

Earth, Universe, Environment and Social issues UJF Faculty

20 research laboratories

850 academic staff

470 technical and administrative staff

640 Ph.D. students

Two graduate intensive European Schools

***ERCA European research course on
atmospheres***

HERCULES: Large Facilities Science

Environmental Sciences at UJF

OSUG: Earth and Planetary Science Observatory with 3 main Institutes in Env. Sciences:

- ❖ Glaciology and Atm. Chemistry (LGGE)
 - ❖ Paleoclimate (CH_4 , $\delta\text{O}18..$) and paleo heavy metal pollution
- ❖ Hydraulics and Meteorology (LTHE)
 - ❖ Floods Risk, African Monsoon, Soil transfer
- ❖ Geophysics and Environmental Geochemistry (LGIT)
 - ❖ Earthquake risk and civil engineering

Env. Geochemistry group at LGIT, with main « large scale » topics:

- Public Health and Geochemistry (As in Bengal delta, Hg in Guyana Amerindian country)
- Industrial and mine waste sites (metal sequestration, phytostabilization) and water
- Soil microbiology and water treatment biofilms
- Deep waste disposal (nuclear waste and CO_2)
- L. Spadini and L. Charlet have been heading the MSc Programme on « Water Resources and Management » (**to be detailed later on**)
- L. Charlet, Editor-in-Chief (J. Hydrology), teaches a distance learning on water resources and pollution, and is Head of a Large facility to be built on Ecotoxicology and Toxicity.

A few examples of our own work:

« Redox-active natural systems »

Laurent Charlet
Lorenzo Spadini
Delphine Tisserand

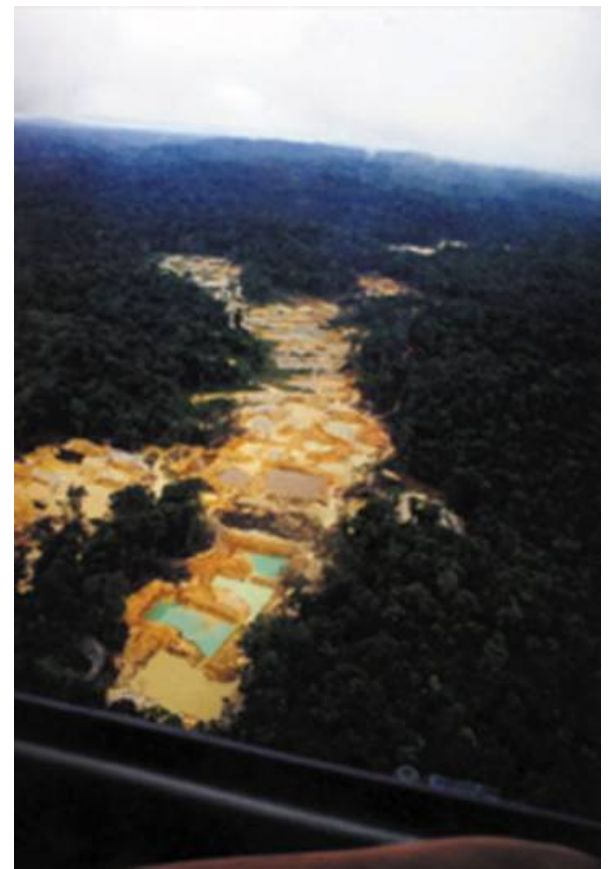
LGIT, Univ. Joseph-Fourier, Grenoble, France

Other research projects in Environmental Sciences related to CALIBRE

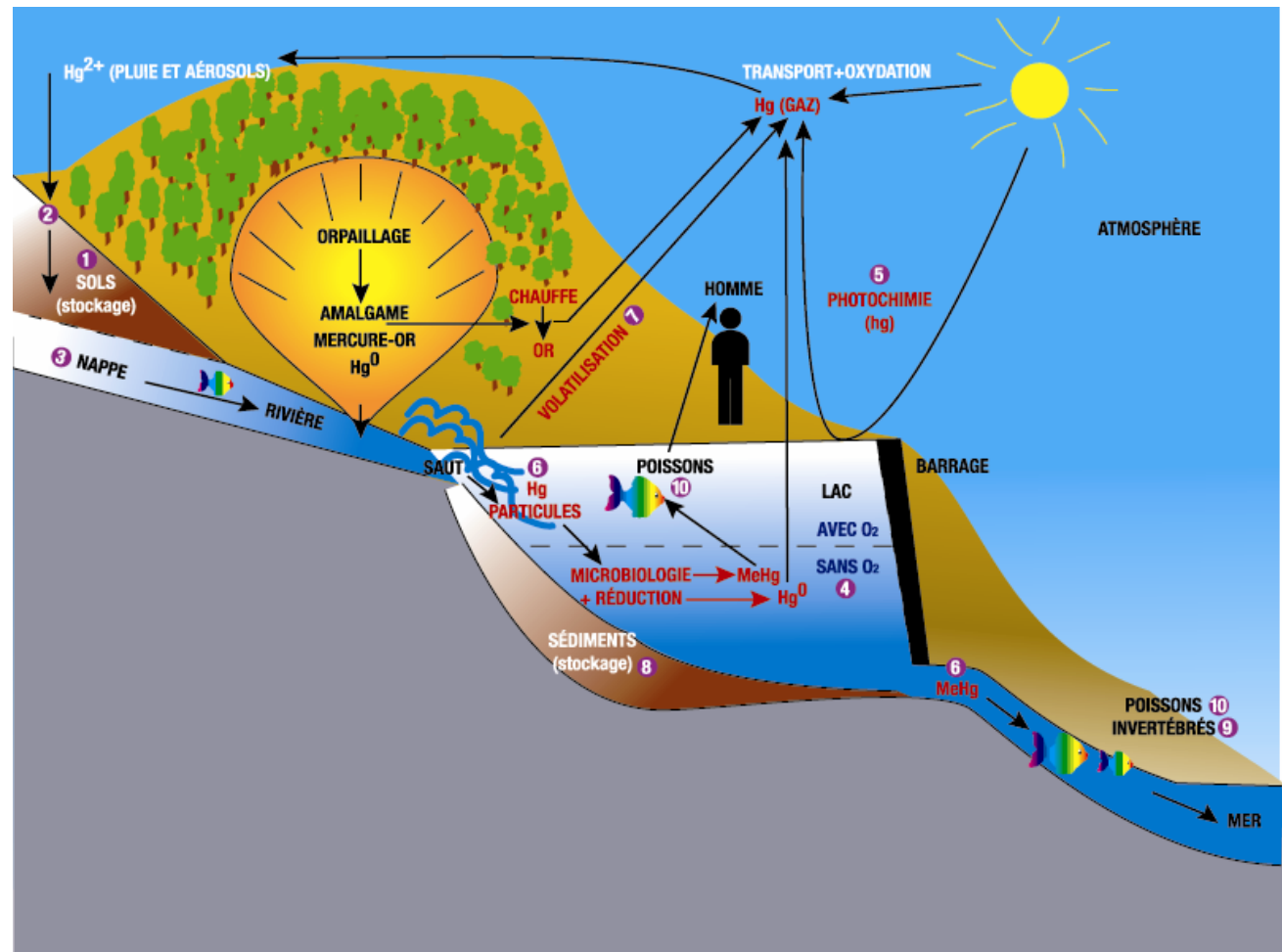
- ❖ Mercury in French
Guyane (1999-2006)
12 teams covering :
 - source
 - exposure route
 - human response to
exposure
- ❖ AQUATRIN (2007-
2010): Geogenic
contaminants (As, SE,
Mn, Fe..) in EU



Mercury in French Guyana: Gold mining in «pristine» rainforest system?

