A Long Shadow of Whaling: Lasting Biogeochemical Legacy in Sediments Near Grytviken, South Georgia (PS 133-2)

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INTRODUCTION

Grytviken (est. 1904), located on the island of South Georgia within the Cumberland Bay fjord, was a major Southern Ocean whaling hub, where >50,000 whales were processed before abandonment in 1966.

The processing of thousands of whales each season released enormous quantities of blood, oil, and organic residues directly into the fjord, enriching the water and sediments with carbon, nitrogen, and sulfur compounds.

In November and December 2022 the RV POLARSTERN cruise PS133/2 "Island Impact" set out to apply geochemical and microbiological methods to study if the sediments surrounding this site still bear the imprint of such intense human activity.

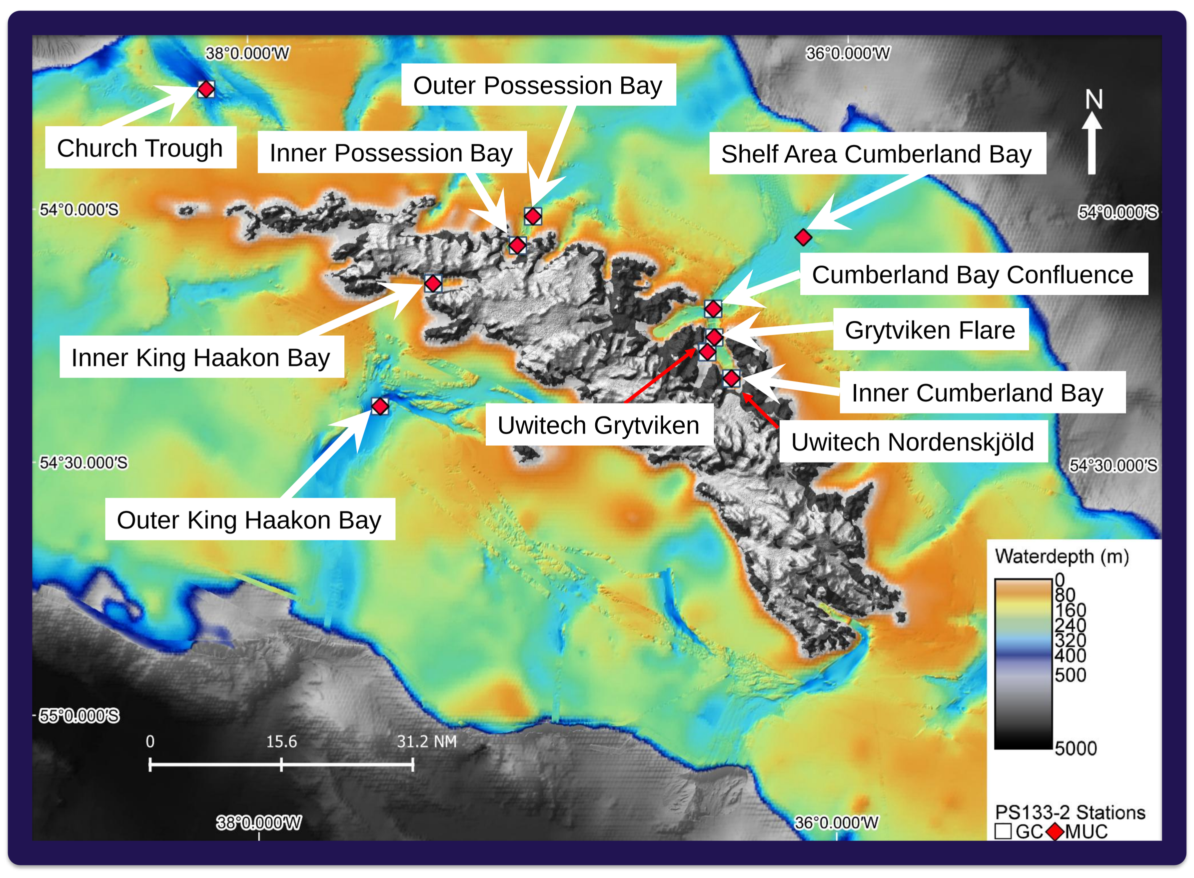

Fig. 1: *Map of South Georgia* with sampling locations of sediment cores taken during PS133-2.

