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Environmental Pollution in Oued El Harrach area, Alger
-A Preliminary Report on Mercury and Heavy Metals Contaminations-

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Abstract

Significant mercury contaminations have been detected in the water and stream sediments of Oued El Harrach and its tributary Oued Smar. Contamination of other potentially toxic elements, such as As, Cr, Cd, Pb, Cu, and Mn is also recognized. The analyses were made using an ICP-MS for both water and sediment samples. Aqua resia extraction method was applied for pre-treatment of sediment samples. The concentration of mercury indicates very high levels, between 3 and 100 ppm, in several sediment samples collected from Oued El Harrach in 2003 and 2004. Mercury concentrations of stream water samples vary between 470 and 0.6 ppb, however, that of wastewater sample directly collected from a chlorine factory of Baba Ali area indicates very high value, more than 4000 ppb. These contaminations can be evaluated as influences of inflowing wastewater from the industrial zones of El Harrach, baba Ali, and Oued Smar, southern part of Alger, into Oued El Harrach river. Immediate counter-measure to protect the environment of river is recommended.

Keywords: Mercury, Heavy metals, Industrial pollution, Soil/Sediment contamination, ICP-MS

1. Introduction

The environmental pollution of Oued El Harrach has not been comprehensively studied although it has been greatly progressing since last decade. The technical cooperation project between ONEDD and JICA focused on the topics on the environmental pollution monitoring of Oued El Harrach, and particularly in the

preliminary stages, the efforts of the project activities concentrate on the study of heavy metal contamination of the stream water and sediments (Table 1).

Table 1: Development of the collaboration on the environmental pollution study of Oued El Harrach area between JICA and ONEDD

- February 2003: Preparatory Study
  - Introduction of JICA technical cooperation in environmental sector
  - Observation of the sites and test sampling
  - Chemical analysis of sludge and sediments in Japan
- January 2004: 1st Collaboration
  - On-site water measurement multiprobe
  - Sampling of Oued El Harrach water
  - Chemical analysis of river water in Japan
- October 2004: 2nd Collaboration
  - Seminar in Ministry auditorium
  - Inspection of factory and sampling with D.E. Wilaya
  - Bottom-sediment sampling in Oued El Harrach
  - Chemical analysis of wastewater in Japan
  - Mineralogical and SEM study of sediments in Japan
- March-April 2005: 3rd Collaboration
  - Installation of an AAS
  - Technology transfer in environmental chemical analysis
  - Offshore and onshore sampling
  - Chemical analysis of wastewater, water, and sediments in ONEDD

Plate 1: The environment of Oued El Harrach is out of control and miserable. There are a pile of industrial and/or municipal solid wastes and inflowing of wastewater. The river water is severely polluted and emitting gases with strong ill odor (Loc. OEH-01, near the estuary).

In this report, the results of preliminary study including field and laboratory studies are summarized. The contents of the report is based on the presentation in the Seminar on Environmental Pollution and Protection in Algeria, Alger, 5th and 6th April 2005, jointly organized by JICA, MATE and ONEDD.

