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Characterizing the main sources of radiocesium using 135Cs/137Cs ratio

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Several decades after the releases, man-made 137Cs still occurs in both the terrestrial and aquatic environments. Such a persistance is not only due to the radioactive period of this radionuclide (half-life = 30.08 y), but also to its strong retention by the clay minerals which makes radiocesium ubiquoulsy present in both the soils and the sediments. While the isotopic signatures of the actinides (e.g., uranium and plutonium) have been used successfully to distinguish the contributions of various sources of nuclides, radiocesium isotopic fingerprint has not yet been applied routinely for source identification. In the current work it is assumed that each anthropogenic source of 137Cs is characterized by a specific 135Cs/137Cs ratio and thereby this latter can be used in the frame of the environmental monitoring programs or the studies of the transfer in the environment.

Thus the present work aims at determining the cesium isotopes ratios in some environmental samples representative of the main sources of 137Cs. The determination of the signatures of the main sources is of primary importance since they constitute the end-members of the mixing equation used to determine the proportion of each source.

Before any environmental analysis, a selective radiochemical protocol to separate Cs fraction from the environmental samples (such as soils and sediments) and an innovative ICP-MS/MS method for the 135Cs/137Cs ratio measurement have been developed.

Then radiocesium isotopes emmited in the atmosphere by the former nuclear weapons tests and the Chernobyl accident were characterized in the soils and the sediments taken in the central part of the Pyrenees (135Cs/137Cs = 4.29 decay corrected to 2022) and in the south of the Alps (135Cs/137Cs = 0.66) respectively, assuming a long range transport of radioactive contaminations in the atmosphere before deposition with rain/snow on the both studied areas. An attempt is also made to characterize a third source, namely radiocesium isotopes routinely released by the nuclear industry by analysing sediments and aquatic vegetals taken in the Rhine river which hosts four nuclear power plants, even if two of them are now shut-down.