



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

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Fallout radionuclides (FRNs), a product of nuclear accidents and weapons testing, are known environmental contaminants. Research into the legacy of events such as the 1986 Chernobyl disaster and the 2011 Fukushima nuclear meltdown has focussed on the impact on human and ecosystem health, however, recent studies are revealing that FRNs, among other environmental contaminants, are being stored within and released from glaciers following deposition onto the ice surface years or decades before the present day. Furthermore, the presence of FRNs within ice surface sediments, or cryoconite, is not confined to a limited geographical area. Indeed, our collective research reveals widespread incidence of FRNs in cryoconite across multiple sites in the Arctic (Sweden, Iceland, Greenland and Svalbard), the European Alps, the Caucasus, British Columbia, and Antarctica. The levels of some FRNs found in these sites are orders of magnitude higher than those detected in many other, non-glaciated environments, raising important questions around the role of glaciers, and specifically cryoconite and its interaction with meltwater, in concentrating levels of FRNs above those found in the surrounding environment. As FRNs are released into the proglacial environment through glacier melting and retreat they may act as a secondary source of environmental contamination many years after the nuclear event of their origin. Given the widespread occurrence of concentrated FRNs in glacier catchments, the impacts on downstream water and environmental quality, including uptake of FRNs into flora and fauna, should be a focus of future research efforts requiring an interdisciplinary approach.