2. The Beginning – Test Sampling of Stream Sediments in 2003

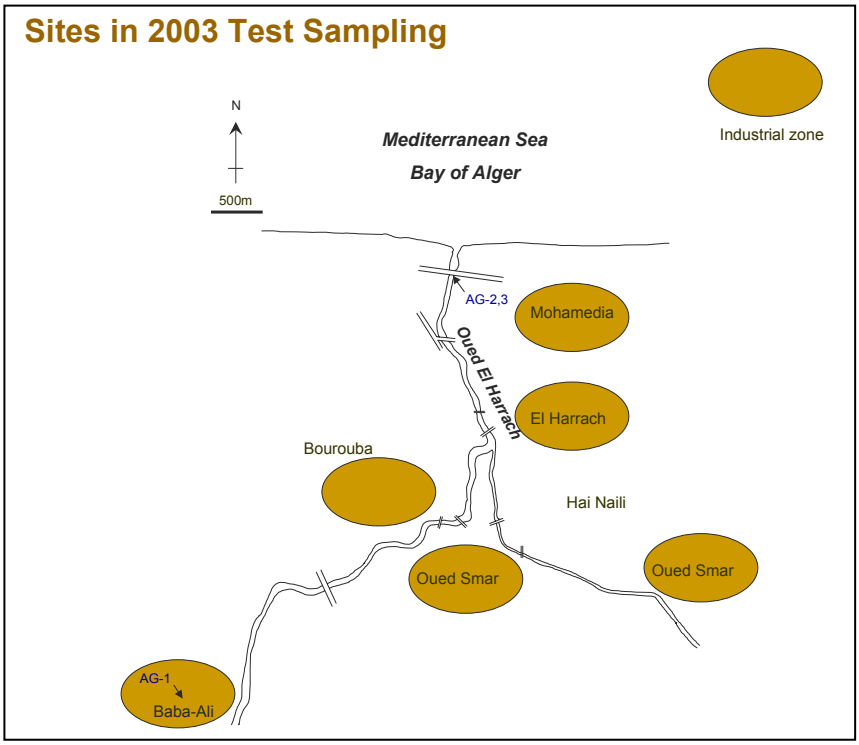

Figure 1: Sketch map of the Oued El Harrach area and sampling sites AG-1, 2 and 3 for the 'test sampling'.

Plate 2: Sampling site of AG-1, sludge in a chlorine factory, Baba Ali.

Plate 3: Sampling site of AG-2 and 3, stream sediments near the estuary of Oued El Harrach.

2-1. Analytical Method for Sediment Samples

A 15.0 gm sample split was digested in 90 mL aqua regia (HCl-HNO_3-H_2O) at 95°C for one hour. The solution is diluted to 300 mL with distilled water. Analysis was made by an Inductively Coupled Plasma-Atomic Emission Spectrometry (ICP-AES) and Mass Spectrometry (ICP-MS). Total 37 elements were measured: B, Na, Mg, Al, P, S, K, Ca, Sc, Ti, V, Cr, Mn, Fe, Co, Ni, Cu, Zn, Ga, As, Se, Sr, Mo, Ag, Cd, Sb, Te, Ba, La, W, Au, Hg, Tl, Pb, Bi, Th, and U. The upper detection limit for Ag, Au, Hg, W, Se, Te, Tl, and Ga is 100 ppm, that for Mo, Co, Cd, Sb, Bi, Th, U, and B is 2 %, and that for Cu, Pb, Zn, Ni, Mn, As, V, La, and Cr is 10 %. The aqua regia digestion of sediment extracts only a fraction of the major elements (pseudo-total analysis) because silicates are not completely dissolved with this method. Owing to this limitation, results are total to near total for trace and base metals and possibly partial for rock-forming elements such as Na, Mg, Al, K, Ca, Mn, and Fe. However, environmentally concerned components like heavy metals or potentially toxic elements (PTEs; Alloways, 1995) not bound to silicates are efficiently dissolved (Ure, 1995), which is indicative for the assessment of toxicity.

2-2. Results of the Test Sample Analysis

The results of analysis of collected samples, factory sludge and sediments from AG-1, 2 and 3, are shown in Figure 2. Several criteria for screening of soil/sediment contamination by PTEs are summarized in Table 1.

Based on the results, it was apparent that the concentrations of Hg in sediments or sludge are extraordinary high level. Concentrations of other PTEs such as:

Cu, Pb, Zn, Ni, Co, Mn, As Cd, Sb, Cr, Ba, and Se

also indicated more or less above the environmental quality standard levels, which means there is **sediment contamination** by heavy metals and other PTEs.
It was really alarming results.

Table 2: Results of analysis of test samples (sediment and sludge) collected in 2003.

	Mo	Cu	Pb	Zn	Ag	Ni	Co	Mn	Fe	As	U	Au
	ppm	ppm	ppm	ppm	ppb	ppm	ppm	ppm	%	ppm	ppm	ppb
AG-1 (factory sludge	0.03	7.69	0.20	<0.1	21	1.0	<0.1	<1	<0.01	0.7	<0.1	<0.2
AG-2 (sediment1)	1.27	17.44	21.42	70.4	155	12.0	1.9	179	0.76	2.7	0.6	<0.2
AG-3 (sediment2)	0.77	33.78	51.37	114.7	342	29.7	14.7	498	3.64	9.4	0.4	29.1

