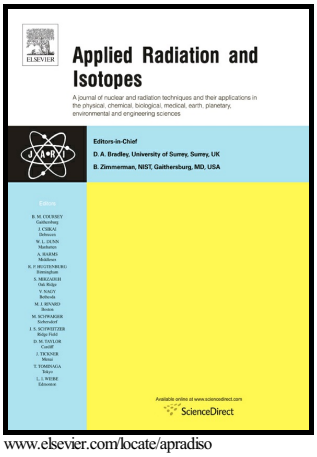

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Abstract

Tritium (^{3}H) in natural waters is a powerful tracer of hydrological processes, but its low concentrations require electrolytic enrichment before precise measurements can be made with a liquid scintillation counter. Here, we describe a newly developed, compact tritium enrichment unit which can be used to enrich up to 2 L of a water sample. This allows a high enrichment factor (>100) for measuring low ^{3}H contents of < 0.05 TU. The TEU uses a small cell (250 mL) with automated re-filling and a CO_2 bubbling technique to neutralize the high alkalinity of enriched samples. The enriched residual sample is retrieved from the cell under vacuum by cryogenic distillation at -20 °C and the tritium enrichment factor for each sample is accurately determined by measuring pre- and post- enrichment ^{2}H concentrations with laser spectrometry.

Keywords: Environmental tritium, tritium enrichment, electrolytic enrichment, deuterium enrichment, tritium enrichment unit/system

1. Introduction

Tritium (^{3}H), a low-energy beta emitter (E_{max}=18.6 keV) with a half-life of 4500 days (Lucas and Unterweger, 2000), is a valuable radioactive tracer for hydrological investigations (Kaufman and Libby, 1954; Buttlar and Libby, 1955; Cameron and Payne, 1965). Tritium activities are typically reported in terms of Tritium Units (TU) where 1TU = 10^{-18} ^{3}H/H or 7.19192 disintegration per minute (dpm) per 1 kg (~1L) of water. ^{3}H is naturally formed in the upper atmosphere by interactions of cosmic radiation with gaseous components (Kaufman and Libby, 1954). .

Atmospheric thermo-nuclear weapons tests in the 1960s added much higher quantities of ^{3}H to the global natural inventory (Kaufman and Libby, 1954; Buttlar and Libby, 1955;