Mercury Mobility in Epibenthic Waters of a Deltaic Environment

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Supporting Information

Table SI.1. Tests for stationary conditions for a sedimentation rate of 50 cm a^{-1} and an environmental change of 50 days (see section 4.3). (I) the interval of the tested zone; (Rates) the production or consumption rates; (Ds) the diffusion rates; (tR) the characteristic time for reaction (tR = [Hg]/R, with [Hg] being Hg concentration and R the reaction rate); (tD) the characteristic time for diffusion (tD = L^2/Ds, with L being the thickness of a consumption/production zone); (tS) the time of environmental stability (50 days); (tA) time for accumulation in the layer; (DaD) the Damköhler number is equal to tD/tR and should be higher than 1. See Figure 5 in the main text for defining the zones. Highlighted numbers refer to values that do not meet the steady-state conditions of the PROFILE model.

			Data				Calculated times			Time ratios			
Species	Peeper	Zone	I	Average conc	Rates (+Prod/-Cons)	Ds	tR	tD	tS	tD/tR	tS/tR	DaD >1	tR
			cm	*nmol cm^{-3}*	*nmol cm^{-3} s^{-1}*	*cm^2 s^{-1}*	*s*	*s*	*s*				*day*
Hg^{II}_{inorg}	A	1	4.3	4.30E-05	-5.43E-11	7.13E-06	7.9E+05	2.6E+06	4.3E+06	3.3	5.5	Yes	9
Hg^{II}_{inorg}	A	2	4.34	5.25E-05	3.42E-11	7.13E-06	1.5E+06	2.6E+06	4.3E+06	1.7	2.8	Yes	18
Hg^{II}_{inorg}	A	3	4.33	1.24E-05	-2.08E-11	7.13E-06	6.0E+05	2.6E+06	4.3E+06	4.4	7.2	Yes	7
Hg^{II}_{inorg}	B	1	7.14	1.46E-05	-1.96E-11	7.13E-06	7.5E+05	7.2E+06	4.3E+06	9.6	5.8	Yes	9
Hg^{II}_{inorg}	B	2	3.56	4.75E-05	2.65E-11	7.13E-06	1.8E+06	1.8E+06	4.3E+06	1.0	2.4	Yes	21
Hg^{II}_{inorg}	B	3	3.6	3.75E-05	-1.53E-11	7.13E-06	2.4E+06	1.8E+06	4.3E+06	0.7	1.8	No	28
Hg^{II}_{inorg}	C	1	11.5	2.51E-05	2.51E-12	7.13E-06	1.0E+07	1.9E+07	4.3E+06	1.9	0.4	Yes	116
Hg^{II}_{inorg}	C	2	11.5	1.70E-05	-1.16E-12	7.13E-06	1.5E+07	1.9E+07	4.3E+06	1.3	0.3	Yes	170
Hg^{II}_{inorg}	D	1	3.33	5.91E-05	-1.41E-10	7.13E-06	4.2E+05	1.6E+06	4.3E+06	3.7	10.3	Yes	5
Hg^{II}_{inorg}	D	2	3.34	2.62E-05	2.02E-11	7.13E-06	1.3E+06	1.6E+06	4.3E+06	1.2	3.3	Yes	15
Hg^{II}_{inorg}	D	3	13.33	9.99E-06	-3.91E-12	7.13E-06	2.6E+06	2.5E+07	4.3E+06	9.8	1.7	Yes	30

