TRITIUM PARTITIONING IN THE BIOSPHERE

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Tritium (T or ^3H), a radioactive isotope of hydrogen, is a low energy beta emitter (≈ β^- 5.7 keV) with a half-life of 12.32 years. Tritium is second only to carbon-14 as the largest radioactive by-product of nuclear activities, including both power production and nuclear weapons production and testing. In the environment ^3H rapidly oxidizes to form tritiated water (T_2O), making it extremely mobile and reactive in biological systems, integrating into numerous cycles of the biosphere. On the Savannah River Site (SRS), Aiken, SC, facilities have produced ^3H for thermonuclear weapons, discharging waste products into the ecosystem which over time resulted in localized contaminated groundwater. The NNSA Tritium Facility currently releases large amounts of ^3H into the atmosphere (e.g., ≈ 24,000 Ci in 2014) during processing to refuel the nuclear stockpile. Therefore, the SRS provides an ideal platform for evaluating the fate and transport of ^3H in the environment. At the SRS Mixed Waste Management Facility (MWMF), T_2O containing groundwater is intercepted before discharge to Four Mile Branch stream to form a collection pond, and then used to irrigate a forested watershed in a manner designed to maximize evapotranspiration, reducing ^3H levels in the stream and the Savannah River. When taken up by plants, T_2O may remain as free tissue water tritium (FTWT), or become organically bound tritium (OBT) in plant tissue through photosynthesis. FTWT is rapidly evapo-transpired, with a relatively short biological half-life, while OBT may persist and remain within the food chain, providing a long-term potential source for exposure. Thus, the objective of our study was to assess ^3H partitioning to the FTWT and OBT fractions at the MWMF and a control site. A variety of samples (i.e., irrigation water, soil, plant tissues, detritus, etc.) were collected and extracted using protocols that differentiate FTWT (i.e., lyophilization) from OBT (i.e., oxidative combustion of organic matter to form CO_2 and T_2O). Results showed that FTWT ^3H levels at the MWMF were generally lower than that of the irrigation pond source, reflecting dilution associated with precipitation. Plant FTWT levels generally reflected levels present in the soil, which were quite variable depending on the timing and duration of MWMF irrigation events. Plant OBT levels did indicate partitioning to the organic fraction at levels more reflective of the long-term exposure history than current soil or FTWT levels. In contrast, samples from the control site displayed extremely low levels of both FTWT and OBT, despite the close proximity to the NNSA Tritium Facility, indicating limited potential for significant ^3H buildup associated with atmospheric releases.

Awmna in the lab.