Statistical Approach for the Distribution of Natural Uranium in the KURT Groundwater

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1. Introduction

For the high-level radioactive waste disposal facilities, it is important to evaluate the characteristics of radionuclides in groundwater and the geochemical factors that control its behavior in case of leakage of radionuclides to groundwater. So far, a number of studies have been conducted to investigated geochemical and biochemical properties of the groundwater in the KAERI Underground Research Tunnel (KURT) [1-4], but statistical approach of natural nuclides in the groundwater have not been carried out. The main aim of this contribution is to assess the distribution of natural uranium in KURT groundwater under various geochemical environments and the geochemical factors which affect existence of aqueous uranium using a statistical approach. Principal component analysis was primarily used to find out possible relationships among the examined parameters.

2. Results

2.1 Principal component analysis (PCA)

PCA is a powerful recognition technique that attempts to explain the variance of a large set of intercorrelated variables with a smaller set of independent variables-principal components. It was usually employed to compare the compositional patterns between the examined water samples and to identify the factors influencing each one [5].

The treatment of dataset with PCA showed two factors interpreting the 64.86% of variance (PC1 36.49%, PC2 28.37%). The PCA plot of PC1 against PC2 is illustrated in the Fig.1. Three groups of KURT groundwater are observed: group A (oxidized high uranium group) with PC1 scores < 0, group B (weak granitic weathered group) with PC2 scores < 2 and group C (high granitic weathered group) with PC1 > 0.

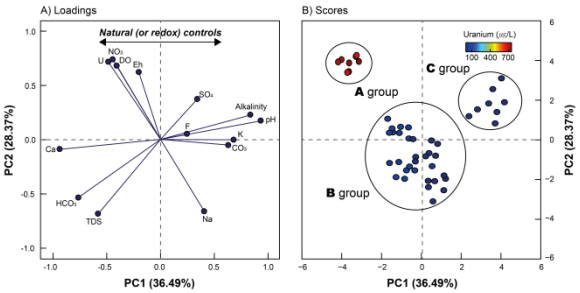

Fig. 1. First vs. second principal component from PCA analysis: A) loadings of the major parameters, B) scores of the natural groundwater samples.

2.2 Hydrochemical characteristics

These three groups represent significant different hydrochemical characteristics according to non-parametric Kruskal-Wallis test. The group A exhibited the high concentrations (or values) of U, DO, Eh and NO_3 and low pH, Na, alkalinity and F. However, groundwater samples in group C showed relatively high concentrations of pH, alkalinity, Na, F and TDS whereas low concentrations of DO and Ca.

The group B samples has high Ca, Na, alkalinity and F. Groundwater from group C is mainly of Na-HCO_3 type, whereas groundwater in groups A and B are Ca-HCO_3 type.

3. Conclusions

The groundwater in KURT was analyzed using the PCA technique to explain the variance of the hydrogeochemical relationship of a large different data. Three major groundwater groups were divided. Group A showed positive correlation with U, DO, Eh and NO_3 indicating mobile property of uranium under oxidized condition. Groundwater in group B was suffered relatively low water-rock interaction and the groundwater type of groups A and B is included in Ca-HCO_3. The C group groundwater is a high granitic weathered group and show positive correlation with F, Na, alkalinity and TDS. And, the water quality type is Na-HCO_3 indicating high interaction between groundwater and contact rock.

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