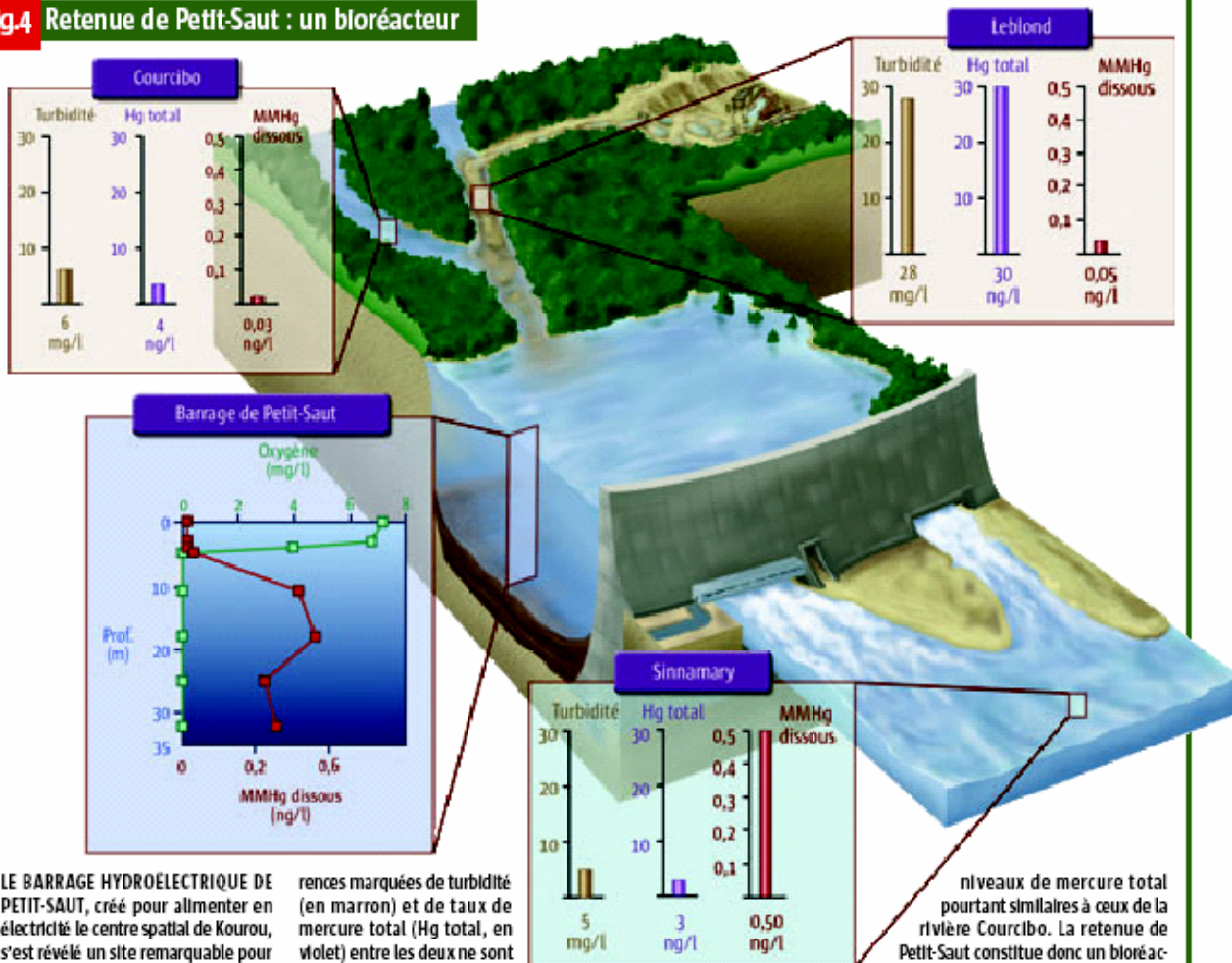


Pathways of mercury downhill from a gold mine and in a dam - similarities with Laos and dams on the Theun Hinboun River and Nam Theun 2 ??



Dam in the tropics: methyl mercury factories,,

Fig.4 Retenue de Petit-Saut : un bioréacteur



LE BARRAGE HYDROÉLECTRIQUE DE PETIT-SAUT, créé pour alimenter en électricité le centre spatial de Kourou, s'est révélé un site remarquable pour l'étude du mercure. En amont du barrage, deux rivières confluent avant de se déverser dans la retenue : la première, Leblond, draine les apports du site d'orpaillage de Saint-Elle ; la seconde, Courcibo, n'a pas été influencée par les activités minières au cours des dernières décennies. Les diffé-

rences marquées de turbidité (en marron) et de taux de mercure total (Hg total, en violet) entre les deux ne sont donc pas surprenantes : l'orpaillage, qui conduit à une amplification de l'érosion des sols naturellement riches en mercure et à des rejets de la forme élémentaire du métal les explique. En revanche, et beaucoup plus étonnant, les concentrations de la forme organique du mercure, le

méthylmercure dans l'eau filtrée (MMHg, en rouge) sont tout à fait comparables entre les deux rivières. Ce qui n'est pas vrai en aval du barrage, où les eaux du fleuve Sinnamary contiennent dix fois plus de méthylmercure, pour des

niveaux de mercure total pourtant similaires à ceux de la rivière Courcibo. La retenue de Petit-Saut constitue donc un bioréacteur extrêmement efficace pour la transformation du mercure en méthylmercure : dès qu'il n'y a plus d'oxygène dans l'eau (courbe verte), en dessous de 5 mètres de profondeur, les conditions sont réunies pour produire du méthylmercure (courbe rouge).
Données M. Coquery

