Radionuclides in glacier mice and cryoconite on Icelandic glaciers

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Glacier mice are ovoid-shaped conglomerates of bryophytes and mineral particles rarely found on glacier surfaces. They form colonies, host diverse communities of organisms, and exhibit the ability to move across the glacier surface. Their movement appears non-random and displays herd-like behaviour. In addition to glacier mice, cryoconite is also found on glacier surfaces as a dark, biogenic granular sediment. It is composed of minerals and organic matter that accumulate at the bottoms of cryoconite holes.

This study presents the first comprehensive investigation of radionuclide occurrence (^{137}Cs, ^{210}Pb, ^{238,239,240}Pu, ^{241}Am) in glacier mice and cryoconite debris on Icelandic glaciers. Ongoing research indicates that glacier surfaces host dynamic ecosystems capable of capturing and processing airborne contaminants. However, glacier mice appear to be less efficient than cryoconite in the bioaccumulation of inorganic pollutants. The objectives of this study are: (a) to determine and compare radionuclide concentrations in glacier mice and cryoconite, and (b) to identify the sources of nuclear contamination in the investigated samples using mass and activity ratios (^{240}Pu/^{239}Pu, ^{238}Pu/$^{239+240}$Pu, and ^{241}Am/$^{239+240}$Pu). Radionuclide analysis was conducted using alpha and gamma spectrometry, and mass ratios were determined using the Agilent 8900 ICP-MS/MS.

We found that glacier mice are characterised by radionuclide activity concentrations (^{137}Cs, ^{210}Pb and ^{241}Am) that are slightly lower than those in cryoconite, except for plutonium isotopes. Additionally, radionuclide contamination in the studied samples exceeds values previously published for Iceland. The high variability of cryoconite radioactivity among the studied glaciers can be attributed to differences in the exposure times of cryoconite granules to meltwater and fallout radionuclides. An interesting finding of our study is the elevated levels of $^{239+240}$Pu in the analyzed samples compared to other samples from Iceland — a phenomenon of currently unknown origin. Moreover, the plutonium and americium signatures in the Icelandic samples show consistent values, primarily attributed to global fallout.

The results confirm that cryoconite and glacier mice affect cycling of pollutants derived from long-range transport in proglacial ecosystems in Iceland, although likely only on a very limited scale.