			Data				Calculated times				Time ratios			
Species	Peeper	Zone	I	Average conc	Rates (+Prod/-Cons)	Ds	tR	tD	tS	tA	tD/tR	tS/tR	DaD >1	tR
			cm	*nmol cm^{-3}*	*nmol cm^{-3} s^{-1}*	*cm^2 s^{-1}*	*s*	*s*	*s*	*s*				*day*
MMHg	A	1	12.5	1.10E-06	2.93E-13	9.01E-06	3.8E+06	1.7E+07	4.3E+06	7.9E+06	4.6	1.1	Yes	44
MMHg	A	2	5.9	6.83E-07	-6.30E-13	9.01E-06	1.1E+06	3.9E+06	4.3E+06	3.7E+06	3.6	4.0	Yes	13
MMHg	A	3	6.6	3.24E-06	2.97E-13	9.01E-06	1.1E+07	4.8E+06	4.3E+06	4.2E+06	0.4	0.4	No	126
MMHg	B	1	4.8	6.00E-07	-5.30E-13	9.01E-06	1.1E+06	2.6E+06	4.3E+06	3.0E+06	2.3	3.8	Yes	13
MMHg	B	2	4.4	1.30E-06	4.77E-13	9.01E-06	2.7E+06	2.1E+06	4.3E+06	2.8E+06	0.8	1.6	No	32
MMHg	B	3	7.8	1.10E-06	5.30E-14	9.01E-06	2.1E+07	6.8E+06	4.3E+06	4.9E+06	0.3	0.2	No	240
MMHg	B	4	4.5	1.92E-06	-1.00E-12	9.01E-06	1.9E+06	2.2E+06	4.3E+06	2.8E+06	1.2	2.3	Yes	22
MMHg	B	5	2.5	1.46E-06	2.00E-12	9.01E-06	7.3E+05	6.9E+05	4.3E+06	1.6E+06	1.0	5.9	No	8
MMHg	C	1	7.67	3.93E-07	-1.41E-13	9.01E-06	2.8E+06	6.5E+06	4.3E+06	4.8E+06	2.3	1.5	Yes	32
MMHg	C	2	7.63	1.29E-06	2.96E-13	9.01E-06	4.4E+06	6.5E+06	4.3E+06	4.8E+06	1.5	1.0	Yes	50
MMHg	C	3	7.7	3.63E-07	-2.89E-13	9.01E-06	1.3E+06	6.6E+06	4.3E+06	4.9E+06	5.2	3.4	Yes	15
MMHg	D	1	12	9.64E-07	2.40E-13	9.01E-06	4.0E+06	1.6E+07	4.3E+06	7.6E+06	4.0	1.1	Yes	46
MMHg	D	2	4	1.05E-06	-1.16E-12	9.01E-06	9.1E+05	1.8E+06	4.3E+06	2.5E+06	2.0	4.8	Yes	11
MMHg	D	3	4	3.34E-06	9.02E-13	9.01E-06	3.7E+06	1.8E+06	4.3E+06	2.5E+06	0.5	1.2	No	43

Table SI.2. Elemental concentrations in pore waters (SWI: sediment-water interface)

