Methylmercury Biogeochemistry and Fate in Deception Island, (Antarctica)

João Canário[1], Holger Hintelmann[2], Beatriz Bento[1], Margarida C. Santos[1], Marcos Mateus[3]

[1]Centro de Química Estrutural, Instituto Superior Técnico, Universidade de Lisboa, PORTUGAL

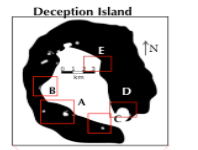
[2]Department of Chemistry, Trent University, Peterborough, CANADA

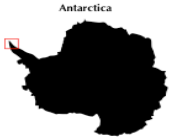
[3]MARETEC, Instituto Superior Técnico, Universidade de Lisboa, PORTUGAL

joao.canario@tecnico.ulisboa.pt

1

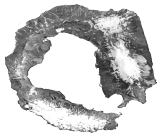
Deception Island





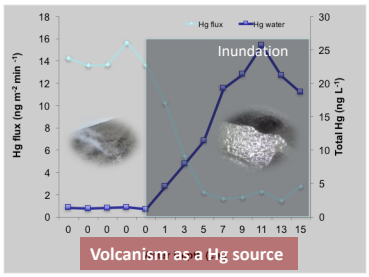
2

Mercury in Deception Island



Hg: 0.02 – 29 ng/L
MeHg: 13 – 33 %
Hg_S: up to 10ppm (1)

Hg: 0.13 – 3.6 ng/L
MeHg: <2 %
Hg_S: up to 0.03 ppm (2, 3)



(1) Mão de Ferro et al., 2014. *Chemosphere* (2) Cossa et al., 2011. *Deep Sea Research II* (3) Canário et al., *Deep Sea Research II, 2017*

3

Questions

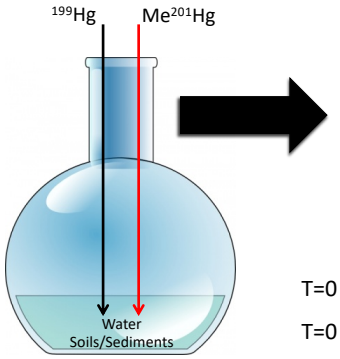
- Why MeHg levels are so high in Deception waters and what are the biogeochemical processes involved?
  Hg METHYLATION/MeHg DEMETHYLATION
- How mercury is transported inside Port Foster bay and is it exported to the open ocean?
  Hg/MeHg TRANSPORT
- Is this mercury (and MeHg) bioavailable?
  Hg/MeHg AVAILABILITY/ACCUMULATION
- What is the impact of this "natural pollution" in the all Deception ecosystem

4

Sampling strategy

5

Methylation/demethylation rates



$^{199}Hg \rightarrow Me^{199}Hg$

$Me^{201}Hg \rightarrow {}^{201}Hg$

Methodology

T=0 - without isotopes – Natural concentrations

T=0 - with isotopes – Instant (chemical/abiotic) methylation

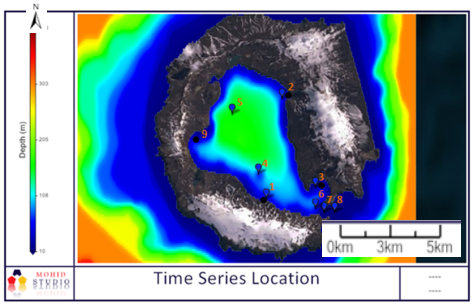
T=1 - with isotopes - (10h) – Biotic methylation/demethylation

T=2 - with isotopes - (24h) - Biotic methylation/demethylation

6

Hg and MeHg transport

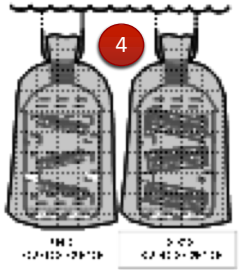
- A Bathymetry was created, that represents Port Foster and the surroundings.
- The tide was applied to the model;
- The time series location were choosen;
- The tidal model was validated;
- The S-T profiles were applied;
- The S-T profiles were frozen in time;

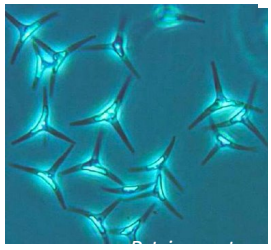


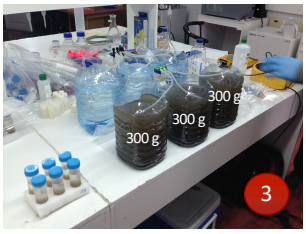
- The Lagrangean Tracers were released in the locations represented with black dots above.
- Residence time of the water inside the bay was estimated

