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An improved method for determination of ^{7}Be in mosses

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Abstract We have measured ^{7}Be activity in moss samples collected from in and around Mumbai, India. The use of heavily shielded Compton suppressor system is more efficient than the conventional gamma spectroscopic system for detection of ^{7}Be. The ^{7}Be accumulation capacities of mosses are more than other plant samples. Therefore monitoring of young moss samples by Compton suppressor system is an excellent tool for determination of atmospheric fallout of ^{7}Be. A positive bias in the high altitude samples has been observed which might be due to any of the two reasons (i) higher cosmic ray flux in the high altitude or (ii) high pollution in the lower altitude area ultimately inhibits uptake of ^{7}Be.

Keywords ^{7}Be · Compton suppressor system · Gamma-spectroscopy · Moss bio-monitoring

Introduction

Cosmogenic radionuclides such as ^{7}Be ($T_{1/2} = 53.22$ days) [1] ^{10}Be ($T_{1/2} = 1.388$ million years) [2], ^{14}C ($T_{1/2} = 5730$ years) [1], ^{26}Al ($T_{1/2} = 0.716$ million years) [1] are continuously produced in the upper atmosphere by the interaction of solar cosmic rays or galactic cosmic rays penetrating from the space into the atmosphere. Analysis of these radionuclides in ultra-trace scale has strong influence in almost all branches of sciences, starting from archaeology to biology, nuclear physics to astrophysics. Two beryllium isotopes ^{7}Be and ^{10}Be are produced by spallation reaction between cosmic rays and nuclei of ^{16}O and ^{14}N in the stratosphere and upper troposphere [3, 4]. Annual production rate of ^{10}Be is 4×10^{-2} atoms/(cm^2 s). Newborn ^{7}Be and ^{10}Be atoms get readily attached to the ambient aerosols and are transported and deposited to the Earth via wet and dry deposition. Owing to its long half-life, the measurement of ^{10}Be in natural archives may reveal several scientific aspects over a geological time-scale. ^{10}Be is extensively used in exposure-dating applications, measurement of oceanic sedimentation rates over a period of millions of years, etc. [5], while the short-lived ^{7}Be is used as a tracer in tracking of atmospheric paths and deposition ways of atmospheric micro-particles [4]. Oceanographers also use the cosmogenic ^{7}Be as a tracer to study the air-sea interaction and water mass mixing input [6]. Variation of ^{7}Be production gives a measure of variation in cosmic rays flux in the Earth atmosphere [7]. Concentrations of both ^{7}Be and ^{10}Be in natural samples are scanty and are extremely difficult to measure. To measure tiny amount of ^{10}Be, one cannot rely on the decay of this long-lived radionuclide as in the experimental time period only a small fragment of the sample is decayed; therefore, statistically significant result cannot be obtained. The mass measurement is much more precise and sensitive compared to decay counting because in mass measurement, every individual atom is counted. Therefore, accelerator mass spectrometry is the only ultra sensitive technique to measure ^{10}Be radionuclides [8–10]. On the other hand, ^{7}Be is short-lived and therefore attempt has been made to measure its concentration in natural samples by measuring the intensity of its 477.6 keV photo peak. However, due to extreme low statistics, a large volume of sample and

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