	Th	Sr	Cd	Sb	Bi	V	Ca	P	La	Cr	Mg	Ba
	ppm	ppm	ppm	ppm	ppm	ppm	%	%	ppm	ppm	%	ppm
AG-1 (factory sludge	<0.1	36.6	<0.01	0.10	<0.02	15	0.12	0.001	<0.5	<0.5	0.04	0.5
AG-2 (sediment1)	0.2	713.9	<0.01	<0.02	0.07	255	5.83	0.012	1.0	11.4	8.63	41.3
AG-3 (sediment2)	3.1	345.1	0.21	0.65	0.31	34	11.13	0.099	5.4	39.6	0.62	227.1

	Ti	B	Al	Na	K	W	Sc	Tl	S	Hg	Se	Te
	%	ppm	%	%	%	ppm	ppm	ppm	%	ppb	ppm	ppm
AG-1 (factory sludge	0.001	<1	<0.01	30.000	0.12	<0.1	<0.1	0.02	0.90	>99999	2.5	<0.02
AG-2 (sediment1)	0.009	<1	0.30	18.893	0.16	<0.1	1.5	<0.02	0.51	>99999	27.4	0.36
AG-3 (sediment2)	0.001	<1	1.37	0.020	0.08	<0.1	7.7	0.06	0.15	20041	0.8	0.06

	Ga	Cs	Ge	Hf	Nb	Rb	Sn	Ta	Zr	Y	Ce	In
	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
AG-1 (factory sludge	<0.1	0.01	0.2	<0.02	0.07	0.2	<0.1	<0.05	<0.1	0.01	<0.1	<0.02
AG-2 (sediment1)	0.8	0.25	1.5	<0.02	0.06	2.6	<0.1	<0.05	<0.1	1.29	2.4	<0.02
AG-3 (sediment2)	3.6	1.35	0.1	0.02	0.12	6.7	2.1	<0.05	0.8	11.00	12.8	0.04

	Re	Be	Li
	ppb	ppm	ppm
AG-1 (factory sludge	<1	<0.1	2.0
AG-2 (sediment1)	<1	<0.1	11.2
AG-3 (sediment2)	1	1.0	23.8

Table 3: Several criteria for environmental screening of soil/sediment contamination (unit: mg/kg except specified).

	NOAA SquiRTs for Freshwater Sediment*					Netherlands**			Japan
PTEs	Background		LTEL	TEL	PEL	UET	Ref.	Interv.	Test	EQS soil
Al	0.26%		2.55%							
Sb	0.16					3				
As	1.1		10.798	5.9	17	17	29	50	30	50
Ba	0.7						200	2000	400	
Cd	0.1-0.3		0.583	0.596	3.53	3	0.8	12	5	9
Cr	7-13		36.286	37.3	90	95	100	380	250	
Co	10						10	300	50	
Cu	10-25		28.012	35.7	197	86	36	190	100	
Fe	0.99-1.8%		18.84%							
Pb	4-17		37	35	91.3	127	85	530	150	600
Mn	400		630			1100				
Mo	10						10	200	40	
Hg	0.004-0.051			0.174	0.486	0.56	0.3	10	2	3
Ni	9.9		19.594	18	35.9	43	35	210	100	
Se	0.29									
Ag	<0.5					4.5				
Sn	5						20	300	50	
Tl	0.1-0.8									
U	0.7-9									
V	50									
Zn	7-38		98	123.1	315	520	140	720	500	

* NOAA Screening Quick Reference Tables (SQuiRTs) (NOAA, 1999). LTEL; Lowest ARCs H. azteca Threshold Effects Level, TEL: Threshold Effects Level, PEL: Probable Effects Level, UET: Upper Effects Threshold. The 'Background' values is obtained from fresh water sediments.

