Glacially derived iron is more bioavailable to Antarctic phytoplankton than other sources

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Motivation

- The region around **South Georgia Island** is one of the most productive in the Southern Ocean and a major contributor to **atmospheric CO_2 uptake** (Bushinsky et al. 2019, Fig. 1).
- Natural iron (Fe) sources like glacial meltwater, benthic fluxes or melting icebergs fertilize phytoplankton blooms in **Fe-limited** waters of the Southern Ocean (Schlosser et al. 2018).
- While Fe fluxes of these sources were estimated by several studies (Borrione et al. 2014, Nielsdóttir et al. 2012) , their **bioavailability remains yet unresolved.**

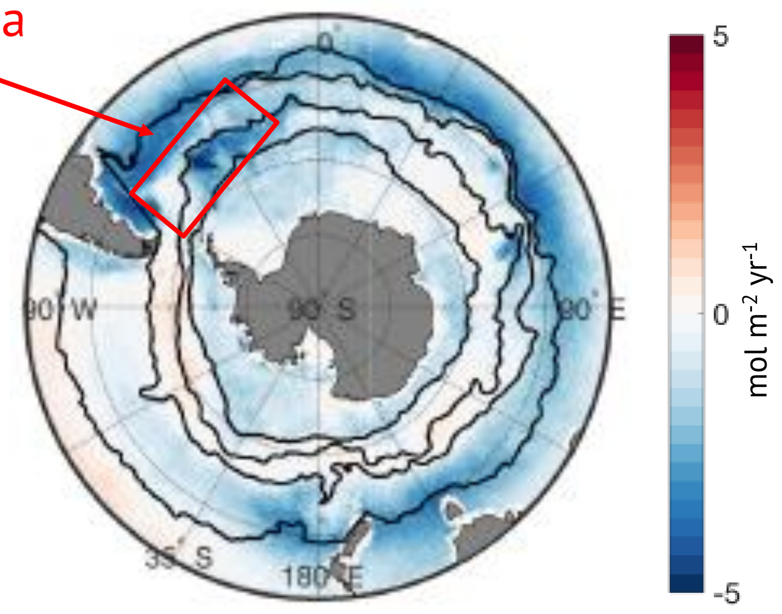


Fig. 1 Southern OceanCO_2 fluxes in summer (Bushinsky et al. 2019)

Objectives

- Quantifying the bioavailability of 4 nearshore Fe sources from South Georgia: Glacial meltwater from two different locations, groundwater and estuarine water by using **radiolabeled ^{55}Fe**
- Assessing the potential of those sources to **fertilize phytoplankton blooms** around South Georgia and thereby enhance carbon fixation

This project was conducted during the GEOTRACES process study *Island Impact*, **RV Polarstern**

Experimental set-up

Filtered seawater (0.2 µm) sampled from a
1) low chlorophyll and
2) high chlorophyll region

Target: Addition of 1 nM of each Fe source to seawater from both regions

Virtual tour clean room container

1) Sampling Fe speciation
- dissolved Fe
- ligands
- humic substances

2) Addition of radioactive tracer

3) Quantification of ^{55}Fe uptake rates by the same phytoplankton community in the low and high chlorophyll water