Fig. 2: *Remnants of the historical whaling station in Grytviken* (photographed in 2022), with Antarctic fur seals resting in the foreground.

MATERIAL AND METHODS

- Sediment was collected at the Grytviken site using a hand-held UWITEC gravity corer deployed from a Zodiac at 17 m water depth.
- Core subsamples were taken for porewater chemistry, porosity, TOC, total S, C/N ratios, Fe speciation, DNA/RNA extractions, and sulfate reduction rates (SRR).
- SRR were determined by syringe incubations with a ^{35}S-sulfate tracer aboard ship, followed by cold chromium distillation in the home laboratory (SRR) [1,2].
- Porewater Fe, Mn, and SO_4^{2-} concentrations were quantified using the Ferrozine assay[3], the Formaldoxime assay[4], and ion chromatography, respectively.
- TOC, total S, and C/N were measured using an elemental analyzer.
- Poorly crystalline and crystalline Fe(II) and Fe(III) were quantified by sequential HCl extractions, and labile, easily reducible Fe(III) by bicarbonate-buffered ascorbate extraction[5].

RESULTS

Fig. 3: *Photograph of a sediment core from the Grytviken site.* The uppermost centimeter is reddish-brown, followed by a 1–2 cm thick grey layer that progressively darkens with depth; sediment below 5 cm is black.

