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Cosmogenic Production of 3He During Low-Level Tritium Measurements by 3He-ingrowth

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Tritium (^{3}H) is a widely used environmental tracers for dating in aquatic systems. Since about 1990 in the Southern Hemisphere and about 2000 in the Northern Hemisphere average annual ^{3}H values in precipitation have been relatively stable resulting in the possibility of high-resolution dating of young water. The resolution of this dating method will ultimately depend on the ^{3}H detection limits. In concept, ultra-low ^{3}H detection limits (mTU) are possible using the ^{3}He-ingrowth method in part because one can substitute time for a dearth of ^{3}H atoms. During the in-growth period ^{3}He can be produced by (1) the decay of ^{3}H, (2) direct cosmogenic production, (3) direct cosmogenic production of ^{3}H that then decays to ^{3}He, and (4) leakage and/or residual ^{3}He in the flask. Traditionally, cosmogenic production has been considered to be negligible with on a few estimates of the production available. We have measured the production of ^{3}He in metal storage flasks filled with very low ^{3}H water for periods up to 2400 days and at elevations ranging from 1500 to 3300 m. At the elevation of our laboratory (1500 m) at 40 ËšN latitude the cosmogenic production of ^{3}He in a stainless steel storage flask is 0.77 ± 0.04 atoms/g/day. For a typical water sample of 500 g and a holding time of 60 days this is over 23,000 atoms which is more than 10X our typical leakage amount. This is equivalent to an apparent ^{3}H value of 75 mTU for this in-growth period. The cosmogenic production of ^{3}He at an elevation of 3300 m is about 2.8X higher than in our laboratory which is consistent with cosmic ray attenuation as a function of atmospheric pressure and consistent with the results of Brown et al. (2000). This suggests a sea-level production rate of 0.27 ± 0.02 atoms/g/day. The direct production of ^{3}H appears to be small (about 1 mTU in 1 year in our lab). Implications of these results to low-level ^{3}H studies and the potential use of water-filled flasks as a cosmogenic production gauge will be discussed.