Pepeer	Remark	Level	$Hg^{II}inorg$	MMHg	Fe^{II}	SO4	Pepeer	Remark	Level	$Hg^{II}inorg$	MMHg	Fe^{II}	SO4
		cm	*nM*	*pM*	*µM*	*mM*			*cm*	*nM*	*pM*	*µM*	*mM*
A	above SWI	-23.0	0.04	0.25			C	above SWI	-25.8	0.07	0.00	1.8	32.6
A	above SWI	-22.0	0.07	0.18			C	above SWI	-23.5	0.06	0.10	1.8	30.8
A	above SWI	-21.0	0.19	0.13			C	above SWI	-21.5	0.07	0.20	1.8	31.2
A	above SWI	-20.0	0.29	0.12			C	above SWI	-19.5	0.06	0.00	1.8	30.8
A	above SWI	-19.0	0.39	0.14			C	above SWI	-17.5	0.04	0.10	1.8	32.9
A	above SWI	-18.0	0.36	0.16			C	above SWI	-15.5	0.05	0.15	1.8	32.0
A	above SWI	-17.0	0.32	0.10			C	above SWI	-13.5	0.06	0.20	1.8	30.4
A	above SWI	-16.0	0.31	0.37			C	above SWI	-11.5	0.10	0.15	1.8	29.9
A	above SWI	-15.0	0.30	0.10			C	above SWI	-9.5	0.11	0.13	1.8	33.1
A	above SWI	-14.0	0.29	0.10			C	above SWI	-7.5	0.10	0.23	1.8	30.3
A	above SWI	-13.0	0.24	0.19			C	above SWI	-5.5	0.14	0.19	1.8	31.4
A	above SWI	-12.0	0.20	0.10			C	above SWI	-3.5	0.08	0.10	1.8	31.1
A	above SWI	-11.0	0.14	0.10			C	above SWI	-1.5	0.05	0.21	1.8	32.6
A	above SWI	-10.0	0.17	0.26			C	below SWI	0.5	0.04	0.20	1.8	34.3
A	above SWI	-9.0	0.24	0.24			C	below SWI	2.5	0.03	0.00	73.1	30.5
A	above SWI	-8.0	0.32	0.22			C	below SWI	4.5	0.07	0.11	35.8	29.4
A	above SWI	-7.0	0.46	0.22			C	below SWI	6.5	0.05	0.77	24.9	31.0
A	above SWI	-6.0	0.58	0.17			C	below SWI	8.5	0.05	1.50	20.9	30.9
A	above SWI	-5.0	0.52	0.10			C	below SWI	10.5	0.06	2.11	16.3	31.9
A	above SWI	-4.0	0.32	0.26			C	below SWI	12.5	0.05	1.10	25.2	31.2
A	above SWI	-3.0	0.28	0.20			C	below SWI	14.5	0.04	1.46	33.3	28.3
A	above SWI	-2.0	0.18	0.13			C	below SWI	16.5	0.05	0.36	58.4	28.1
A	above SWI	-1.0	0.16	0.10			C	below SWI	18.5	0.03	0.25	85.8	23.1
A	below SWI	0.0	0.08	0.11			C	below SWI	20.5	0.03	0.33	97.4	22.4
A	below SWI	1.0	0.04	0.11			C	below SWI	22.5	0.03	0.46	119.1	18.5
A	below SWI	2.0	0.01	0.68									
A	below SWI	3.0	0.04	1.26			D	above SWI	-27.0	0.02	0.33		
A	below SWI	4.0	0.04	1.21			D	above SWI	-26.0	0.05	0.38		
A	below SWI	5.0	0.07	1.17			D	above SWI	-25.0	0.06	0.15		
A	below SWI	6.0	0.06	1.17			D	above SWI	-24.0	0.05	0.30		
A	below SWI	7.0	0.06	1.63			D	above SWI	-23.0	0.05	0.22		
A	below SWI	8.0	0.05	1.39			D	above SWI	-22.0	0.10	0.33		
A	below SWI	9.0	0.01	1.82			D	above SWI	-21.0	0.08	0.26		
A	below SWI	10.0	0.01	1.31			D	above SWI	-20.0	0.03	0.21		
A	below SWI	11.0	0.01	0.63			D	above SWI	-19.0	0.05	0.26		
A	below SWI	12.0	0.01	0.94			D	above SWI	-18.0	0.04	0.29		
A	below SWI	13.0	0.01	1.25			D	above SWI	-17.0	0.04	0.19		
A	below SWI	14.0	0.01	0.76			D	above SWI	-16.0	0.03	0.22		
A	below SWI	15.0	0.01	0.24			D	above SWI	-15.0	0.05	0.34		
A	below SWI	16.0	0.01	0.31			D	above SWI	-14.0	0.07	0.22		
A	below SWI	17.0	0.02	0.50			D	above SWI	-13.0	0.10	0.39		
A	below SWI	18.0	0.03	0.97			D	above SWI	-12.0	0.11	0.34		
A	below SWI	19.0	0.03	0.89			D	above SWI	-11.0	0.16	0.48		
A	below SWI	20.0	0.02	3.59			D	above SWI	-10.0	0.20	0.29		
A	below SWI	21.0	0.03	2.56			D	above SWI	-9.0	0.16	0.43		
A	below SWI	22.0	0.04	3.58			D	above SWI	-8.0	0.15	0.23		
A	below SWI	23.0	0.03	3.58			D	above SWI	-7.0	0.13	0.21		
A	below SWI	24.0	0.03	4.61			D	above SWI	-6.0	0.51	0.23		
A	below SWI	25.0	0.02	4.29			D	above SWI	-5.0	0.45	0.25		
							D	above SWI	-4.0	0.46	0.38		
B	above SWI	-23.8	0.08	0.14	1.8	30.2	D	above SWI	-3.0	0.30	0.17		
B	above SWI	-21.5	0.10	0.10	1.8	30.6	D	above SWI	-2.0	0.21	0.27		
B	above SWI	-19.5	0.14	0.17	1.8	30.1	D	above SWI	-1.0	0.18	0.30		
B	above SWI	-17.5	0.21	0.21	1.8	31.0	D	below SWI	0.0	0.14	0.16		
B	above SWI	-15.5	0.21	0.26	1.8	30.6	D	below SWI	1.0	0.05	0.19		
B	above SWI	-13.5	0.25	0.28	1.8	32.7	D	below SWI	2.0	0.04	0.63		
B	above SWI	-11.5	0.16	0.32	1.8	31.5	D	below SWI	3.0	0.03	0.63		
B	above SWI	-9.5	0.20	0.30	1.8	31.5	D	below SWI	4.0	0.03	1.07		
B	above SWI	-7.5	0.29	0.28	1.8	30.8	D	below SWI	5.0	0.03	0.62		
B	above SWI	-5.5	0.15	0.33	1.8	33.2	D	below SWI	6.0	0.03	0.79		
B	above SWI	-3.5	0.12	0.31	1.8	29.6	D	below SWI	7.0	0.02	1.50		
B	above SWI	-1.5	0.09	0.21	1.8	32.1	D	below SWI	8.0	0.01	2.12		
B	below SWI	0.5	0.13	0.15	82.0	33.6	D	below SWI	9.0	0.00	1.81		
B	below SWI	2.5	0.04	0.45	153.1	28.8	D	below SWI	10.0	0.01	0.56		
B	below SWI	4.5	0.03	0.74	124.6	32.3	D	below SWI	11.0	0.00	0.79		
B	below SWI	6.5	0.04	1.43	56.0	30.5	D	below SWI	12.0	0.00	0.89		
B	below SWI	8.5	0.05	1.91	33.8	32.0	D	below SWI	13.0	0.00	0.70		
B	below SWI	10.5	0.06	1.24	23.6	31.3	D	below SWI	14.0	0.00	0.98		
B	below SWI	12.5	0.06	0.99	43.2	33.1	D	below SWI	15.0	0.00	0.82		
B	below SWI	14.5	0.07	1.19	84.9	27.5	D	below SWI	16.0	0.01	1.79		
B	below SWI	16.5	0.09	1.25	96.2	28.4	D	below SWI	17.0	0.02	3.98		
B	below SWI	18.5	0.12	1.39	107.4	23.1	D	below SWI	18.0	0.02	3.18		
B	below SWI	20.5	0.08	1.92	118.0	23.8	D	below SWI	19.0	0.02	3.25		
B	below SWI	22.5	0.08	2.18	150.6	19.7	D	below SWI	20.0	0.03	3.96		
B	below SWI	24.5	0.13	2.60	82.9	15.8							

