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THE RELATIONSHIP BETWEEN TRITIUM AND GROUNDWATER CHEMISTRY IN EASTERN MONTANA

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The Fox Hills, Hell Creek, and Fort Union Formations, as well as sands and gravels associated with the Yellowstone and Missouri rivers form important aquifers in eastern Montana. As part of a reconnaissance study, samples were analyzed for tritium and major ions to assess the quality, sources, and ages of groundwater in the region. Groundwater evolves from a variable Ca-Mg-SO4-HCO3 type water with inconsistent TDS content (~500 to 5,000 mg/L) in the shallow aquifers (< 200 feet deep) to a predominately Na-HCO3 type water with relatively consistent TDS (~1,000 to 3,000 mg/L) in the deeper aquifers. Tritium was detected in only one of the ten samples from the deep, regionally extensive and confined Fox Hills lower Hell Creek aquifer; the one detection occurred in an area where the aquifer is unconfined and exposed at the surface. Tritium was detected in 17 of the 27 samples from the generally unconfined Fort Union, upper Hell Creek, and sand and gravel aquifers; the concentrations ranged from 5.5 to 49.8 tritium units. Although the groundwater chemistry from the shallow aquifers is variable, the Ca+Mg/Na ratio and the frequency of tritium and nitrate detection appear to be related. Groundwater that has a Ca+Mg/Na ratio greater than one is more likely to be post-1953 water and have detectable levels of nitrate. Of the 17 samples with detectable tritium (post-1953 water), 16 had a Ca+Mg/Na ratio greater than one, and 15 had detectable nitrate levels; the concentrations ranged from 0.25 to 44.4 mg/L nitrate as N. Only 4 of the 10 samples with no detectable tritium (pre-1953 water) had a Ca+Mg/Na ratio greater than one, and only 2 had detectable nitrate levels. This association between the Ca+Mg/Na ratio, tritium, and nitrate suggests that in this hydrogeological setting the chemical signature of groundwater may be used to assess groundwater age and the potential for contamination. Additionally, the data show a potential to assess the rate of chemical evolution from Ca-Mg-SO4-HCO3 type to Na-HCO3 type water.

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