Understanding the biogeochemical functioning and Hg cycling of High Altitude Andean lakes

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Importance of using combined in situ approaches
Natural (trans)formation of organometallic compounds

**Hg Geochemical Cycle**

- **Abiotic processes**
  - Photochemical
  - Salinity
  - Temperature

- **Biotic processes**
  - Phytoplankton
  - Bacteria

High Altitude lakes of the Altiplano region: = Extreme Environments

- High daily gradient
- High productivity
- High UV
- Low O2
Endoreic basin, Salinity Gradient

Lac Titicaca
8,562 km²

Rio Desaguadero

Lac Poopo
2,500 km²

Lac Uru Uru
260 km²

Zone de Salars
Uru Uru lake

Hg transfer in both food chains

Mercury transfer in both food chains showed the highest accumulation in higher trophic position, as is the case of grebe bird.

Hg concentrations are above the limit. A monitoring process should be established for this highly toxic metal.
Where, When Hg methylates and demethylates?

Sampling: Dry & wet seasons (Oct. 2010, May 2011)
Lac Titicaca 8 562 km²
Rio Desaguadero
Lac Poopo 2500 km²
Zone de Salars
Lac Uru Uru 260 km²
Vers Lac Poopo
Acid Mine drainage

EC2CO CYTRIX 2010-2012 « COMIBOL »

EE2CO CYTRIX 2010-2012 « COMIBOL »
Geographical Trend

30-60% MeHg!
Diurnal temporal variations of Mercury

UU1 (South), dry season

UU1 (South), wet season
Mercury species transformation experiments

In situ incubations were conducted by adding enriched isotopes (MM$^{201}$Hg and $^{199}$IHg) to different sample sediments, substrates biorganic and water samples for determining Hg methylation (M) and MMHg demethylation (D) rates.

Non Filtered water  \[ \rightarrow \]

Incubation

Diurnal & dark Conditions, 24 H

$^{201}$MMHg 0.1 ng L$^{-1}$

+ $^{199}$IHg 2 ng L$^{-1}$
Main Results

- Methylation (M) & Demethylation (D) rates (Dry season)

Methylation rates
UU12 (North): waters 4.6%; sediments: 1.1%
UU1 (South): waters: 0.9%; sediments: 0.25%; floating aggregates: 9.57%
Net methylation/demethylation
Uru Uru Lake (dry season)

Sediments
Net methyl.: 0.5 ± 0.2 ng/g d

Water
Net methyl.: 0-0.05 ng/g d

Bio-org. aggreg.
Net methyl.: 5.8±1.8 ng/g d
Lago Grande deep pelagic system

Río Coata
Río Suchez
Isla del Sol
Isla Taquile
Copacabana Embayment
Río Ilave
Rio Desaguadero

Contour Interval 30 m
Shoreline Elevation 3809 m

16° 00' S 7° 00' W

Lago Menor Shallow productive system
Lakes of the Altiplano: in situ exploration of the (a)biotic Processes controlling the Aquatic biogeoCHEmistry of Mercury At the Molecular and Isotopic scAle.

IRD GET/BOREA/LEMAR/ISTERRE - CNRS IPREM/IPGP

High Frequency measurements

Diving in situ incubations
Why continuous measuring of biogeochemistry in aquatic ecosystems?

1. Because it's became possible: from the origin to new generations of sensors
2. Because it's the right time scale of physical and biogeochemical processes
3. Forecasting models wait for these dataset
6 Water quality param. online for each station. $C_{25}$, T°, Press., $O_2$, pH, chlorophyll (4 algae classes),

5 meteor. param. Air T, RH, Wind speed and dir., pluviometry, solar irradiance
O2, Optodes Sensors
O2, Optodes

-1,5 m

-5,5 m Interface Herbier
Total Chlorophyll-α dynamics at Huatajata (1.5-m depth)

using FluoroProbe bbe: in vivo Chl-α fluorescence
45-min record interval
32 records / 24 hrs

February-May 2013
June-September 2013
Rainy
Dry season
25+ Researchers, Technicians, Students