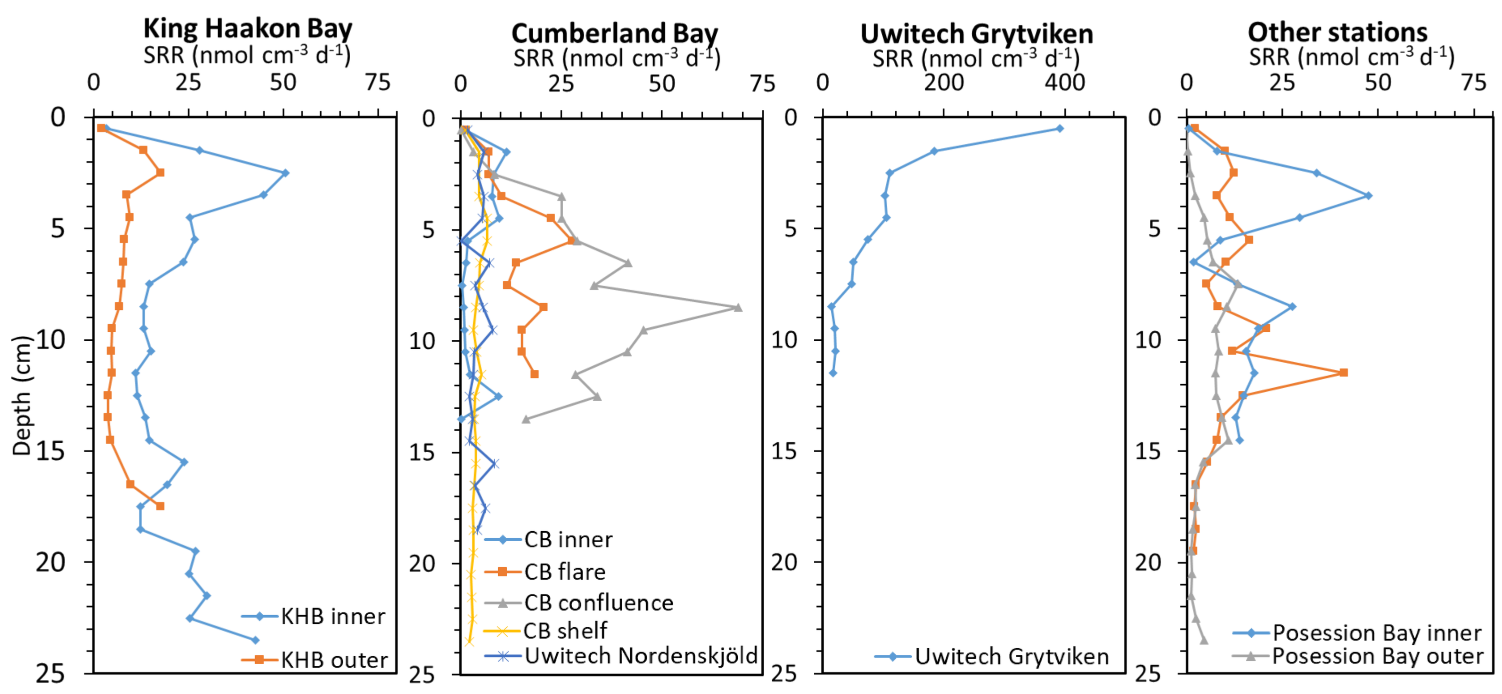

Fig. 4: *Sulfate reduction rates (SRR)* measured in samples from PS133-2. Note the different x-axis scale used for the Grytviken panel.

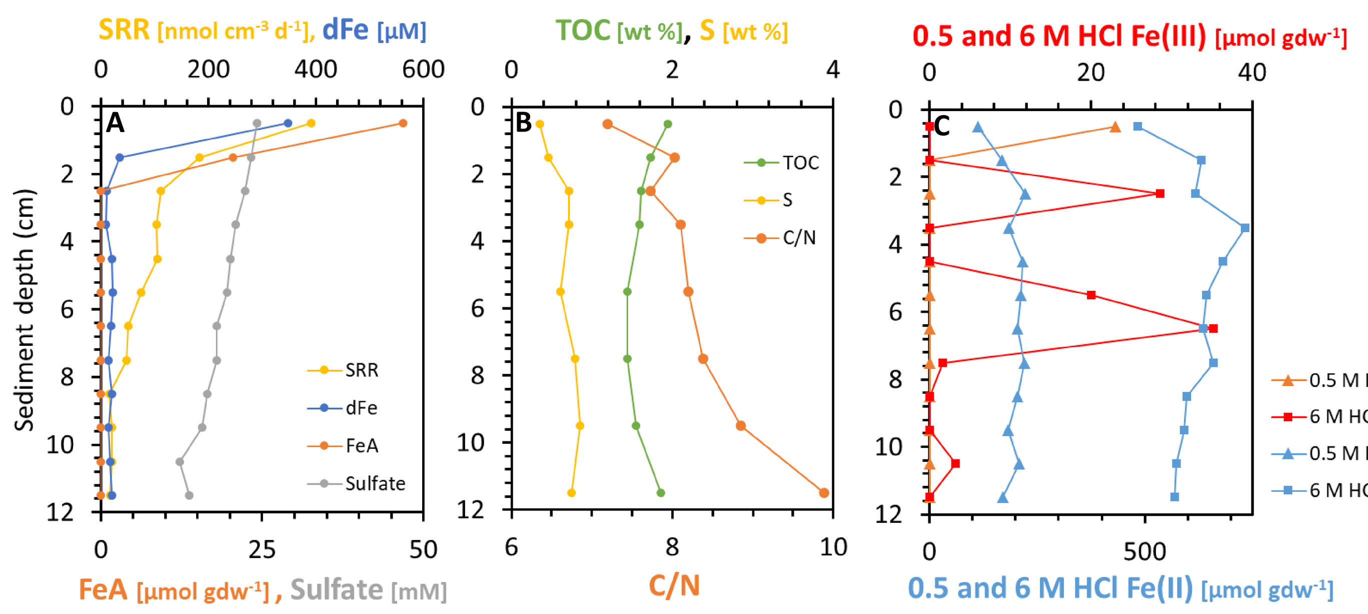

Fig. 5: *Geochemical parameters determined for the Grytviken core.* A: SRR, dFe, FeA and sulfate. B: TOC, S, and C/N. C: Sequential HCl Fe extractions.

- **The intense, decades-long organic loading potentially strongly altered nearby sediments**, driving highly reducing conditions, extremely high SRR, and tightly coupled iron–sulfur cycling rarely observed outside eutrophic coastal systems.
- **Over half a century after the end of commercial whaling, sediments still seem to retain this anthropogenic imprint**, demonstrating long-term "sedimentary memory" and the persistence of historical human impacts on benthic biogeochemistry.

OULTOOK

Ongoing analyses: RNA-based sequencing of microbial communities from Grytviken sediments and additional sites sampled during PS133-2.

→ Are microbial communities uniquely adapted to the environmental conditions at Grytviken?

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