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Americium-241 in peat bogs as a marker of the beginning of the Anthropocene: examples from Europe and North America.

Andrii Oleksandrenko[1], Peter Appleby[2], Tommy Noernberg[1], and William Shotyk[1]
[1]Department of Renewable Resources, University of Alberta, Edmonton, Alberta, Canada
[2]Department of Mathematical Sciences, University of Liverpool, Liverpool, UK

Americium-241 (^{241}Am) is present in the terrestrial and aquatic environment around the globe as a result of the atmospheric testing of high yield thermonuclear weapons carried out mainly in the 1950s and 1960s. Radioactive debris (including mainly ^{137}Cs, ^{90}Sr, and various Pu isotopes) from the tests was injected high into the stratosphere where it was rapidly dispersed around the world. Over a period of months this material slowly returned to the troposphere, and from there was quickly removed by wet and dry fallout onto the earth's surface. Amounts of ^{241}Am in freshly deposited weapons test debris were essentially zero. Its presence today is through in-growth from its short-lived precursor ^{241}Pu (half-life 14.4 years). By this process concentrations of ^{241}Am have steadily increased with time and will continue to do so through to around 2040. Widely considered to be immobile in soils and sediments, with its well-known origins and long half-life (432 years), ^{241}Am is in many ways an ideal chronostratigraphic marker of the nuclear age. Calculations show that the ^{241}Am record in any ideal natural archive is a faithful representation of the history of weapons test fallout. Beginning in the early 1950s, fallout reached a peak in 1963 and then declined rapidly following the implementation of the test ban treaty. A number of scientists have proposed that the weapons test fallout peak could be used to mark the start of the Anthropocene. Various geological archives preserve the record of fallout, though with varying degrees of fidelity. They include polar snow and ice, marine and lacustrine sediments, and peat bogs. Bogs are ombrotrophic peatlands in that the plants growing there receive nutrients and contaminants exclusively from the atmosphere. The purpose of this study is to determine the fidelity of ^{241}Am records in peat bog cores.
Specifically, we compare the position of the ^{241}Am concentration peak with the 1963 depth determined by ^{210}Pb dating. We use 39 peat cores from Europe, North America, and Indonesia collected by our team during the past 30 years for studies of atmospheric deposition of trace metals, all of which had been independently dated using ^{210}Pb. We find that 18 of the cores provide an excellent agreement between the ^{241}Am and ^{210}Pb dates, 12 were in good agreement, and 9 agreed poorly. Possible reasons for the discrepancy in the 9 cores with the poor agreement are 1) the sensitivity of the gamma spectrometer for detecting ^{241}Am, and 2) disruptions to the fallout records caused e.g. by disturbances to the peat bog or changes in the peat topography or hydrology. Small scale horizontal and vertical variations in bogs help explain why in a triplicate of peat cores collected from Wildseemoor in the Black Forest of Germany, excellent agreement was

found in one core, good agreement in a second, and poor agreement in the third. A peat core collected from Gola di Lago, a small fen in Switzerland, showed excellent agreement; this suggests that samples from minerotrophic peatlands may also be useful to mark the start of the Anthropocene.