Permafrost degradation:

When we thought that things could not go worst

João Canário[1,4]

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1

Permafrost thaw

2

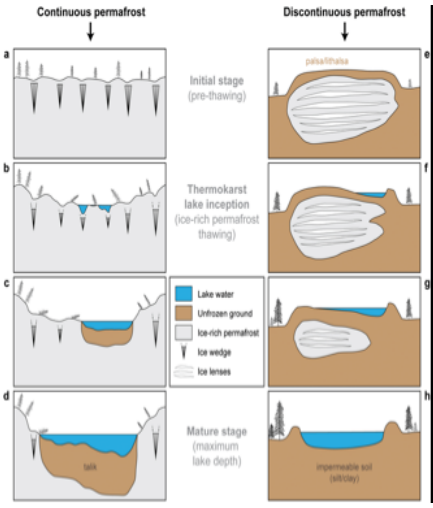
Changes in Landscape

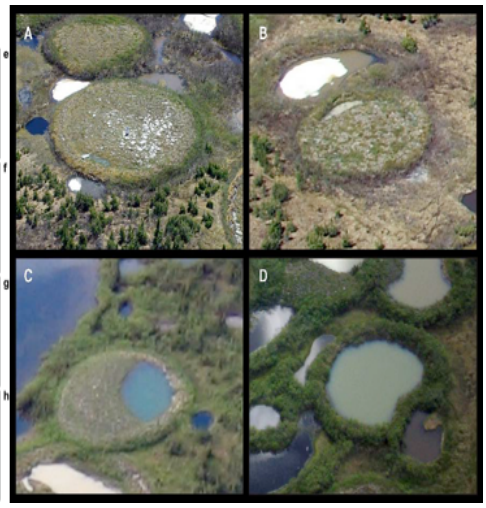
95% less permafrost

325% more trees

3

Formation of thaw lakes





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Carbon pool in Arctic permafrost soils

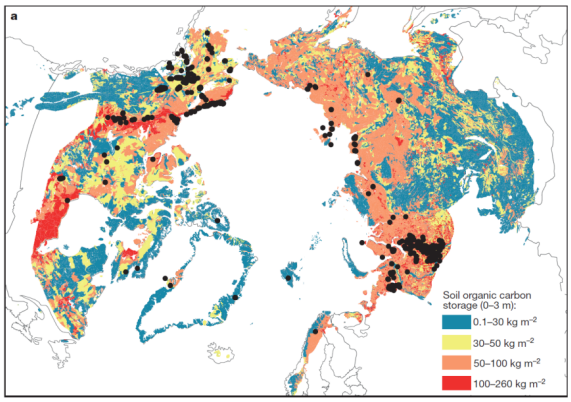
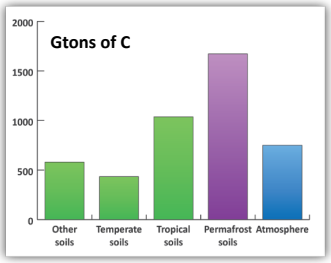
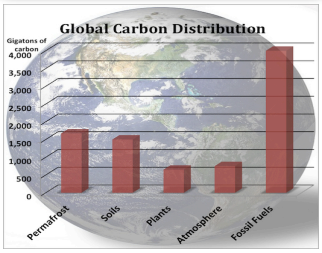


Figure 1 | Soil organic carbon maps. a, Soil organic carbon pool (kg C m^{-2}) contained in the 0–3 m depth interval of the northern circumpolar permafrost zone[12]. Points show field site locations for 0–3 m depth carbon inventory measurements; field sites with 1 m carbon inventory measurements number in the thousands and are too numerous to show. **b**, Deep permafrost carbon pools (>3 m), including the location of major permafrost-affected river deltas (green triangles), the extent of the yedoma region previously used to estimate the carbon content of these deposits[13] (yellow), the current extent of yedoma region soils largely unaffected by thaw-lake cycles that alter the original carbon content[15] (red), and the extent of thick sediments overlying bedrock (black hashed). Yedoma regions are generally also thick sediments. The base map layer shows permafrost distribution with continuous regions to the north having permafrost everywhere (>90%), and discontinuous regions further south having permafrost in some, but not all, locations (<90%)[16].