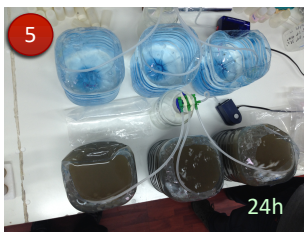
7

Hg (and MeHg) bioavailability





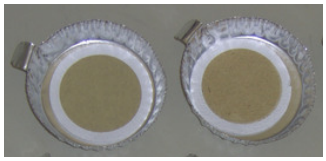


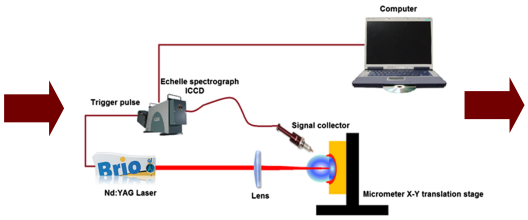


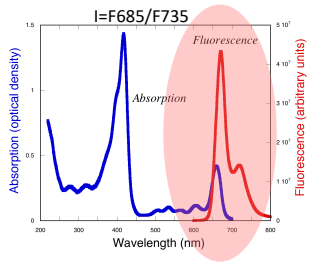
(Cabrita et al., 2013. Env. Sci. Poll. Res. ; Cabrita et. al., 2013. Mar. Env. Res.)

8

Hg (and MeHg) effects - LIF

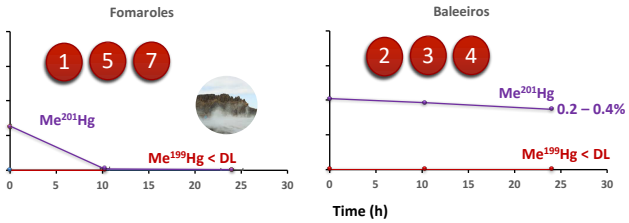






9

Hg methylation/demethylation in solids



$^{199}Hg \rightarrow Me^{199}Hg$ / $Me^{201}Hg \rightarrow {}^{201}Hg$

% Hg_C = $^{XXX}Hg_{transformed}$ / $^{XXX}Hg_{add}$ (daily basis)

No obvious correlations between methylation rates and MeHg levels in pyroclastic gravel but MeHg and C_{org} showed some strong correlations ($p<0.05$)

No *in situ* methylation Sorption processes

10

Hg methylation/demethylation in water

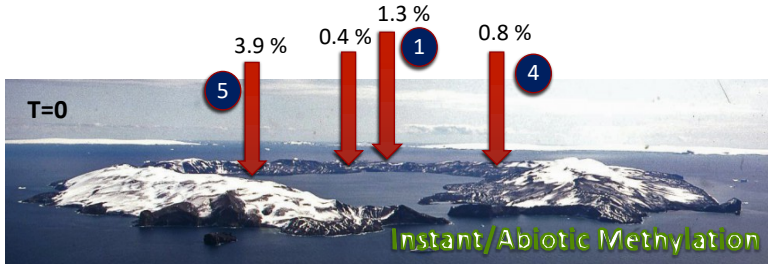
MeHg/Hg = 0.5 % [8] [9] - 7.9 % [4]

Hg/MeHg = 0 - 0.4% for all stations

Similar or higher than the ones found in Arctic Waters (0.6%)

Lehnherr et al., 2011), *Nature Geoscience*

Hg METHYLATION HIGHER THAN DEMETHYLATION

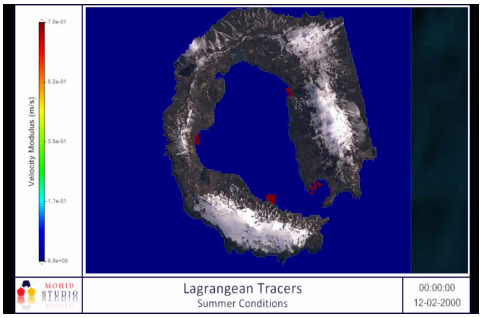


11

Water circulation and residence time

An **important indicator** for understanding the hydrodynamics is the **residence time**, because it gives the **average amount of time a particle "stays" in the bay**.

