Circulation in the Arctic and North Atlantic Oceans revealed by ^{129}I and ^{137}Cs tracers from European nuclear fuel reprocessing plants

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The development during the past 10 years of analytical techniques to measure ^{129}I by accelerator mass spectrometry has led to recent advances in its use as an oceanographic tracer, particularly in the Arctic Ocean. Large quantities of ^{129}I ($t1/2 = 16 \times 10^6$ yr) have been discharged from the Sellafield (UK) and La Hague (France) nuclear fuel reprocessing plants into the Irish Sea and English Channel, respectively since the 1960s. Together with ^{137}Cs ($t1/2 = 30$ yr), derived mainly from Sellafield, the ^{129}I reprocessing signal is transported into the North Sea and Norwegian Coastal Current and then enters the Arctic Ocean through Fram Strait and the Barents Sea where both tracers independently reflect the circulation of Atlantic origin halocline and intermediate water. Combined measurements of ^{129}I and ^{137}Cs, together with a knowledge of the historical record of reprocessing plant discharges, can be used to identify a given year of transport through the Norwegian Coastal Current (NCC), thereby permiting the determination of a transit time from the NCC to a given sampling location, similar to a ventilation age determined using atmospherically-derived tracers such as tritium and chlorofluorocarbon compounds (CFC's). Measurements of ^{129}I and ^{137}Cs conducted on seawater samples collected during icebreaker and US Navy nuclear submarine cruises to the Central Arctic Ocean clearly delineate circulation features such as the boundary between Atlantic and Pacific-origin water that is presently aligned with the Mendeleyev Ridge. These results have been interpreted using a

transit time model which provided estimates of 6-7 yr (± 0.5 y) for the passage of Atlantic Water from the Norwegian Coastal Current (60°N) to the Eurasian slope of the Makarov Basin, 8-10 years to the Mendeleyev Ridge and > 10 yr to the interior of the Canada Basin.