Fig. SI.1. Dialyzer (Peeper). (a) 50-cell Peeper without membrane; (b) Peeper inserted in the Rhône prodelta sediments.

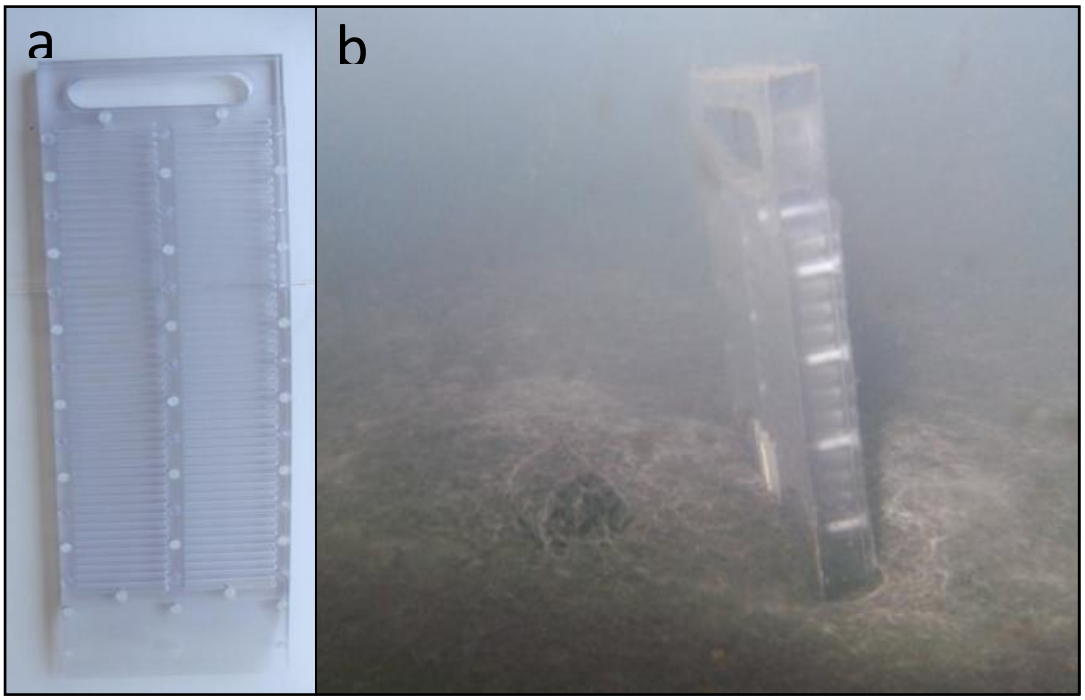

Fig. SI.2. (a) Pelicase for the Peepers' transport under nitrogen; (b) pore for nitrogen inlet; (c) pressure valve; (d) nitrogen tank and flow meter.