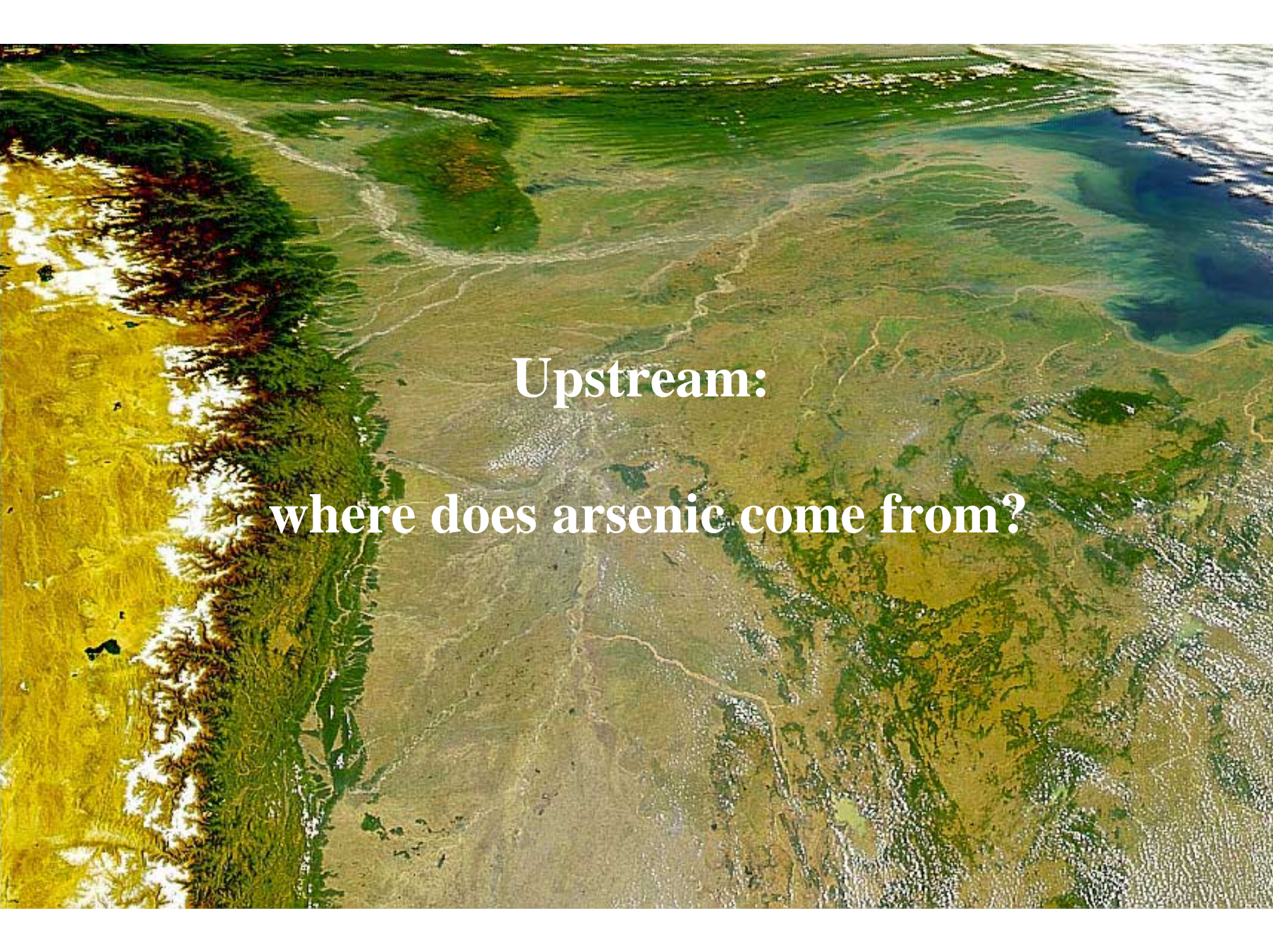
methyl mercury which end up contaminating fish and kids





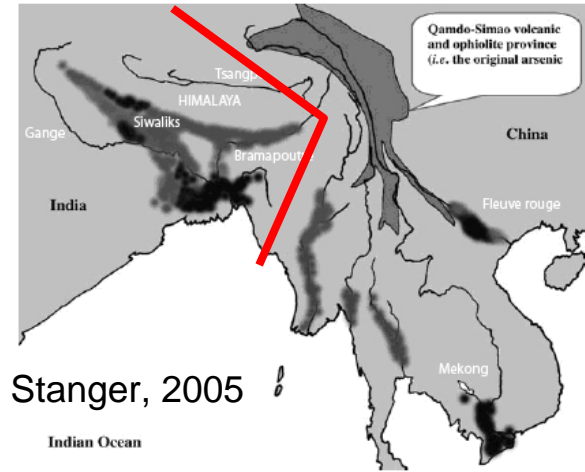
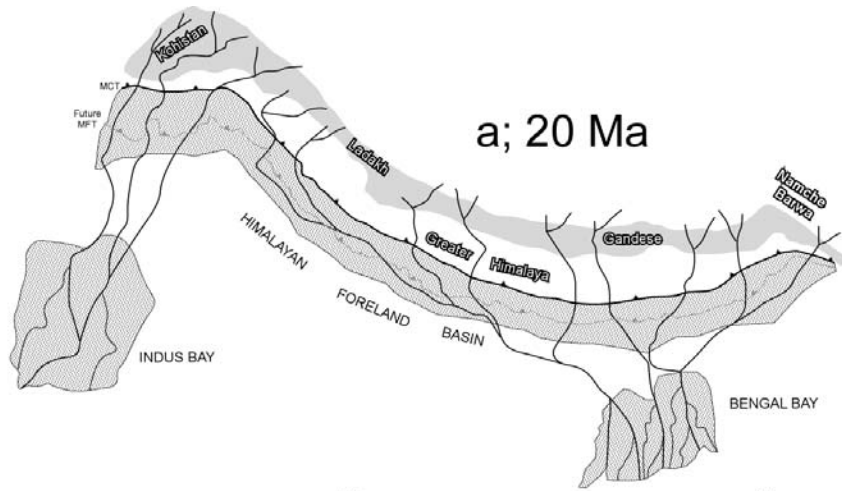
Arsenic in Bengal

From field scale to molecular modeling



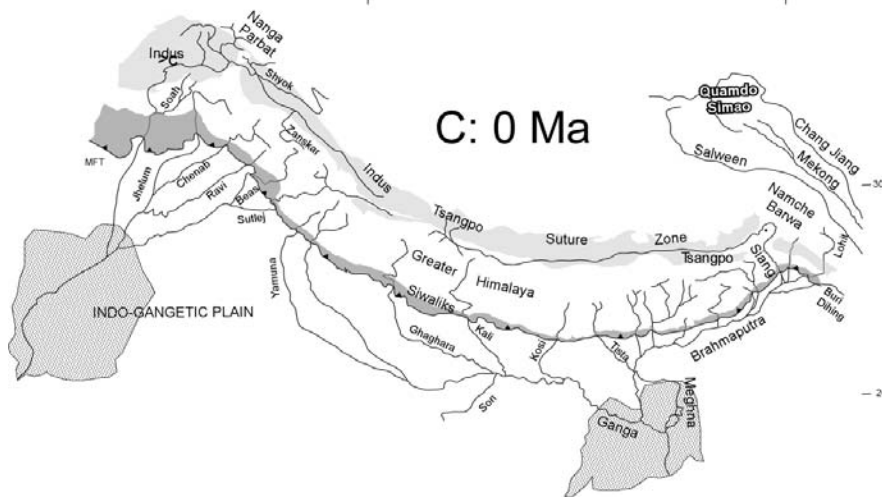
Upstream:

where does arsenic come from?



