Distribution of anthropogenic mercury in French Guyana river sediments downstream from gold mining sites

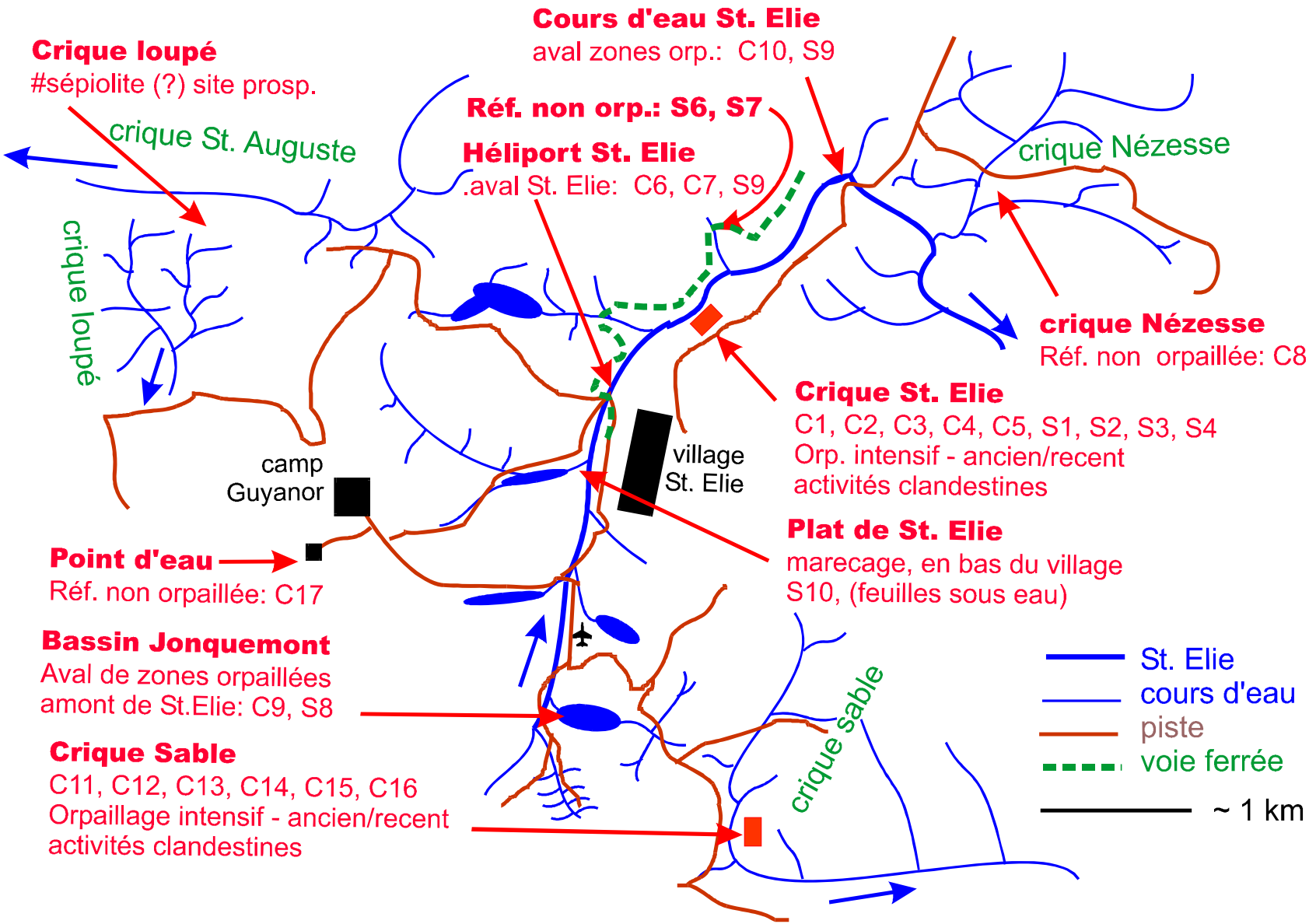
L. Spadini, L. Charlet

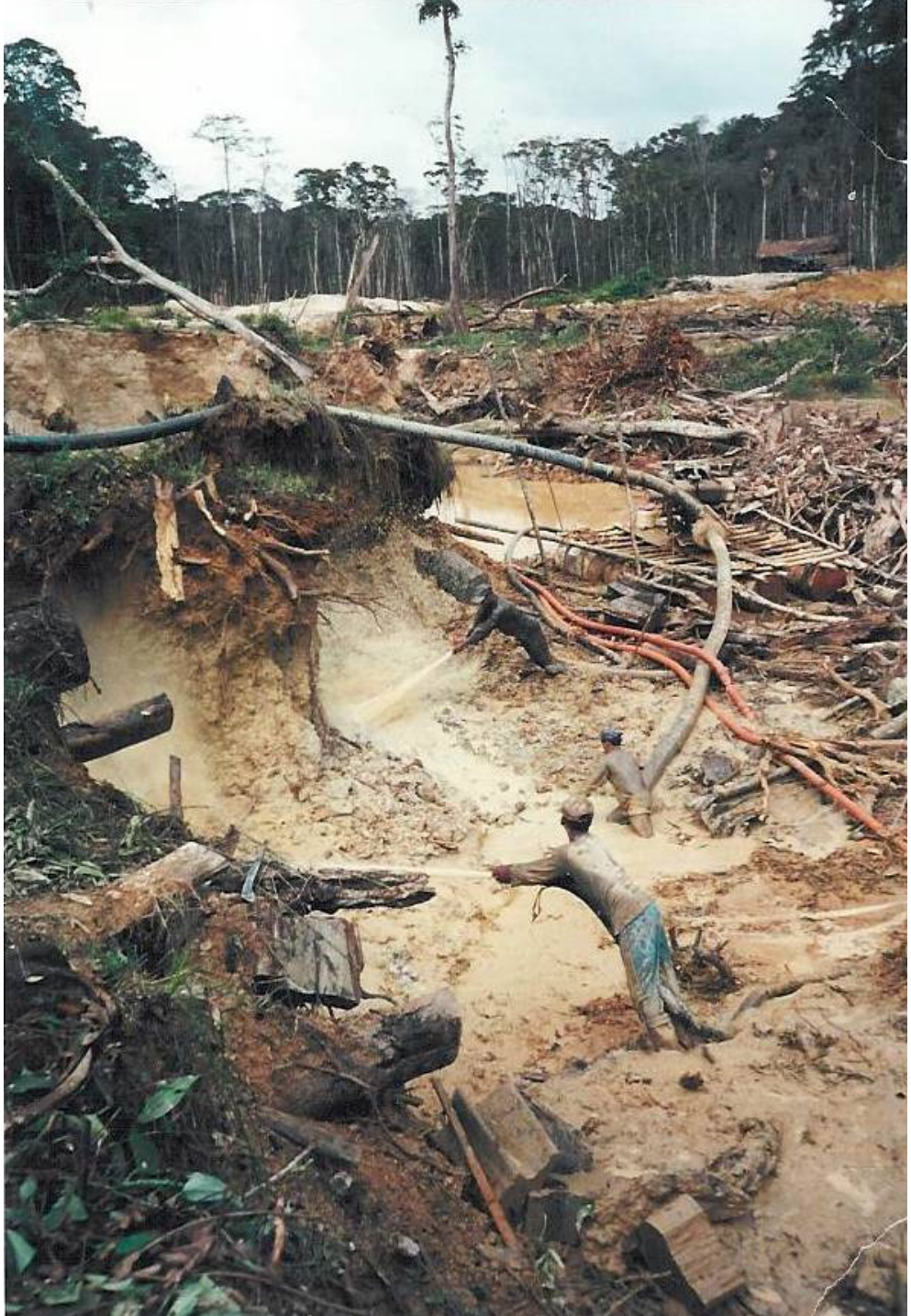
I. St. Elie

II. Inini (Dorlin)

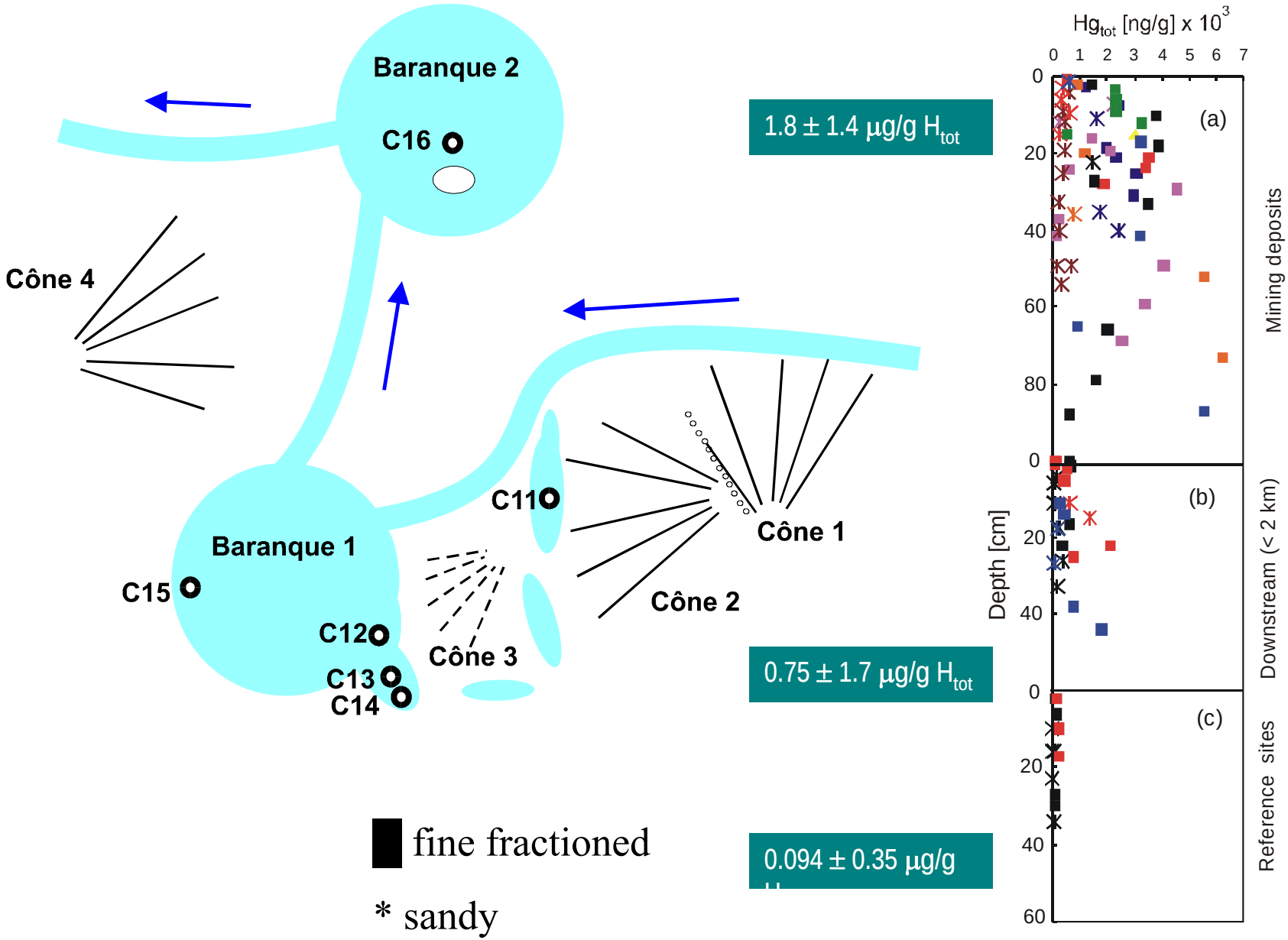
III. Ecerex

St. Elie


Crique loupé
#sépiolite (?) site prosp.
crique St. Auguste
crique loupé
Cours d'eau St. Elie
aval zones orp.: C10, S9
Réf. non orp.: S6, S7
Héliport St. Elie
.aval St. Elie: C6, C7, S9
crique Nézesse
crique Nézesse
Réf. non orpaillée: C8
Crique St. Elie
C1, C2, C3, C4, C5, S1, S2, S3, S4
Orp. intensif - ancien/recent
activités clandestines
camp
Guyanor
village
St. Elie
Point d'eau
Réf. non orpaillée: C17
Plat de St. Elie
marecage, en bas du village
S10, (feuilles sous eau)
Bassin Jonquemont
Aval de zones orpaillées
amont de St.Elie: C9, S8
Crique Sable
C11, C12, C13, C14, C15, C16
Orpaillage intensif - ancien/recent
activités clandestines
crique sable
St. Elie
cours d'eau
piste
voie ferrée
~ 1 km

