Development of a Method for the Detection of Technetium-99 in Soil

J.B. Miller*; M. Laudeman; L. Miller; G. Schweitzer; T. Hatmaker

A better method has been developed for the separation and detection of technetium-99 in soils. This new technique uses fewer, less toxic chemicals; requires less time; and produces little liquid waste compared to previous methods. In addition, the process is technically simple and inexpensive.

A 1.00 g soil sample is leached with 20.0 ml of 10% sodium hypochlorite and centrifuged. The soil is then leached with another 20.0 ml of 10% sodium hypochlorite and centrifuged. The hypochlorite solutions are combined and treated with 10.0 ml of 30% hydrogen peroxide. This procedure promotes technetium in the soil to the plus seven oxidation state. When in the plus seven state, technetium forms a very stable and soluble ion, pertechnetate. After the peroxide treatment, the solution is evaporated at 80°C to decrease the volume. After this solution has cooled, a liquid/liquid extraction is performed with 10 ml of cyclohexanone. The pertechnetate ion forms a complex with cyclohexanone. Therefore, technetium in the aqueous phase is efficiently transferred to the cyclohexanone phase. Other beta emitters common in contaminated soil are not transferred to the cyclohexanone as efficiently, so the technetium has been effectively isolated. The cyclohexanone extraction is repeated twice to increase the total extraction efficiency. Total extraction efficiency with three extraction steps is greater than 99%. The sample can be counted using either gas proportional counting or liquid scintillation counting. In either method, the total cyclohexanone volume is involved in the counting. It is either mixed with scintillation cocktail and counted or evaporated to dryness on a planchet and counted. Work at the University of Tennessee, with a liquid scintillation counter, yielded a method efficiency of 93±2%. Reproducibility errors were below ±5%. Work at the Oak Ridge Institute of Science and Education Energy/Environment Systems Division (ORISE EESD), with a gas proportional counter, yielded a method efficiency of 97%. Gas proportional counting is the preferred detection method because it does not result in liquid mixed waste, as liquid scintillation counting does. Detection limits are controlled by the counting system used and could easily approach 1 pCi/g.