On the tracks of man-made radionuclides in the Indonesian Throughflow sediments

Daniela Pittauerová[1,2], Stephan Steinke[1] & Helmut Fischer[2]

[1]MARUM – Center for Marine Environmental Sciences, University of Bremen, [2]Institute of Environmental Physics, University of Bremen

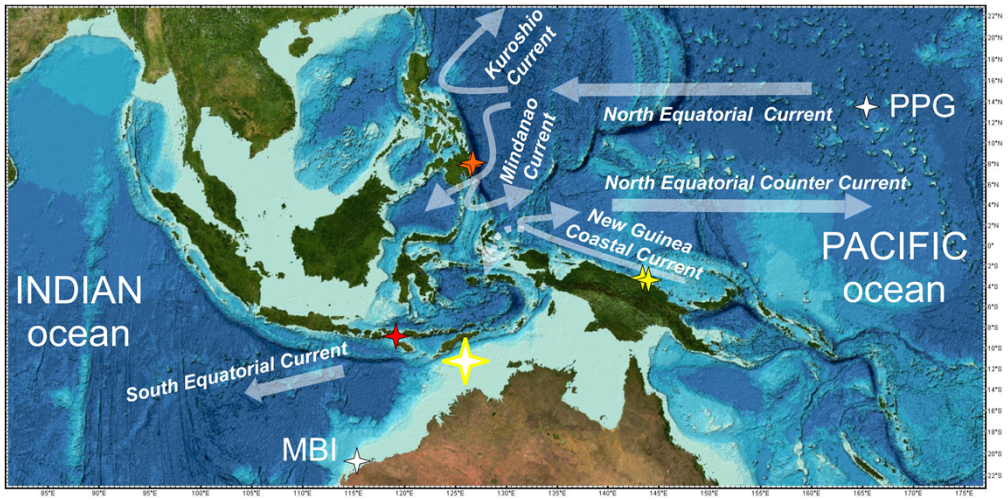

Fig. 1: Map of the study area. PPG = Pacific Proving Grounds, MBI = Monte Bello Islands.

- Indonesian Throughflow (ITF): a complex array of passages within the Indonesian archipelago and a pathway for radionuclide transport along with the water masses between the Pacific and the Indian Ocean.
- Natural and man-made radionuclides were studied in the ITF sediment cores off Indonesian island of Sumba as chronometers to cover the Anthropocene and to provide a combined age model together with radiocarbon in order to support paleoclimate interpretations[1].

Sediment site GeoB 10065

- Non-destructive gamma spectrometry was used for analyzing natural and anthropogenic radionuclides in sediment cores
- Summing spectra of 4-5 following individual samples allowed improving of counting statistics (Fig. 2)
- In individual spectra ^{137}Cs was below decision threshold, it could be quantified in summed up intervals (Fig. 2, 3)
- Unusually high concentrations of ^{241}Am were observed (Fig. 3)

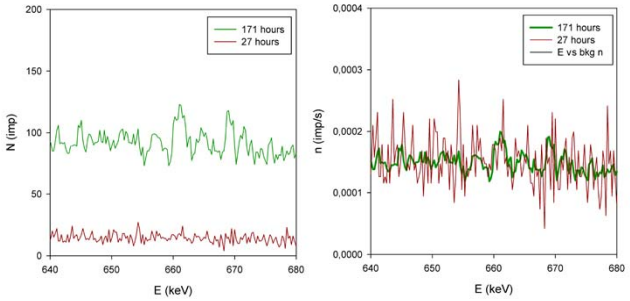

Fig. 2: Close-up of gamma spectra in the area of 662 keV (^{137}Cs) before (red) and after (green) summing

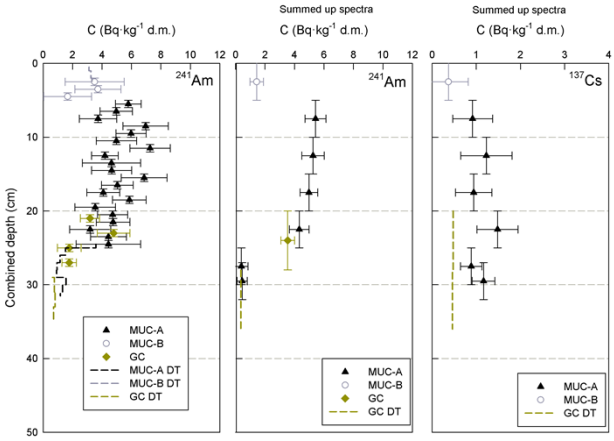

Fig. 3: Left: Depth profile of ^{241}Am. Center and right: depth profiles of ^{241}Am and ^{137}Cs based on summed up intervals.

Sources of artificial radionuclides

- The ^{241}Am/^{137}Cs ratios do not correspond to the global fallout signature (expected value: 0.01)

^{241}Am	141 ± 14 Bq·m^2
^{137}Cs	55 ± 10 Bq·m^2
^{241}Am / ^{137}Cs	2.6 ± 0.6

- High ^{241}Am/^{137}Cs ratios in sediments were found within 800 km range of the Pacific proving grounds (PPG), however these decreased significantly below 1 in more distant locations in the NW Pacific[2]
- Possible regional radionuclide contributions:
  - U.S. tests performed at the Pacific Proving Grounds (1946-62)
  - British bomb tests at Australian Monte Bello Islands (1952-56)
  - the SNAP-9A satellite carrying plutonium batteries burnt in the atmosphere (1964)
  - others?
- Each of these sources has an unique isotopic fingerprint

Outlook

- Contributions of individual sources preserved in the sediment archives will be studied at several ITF locations:
  - the North Pacific inflow portal (the effect of the PPG is expected to be the strongest)
  - the South Pacific inflow portal (the global fallout should dominate)
  - Timor Sea shelf and slope
- Gamma spectrometry: ^{241}Am, ^{137}Cs
- Alpha spectrometry: ^{238}Pu, ^{239,240}Pu
- Mass spectrometric methods (AMS, ICP-MS): ^{240}Pu/^{239}Pu, ^{241}Pu

- **Global nuclear weapon fallout:** The testing of nuclear weapons in the atmosphere between 1945 and 1980 (with maximum in 1963) was the most significant source of artificial radionuclides in the environment.
- **^{137}Cs:** A major fission product and one of the long lived nuclear fallout radioisotopes (half-life of 30 years) is easily detectable by non-destructive gamma spectrometry.
- **^{241}Am:** A less common nuclear fallout radioisotope (half-life of 432 years), present usually as a decay product of ^{241}Pu, which is formed during a nuclear explosion by neutron activation.

REFERENCES:
[1] Steinke et al., 2014. Quaternary Science Reviews, vol. 93, pp. 142-154.
[2] Moon, D.-S. et al., 2003. Deep Sea Research Part II: Topical Studies in Oceanography, 50: 2649-2673.