicators of anthropogenic contamination in many watersheds of the world.

In other to investigate spatial and temporal variations of the concentration of dissolved anions, trace elements and environmental isotopes in river waters in South Korea, we collected river water samples from 7 major rivers (Fig. 1) in November 2006 (winter samples at low water stage). These rivers include the Han, the Geum, the Mankyung, the Youngsan, the Sumjin, the Nakdong, and the Hyungsan Rivers, from north to south. For comparison, summer river water samples will be collected in August 2007 (at high water stage).

2. Method

River water samples were collected from two sampling locations per each river (i.e. from a site of the lower reaches and from outflow of dams in the middle/upper reaches). The geochemical parameters such as pH, electrical conductivity (EC), dissolved oxygen (DO), and temperature were measured in the field. Alkalinity was determined by Gran titration method using 0.01 N HCl within 24 hours after sampling. Water samples for isotope ($\delta^{18}O$ and δD) and chemical (anion and cation) analysis were passed through 0.45㎛ membrane filters and stored at ~4℃ before analysis.

Water samples for cation analysis were acidified with ultrapure HNO_3 to a pH of <2 in the field. Cations were analyzed by ICP-MS (X-7, Thermo Elemental) and ICP-AES (Optima 4300DU, Perkin Elmer) at the Korea Basic Science Institute (KBSI). Anions were analyzed by ion chromatography (Dionex DX-500 IC) at the Korea Institute of Geoscience and Mineral Resources (KIGAM). The oxygen and hydrogen isotopic compositions were

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analyzed using GV Optima stable isotope ratio mass spectrometer at the KBSI.

3. Results and discussion

Concentrations of cations and anions of water samples are generally higher in the lower reaches of rivers than in the upper reaches because of the accumulated effects of chemical weathering and contamination. Espacially in the lower reaches of the Hyungsan, the Geum, the Youngsan, and Nakdong Rivers, concentrations of Cl^-, NO_3^-, and SO_4^{2-} are predominantly higher than those of other river waters. As shown in Fig. 1, water samples collected from the upper reaches of rivers show a water type of $Ca-HCO_3$. Unlike these water samples, water samples collected from the lower reaches of rivers belong to $Na-HCO_3-SO_4$ type. This change in water type is probably attributed to contamination from anthropogenic sources (e.g., fertilizers and pesticides etc.) en route (Zhang et al., 1995).

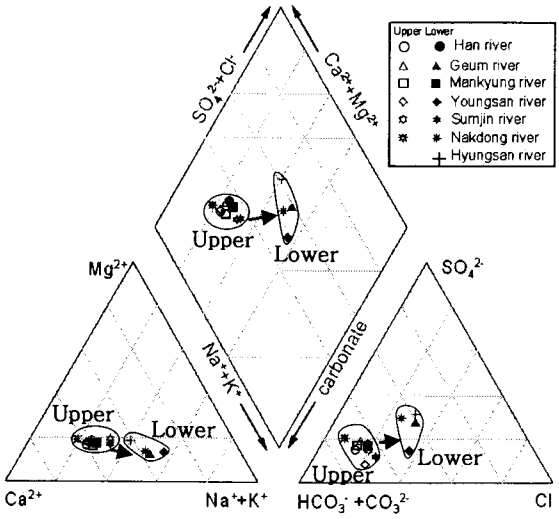

Fig. 1. Piper diagram for 7 major rivers in South Korea. The arrows indicate the change in water type by anthropogenic contamination.

The trace elements are affected by interactions of controlling factors, such as changes in the hydrological flow path, exchanges between suspended particles and dissolved compounds, and input of contaminants due to human activities (Sherell and Ross, 1999). All trace elements except for boron show significantly low concentration in all sampling points of 7 rivers. Overall, boron is higher in water samples of $Na-HCO_3-SO_4$ type in the lower reaches of the rivers, indicating contamination by detergent and sewage. In particular, boron shows the highest value (~0.2 ppm) in the lower reaches of Geum River, and this may result from the combination of detergent contamination and coal

mining activities around the upper Geum River watershed because boron is commonly rich in coal (Williams and Hervig, 2004).

In summary, the water samples in the lower reaches of the Geum, the Youngsan, the Nakdong and the Hyungsan Rivers are significantly affected by anthropogenic activities compared to the other major rivers. In the near future, further investigations on chemical and isotopic composition of dissolved loads of river waters will be conducted for wet season (high water stage).

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