Study on Uranium in Groundwater of Madurai district, Tamil Nadu

Uranium and other radionuclides in water can cause health issues if present in higher concentrations. This study aimed at studying the behavior of Uranium in groundwater in Madurai district. Over 200 samples were collected from different seasons [Pre-monsoon (PRM), South-west monsoon (SWM), Northeast monsoon (NEM), and Post-monsoon (POM)] across diverse lithological units for U, ^{222}Rn, $\delta^{18}O$ and δD along with major ions and trace metals measurements. Electrical resistivity surveys were conducted to characterize the subsurface and the results were confirmed with the lithologs. It was observed that the order of U concentrations in different seasons was SWM > PRM > POM > NEM according to maximum values.

The comparison between the U concentration and groundwater level indicates that the uranium concentration varies primarily due to hydrological conditions. Rainfall recharge raises groundwater levels, dissolving uranium and increasing the U concentration during SWM. However, during NEM, the increase of groundwater recharge lowers U concentration. The substantial correlation between U and ^{222}Rn suggests that U could be the source of ^{222}Rn in groundwater during PRM, SWM, and NEM. The fact that the pH-Mg relationship is negative indicates that ion exchange mechanisms are predominant. Uraninite and the $U_4O_7(c)$ field are more prevalent in the samples from SWM, NEM, and POM. It is also observed that only a small percentage of SWM samples are saturated in the Uraninite field. The dominant species of U in PRM and POM is $UO_2(CO_3)_2^{2-}$ and in SWM and NEM is $UO_2(HPO_4)_2^{2-}$. The good correlation was observed between the U and the $UO_2(CO_3)_2^{2-}$, $UO_2(CO_3)_3^{4}$, $UO_2(OH)_3^{0}$, $UO_2(HPO_4)_2^{2-}$, Mg, PO_4, HCO_3 and H_4SiO_4.

There are two major factors influencing the resistivity, viz. lineament and lithology. The greater weathered thickness is noted in the southeastern part of the study area. In contrast, the northeastern part of the study area has higher U concentration, corroborated with increased weathered thickness of the area. Stable isotopes reflect two different signatures: enrichment of $\delta^{18}O$ with low U content and depleted $\delta^{18}O$ with high U levels. This is due to the recharge from precipitation or weathering-induced factors. The enriched isotopic signatures indicate that evaporated surface water bodies, such as lakes are contributing to groundwater recharge. PCA analysis indicated four significant processes/factors, viz., anthropogenic, ion exchange, weathering and fluoride dissolution. The spatial distribution of these processes reveals that lineament, water level, land use, and lithology are the major driving forces for the observed changes in the chemical composition of groundwater including uranium distribution in the study area.

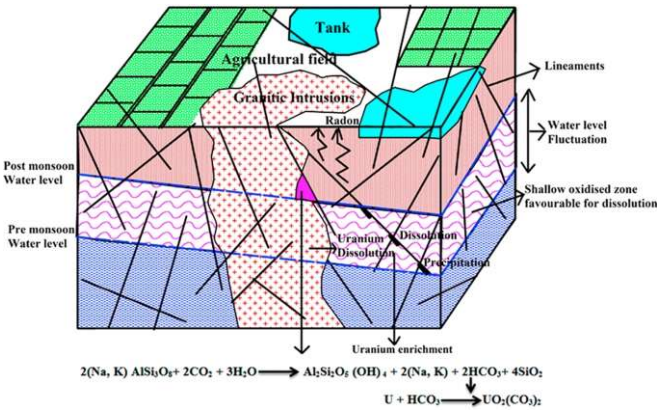

Fig.1: Schematic representation of the occurrence of uranium and radon in the groundwater of the Madurai district of Tamil Nadu, India

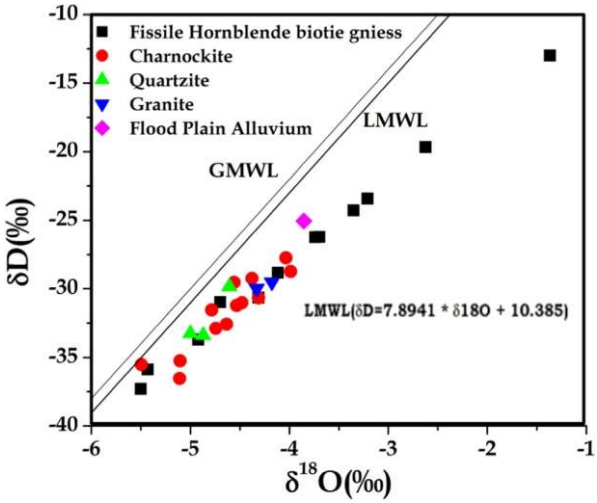

Fig.2: Plot for $\delta^{18}O$ versus δD of groundwater samples compared with GMWL (Global Meteoritic water line) and LMWL (Local Meteoritic water line) of the Madurai district of Tamil Nadu, India

Highlights of the work carried out by **Dr. C. Thivya** under the supervision of **Prof. S. Chidambaram** as a part of her doctoral thesis work. She was awarded PhD degree from Annamalai University, Tamil Nadu in Department of Earth Sciences in 2014 supported by Board of Research in Nuclear Sciences (BRNS), Research Project vide Ref. No.2012/35/12/BRNS/1918 dated 2012.