Recent survey of plutonium at the Montebello Islands nuclear test sites: uptake in marine and terrestrial organisms in a radioactive-particle environment

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Abstract:

The plutonium (Pu) residues from the former nuclear weapons tests at the Montebello Islands, Australia, provide unique opportunities for radioecological science. The area has important ecological and conservation values and supports marine and terrestrial threatened species. Local fallout from the 1950s tests left a legacy of fission products and actinides, often in the form of radioactive particles. Plutonium is pervasive and persistent at the sites. Of the nuclear test residues, it remains the primary exposure hazard to wildlife, human visitors and researchers. The highest ^{total}Pu measurement in soil found by our limited 2015 sampling (25,050 Bq kg^{-1}) is well above post-cleanup levels at Maralinga and international benchmarks (e.g. the 100 Bq kg^{-1} IAEA benchmark for the release of material to the public).

Other residual radionuclides are present and generally rank (highest-to-lowest activity concentrations): ^{total}Pu > ^{137}Cs > ^{90}Sr > ^{241}Am > ^{152}Eu > ^{total}U > ^{230}Th > ^{60}Co although some local variation exists. Across ecological zones, radionuclide levels generally rank: island soils > dunes > beach above high tide (turtle nesting zones) > sea sediments > and intertidal zone. The intertidal beach is the least contaminated zone as many of the radionuclides have been washed into the nearby waters and sea sediments by daily waves as well as frequent storms. However, higher activity concentrations occur below the surface sands, with the maximum occurring at ~1 m at Burgundy Bay beach near the Mosaic G2 test site.

At the ground-zero areas, gamma dose rates have reduced by about 100-fold since 1962 due to the depletion of short-lived neutron activation products. The gamma emissions are easily detected by hand-held devices. Away from these areas, the Pu, in particular, is persistent but is not readily detectable in the field. The use of hand-held detectors or radiation badges alone does not effectively detect the Pu, ^{90}Sr, and other key radionuclides, and therefore may provide a false sense of security to researchers and island visitors.

Radionuclide activity concentrations were measured for representative ecological organisms including: algae, oysters, sea cucumbers, crabs, stingrays, fish, and sea turtles. The Pu isotopic signatures from the three tests are distinct from each other, and from world-wide fallout. These signatures could aid in determining local vs regional occupancy and may be useful, along with stable isotopes and other markers, in migration and habitat usage studies for turtles and other species.