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A fast semi-quantitative method for Plutonium determination in an alpine firn/ice core

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Plutonium is present in the environment as a consequence of atmospheric nuclear tests carried out in the 1960s, nuclear weapons production and releases by the nuclear industry over the past 50 years. Plutonium, unlike uranium, is essentially anthropogenic and it was first produced and isolated in 1940 by deuteron bombardment of uranium in the cyclotron of Berkeley University. It exists in five main isotopes, ^{238}Pu, ^{239}Pu, ^{240}Pu, ^{241}Pu, ^{242}Pu, derived from civilian and military sources (weapons production and detonation, nuclear reactors, nuclear accidents). In the environment, ^{239}Pu is the most abundant isotope. Approximately 6 tons of ^{239}Pu have been released into the environment as a result of 541 atmospheric weapon tests

Nuclear Pu fallout has been studied in various environmental archives, such as sediments, soil and herbarium grass. Mid-latitude ice cores have been studied as well, on Mont Blanc, the Western Alps and on Belukha Glacier, Siberian Altai.

We present a Pu record obtained by analyzing 52 discrete samples of an alpine firn/ice core from Colle Gnifetti (M. Rosa, 4450 m a.s.l.), dating from 1945 to 1991. The^{239}Pu signal was recorded directly, without preliminary cleaning or preconcentration steps, using an ICP-SFMS (*Thermo Element2*) equipped with a desolvation system (*APEX*). ^{238}UH^{+} interferences were negligible for U concentrations lower than 50 ppt as verified both in spiked fresh snow and pre-1940 ice samples.

The shape of ^{239}Pu profile reflects the three main periods of atmospheric nuclear weapons testing: the earliest peak starts in 1954/55 to 1958 and includes the first testing period which reached a maximum in 1958. Despite a temporary halt in testing in 1959/60, the Pu concentration decreased only by half with respect to the 1958 peak. In 1961/62 Pu concentrations rapidly increased reaching a maximum in 1963, which was about 40% more intense than the 1958 peak. After the sign of the "*Limited Test Ban Treaty*" between USA and URSS in 1964, Pu deposition decreased very sharply reaching a minimum in 1967. The third period (1967-1975) is characterized by irregular Pu profiles with smaller peaks (about 20-30% compared to the 1964 peak) which could be due to French and Chinese tests.

Comparison with the Pu profiles obtained from the Col du Dome and Belukha ice cores by AMS (Accelerator Mass Spectrometry) shows very good agreement. Considering the semi-quantitative method and the analytical uncertainty, the results are also quantitatively comparable. However, the Pu concentrations at Colle Gnifetti are normally 2-3 times greater than in Col du Dome. This could be explained by different air mass transport or, more likely, different accumulation rates at each site.