Goldschmidt 2025 Abstract
https://doi.org/10.7185/gold2025.27386

Assessing geogenic and agricultural contaminants of uranium, arsenic, fluoride, boron, and nitrate in bedrock groundwater from a mountainous area in the mid-eastern region of South Korea

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Groundwater is an essential resource, and its safe, sustainable utilization requires an understanding of both geogenic and agricultural contaminants [1]. Despite its importance, few studies have concurrently examined groundwater flow systems along with characterization of contaminants [2]. This study investigates groundwater recharge processes and the distribution of inorganic contaminants—specifically uranium, arsenic, fluoride, boron, and nitrate—in a mountainous aquifer in mid-eastern South Korea. A total of 122 groundwater samples were collected from bedrock wells in a 2,688 km^2 area. Forest area, which comprises 78.8% of the area, is the predominant land type, followed by dry farmland (7.9%), paddy fields (4.9%), orchards (0.9%), and livestock area (0.2%). Stable isotopes revealed distinct differences between regional and local flow paths, while correlations with land uses indicated that paddy fields exhibit more enriched $\delta^{18}O$ values and significantly higher concentrations of Mg^{2+}, NO_3^-, and Cl^- compared to other land uses, suggesting evaporation effect and agricultural contamination. Contaminants typically associated with these interactions—particularly fluoride and boron—exhibited strong correlations with groundwater flow paths, whereas uranium and arsenic appeared more closely linked to underlying geological and tectonic factors than to flow paths. These findings indicate that while the transport and distribution of most inorganic contaminants are significantly influenced by groundwater flow systems, the behavior of arsenic and uranium is predominantly controlled by geological and tectonic factors. Overall, our findings underscore the importance of considering groundwater flow systems understanding groundwater quality changes, and establishing effective groundwater management policies.

References:

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