Stanger, 2005

Indian Ocean

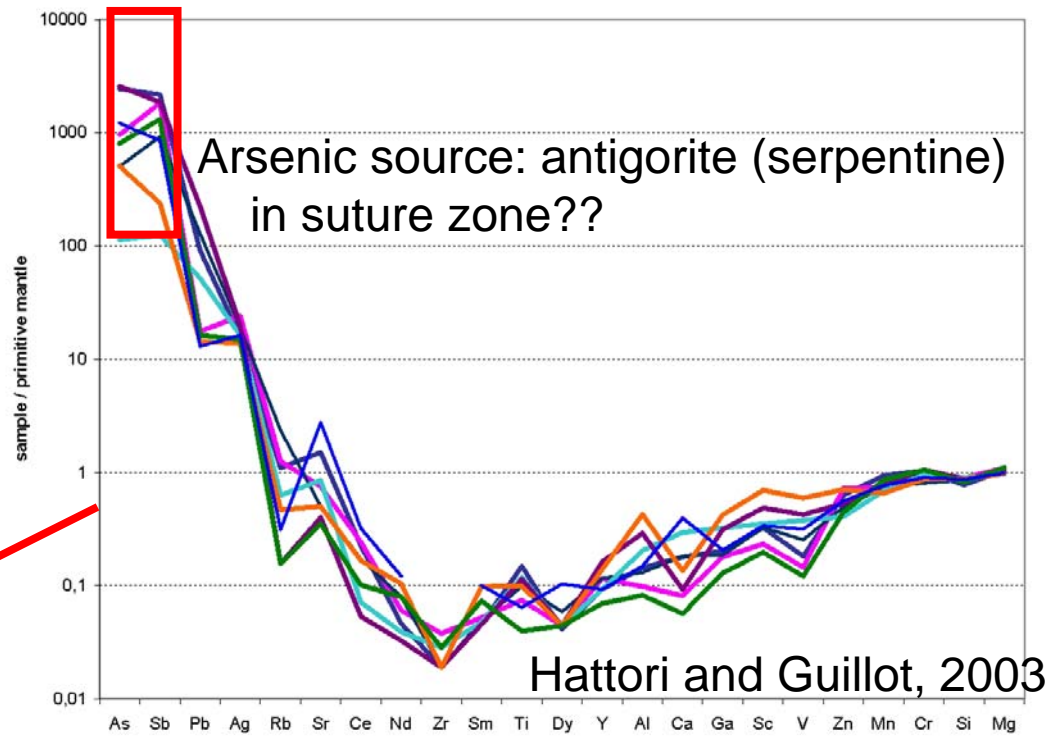
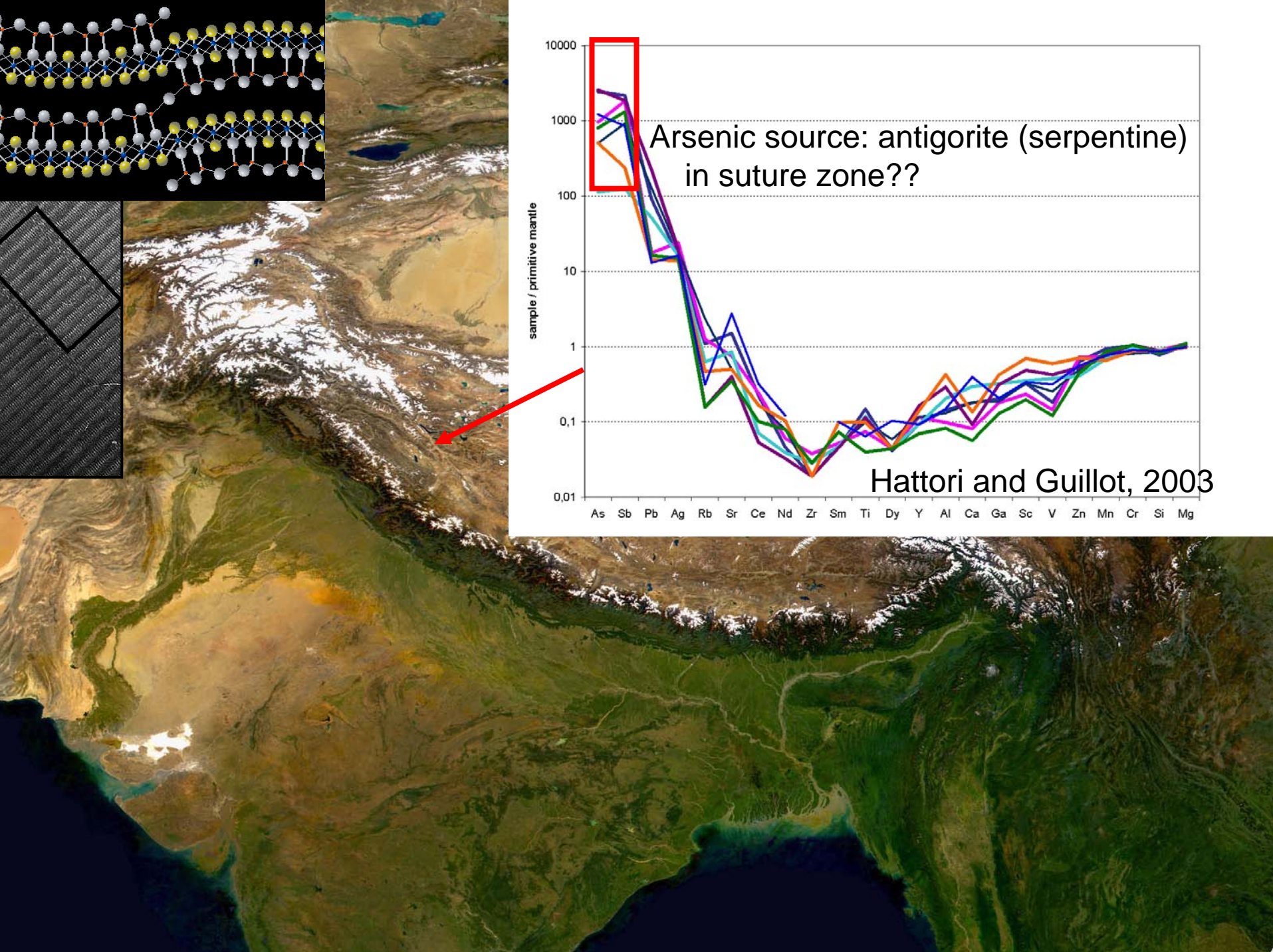
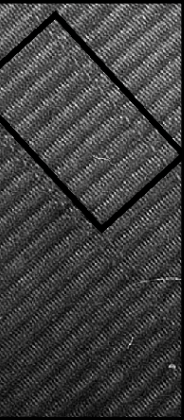
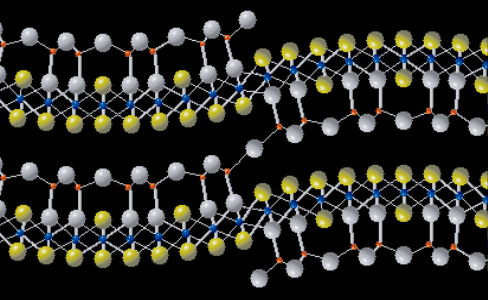