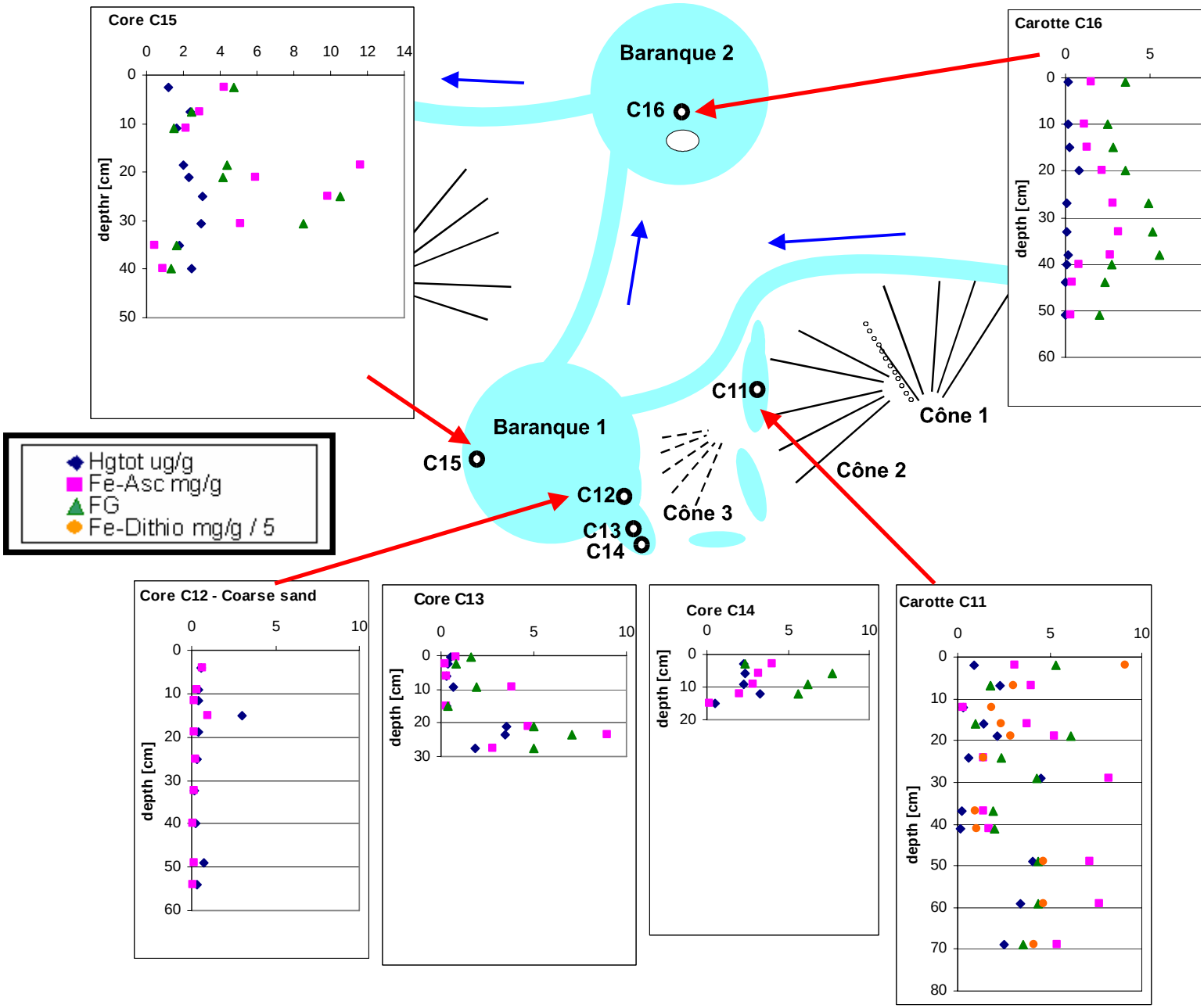



C10
C8

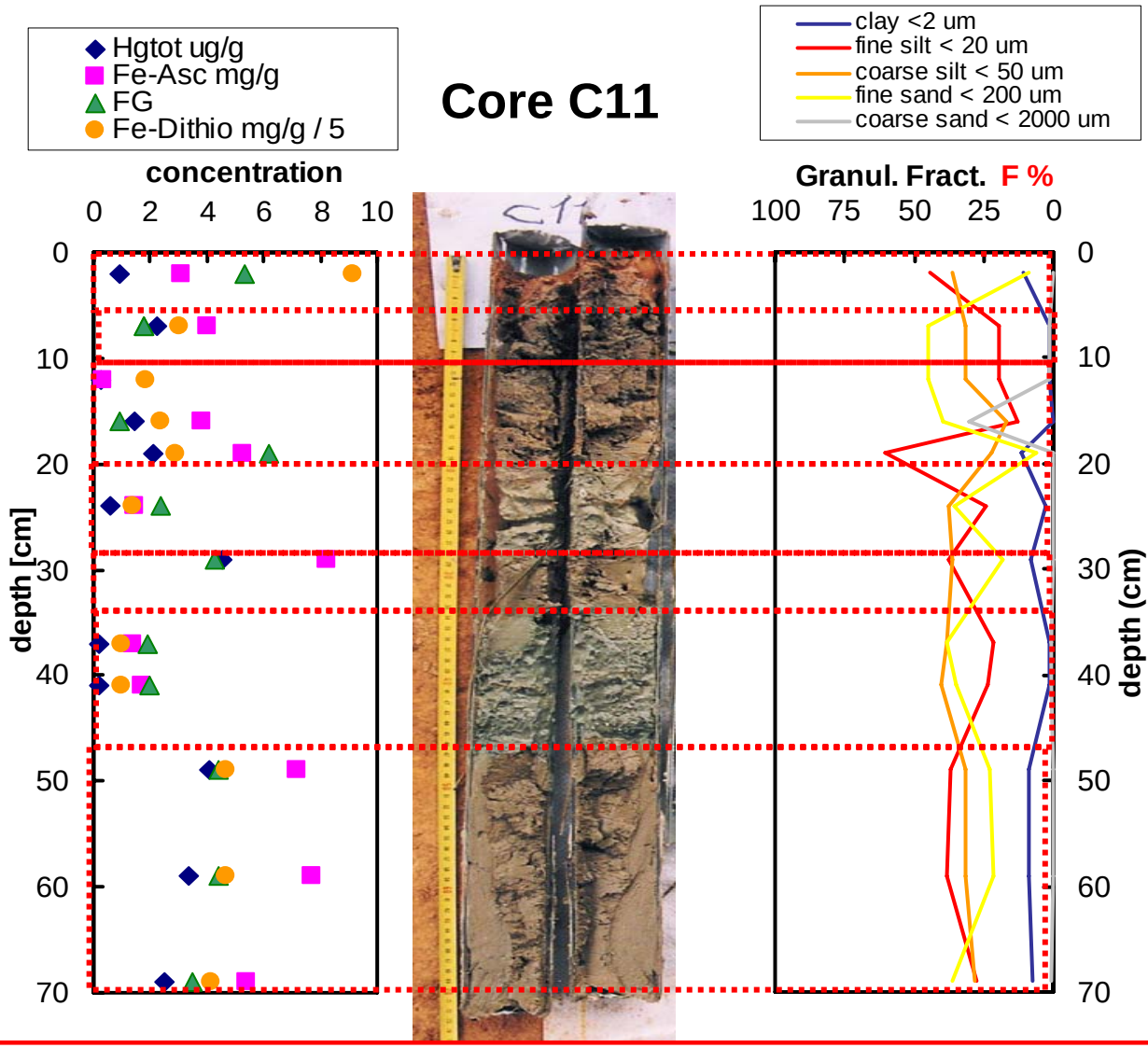

Baranque 2
C16
Cône 4
Baranque 1
C15
C12
C13
C14
C11
Cône 3
Cône 1
Cône 2
1.8 ± 1.4 µg/g H tot
0.75 ± 1.7 µg/g H tot
0.094 ± 0.35 µg/g
fine fractioned
* sandy
Hg tot [ng/g] x 10 3
0 1 2 3 4 5 6 7
Depth [cm]
(a)
(b)
(c)
Mining deposits
Downstream (< 2 km)
Reference sites

Mercury in mining sediment		Mercury in sediment downstream
V = 20 x 20 m^2 x 4 m depth d = 2.7 kg/l, porosity 30% **1.8 µg/g** **>> 2.3 kg mercury in excavation.**		Estimation: V = 30 km x 20 m x 3 m (Dimension of hypothetical valley) d = 2.7 kg/l, porosity 30% **0.75 µg/g** **>> 1.1 t mercury sediment volume**
Note: ~ 0.5 kg gold extracted for 1 kg Hg used		Note: ~ 10 t gold/ year produced in French Guyana (2) >> 20 t mercury / year
>>>>> local pollution		>>>> Relatively small quantity stocked in superficial downstream sediments

(2) Colonnel Turckheim, Commandant in Cayenne 1998. Estimations are based on Helicopter fuel consumption and rentability calculations.


