

## Helium-3/Helium-4 Ratios in Soil Gas as an Indicator of Tritium Contamination Near the 618-11 Burial Ground, Hanford Site, Washington

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### Abstract

Pacific Northwest National Laboratory sampled and analyzed soil gas for helium-3 and helium-4 concentrations from the vicinity of the 618-11 burial ground. Helium-3, the first daughter product from tritium decay, was used to investigate the source and extent of tritium contamination in the area. Seventy soil-gas sampling points were installed around the perimeter of the 618-11 burial ground, approximately 122 meters downgradient of well 699-13-3A, and in four transects downgradient of the burial ground to a maximum distance of 946 meters. Soil-gas samples were collected, analyzed for helium isotopes, and helium-3/helium-4 ratios were calculated from these 70 points. Helium-3/helium-4 ratios determined from the sampling points showed significant enrichments compared to ambient air helium-3/helium-4 ratios. The highest helium-3/helium-4 ratios were located along the north perimeter of the burial ground. Helium-3/helium-4 ratios (normalized to their abundances in ambient air) ranged from 1.0 to 62 around the burial ground. The helium-3/helium-4 ratios from the 4 transects downgradient of the burial ground ranged from 0.988 to 1.68. The helium-3/helium-4 ratios from around the burial ground suggest there is a vadose zone source of tritium along the north side of the burial ground. This vadose zone source is likely the source of tritium in the groundwater. The helium-3/helium-4 ratios also suggest the groundwater plume is traveling east-northeast from the burial ground, and the highest groundwater tritium value may be to the north of well 699-13-3A. Finally, there appears to be no significant upgradient sources of tritium affecting the burial ground since all the upgradient helium-3/helium-4 ratios equal the air background level of 1.0. Based on the helium-3/helium-4 results from the soil-gas survey, six downgradient sampling locations were identified to verify the tritium groundwater plume locations and tritium groundwater concentrations. The results of the measurement of helium isotopes in soil gas provided a rapid and cost-effective technique to define the shape and extent of tritium contamination from the 618-11 burial ground.