Schuur et al 2015

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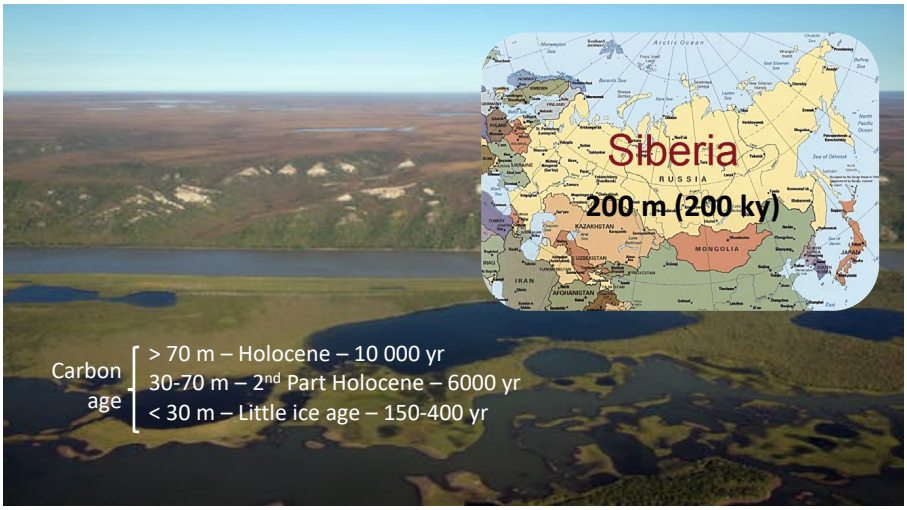
Carbon age



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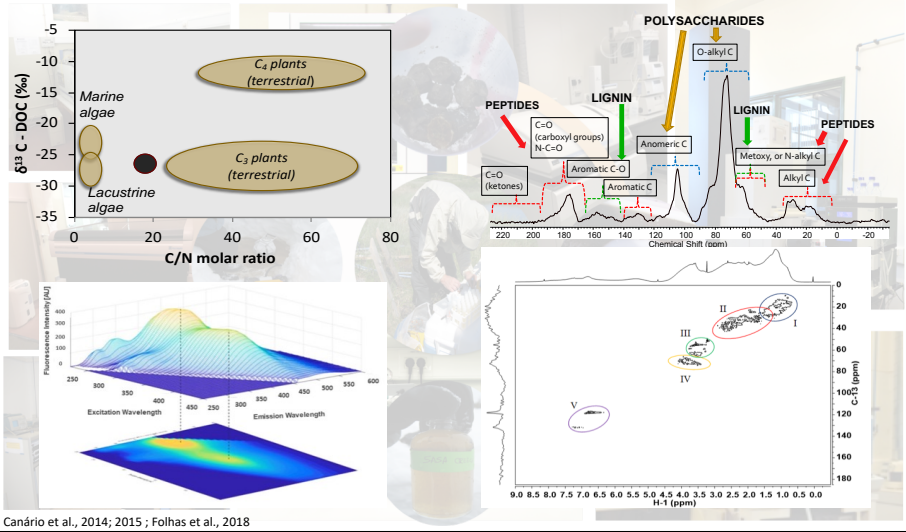
Organic matter composition



Canário et al., 2014; 2015 ; Folhas et al., 2018

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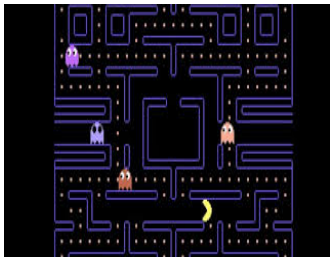
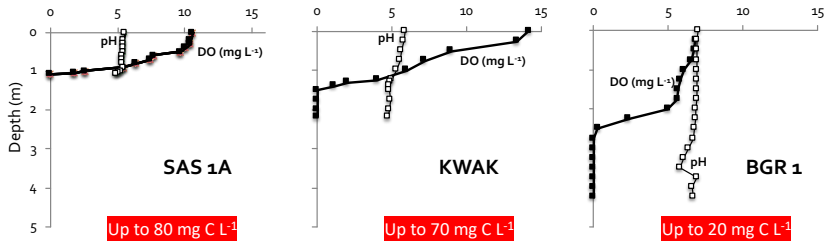
Organic matter degradation