Core C15
depthr [cm]
Carotte C16
depth [cm]
Baranque 2
C16
Baranque 1
C15
C12
C13
C14
C11
Cône 1
Cône 2
Cône 3
Hgtot ug/g
Fe-Asc mg/g
FG
Fe-Dithio mg/g / 5
Core C12 - Coarse sand
Core C13
Core C14
Carotte C11

Core C11



- **Stratified**
- **Heterogeneous Granulometry**

Apparent correlation:

> Hg_{tot}

> Fe_{Asc}

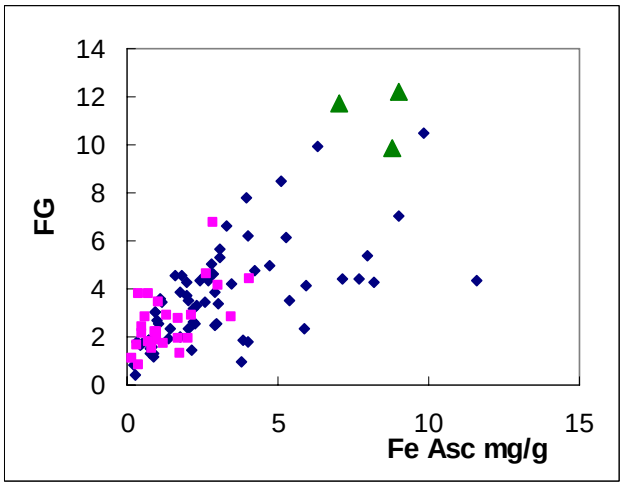
> Granul. Factor FG

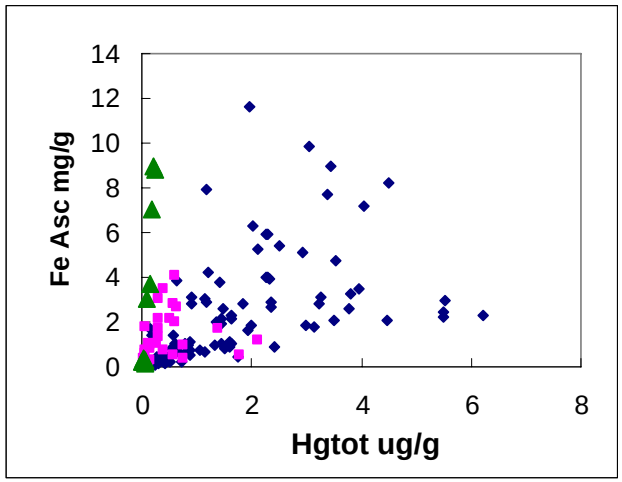
Representative for most of the St. Elie cores

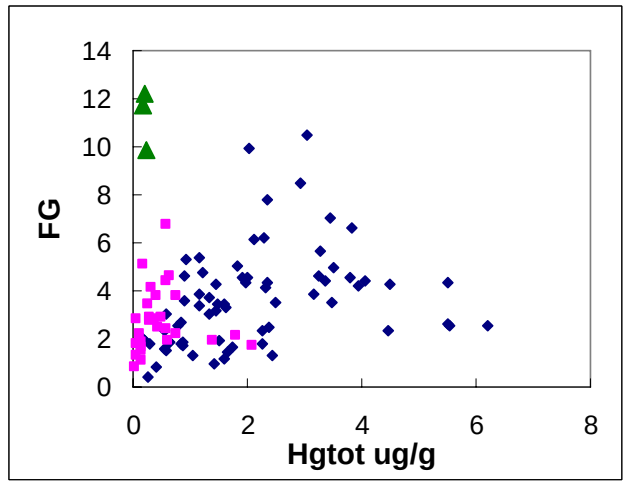
$$FG = (25 \times F\%_{Clay} + 5 \times F\%_{FineSilt} + 1 \times F\%_{CoarseSilt} + 0.2 \times F\%_{FineSand}) / 100$$