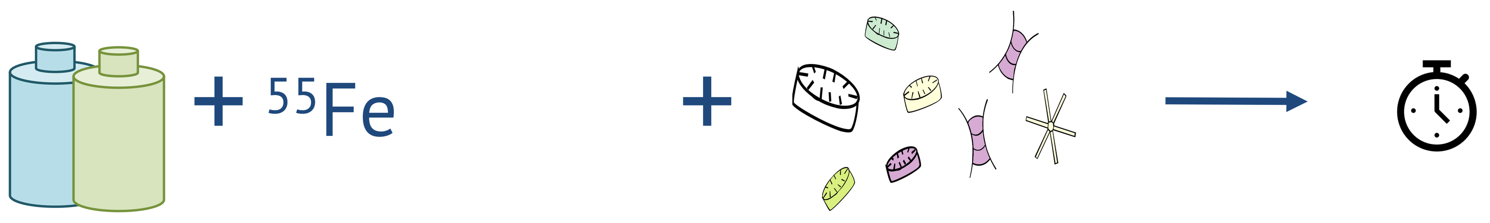
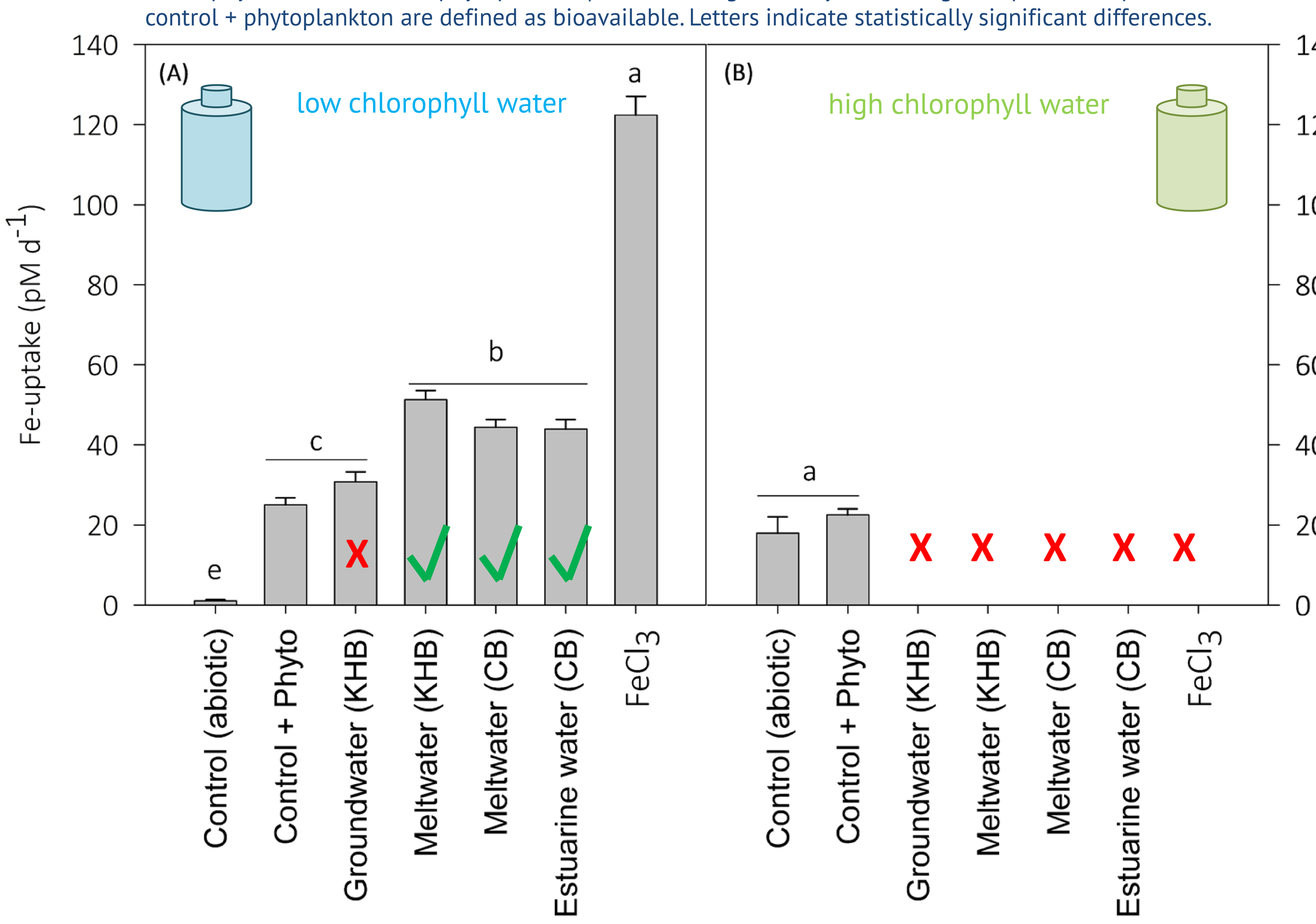


Fig. 2 Intracellular Fe uptake (pM d^{-1}) of the same natural phytoplankton community for natural Fe sources in comparison to an abiotic control (low/high chlorophyll water + ^{55}Fe), control + phytoplankton (low/high chlorophyll water + ^{55}Fe + phytoplankton). Sources significantly enhancing Fe uptake compared to the control + phytoplankton are defined as bioavailable. Letters indicate statistically significant differences.



Results

Low chl water

- **3 bioavailable Fe sources**: Meltwater (KHB and CB) and estuarine water from CB act as **Fe fertilizers of low chlorophyll waters** around South Georgia (fig. 2A).
- **1 non-bioavailable Fe source:** Fe associated to groundwater is not bioavailable to phytoplankton.

Using the phytoplankton community's Fe:C uptake ratio of 4.23 µmol:mol, the three bioavailable Fe sources are estimated to increase CO_2 fixation by 75-105%.

High chl water

- No difference between abiotic control and control + phytoplankton (fig. 2B) indicates aggregate formation from dissolved organic matter, which scavenged Fe.

biological Fe uptake processes of natural Fe sources in the high chlorophyll water could not be quantified.

The bioavailability of Fe is dependent on the properties of the Fe source itself and on the biogeochemical characteristics of the receiving seawater.

References
Bushinsky et al. *Reassessing Southern Ocean Air-Sea CO_2 Flux Estimates With the Addition of Biogeochemical Float Observations.* GBC (2019). **Schlosser et al.** *Mechanisms of dissolved and labile particulate iron supply to shelf waters and phytoplankton blooms off South Georgia.* BGS (2018). **Borrione et al. 2014** *Sedimentary and atmospheric sources of iron around South Georgia, Southern Ocean: a modelling perspective.* GBC (2014). **Nielsdóttir et al.** *Seasonal and spatial dynamics of iron availability in the Scotia Sea.* Mar. Chem. (2012).

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