** Guide values and quality standards used in the Netherlands for assessing soil contamination. Ref.: Reference value, Interv.: Intervention value, Test: Test value (Alloway, 1995)

*** Critical soil total concentration: the range of values above which toxicity is considered to be possible (Kabata-Pendias and Pendias in Alloway,1995)

EQS soil: Environmental Quality Standards for Soil (Japan)

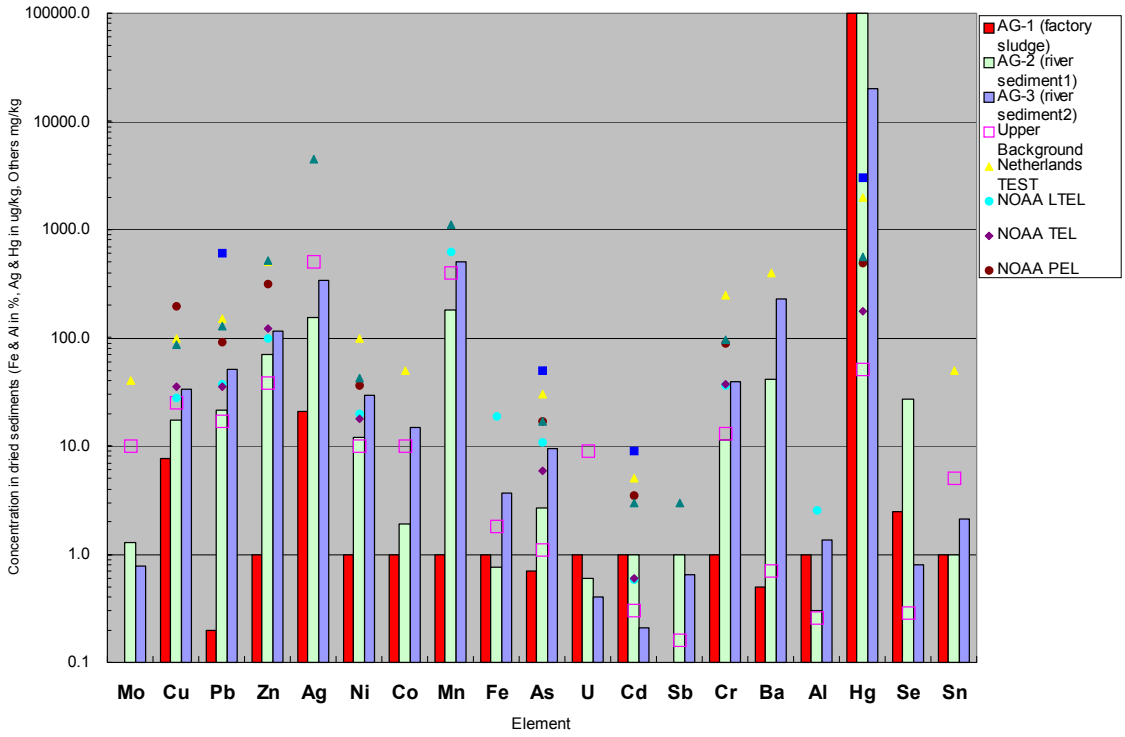

Figure 2: Bar diagram shows the concentration of each potentially toxic elements (PTEs). Various marks of plot are show different values of environmental quality standards (see Table 3), where if the bar diagram exceed a plot, the concentration is more or less above the standards (source: Yoshida, 2004).

3. Survey and Sampling of Oued El Harrach Water in January 2004

In response to the results of the analysis of test samples 2003, a collaborative study of Oued El Harrach was carried out between ONEDD and JICA for the first time.

Plate 4: Illegally disposed solid wastes along the river near the junction of Oued El Harrach and Oued Smar.

Plate 5: On-site water quality analysis using a multi-parameter probe.