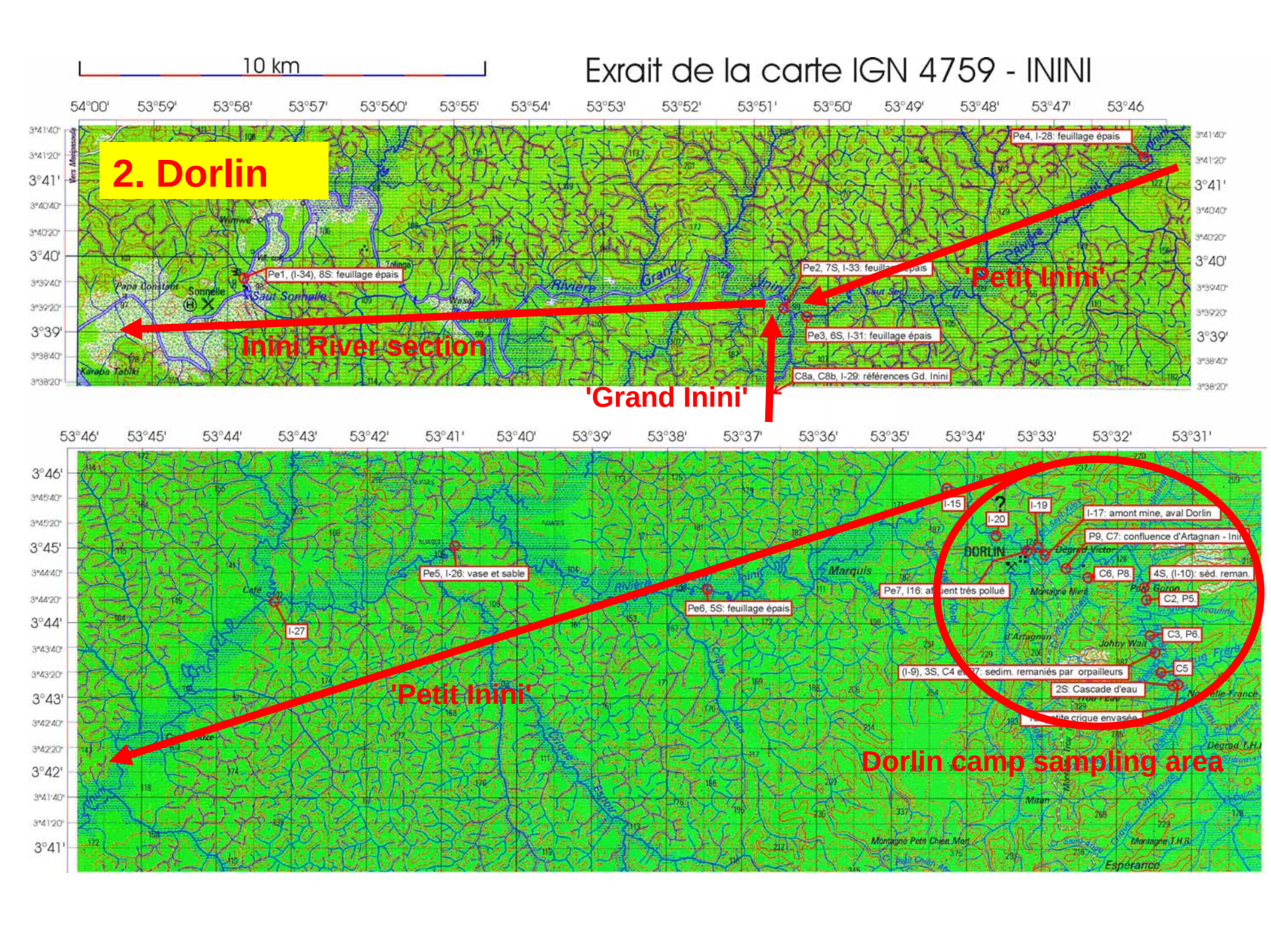
Correlation Diagrams St. Elie

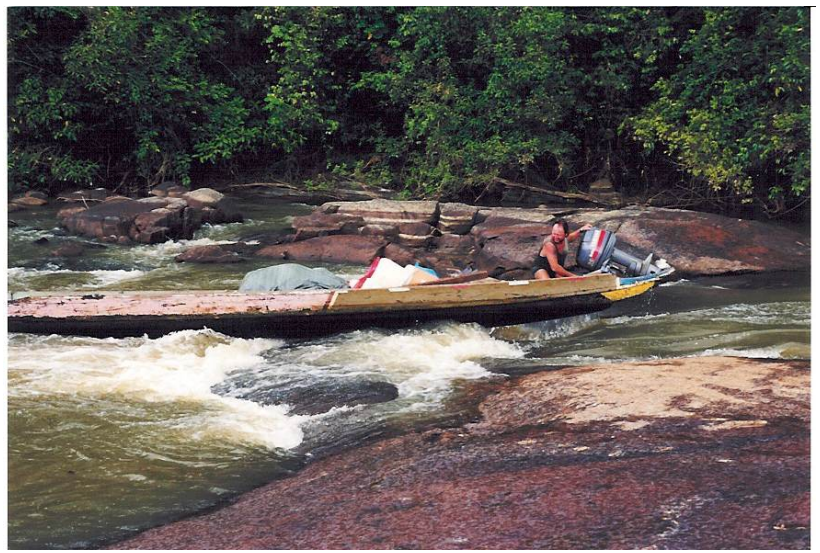
Mining sites (Crique St. Elie (C1 to C5) & Crique Sable (C11 to C15)
Downstream mining sites (1 to 3 km); (C6, C7, C9, C10)
Reference sites (upstream mining sites); (C8, C17)

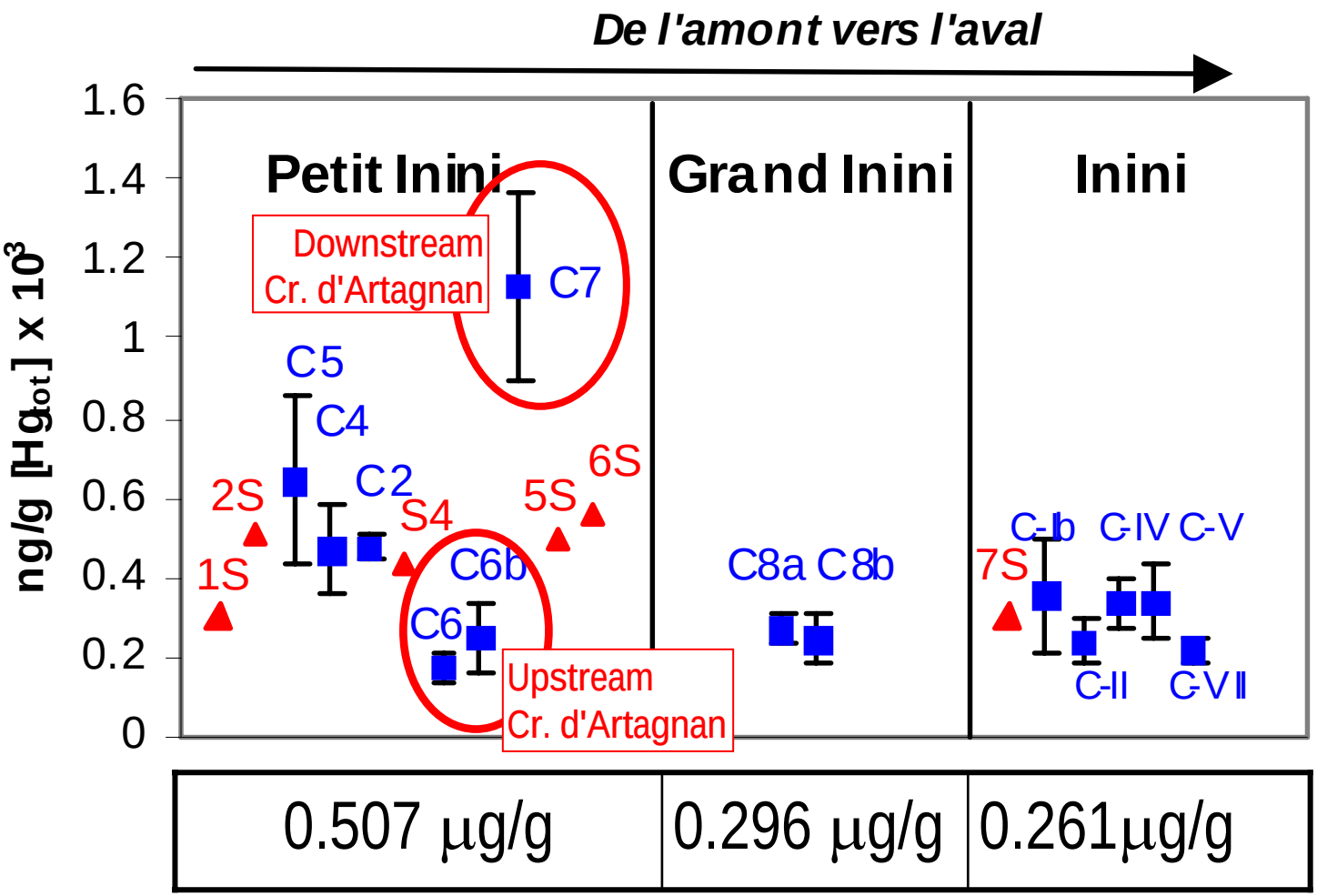






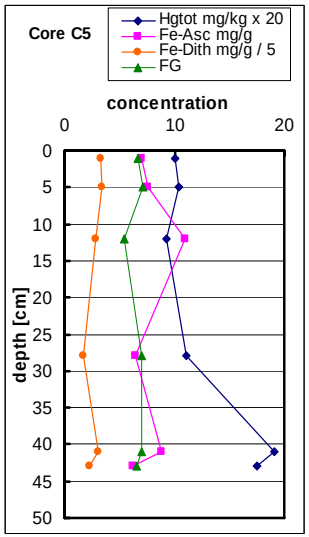

10 km
Exrait de la carte IGN 4759 - ININI
2. Dorlin
Pe4, I-28: feuillage épais
Pe1, (I-34), 8S: feuillage épais
Pe2, 7S, I-33: feuillage épais
Pe3, 6S, I-31: feuillage épais
C8a, C8b, I-29: références Gd. Inini
'Petit Inini'
Inini River section
'Grand Inini'
Pe5, I-26: vase et sable
Pe6, 5S: feuillage épais
Pe7, I16: affluent très pollué
I-27
I-15
I-20
I-19
I-17: amont mine, aval Dorlin
P9, C7: confluence d'Artagnan - Inini
DORLIN
C6, P8
4S, (I-10): séd. remaniés
C2, P5
C3, P6
C5
2S: Cascade d'eau
'Petit Inini'
Dorlin camp sampling area