Reaction (Berner, 1980)	ΔG⁰ (KJ mol^{-1} of CH_2O)
$CH_2O + O_2 \rightarrow CO_2 + H_2O$	-475
$5CH_2O + 4NO_3^- \rightarrow 2N_2 + 4HCO_3^- + CO_2 + 3H_2O$	-448
$CH_2O + 3CO_2 + H_2O + 2MnO_2 \rightarrow 2Mn^{2+} + 4HCO_3^-$	-340
$CH_2O + 7CO_2 + 4Fe(OH)_3 \rightarrow 4Fe^{2+} + 8HCO_3^- + 3H_2O$	-114
$CH_2O + SO_4^{2-} \rightarrow H_2S + 2HCO_3^-$	-77
$CH_2O \rightarrow CH_4 + CO_2$	-58





Up to 80 mg C L^{-1} | Up to 70 mg C L^{-1} | Up to 20 mg C L^{-1}

Canário et al., 2014; 2015

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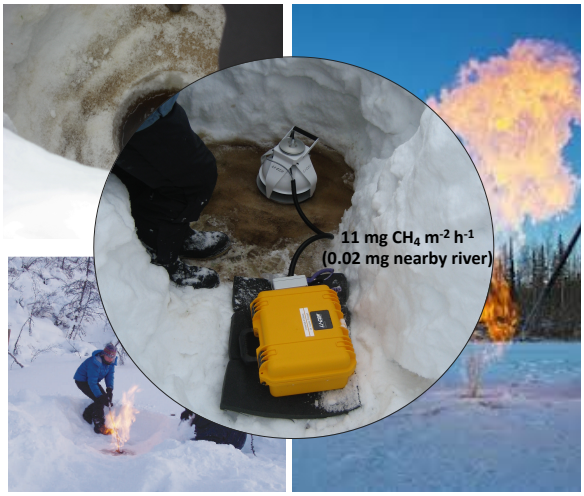
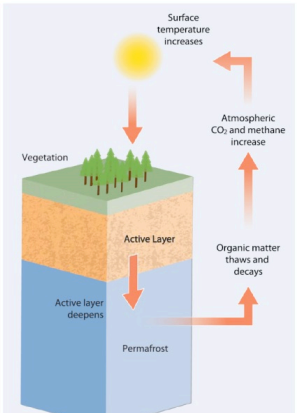
Carbon feedback





The impact of the permafrost carbon feedback on global climate

Kevin Schaefer[1], Hugues Lantuit[2,3], Vladimir E Romanovsky[3,4], Edward A G Schuur[5] and Ronald Witt[1]

Grabielle Walker, 2007. Nature 442:718-721; Pilote et al., 2016

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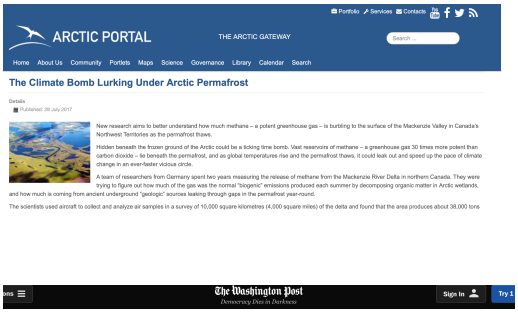
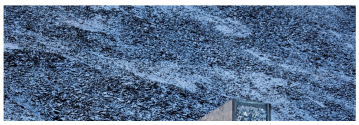
Permafrost thaw the new climate bomb ?



