

The Relationship Between Deuterium Excess and Uranium Groundwater Concentrations in Whitehall, Montana

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Uranium can become elevated in the environment and pose a human health risk to water resources. Therefore, it is important to understand the origin, transport and concentration of uranium in the environment. With this study we propose that deuterium ($\delta(^2\text{H})$) excess may be a viable way to understand uranium groundwater contamination that is mainly derived from the surface. We collected 23 water samples and compiled data from a study done by the United States Geological Survey (USGS) within the area of Whitehall, MT. With a linear regression we show that there is a significant relationship between deuterium excess and uranium water concentrations for our data ($t_{19} = -3.015, p = 0.0071, R^2 = 0.32$). We also showed that there is a significant linear relationship between uranium water concentrations and nitrate water concentrations for our data ($t_{19} = 2.573, p = 0.0192, R^2 = 0.27$). In addition we showed that there is a significant linear relationship between calcium carbonate and uranium groundwater concentrations for the compiled USGS data ($t_{66} = 6.295, p = 2.846e^{-8}, R^2 = 0.38$). The results of a Wilcoxon rank sum test showed that wells close to ponds have a significantly higher median uranium concentration for our data added to the USGS data ($WRS_{8,12}, W = 111.5, p = 0.033778$). With this relationship we may infer that an influx of uranium into the aquifer originates at the surface most likely from the Boulder Batholith. These results are also consistent with a model that involves insoluble uranium being transported in suspension and settling out in ponds where an influx of nitrates and/or carbonates react to produce higher concentrations of water-soluble forms of uranium. We suggest that the relationship found between uranium concentration and deuterium excess in water samples may be related to the higher rates of evaporation in ponds. Thus, in this specific hydrologic environment of valley ponds close to the Boulder Batholith source, deuterium excess may serve to help predict levels of uranium concentration.