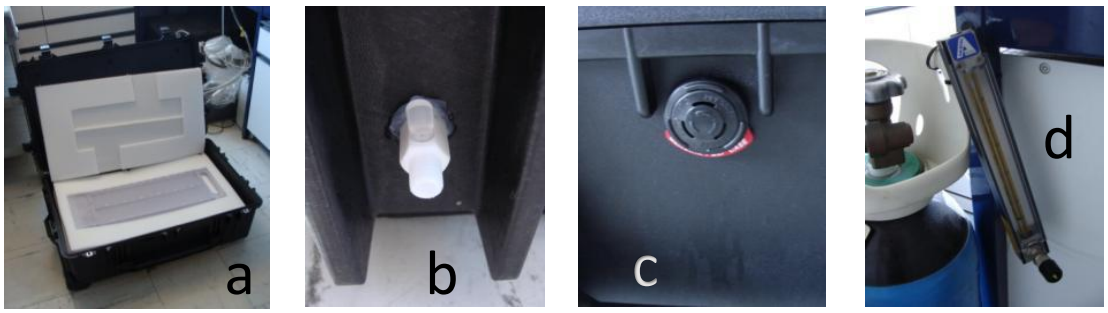

Fig. SI.3. Rhône River discharge (a) and turbidity at Sta. ME during the peepers' deployments (5 May- 11 July 2011). Redrawn from Fuchs R. (2019) *Qualification des données MESURHO 2009-2018*. Rapport IFREMER/ODE/LER-PAC 19. Doi:10.13155/62695.

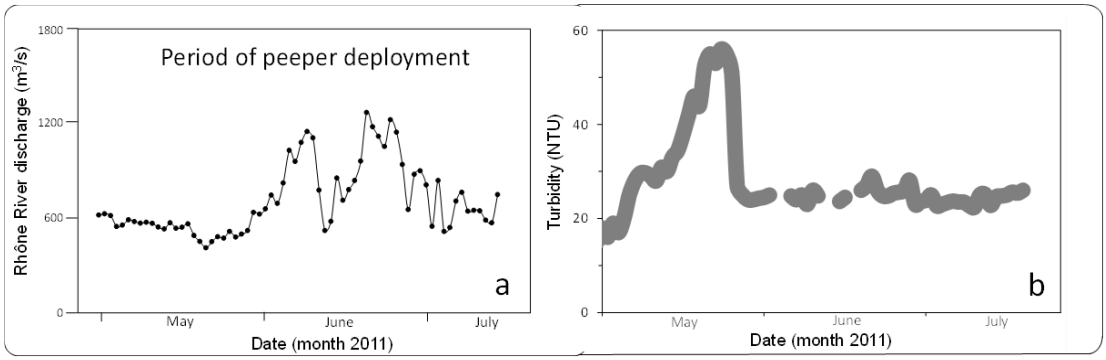

Fig. SI.4. Principal component analysis (PCA) is used here to summarize the whole relationships between variables for the 4 peepers' data. It allows a dimensional reduction by projecting each data point onto only the first few principal components to obtain lower-dimensional data. The first principal component (F1) explains 61.4 % of the global variation whereas F2 explains 11.4%. F1 clearly relates to the redox conditions of the epibenthic and pore waters, with positive values being toward anoxic conditions (see the opposite positions between SO_4^{2-} and Fe^{II} relative to F1). The significance of F2 is more difficult to interpret. Statistics were run using *RStudio* (version 4.2.2, 2022).

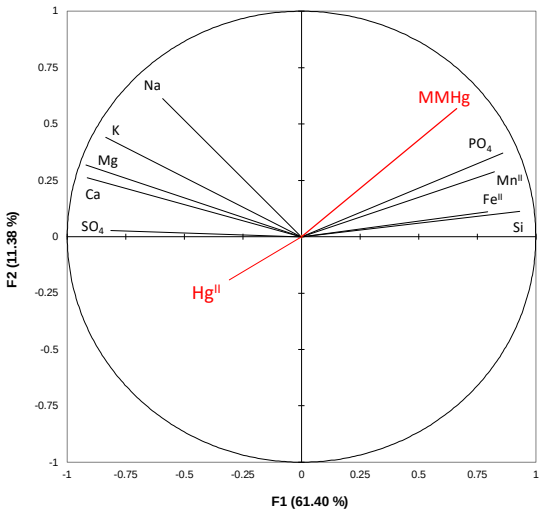

Fig. SI.5. MMHg profile from the averaging of Peeper A, B, C, and D values. Note that the MMHg gradient at the SWI is near zero, suggesting a negligible diffusion across this interface.