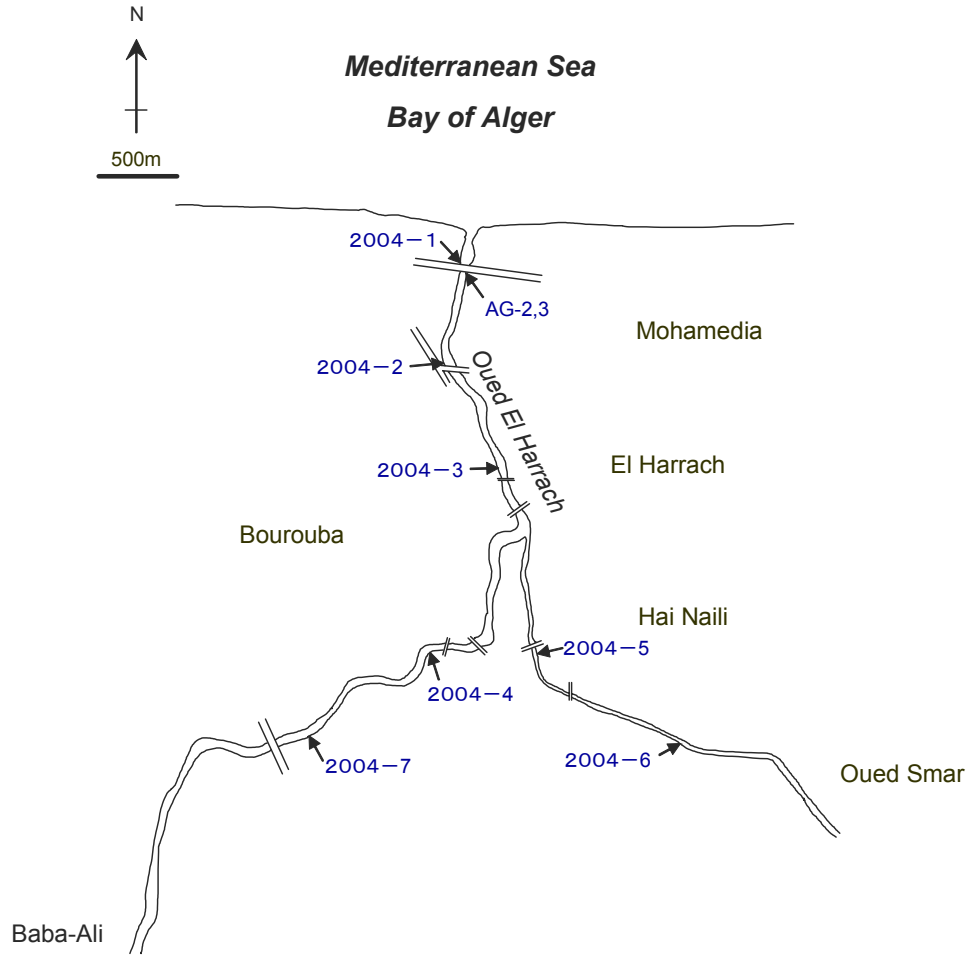

Figure 3: Locations of the sampling sites along Oued El Harrach and Oued Smar in January 2004.

The survey was held along Oued El Harrach and collected seven stream water samples at the locations shown in Figure 3. Five samples were collected from Oued El Harrach, and other two were from Oued Smar. It was observed that various kind of solid wastes such as municipal and industrial solid wastes were disposed illegally in the river and along the river bank (see Plate 4). It is also observed that industrial wastewater as well as sewerage water were directly discharged into river stream (see Plate 6).

The samples collected were prepared for pH<2.0 using HNO_3. Analysis was made by an Inductively Coupled Plasma Mass Spectrometry (ICP-MS). Total 74 elements were measured: Li, Be, B, Na, Mg, Al, Si, P, S, Cl, K, Ca, Sc, Ti, V, Cr, Mn, Fe, Co, Ni, Cu, Zn, Ga, Ge, As, Se, Br, Rb, Sr, Y, Zr, Nb, Mo, Ru, Rh, Pd, Ag, Cd, In, Sn, Sb, Te, I, Cs, Ba, La, Ce, Pr, Nd, Sm, Eu, Gd, Tb, Dy, Ho, Er, Tm, Yb, Lu, Hf, Ta, W, Re, Os, Ir, Pt, Au, Hg, Tl, Pb, Bi, Th, and U. The results of analysis are summarized in Table 4.

