DATING THE ANTHROPOCENE IN DEEP-SEA SEDIMENTS: A GAMMA SPECTROMETRIC APPROACH

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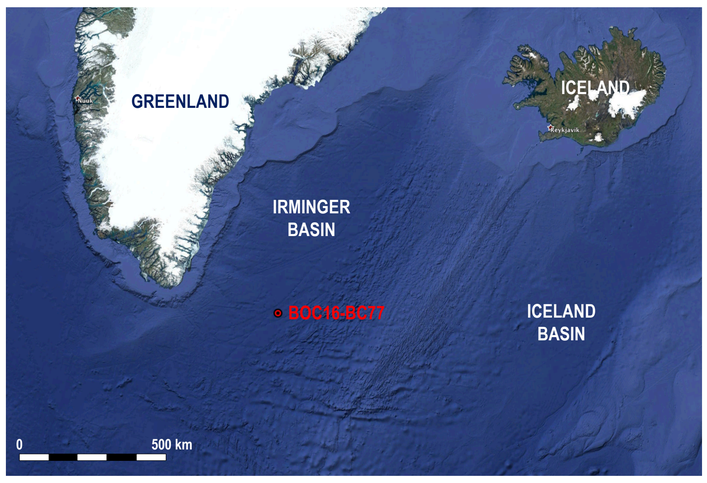


INTRODUCTION:

High latitudes of the North Atlantic Ocean play a decisive role in the Meridional Overturning Circulation (MOC). Surface waters from this region uptake an important proportion of atmospheric CO_2 which is exported to the deep-sea throught the NADW. This mechanism reduce the CO_2 accumulation in the atmosphere and hence the global warming, but causes ocean acidification. Besides, biological pump removes CO_2 from surface waters and a fraction is transferred to deep-sediments as organic matter (OM) and mineral particles, mainly calcareous remains. The amount of OM in sediments is controlled by biological production, but also by bottom ventilation.

This work is addressed to quantify the fluxes of organic and inorganic carbon reaching the bottom of the Irminger Basin in order to evaluate the role of this basin as carbon sink during the Anthropocene. This requires an accurate chronology, obtained by means of gamma-ray spectrometry measurements of ^{210}Pb.

Detected changes of organic and inorganic carbon along the last 150 years could be used to infer recent productivity, bottom ventilation an MOC fluctuations.

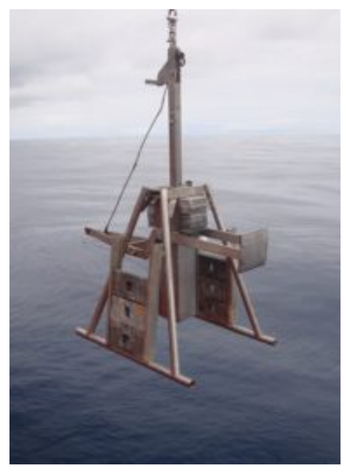
Box-core BOC16-BC77 was retrieved from the central area of Irminger Basin (59º29.5N; 37º41.15W), at 3118 m water depth.

MATERIAL AND METHODS:

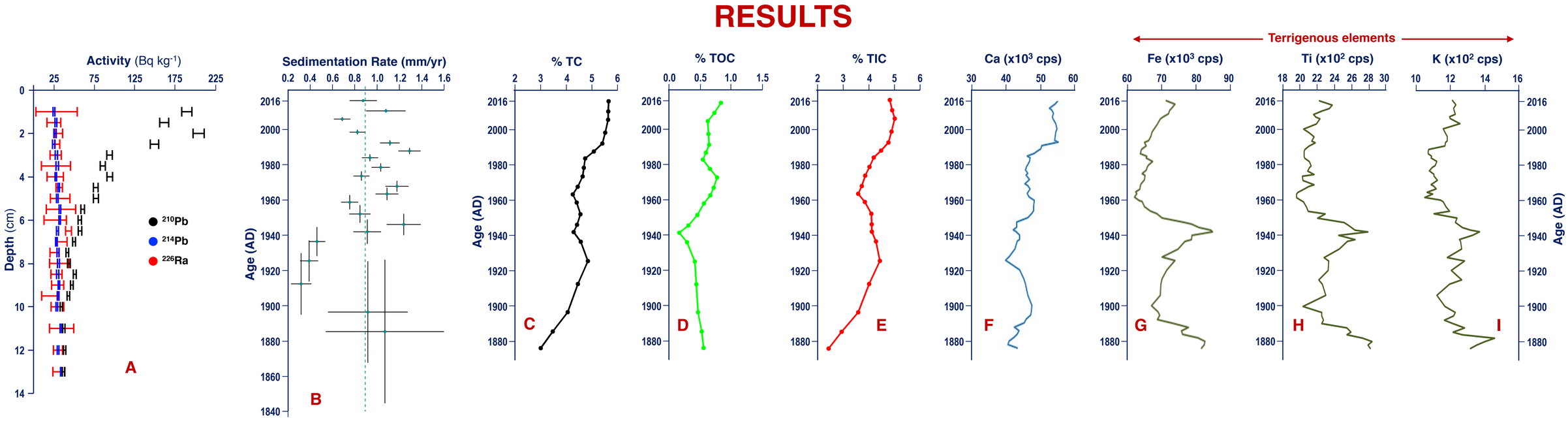
Mazinger detector, cryostat and shielding (LRI Usal)

