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Litho-Stratigraphic and Structural Controls on the Groundwater Flow Dynamics and Hydrogeochemical Setting of the Mekelle Outlier and Surroundings, Northern Ethiopia

The isotopic signatures (Î´18O, Î´2H and tritium) and patterns of dissolved-ion concentrations in the groundwater, coupled with understanding of the three-dimensional geological framework, are used to conceptualize the groundwater flow model and recharge-discharge mechanisms in this complex hydrogeological environment. Most groundwater samples lay close to the Addis Ababa LMWL indicating meteoric origin. Slight shifts of some samples from this line are attributed to the altitude effect and the isotopic exchanges of rain droplets with the local air mass that have different isotopic composition (more depleted and higher d-excess) from that of Addis Ababa. This effect also results to a smaller slope of the LMWL of the study area (Î´2H = 6ÃÎ´18O + 9.8; R2 = 0.8). The equation for the evaporation line for the area is Î´2H = 4.47Î´18O + 6.42; R2 = 0.8. The Î´18O of shallow groundwater at different altitudes indicates a depletion rate of -0.51 â°/100m towards highlands. Isotopic signatures indicate groundwater-surface water interaction. Isotopic measurement of groundwater samples in different seasons indicates a significant amount interflow (throughflow) that is pumped in wells during the summer season and disappears shortly after the rainy season passed. Three groundwater flow systems are identified. Tritium data indicate modern groundwater recharge.

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