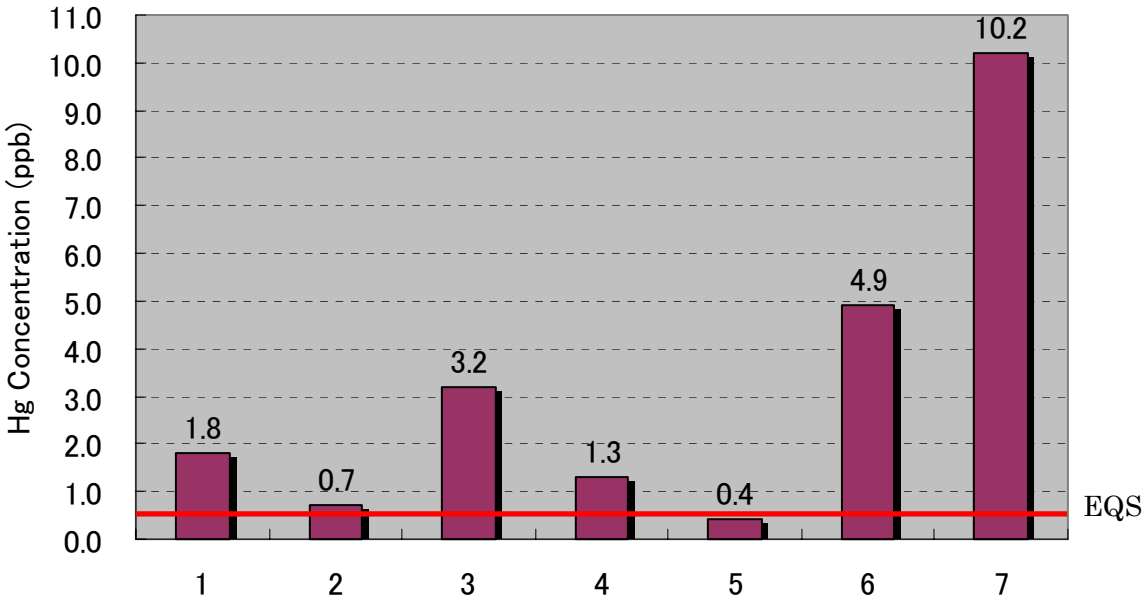

Figure 4: Variation of the Hg concentration in water of Oued El Harrach and Oued Smar. The environmental quality standard (EQS) for Hg concentration in river water is 0.5 ppb. The number of horizontal axis shows the number of sampling site OEH. Every samples except OEH-05 indicate above the EQS. In particular, OEH-07, down stream of Baba Ali, marks very high concentration of 10.2 ppb.

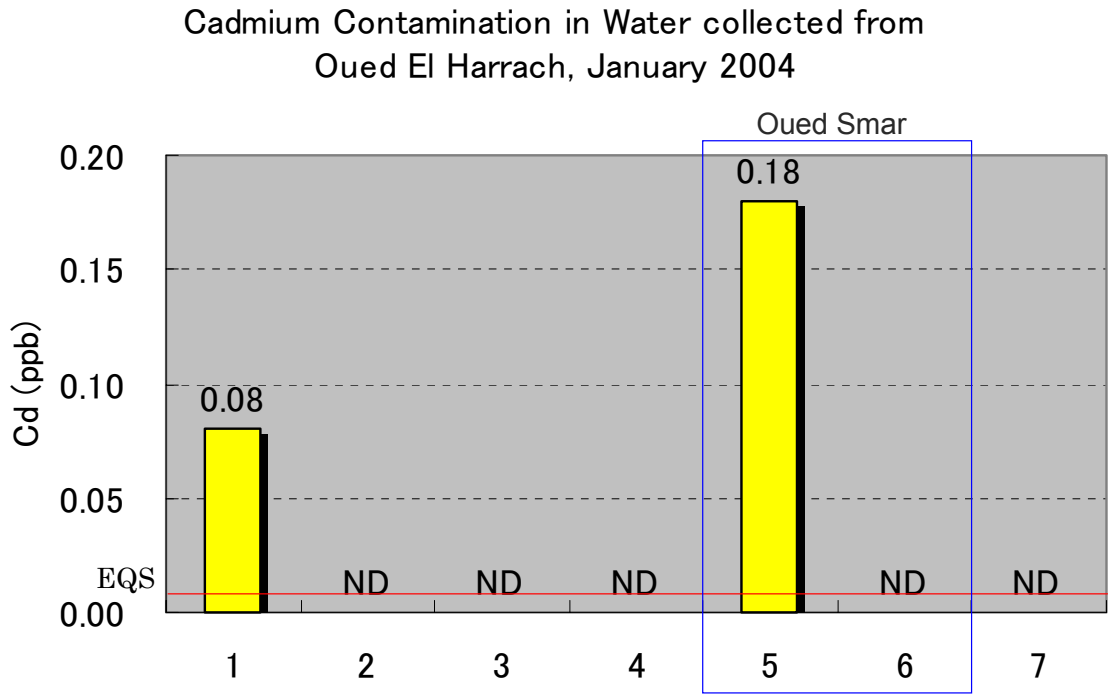

Figure 5: Variation of the Cd concentration in water of Oued El Harrach and Oued Smar. Two samples, OEH-01 and 05 show high concentration above the EQS.