**Check these sources
for Mekong as well**

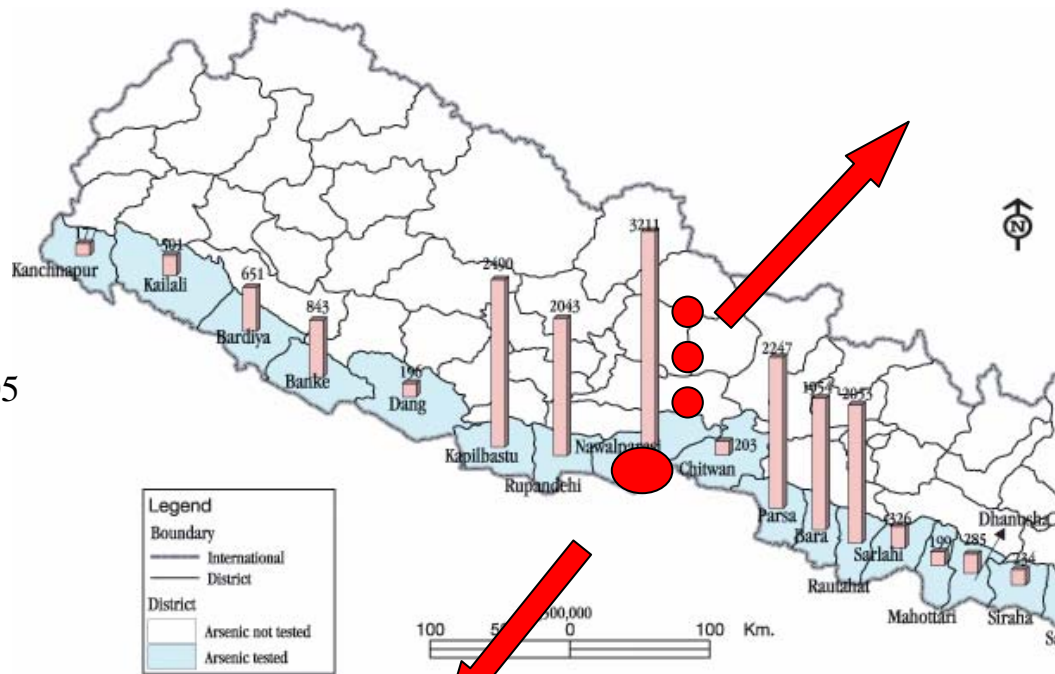
Our current hypothesis:

- 1) Convergent boundary serpentines are source of As
- 2) Hydrology has changed over the years
- 3) Siwaliks is a temporary storage zone since 20 Ma

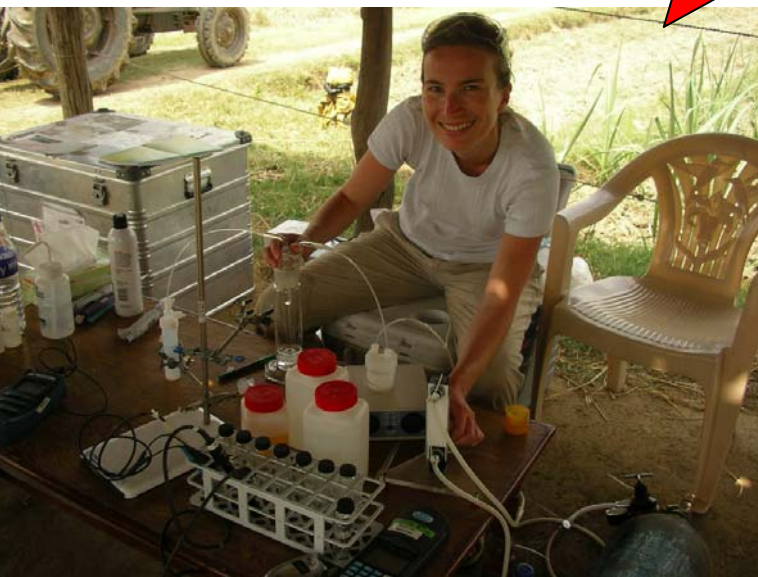
(Guillot and Charlet, 2007)



USGS, 2005



Student at work



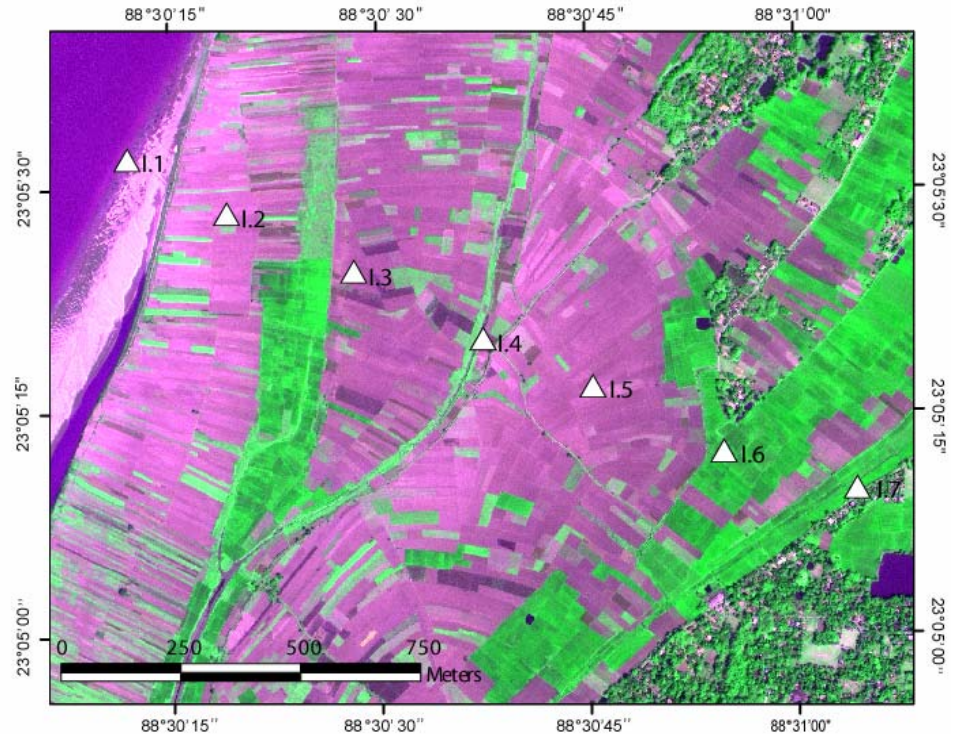
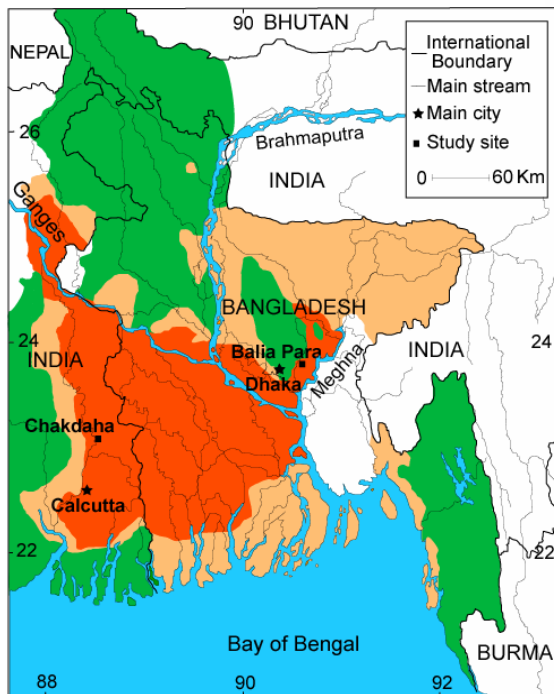
Delphine
At work

**Nepal field campaign,
March 2007**

Question: how is Arsenic released/transformed in the aquifer??