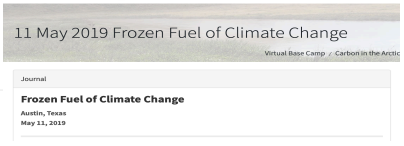


KATE YODER SCIENCE 03.15.19 08:00 AM

THE ARCTIC'S 'CARBON BOMB' COULD SCREW THE CLIMATE EVEN MORE

Climate and Environment

The Arctic's carbon bomb might be even more potent than we thought



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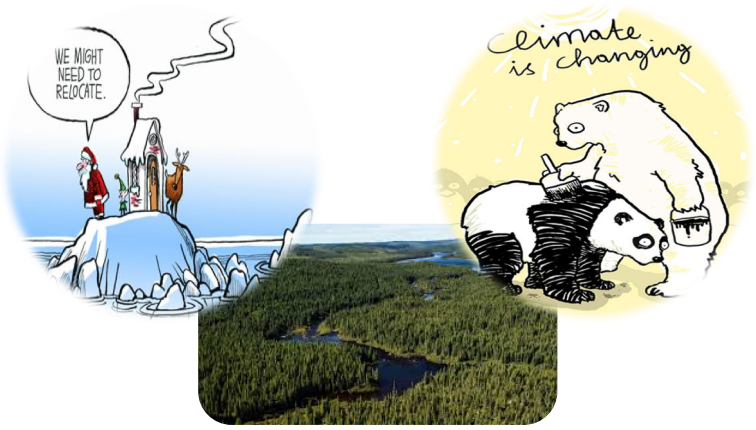
Adaptation / Mitigation / Remediation



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But carbon is not the only threat

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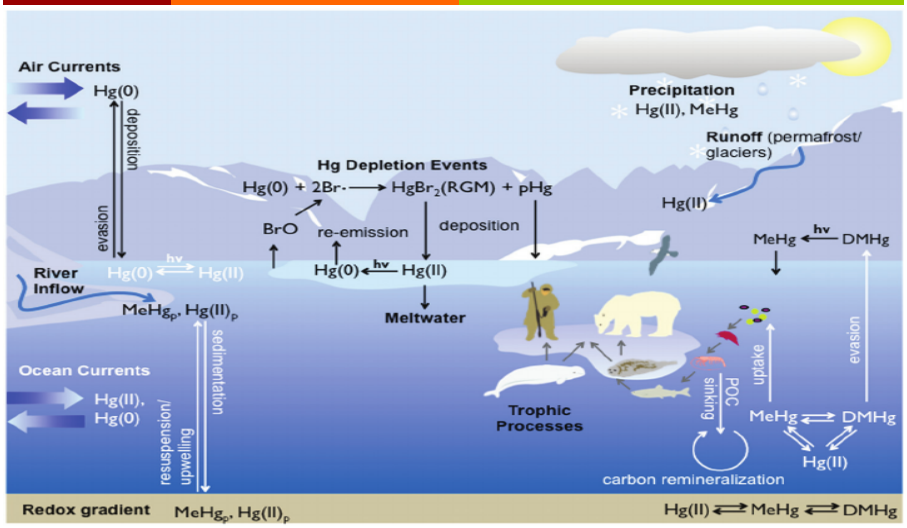
Mercury cycle in the Arctic



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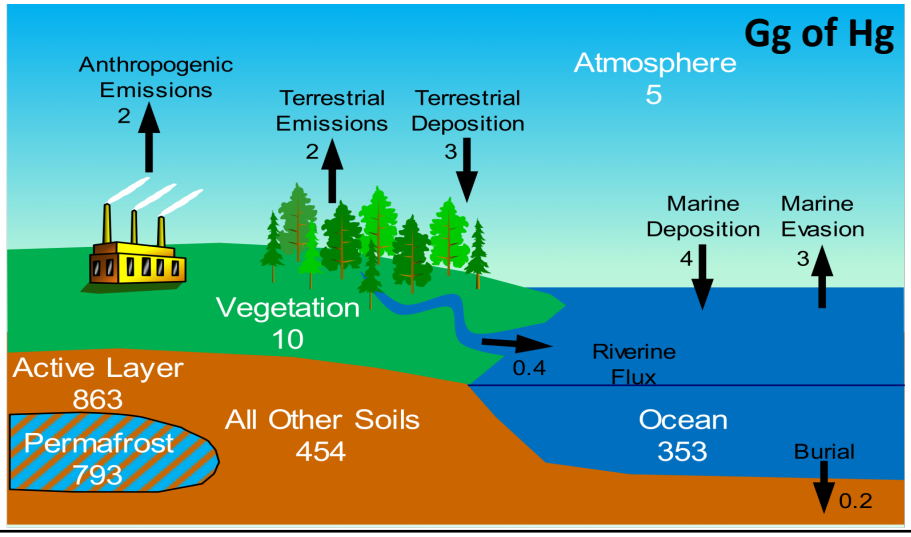
Mercury pool with permafrost included