1.7 years



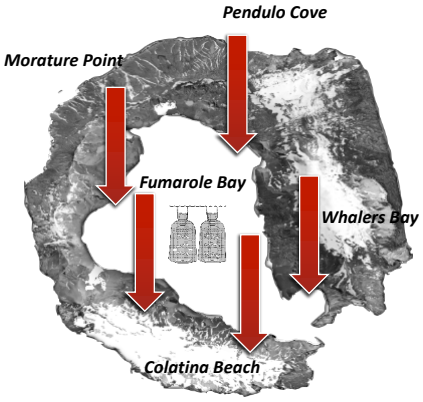
0.16% of the water is renewed on a daily basis

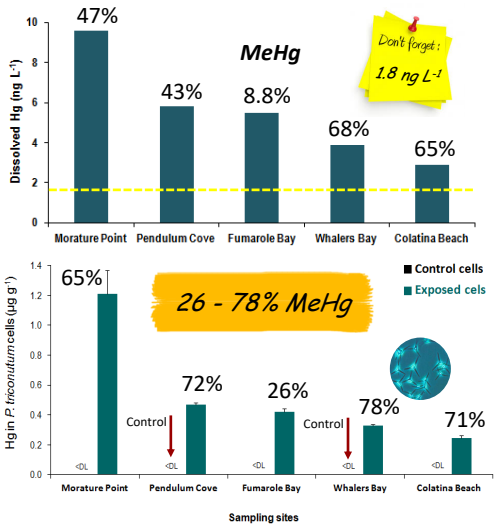
0.16% Hg will be exported to open ocean per day

Accumulation of Hg and MeHg inside Port Foster Bay

12

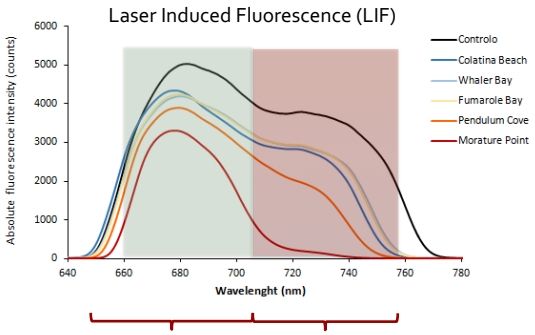
Hg/MeHg accumulation

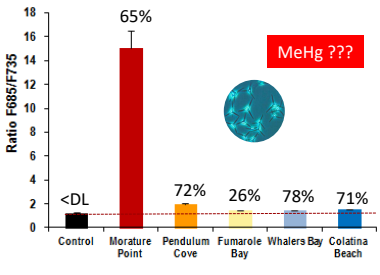


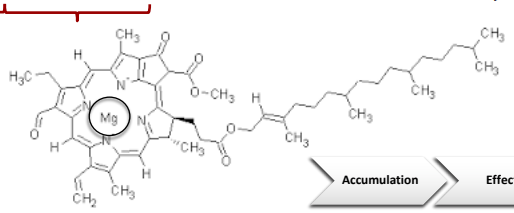


13

Hg impacts on physiology



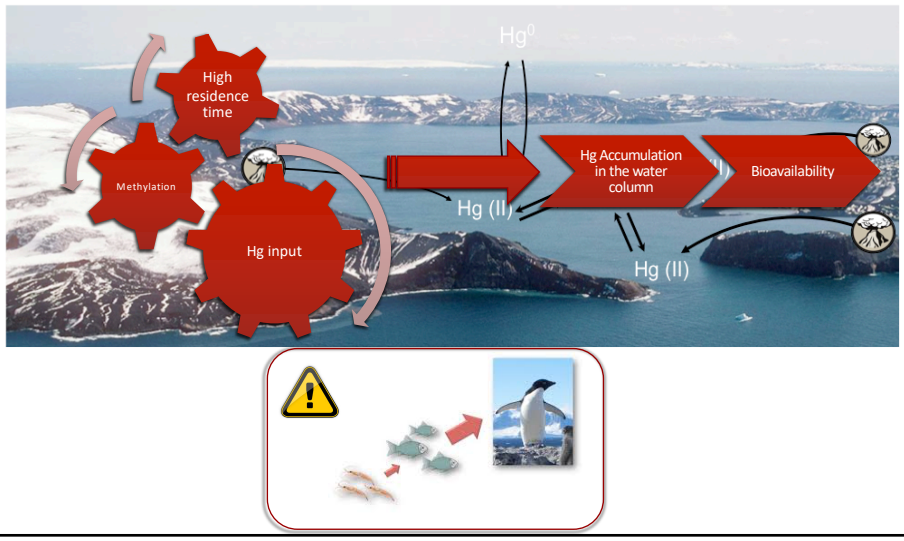




Accumulation → Effects → Adaptation

14

Conclusions



15