Monitoring of environmental samples from the vicinity of a decommissioning nuclear power plant in Italy

M. De Cesare,[1,2] L.K. Fifield,[1] S.G. Tims,[1] N. De Cesare,[2,3] A. D'Onofrio,[2,3]
A.M. Esposito,[4] A. Petraglia,[2] V. Roca,[5,3] C. Sabbarese,[2,3] and F. Terrasi[2,3]

[1]*Department of Nuclear Physics, The Australian National University, ACT 0200, Australia*
[2]*CIRCE, INNOVA, and Dipartimento di Matematica e Fisica,*
Seconda Univesità di Napoli, Caserta 81100, Italy
[3]*INFN Sezione di Napoli, Napoli 80100, Italy*
[4]*Società Gestione Impianti Nucleari - SoGIN, Roma 00100, Italy*
[5]*Dipartimento di Fisica, Università di Napoli, Napoli 80100, Italy*

Italy built and commissioned 4 nuclear power plants between 1958-1978, which delivered a total of 1500 MW. All four were closed down after the Chernobyl accident following a referendum in 1987. One of the plants was Garigliano, commissioned in 1959. This plant used a 160 MW BWR and was operational from 1964 to 1979, when it was switched off for maintenance. It was definitively stopped in 1982, and is presently being decommissioned. The work reported here was motivated by the desire to lower the level of risk perception by the surrounding population by (hopefully) showing that the cumulative effect of the operation and decommissioning of the plant on the nearby environment has been negligible. In addition, measurements on structural samples from the plant itself, which are underway, are relevant for the optimization of the decommissioning programme.

The Center for Isotopic Research on Cultural and Environmental heritage (CIRCE) [1], recently upgrated for actinides measurements [2–4], in Caserta, Italy, and the Australian National University (ANU) [5] in collaboration with SoGIN (Nuclear Plant Management Company) started a research program for measuring the concentration and isotopic ratios of U and ^{x}Pu isotopes in and around the Garigliano Nuclear Power Plant (GNPP). The measurements employed AMS, and were applied to the analysis of both environmental and structural samples to quantify and determine the origin of any U or ^{x}Pu. In this report we present results on environmental samples, collected up to 4.5 km from the plant.

The ^{236}U and ^{x}Pu environmental concentrations as well as the ^{240}Pu/^{239}Pu, ^{236}U/^{238}U and ^{236}U/^{239}Pu ratios are consistent with global fallout from the nuclear testing era, i.e. the values are of the same order as a sample from the Sele plain, Salerno province, which is geologically similar but is 130 km from the GNPP. We see no evidence for any contribution from the Nuclear Plant. Changes in the ^{236}U and ^{x}Pu concentrations from site to site around the GNPP are reflected in the ^{137}Cs. The ^{137}Cs/$^{239+240}$Pu activity ratios vary, however, between 40 and 160, which are higher than in the global fallout from the nuclear testing era. It is likely that this variability reflects the influence of Chernobyl, since the fallout from Chernobyl contained appreciable ^{137}Cs but negligible ^{x}Pu or ^{236}U [6]. Differences between sites in soil loss during the period from the 1960s (global fallout from nuclear testing) until 1986 (Chernobyl) could then account for the differences in ^{137}Cs/$^{239+240}$Pu ratios. These studies, like [6–8], demonstrate that ^{236}U and ^{x}Pu isotopes are equally useful as sensitive fingerprints of releases from nuclear facilities.

[1] F. Terrasi *et al.*, Nucl. Instr. and Meth. in Phys. Res. B **259**, 14 (2007).
[2] M. De Cesare *et al.*, Nucl. Instr. and Meth. in Phys. Res. B **268**, 779 (2010).
[3] M. De Cesare *et al.*, Radiocarbon **52 (Nr 2-3)**, 286-294 (2010).
[4] M. De Cesare, Nuclear Power - Control: Reliability and Human Factors, ISBN 978-953-307-599-0, 2011.
[5] L.K. Fifield *et al.*, Nucl. Instr. and Meth. in Phys. Res. B **117**, 295 (1996).
[6] F. Quinto *et al.*, Appl. Rad. Isot. **67**, 1775 (2009).
[7] L.K. Fifield, Quaternary Geochronology **3**, 276 (2008).
[8] A. Sakaguchi *et al*, Science of the Total Environment **407**, 4238 (2009)