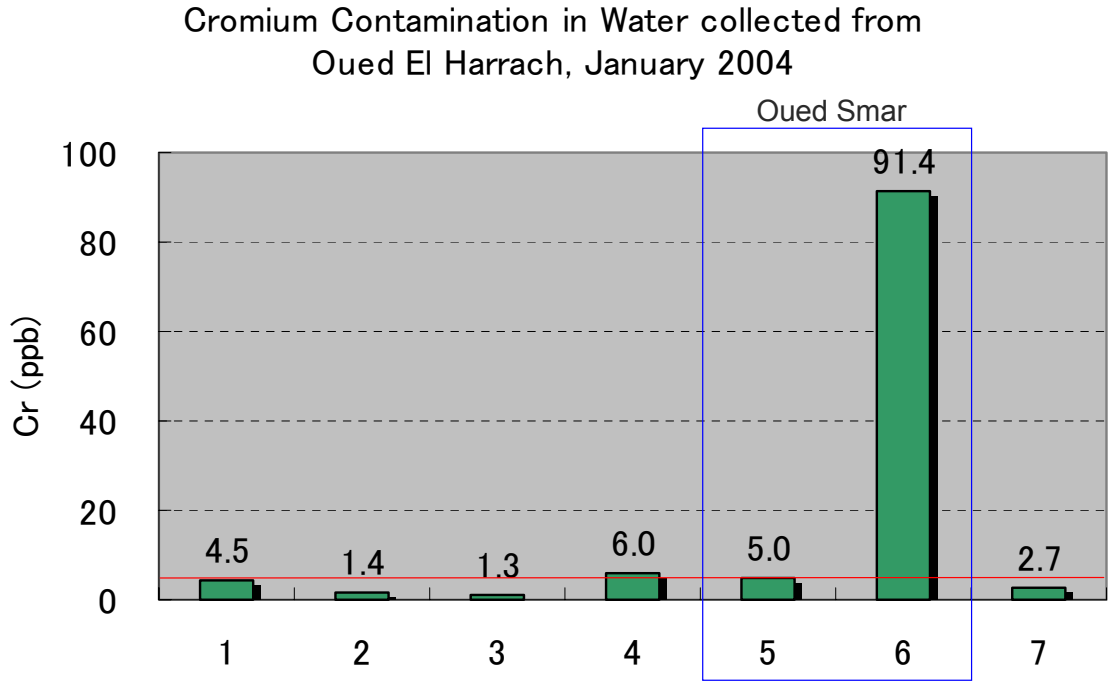

Figure 6: Variation of the Cd concentration in water of Oued El Harrach and Oued Smar. The OEH-06 show abnormally high concentration.

Table 4: Results of water analysis of the samples collected in January 2004.

	Ag	Al	As	Au	B	Ba	Be	Bi	Br	Ca	Cd	Ce
OEH-	ppb	ppb	ppb	ppb	ppb	ppb	ppb	ppb	ppb	ppb	ppb	ppb
1	0.06	11	3.5	< .05	118	39.51	< .05	< .05	194	104266	0.08	0.15
2	0.15	32	5.0	< .05	116	40.70	< .05	< .05	200	100402	< .05	0.02
3	1.1	29	4.1	< .05	119	36.63	< .05	< .05	190	96275	< .05	0.07
4	< .05	32	3.7	< .05	101	34.46	< .05	< .05	157	93375	< .05	0.05
5	0.14	82	5.3	< .05	142	56.31	< .05	< .05	369	109233	0.18	0.12
6	0.21	64	4.5	< .05	327	49.04	< .05	< .05	273	99778	< .05	0.06
7	0.34	93	4.9	< .05	103	35.50	< .05	< .05	133	91992	< .05	0.13