Pelagic sediments from deep, central Irminger Basin recovered using a box-corer were sampled every 1 cm for sedimentary and geochemical analyses. Total carbon (TC), total inorganic carbon (TIC) and total organic carbon (TOC) have been measured using a LECO CN. Semiquantitative elemental composition has been measured by means of a XRF core scanner (ITRAX).

Sediment slices of 0.5 cm thick were subsampled up to 10 cm and 1 cm thick below 10 cm for geochronological analyses. A novel approach based on low level background gamma-ray spectrometry using Mazinger (made up of two hyper-pure germanium (HPGe) detectors together with active and passive shieldings) has been used. This method allows for an optimal chronological framework based on ^{210}Pb dating of sediments younger than 150-200 years. It is a non-destructive technique and facilitates information on all gamma emitters present in the sediments (^{226}Ra, ^{234}Th, ^{137}Cs, ^{241}Am). The fundamental principle of the dating model is based on two facts: the enrichment of ^{210}Pb with respect to ^{226}Ra in aerosols and suspended particles in the atmosphere, which fall on the ocean, and the higher affinity of ^{210}Pb for organic matter (OM) and suspended particles, resulting in an excess of this isotope with respect to ^{226}Ra within the sediments.



RESULTS



A: ^{210}Pb, ^{214}Pb and ^{226}Ra activities versus depth. Minimum detectable activities (MDA) were below 0.6 Bq kg^{-1}, 0.56 Bq kg^{-1} and 2.26 Bq kg^{-1}, respectively. Using a *Constant Rate of Supply* (CRS) model, the first 13 cm of this core record the last 140 years, approximately.

B: Based on this chronology, the average sedimentation rate of core BOC16-BC77 is 0.83 ±0.13 mm/yr, which results quite high for a deep-sea basin. Considering a flux of ^{210}Pb of 30.8 ±4.6 Bq m^{-2} yr^{-1}, the mean Mass Accumulation Rate (MAR) or sedimentary flux to the bottom during the Anthropocene would be around of 829.3 ±100 g m^{-2} yr^{-1}.

C-E: TC, TOC and TIC relative abundances show a general increasing trend towards nowadays. A noticeable drop of TOC is recorded at 1942 AD, coinciding with a conspicuous peak showed by terrigenous elements, Fe, Ti and K (**G-I**) and enhanced sedimentation rate (**B**). Despite relatively lower sedimentation rates during the last 25 years than during previous decades, higher values of TC, TIC and Ca are recorded, suggesting an enhanced biogenic input.

G-I: Strong terrigenous input is shown at around 1880 causing a dilution of TC and calcareous biogenic components (TIC and Ca), but terrigenous input decreased progressively up to the beginning of the 20th century. In fact, the lower sedimentation rates of the Anthropocene occurred during the first three decades of the 20th century.

CONCLUSIONS:

- **Gamma-ray spectrometry is shown as an accurate technique and sensitive enough for dating deep-sea pelagic sediments from Irminger Basin.**
- **Obtained age-model reveals that in the central and deeper areas of Irminger Basin, the first 13 cm of sediment represent approximately 140 years.**
- **Accordingly, the average sedimentation rate of the core is 0.83 ±0.13 mm yr^{-1}, which results quite high for a deep-sea basin.**
- **^{210}Pb dated profiles allowed us to estimate the amount of exported material from the water column to the bottom sediments: During the last 150 years, 31.9 ±14 g m^{-2} yr^{-1} of inorganic carbon (interpreted as calcareous biogenic input) and 4.5 ±2.8 g m^{-2} y^{-1} of organic carbon have been accumulated in deep Irminger Sea sediments. This region is acting as a substantial carbon sink, where we estimate more than 22 Tg C y^{-1} are being sequestered into the sediments.**
- **Fluctuating values of terrigenous and biogenic proxies suggest short time-scale changes of bottom currents and/or biological productivity during the Anthropocene, being the most recent 25 yr the interval showing enhanced biological productivity.**

ACKNOWLEDGEMENTS:
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