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$^{233}$U/$^{236}$U – A new tracer for environmental processes?

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Apart from the production of $^{236}$U by fast neutrons in thermonuclear weapons via the reaction $^{238}$U(n,$3n$)$^{236}$U, $^{236}$U can be also produced in nuclear power plants and fission bombs via $^{235}$U(n,$\gamma$)$^{236}$U using thermal neutrons. In contrast, the principle production path for $^{233}$U is via the reaction $^{235}$U(n,$3n$)$^{233}$U, which requires fast neutrons with energies above 13 MeV (Gorbatchev et al., 1980). Therefore, an increased production can be expected in thermonuclear weapons using Oralloy (uranium enriched in $^{235}$U) as blanket or tamper. Consequently, in average, fallout from nuclear weapons testings should show a higher $^{233}$U/$^{236}$U ratio than emissions from thermal nuclear power plants or reprocessing plants which allows source identification for contaminations present in the environment.

However, the cross section of the reaction $^{235}$U(n,$3n$)$^{233}$U for 14 MeV neutrons is only about 0.1 barn, as shown in Figure 1. As there is only little experimental data available for the cross-section of this reaction and the utilization of Oralloy is not readily accessible for all nuclear devices which exploded during the period of atmospheric testing, the $^{233}$U fallout from thermonuclear weapons can be only roughly estimated to be around one to two orders of magnitude smaller than $^{236}$U fallout. Consequently, neglecting n capture on $^{232}$Th in rocks and local contaminations from the $^{232}$Th fuel cycle, the environmental concentrations of $^{233}$U can be expected to be extremely low, so that its detection is challenging also for the highly sensitive Accelerator Mass Spectrometry (AMS).

After an introduction to possible production paths of $^{233}$U and $^{236}$U, respectively, first results of the $^{235}$U/$^{236}$U ratio detected in samples from the different environmental reservoirs named before will be presented in this talk and the interpretation of the data will be discussed.

EXFOR/ENDF database, 2016
www-nds.iaea.org/exfor/servlet/X4sMakeX4