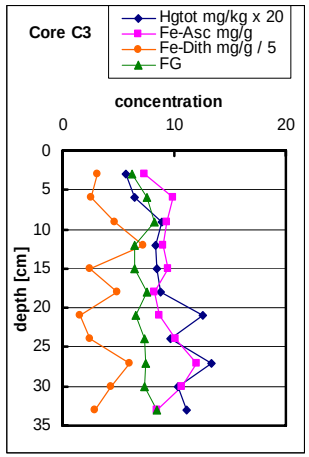



De l'amont vers l'aval
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
ng/g [Hgtot] x 10³
Petit Inini
Grand Inini
Inini
Downstream
Cr. d'Artagnan
C7
C5
C4
C2
2S
S4
5S
6S
1S
C6b
C6
Upstream
Cr. d'Artagnan
C8a C8b
7S
C-Ib
C-IV C-V
C-II
C-VII
0.507 µg/g
0.296 µg/g
0.261µg/g

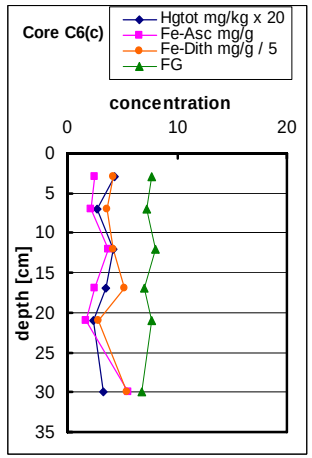
Inini river system: representative core profiles

