THE DETERMINATION OF $^{210}\text{Pb}$ AND $^{210}\text{Po}$ IN BIOLOGICAL AND ENVIRONMENTAL MATERIALS

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The naturally-occurring radionuclides, $^{210}\text{Pb}$ and $^{210}\text{Po}$ (22 y and 138.4 d half-lives, respectively), are important for their contributions to the natural radiation dose in the environment and from technologically-enhanced sources. A description is presented of the methods for the analysis of these nuclides in which the samples are ashed at low temperature by wet ashing or with atomic oxygen (low-temperature asher). The method uses plating of the Po at two different times onto silver disks which are then counted. The polonium daughter is used to determine both the $^{210}\text{Pb}$ and $^{210}\text{Po}$ using the Bateman equations for radioactive growth and decay. The tracer and non-tracer methods are compared for efficiency.

Introduction

The naturally-occurring radionuclides, $^{210}\text{Pb}$ and $^{210}\text{Po}$ (22 y and 138.4 d half-lives, respectively), are important for their contributions to the natural radiation dose in the environment and from technologically-enhanced sources, such as uranium and phosphate mining and milling operations. They are of particular interest because they contribute a substantial fraction of the dose from natural sources.¹ Recent studies of radon in houses has increased interest in these nuclides as the long-lived decay products, which may be used to estimate the exposure to $^{222}\text{Rn}$ from measurements on body content and excretion rates, in addition to the doses contributed by these nuclides, themselves. Studies of $^{210}\text{Pb}$ metabolism have been used for estimating parameters of lead metabolism in animals and man.²

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Analytical methods

Lead-210 has been determined from its 47-keV gamma ray directly, both in vivo and in chemical samples. With the proper equipment and sufficient activities, this method is useful because it is simple to use, it can be used to determine the \(^{210}\text{Pb}\) content in vivo and in environmental samples under certain conditions. However, normally it can be used only to determine \(^{210}\text{Pb}\) and not \(^{210}\text{Po}\), unless the ratios of the nuclides are known, such as those in old samples (> 1 yr). The disadvantage is that it requires a gamma spectrometer with special calibrations because of the low energy of the gamma ray. For in vivo measurements, it is particularly useful where the \(^{210}\text{Pb}\) is near the surface.

The most common modes of analyses are the indirect ones from the activities of the decay products, either from the 5-day half-life daughter, \(^{210}\text{Bi}\), with a 1-MeV beta particle, or the 138.4-day half-life \(^{210}\text{Po}\), which emits a 5.3-MeV alpha particle. The \(^{210}\text{Bi}\) is used to determine both the \(^{210}\text{Bi}\), itself, and the \(^{210}\text{Pb}\). The \(^{210}\text{Bi}\) grows in from the parent \(^{210}\text{Pb}\), it is separated, and the beta particle is counted. The relatively short half life of this nuclide makes analysis of the \(^{210}\text{Pb}\) relatively faster than some other methods, and the high-energy beta particle is easy to detect. The disadvantage is that beta counter backgrounds are usually substantially greater than those of alpha counters, with poorer detection limits.

The principal method of analysis in our laboratory was the more sensitive separation of the Po by spontaneous replacement deposition, and counting of the Po alpha particle. After removal