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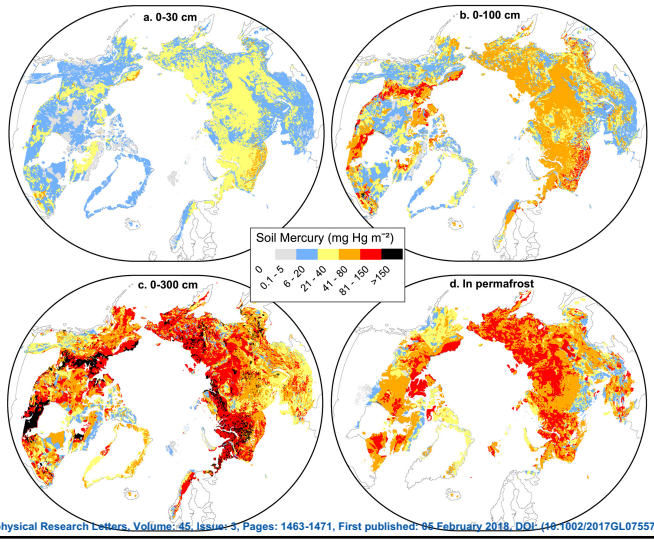
Mercury in permafrost soils



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Permafrost thaw lake sites

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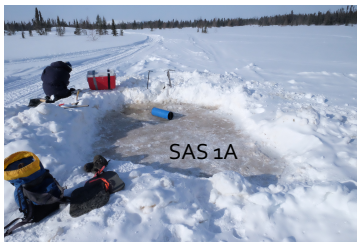
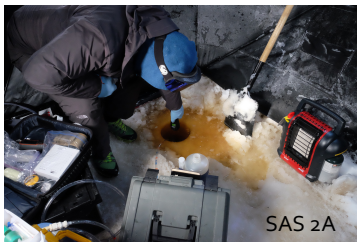
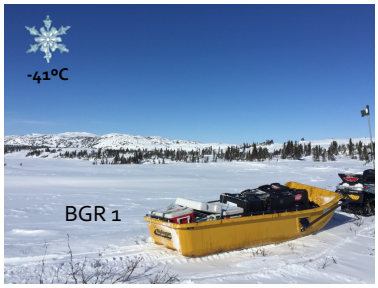
Mercury in permafrost soils







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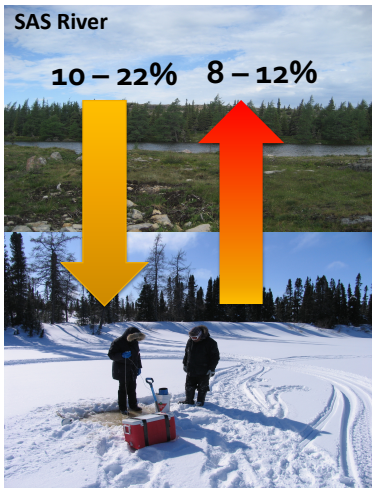
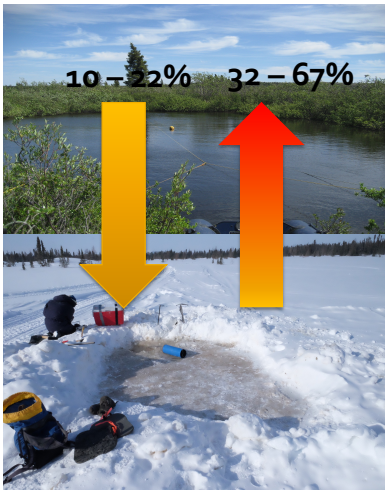
Mercury volatilization from permafrost