Petit Inini

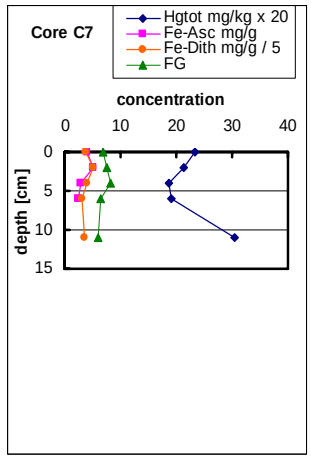




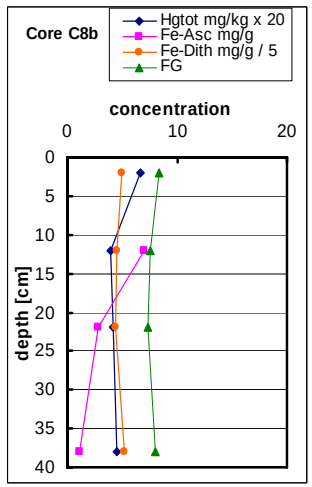
C6 core



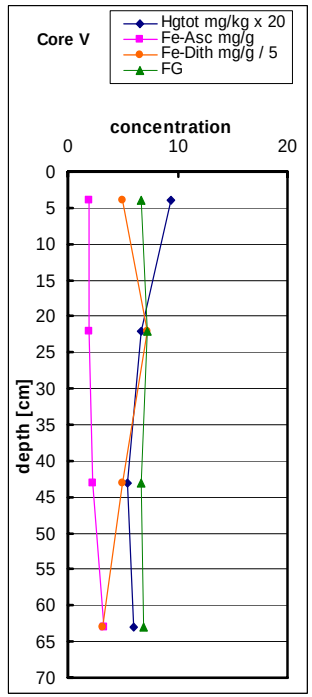
C7 core



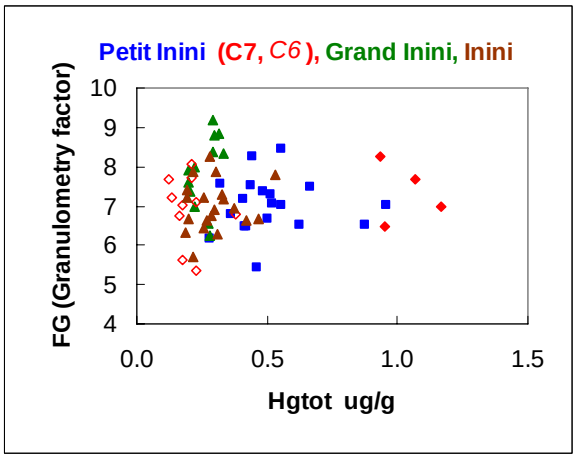
Inini

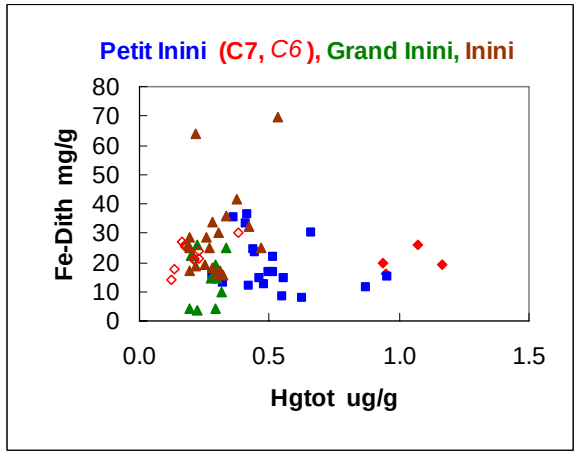


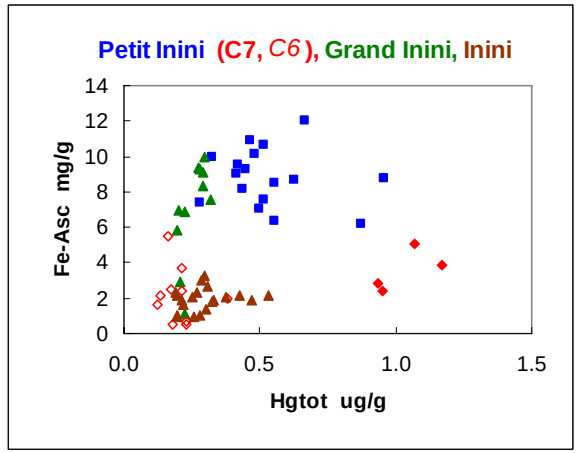
Grand Inini

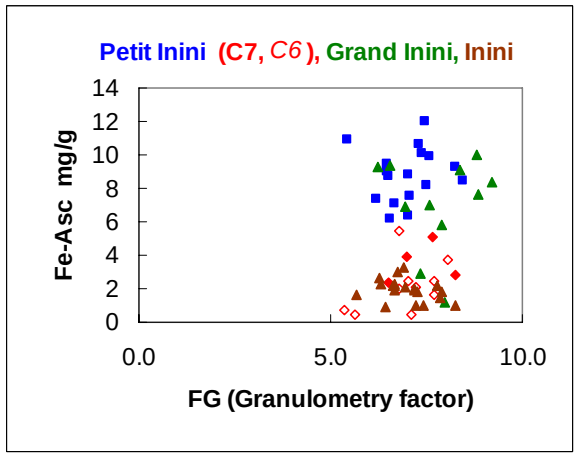