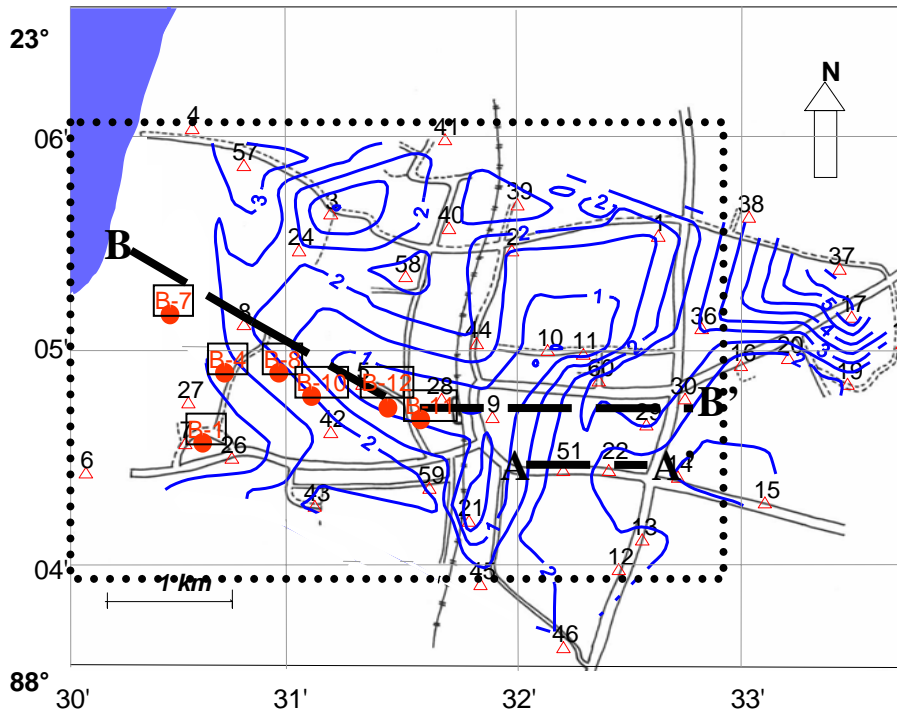


Redox in ground water recharge (along the Hoogly River, West Bengal, India)

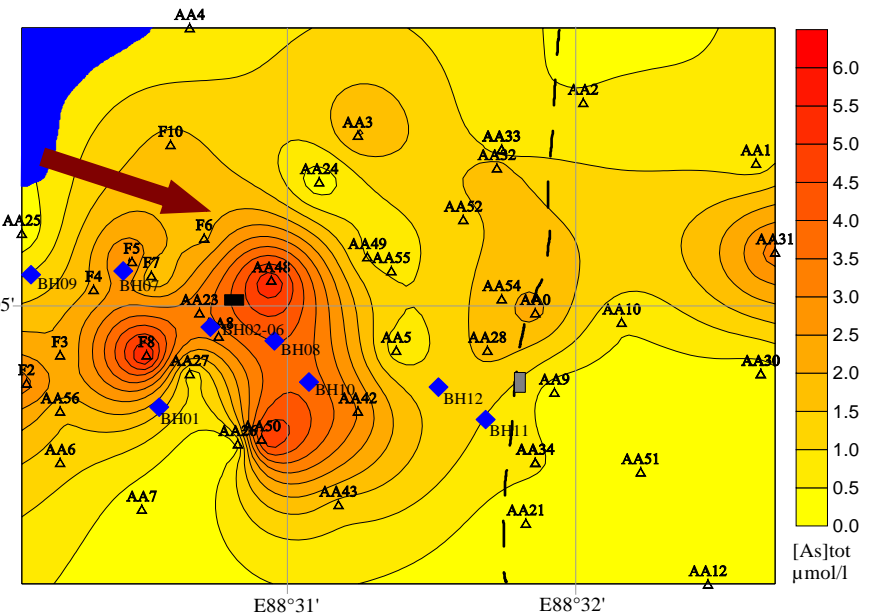


Pore water sampling device: A. Van Geen, Lahmont Observatory, Columbia University (Métral et al. submitted)

Water move and Arsenic « hotspot »

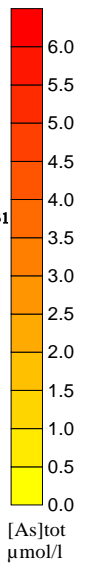


- △ Tubewell
- Borehole piezometer
- 5 — Isopiezometric curve (m)
- Hoogly river



- Hoogly river
- — railway
- Railway station
- School
- ◆ New piezometers
- △ Tubewells

➔ Groundwater Flow Direction





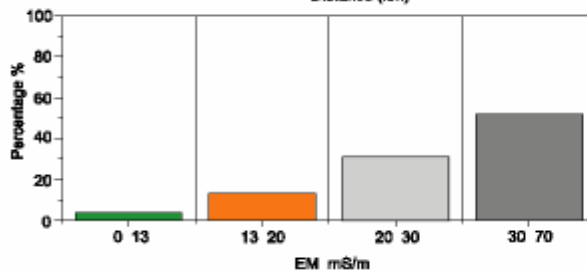
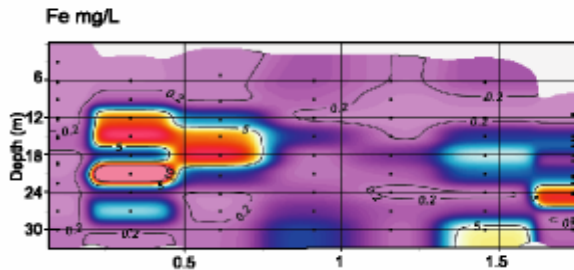
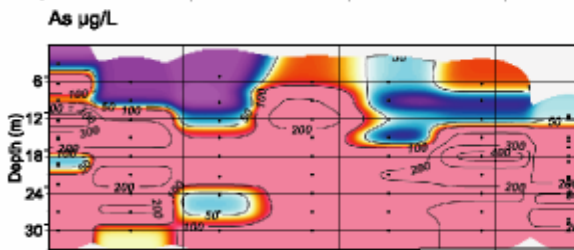
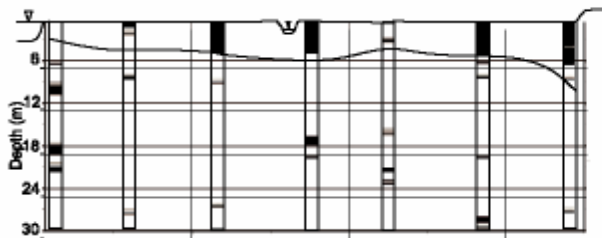
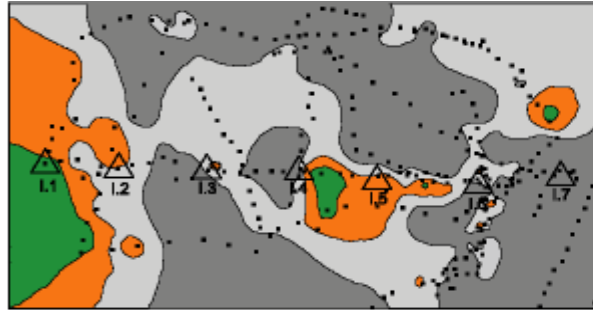
ElectroMagnetic
conductivity

