

Brief comments on natural archives

Radionuclide tracers to understand climate change

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Natural Archives

The most well-known application: Dendroclimatology

 <u>Dendroclimatology</u> is the science of determining past climates from trees. Tree rings are wider when conditions favor growth, narrower when times are difficult. <u>Wikipedia</u>



From: https://www.global-climate-change.org.uk



Natural Archives C-14 dating

• <u>Williard Libby</u>: Nobel Prize chemistry 1960

- Tested his ¹⁴C-dating technique on artefacts with known age e.g. sequoia tree rings and museum items.
- Developed low-level counting techniques (e.g. muon shield)







Natural Archives	subcategory 🔽	Radionuclides of main interest 🔽	Issues addressed 💽	Comments
lce core				
		Anthro (Cs-137, H-3, Pu-XXX)	Chronologies, climate change	
Marine biota	/Carbon cycle			
	Corals	Anthro, Pb-210, Ra-226	Environmental conditions	
	Blue Carbon, fluxes	Pb-210, Ra-226, Th-234, anthro	C sequestration	Mangroves, sea grass
	Giant clam shells, fish otoliths	Anthro, Pb-210, Ra-226	as above	In addition: Light cycle from Sr/Ca and Mg/Ca ratio
Tree rings			·	
		Anthro (Cs-137, H-3, Pu-XXX)	Year of contamination	
Human bones				
	Contamination	Sr-90, Th	Year of contamination	
	Stable isotopes		Food patterns (sea-food) Weaning patterns	Sr/Ca ratio can be determine using (fast) neutron activatio and gamma-ray spectrometr
	Radon-exposure	Pb-210	Dose-risk assessment	
cean/sea water/	/sediment			
	Sedimentary processes	Be-7, Pb-210, Ra-226, Th, anthro	Deposition, transport	
	Coastal processes (SGD), hydrothermal plumes	Ra-223, 224, 226, 228	 * Transport of nutrients * Age of plume * Speed of travel 	Impact on climate models
	Ocean mixing,/ventilation, currents	H-3, C-14, Sr-90, Tc-99, Cs-134, 137, I-129, Np-237, Pu-XXX; Ra-XXX Ar-39, Kr-85, U-233, U-236	 * Transport of nutrients, heat * Residence/transit time * uptake of CO2 	Impact on climate models
Meteorites	stony/iron			
		Al-26, Na-22, Fe-60, Co-60, Co-59, cosmogenic activation products	* Age of solar system* Terrestrial age* Path through space	
Soil/sediment				
		Anthro, Primordial	* Diffusion rate * Year of contamination	

Quick and rough overview of some natural archives where radionuclides can play a role.

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Anthro=Anthropogenic radionuclides





Clams, oysters and mussels

Impact of human activities.

Onset of anthropocene

Edited by Peter Doyle Volume 34 Number 5 September/October 2018

GeologyToday

Special issue: The Anthropocene

How to date natural archives of the Anthropocene

The palaeontological record of the Anthropocene Global warming and the Anthropocene WILEY Blackwell



TRACERS IN THE SEA W. S. Broecker and T.H. Peng

1982



JGR Oceans

RESEARCH ARTICLE 10.1029/2020JC016740

Key Points:

- Tracer ¹²⁹I distributions in Arctic Ocean shifted from cyclonic to anticyclonic between 1995 and 2015 as Arctic Oscillation (AO) shifted positive to negative
- ¹²⁹I results show that 2015 shift to anticyclonic circulation was accompanied by weakening of boundary currents and broadening and deepening of Beaufort Gyre
- Agreement between ¹²⁹I distributions and simulations from a regional, sea ice-ocean model reveal linkages between arctic circulation and shifts in climate indices

2021

A Changing Arctic Ocean: How Measured and Modeled ¹²⁹I Distributions Indicate Fundamental Shifts in Circulation Between 1994 and 2015

John N. Smith¹, Michael Karcher^{2,3}, Nuria Casacuberta⁴, William J. Williams⁵, Tim Kenna⁶, and William M. Smethie Jr.⁶

¹Bedford Institute of Oceanography, Dartmouth, NS, Canada, ²Alfred Wegener Institute for Polar and Marine Research, Bremerhaven, Germany, ³O.A.Sys – Ocean Atmosphere Systems GmbH, Hamburg, Germany, ⁴ETH Zurich, Zurich, Switzerland, ⁵Institute of Ocean Sciences, Sidney, BC, Canada, ⁶Lamont Doherty Earth Observatory of Columbia University, Pallisades, NY, USA

Abstract ¹²⁹I measurements on samples collected during GEOTRACES oceanographic missions in the Arctic Ocean in 2015 have provided the first synoptic ¹²⁹I sections across the Eurasian, Canada, and Makarov Basins. During the 1990s, increased discharges of ¹²⁹I from European nuclear fuel reprocessing plants produced a large, tracer spike whose passage through the Arctic Ocean has been followed by ¹²⁹I time series measurements over the past 25 years. Elevated ¹²⁹I levels measured over the Lomonosov



The Sandwich spectrometer



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- Network for underground radioactivity labs since 2000
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Thank you



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