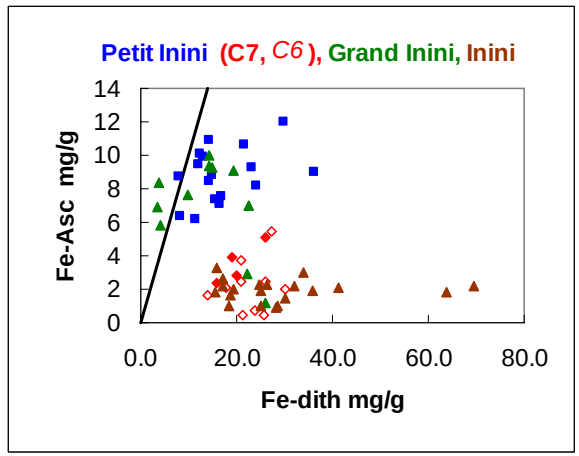
Correlation Diagrams Dorlin











Dissolved Hg:

~ 2 ng/l (M. Coquery) 10^{-12} g/l

Suspended mercury:

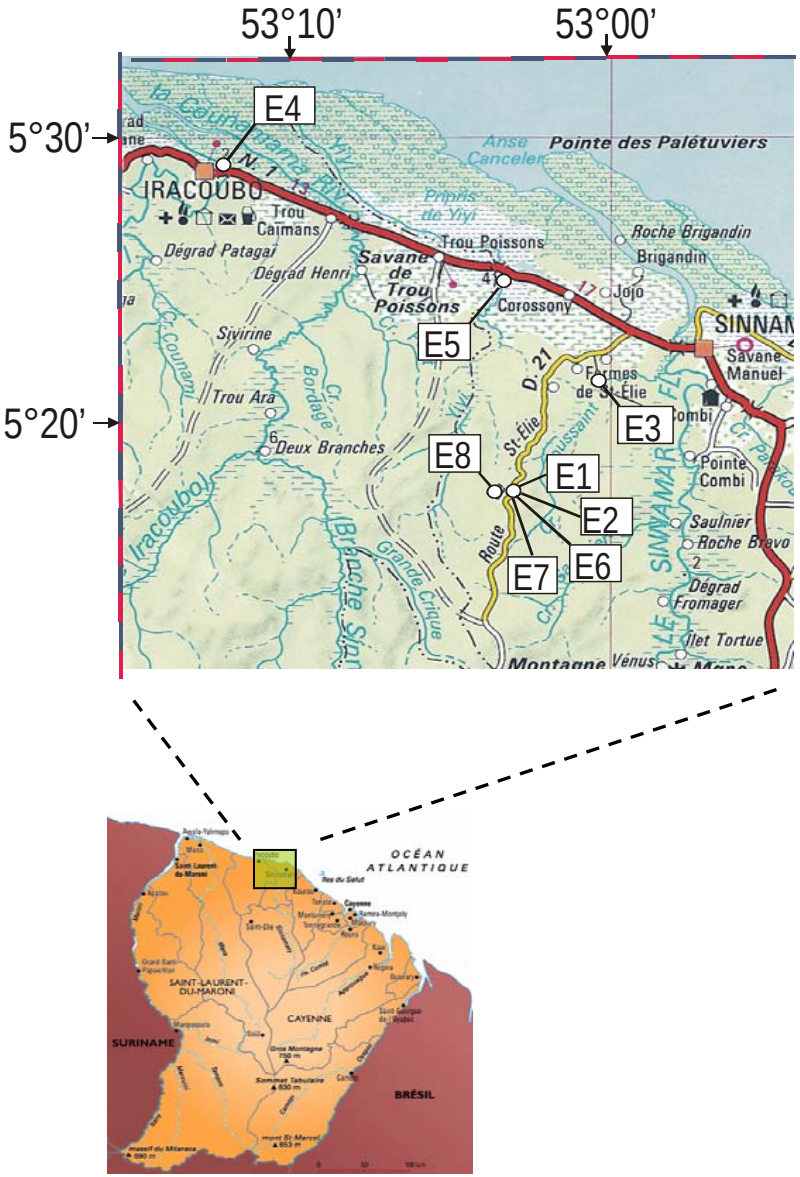
Crique sans nom: SMC ~ 20 mg/l, Hg_{fixed} ~ 0.5 µg/g 10^{-11} g/l

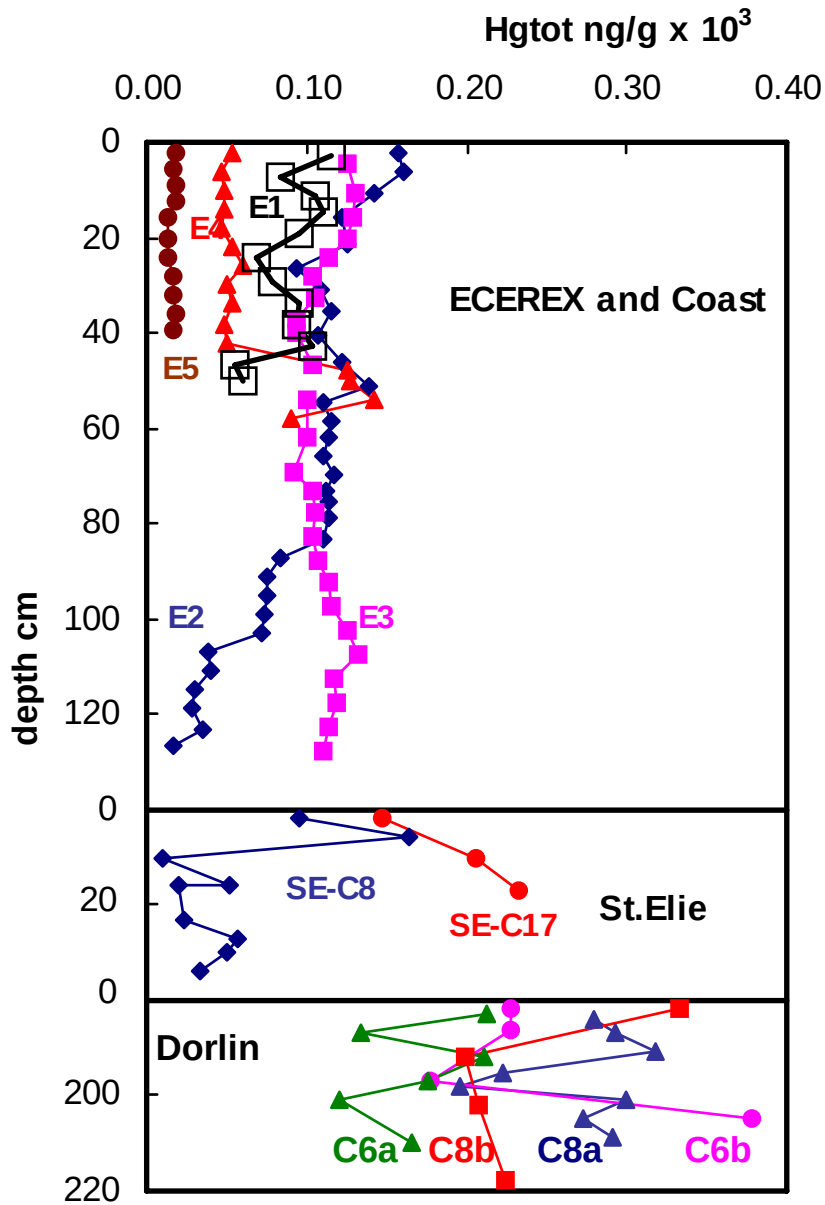
Petit Inini SMC ~ 2000 mg/l, Hg_{fixed} ~ 0.5 µg/g 10^{-9} g/l