Lithology
(black = clay)

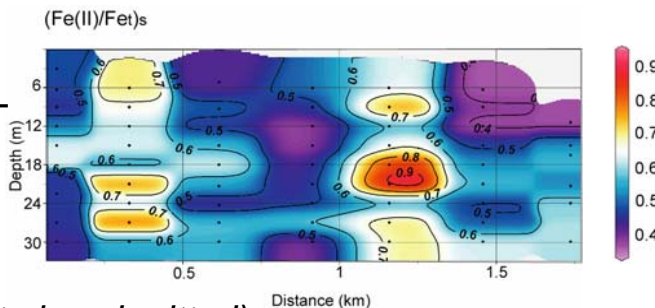
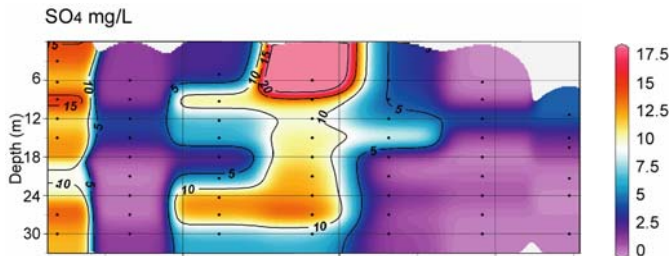
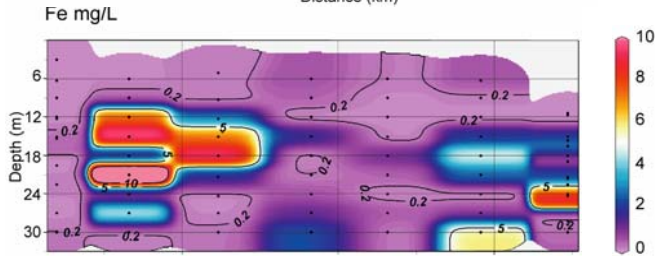
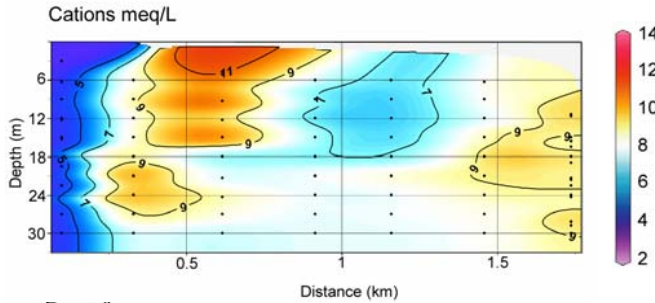
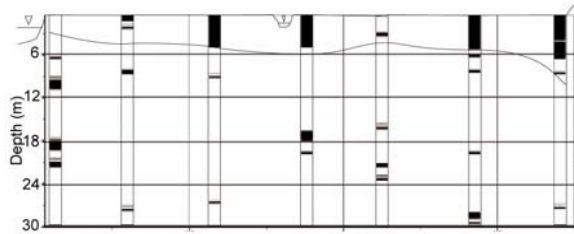
Arsenic
in solution

Fer
in solution

EM



EM mS/m



Zonation:

+ temporal fluctuation with Monsoon

- below impermeable
(high E.M.) soil layer°
anoxic (S(-II) dominated)

- below more permeable
(low E.M.) soils
suboxic, Fe(II) dominated

Fe^{II}(aq)

S^{VI}(aq)

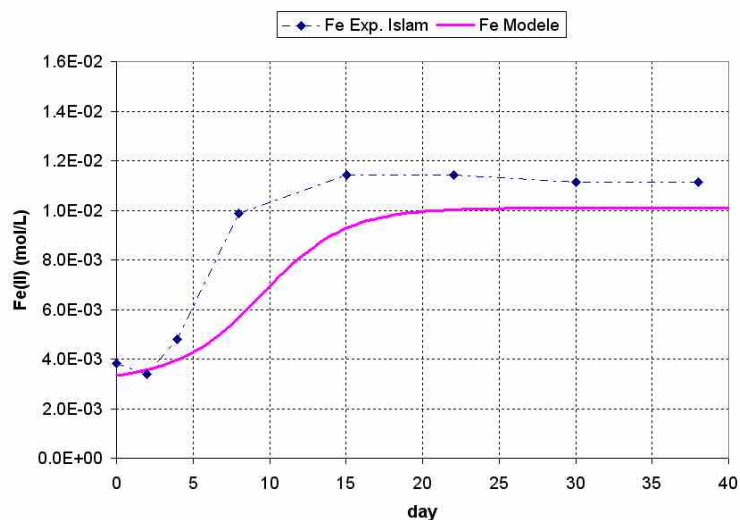
Solid
Fe(II)/Fe_T

(Métral et al.; submitted)

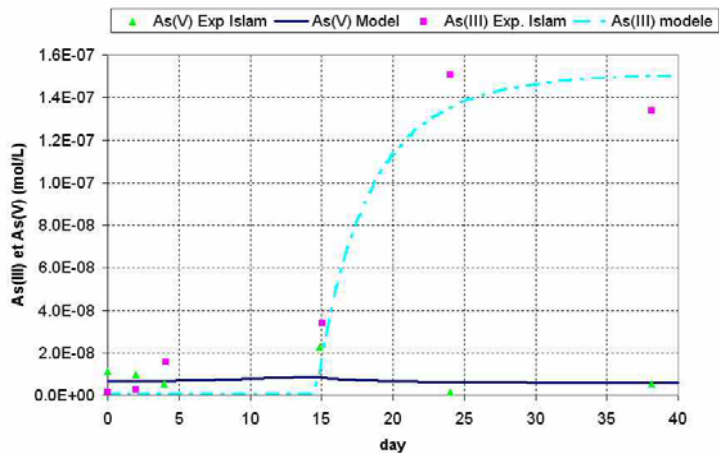


But also molecular scale investigations.....