Pilote et al., 2016; 2017

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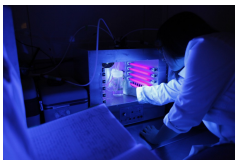
Mercury release during OM degradation



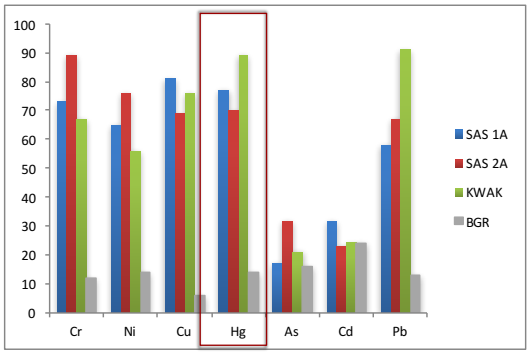
10 mL Lake water in quartz tube

200 µL of $K_2S_2O_8$

45 min irradiation in a UV Chamber

200 µL of $NH_2OH.HCl$

ICP-MS and CV-AFS



Canário et al., 2016: 2017

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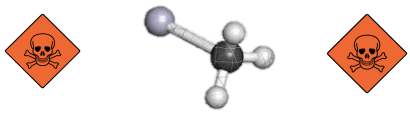
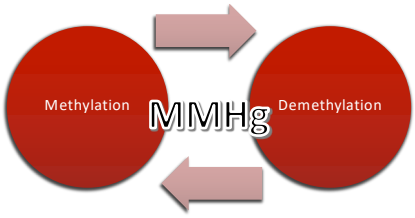
High proportion of Hg and MMHg

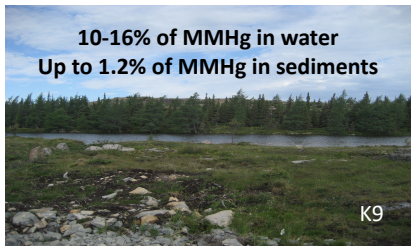


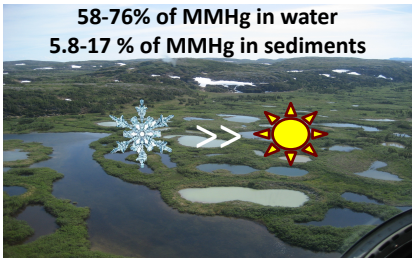
Monomethylmercury

$Hg(II) \rightleftarrows MMHg$



Pilote et al; 2016, 2017





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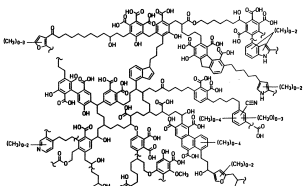
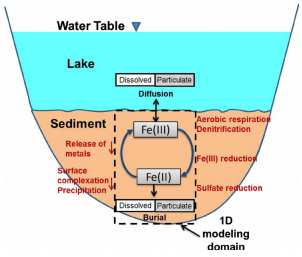
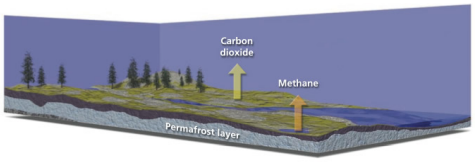
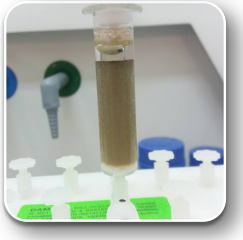
What's next: NOM characterization









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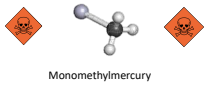
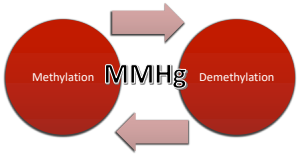
What's next: Hg methylation and fate

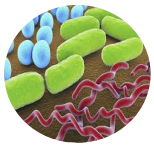


Rates

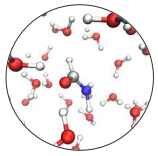
Mechanisms

Microbes





biotic



abiotic

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What's next: Fluxes

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Thank's a lot for your attention !!

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