The widespread presence of fallout radionuclides in cryoconite: an anthropogenic legacy and emerging issue

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What is cryoconite?

- A sediment found on the surface of glaciers containing both organic and inorganic material (biological matter, mineral material, black carbon, and a range of contaminants).

- It contributes to darkening of the ice surface (albedo) and enhances melting.

- Cryoconite holes are known hotspots of biodiversity, including microbial life.

- Shown to be an efficient accumulator of carbon and nitrogen, and now FRNs.
About the study

- Glaciers are stores for materials deposited onto the ice surface, including pollutants such as fallout radionuclides (FRNs), a product of nuclear events/accidents.

- The interaction of meltwater and cryoconite offers an opportunity for hyper-accumulation of contaminants.

- To investigate the spatial extent of FRNs and whether they are present at potentially harmful levels, we are developing a collaborative database to improve understanding of contaminant storage and release from glacier catchments across the global cryosphere.
Lead (Pb-210) – *natural FRN*

- Excess (atmospherically-deposited) fraction of Pb-210 in cryoconite is one to two orders of magnitude higher than in lichens, mosses, and on moraines.

- Highest average value = 9791 Bq/kg (Isfallsglacïaren, Arctic Sweden).

- Highest single value = 14682 Bq/kg (Isfallsglacïaren, Arctic Sweden).
Caesium (Cs-137) – artificial FRN

- Large amounts deposited after Chernobyl. Some wild boar meat in Sweden still contains up to 10x more (16000 Bq/kg) than the legal limit (1500 Bq/kg).

- Highest average value = 3069 Bq/kg (Isfallsglaciaren, Arctic Sweden).

- Highest single value = 13558 Bq/kg (Morteratsch Glacier, Swiss Alps).
Amerimium (Am-241) – artificial FRN

- A more rarely-observed FRN. Increasing in the environment due to the decay of its parent nuclide (Pu-241).

- Highest average value = 30 Bq/kg (Morteratsch Glacier, Swiss Alps).

- Highest single value = 120 Bq/kg (Morteratsch Glacier, Swiss Alps).
Impacts?

• Hyper-accumulation of historical contaminants through interaction with snow, meltwater and cryoconite could result in secondary environmental contamination under future glacier melt and retreat.

• This may have consequences for water quality and uptake in the food chain (e.g. reindeer in Sweden).

• The efficient accumulation of FRNs and other contaminants by cryoconite may offer opportunities for bio-remediation.

• An interdisciplinary approach is required to improve understanding of FRN accumulation and to assess potential environmental and socio-economic impacts.

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