>> Transfer in the river: Mercury fixed to the SM

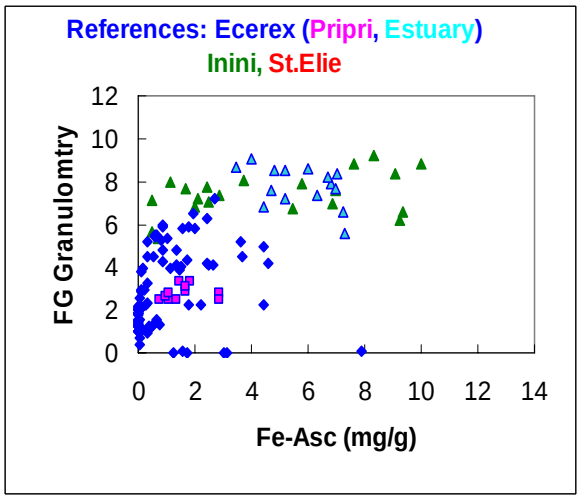
Inini – Maroni merge

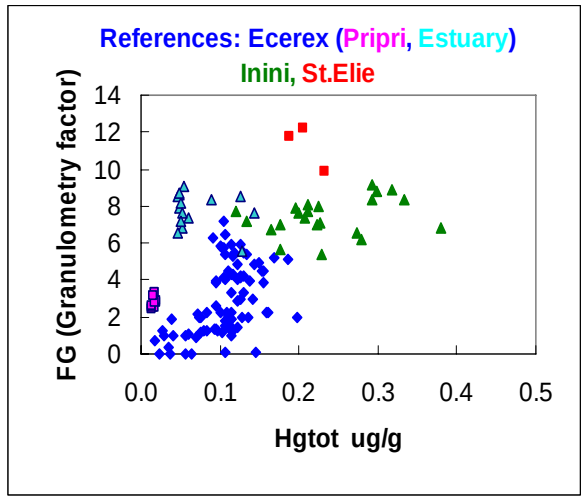
3. Ecerex

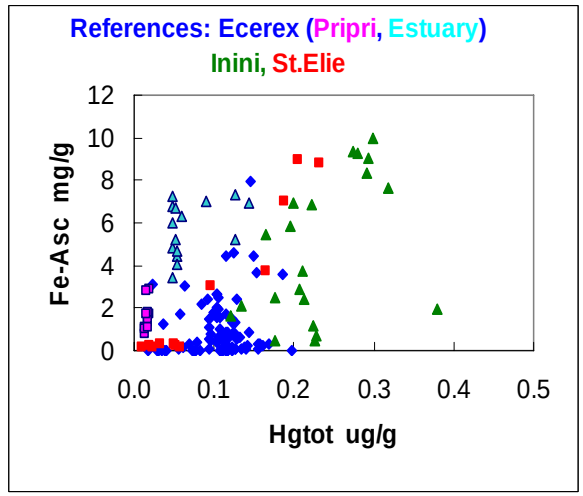

53°10'
53°00'
5°30'
5°20'
E4
E5
E8
E1
E2
E3
E7
E6
IRACOUBO
Trou Caimans
Dégrad Patagai
Dégrad Henri
Savane de Trou Poissons
Trou Poissons
Corossony
Jojo
Roche Brigandin
Brigandin
Pointe des Palétuviers
Anse Canceler
Pripris de Yiyi
Sivirine
Trou Ara
Deux Branches
Formes de St-Élie
Savane Manuel
Pointe Combi
Saulnier
Roche Bravo
Dégrad Fromager
Ilet Tortue
Montagne Vénus
SINNAMARY
OCÉAN ATLANTIQUE
SAINT-LAURENT-DU-MARONI
CAYENNE
SURINAME
BRÉSIL


Hgtot ng/g x 10³
0.00
0.10
0.20
0.30
0.40
depth cm
0
20
40
60
80
100
120
0
20
0
200
220
E4
E1
E5
E2
E3
ECEREX and Coast
SE-C8
SE-C17
St.Elie
Dorlin
C6a
C8b
C8a
C6b

Correlation Diagrams of Reference Sites







Mean Values & Standard Deviations

	Dorlin	St. Elie	Ecerex
Mining sediments	Petit Inini	Minig sites	
Hgtot µg/g	**507** ± 312	**1784** ± 1414	
Fe_{Asc} mg/g	2.98 ± 1.40	2.47 ± 2.42	
Fe_{Dith} mg/g	21.2 ± 4.9	--	
FG	7.41 ± 0.49	3.62 ±2.05	
Downstream	Inini	Downstream	
Hgtot µg/g	**296** ± 97	**750** ± 1710	
Fe_{Asc} mg/g	1.95 ± 0.58	1.35 ± 1.07	
Fe_{Dith} mg/g	29.3 ± 14.7	--	
FG	7 ± 0.65	2.77 ± 1.35	
Reference Sites	Gd Inini	'Virgin' sites	Ecerex (Rain forest)
Hgtot µg/g	**261** ± 49	**94** (few values)	**106** ± 35
Fe_{Asc} mg/g	7.02 ± 2.80	2.77	1.21 ± 2.44
Fe_{Dith} mg/g	15.0 ± 8.2	----	
FG	7.85 ± 0.94	11.27	2.84 ± 1.87

Conclusions

1) Mining affects the Hg_{tot} content of water courses and small rivers several km downstream the mining site.

2) No Hg impact to sediments is observed upstream mining sites, suggesting that the atmospheric impact related to mining activities is not significant.

3) Extracted iron correlates positively to both, granulometry and Hg content. The ‘Fe specific affinity’ of Hg is thus eventually related to the specific surface rather than to specific Hg – Feoxide interactions.

Thanks to…

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