METHODS AND RESULTS OF $^{99}$Tc ANALYSIS OF NEVADA TEST SITE GROUNDWATERS

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Samples of the long-lived fission product $^{99}$Tc were isolated from liter quantities of selected groundwaters from the Cheshire, Billby, Nash, Bourbon, Cambirc and Faultless event sites and the $^{99}$Tc concentrations determined by liquid scintillation counting. Although $^{99}$Tc was detected in several of the samples, the concentrations did not exceed the MPC$_{w}$ of $3 \times 10^{-6}$ $\mu$Ci/ml and the results indicated that the Tc was present primarily in solution rather than sorbed on colloidal-size material.

Introduction

Technetium-99 is produced in the nuclear fission process and thus is present in both spent nuclear reactor fuel and nuclear test debris. It is a low energy beta emitter with a maximum energy of 292 keV and a half-life of $2.13 \pm 0.05 \times 10^{5}$ years$^{1}$. ISHERWOOD$^{2,3}$ has used the EQ3/6 Geochemical Computer Code to predict the chemical speciation and solubility of Tc under groundwater conditions. Since the Nevada Site groundwaters tend to be oxidizing (Eh $> 250$ mv) and have pH values between 7 and 9$^{4,5}$, $\text{TcO}_4^-$ was predicted to be the major solution species in these waters and technetium concentrations would not be limited by solubility. Technetium should be present in some of the Nevada Test Site (NTS) water samples$^{2,3}$. Laboratory measurements conducted under oxidizing conditions indicate Tc is not sorbed to any extent in crushed rock samples from the NTS$^{6,7}$. Thus, one would expect Tc to be rather mobile in the environment and to follow tritium rather closely in its migration behavior. Because of the

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long half-life and its high solubility and low sorptive properties under oxidizing conditions, Tc-99 is considered a potential hazard if released to environmental waters.

Experimental

Because there are no gamma-rays emitted in the decay of Tc-99, low-level gamma spectroscopy methods could not be applied. Since beta counting techniques are not as specific or sensitive as the gamma-ray methods, a chemical isolation and concentration of the Tc-99 was needed for reliable analyses.

Materials

One to four liter portions of archived NTS water samples were used in this work. All reagents used were of analytical grade and solutions were made up with distilled, deionized water. The anion resin was obtained from Bio-rad Laboratories of Berkeley, California.

The Tc-99 standard used to calibrate the liquid scintillation counter and test the separation procedures was obtained from and certified by the U.S. National Bureau of Standards (Standard Reference Material 4288). A beta energy spectrum obtained with the liquid scintillation counter from an aliquot of the stock solution is shown in Figure 1. The Tc-99 was counted with a 90.7 ± 1.2% efficiency.

The Tc-95m (T½ = 61d) used for chemical yield determinations was produced through the irradiation of a 0.003-inch thick niobium foil with 30-MeV alpha particles at the Lawrence Berkeley Laboratory's 88-inch cyclotron. After dissolution of the foil in 5-mL of a mixture of 27M HF and 1M HNO₃, the solution was diluted to 100-mL, a stoichiometric amount of H₂BO₃ was added to complex the fluoride ion, and the solution processed