Arsenic and Bacteria: decoupling Fe&As reduction; an Eh-based model



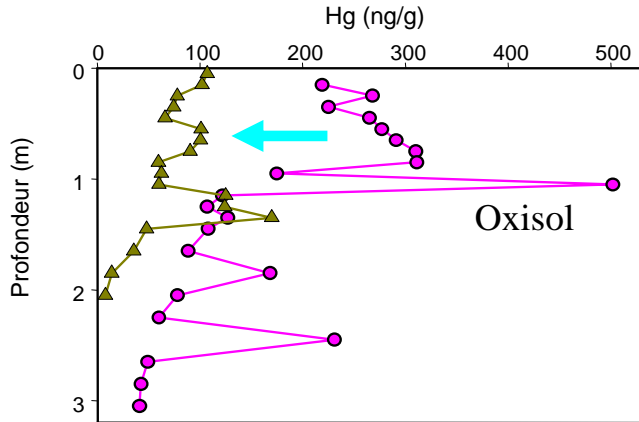
Data from Islam et al., 2004



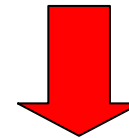
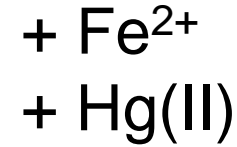
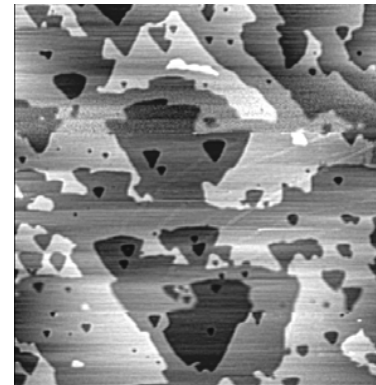
(Burnol et al. in prep)

Mercury, Fe²⁺ and micas: reduction and volatilisation or methylation

Hydromorphic soils et oxisol



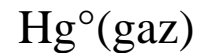
Clay (phlogopite)



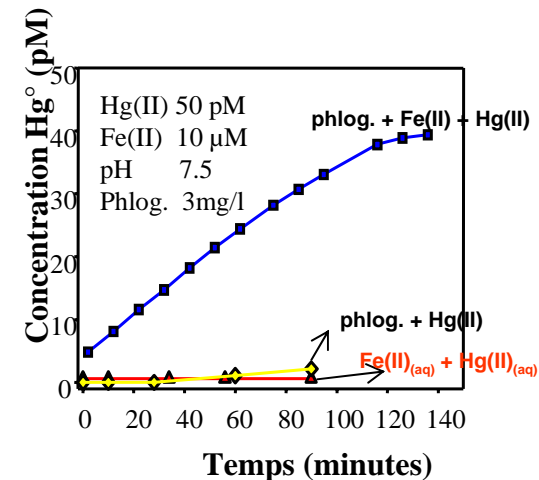
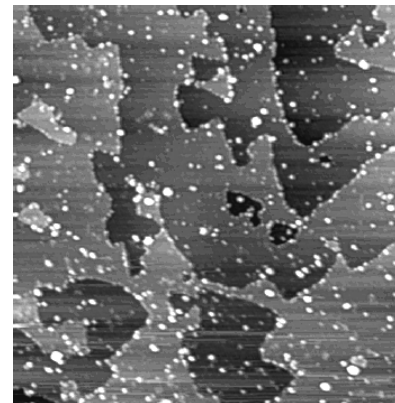
Production of:



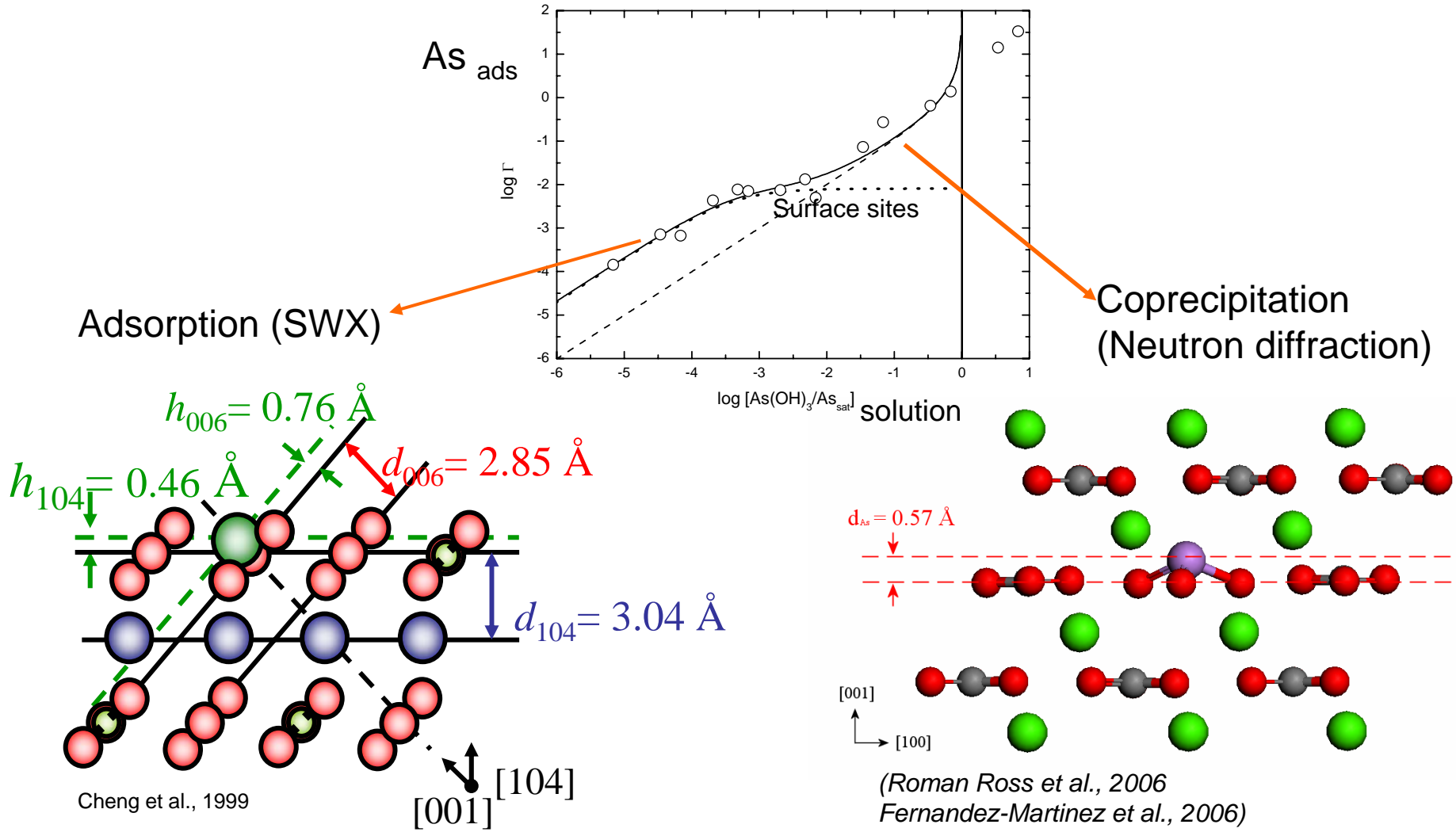
and



k_{obs}, min^{-1}	avec FeCit
$0.3 \cdot 10^{-3}$	horizon 30-40 cm
$0.3 \cdot 10^{-3}$	horizon 60-70 cm
$5.1 \cdot 10^{-3}$	horizon 90-100 cm
$11.6 \cdot 10^{-3}$	phlogopite
$2.7 \cdot 10^{-5}$	bacteria (sediment)



Arsenic sequestration in calcite mineral : adsorption and coprecipitation (neutron and X-ray diff.)



Redox systems investigated at different scales