	Cl	Co	Cr	Cs	Cu	Dy	Er	Eu	Fe	Ga	Gd	Ge
OEH-	ppm	ppb	ppb	ppb	ppb	ppb	ppb	ppb	ppb	ppb	ppb	ppb
1	322	0.56	4.5	0.13	2.4	< .01	< .01	< .01	211	< .05	< .01	< .05
2	490	0.60	1.4	0.14	3.5	< .01	< .01	< .01	292	< .05	< .01	< .05
3	336	0.57	1.3	0.14	3.2	< .01	< .01	< .01	245	< .05	< .01	< .05
4	320	0.53	6.0	0.12	2.6	0.01	< .01	< .01	265	< .05	< .01	< .05
5	436	0.93	5.0	0.10	2.9	0.02	< .01	< .01	688	0.06	0.03	< .05
6	415	0.71	91.4	0.09	5.7	0.01	0.01	< .01	367	0.08	0.05	< .05
7	470	0.99	2.7	0.08	3.0	0.03	0.01	0.01	268	< .05	0.04	< .05

	Hf	Hg	Ho	In	Ir	K	La	Li	Lu	Mg	Mn	Mo
OEH-	ppb	ppb	ppb	ppb	ppb	ppb	ppb	ppb	ppb	ppb	ppb	ppb
1	< .02	1.8	< .01	< .01	0.41	8557	0.21	19.6	< .01	33645	78.73	0.8
2	< .02	0.7	< .01	< .01	< .05	7006	0.01	18.4	< .01	33454	84.16	0.5
3	< .02	3.2	< .01	< .01	< .05	6218	0.01	18.9	< .01	34212	81.72	0.5
4	< .02	1.3	< .01	< .01	< .05	5552	0.02	17.0	< .01	33815	69.62	0.4
5	< .02	0.4	< .01	< .01	< .05	30779	0.03	14.1	< .01	23510	194.66	1.1
6	< .02	4.9	< .01	< .01	0.41	34008	0.05	10.3	< .01	27511	101.41	0.7
7	< .02	10.2	< .01	< .01	< .05	4978	0.10	15.8	< .01	32029	82.02	0.5

	Na	Nb	Nd	Ni	Os	P	Pb	Pd	Pr	Pt	Rb	Re
OEH-	ppb	ppb	ppb	ppb	ppb	ppb	ppb	ppb	ppb	ppb	ppb	ppb
1	107782	0.01	< .01	0.3	< .05	1606	0.5	< .2	< .01	< .01	5.44	0.01
2	110828	0.01	0.06	< .2	< .05	1348	1.9	< .2	0.01	< .01	5.01	0.01
3	96216	0.01	0.04	< .2	< .05	1102	1.1	< .2	< .01	< .01	4.07	< .01
4	87233	< .01	0.03	< .2	< .05	830	0.8	< .2	< .01	< .01	3.32	< .01
5	116817	0.02	0.06	1.1	< .05	3708	3.3	< .2	0.01	< .01	19.13	0.02
6	146014	0.02	0.05	3.1	< .05	8812	1.5	< .2	0.01	< .01	15.85	0.01
7	77504	0.01	0.10	0.9	< .05	795	1.2	< .2	0.02	< .01	3.07	< .01

	Rh	Ru	S	Sb	Sc	Se	Si	Sm	Sn	Sr	Ta	Tb
OEH-	ppb	ppb	ppm	ppb	ppb	ppb	ppb	ppb	ppb	ppb	ppb	ppb
1	0.05	< .05	81	0.37	1	2.9	6989	< .02	0.41	1106.9	< .02	< .01
2	0.02	< .05	77	0.35	< 1	3.2	6964	< .02	0.11	1105.0	< .02	< .01
3	0.02	< .05	74	0.31	< 1	2.7	6564	< .02	0.13	1105.9	< .02	< .01
4	0.02	< .05	77	0.26	< 1	2.2	6062	< .02	0.08	1130.3	< .02	< .01
5	0.01	< .05	55	1.35	< 1	3.7	9297	< .02	0.23	667.1	< .02	< .01
6	0.05	< .05	65	0.46	< 1	3.2	8832	< .02	0.44	720.6	< .02	< .01
7	0.02	< .05	69	0.34	1	2.2	5934	0.03	0.12	1066.3	< .02	< .01

	Te	Th	Ti	Tl	Tm	U	V	W	Y	Yb	Zn	Zr
OEH-	ppb	ppb	ppb	ppb	ppb	ppb	ppb	ppb	ppb	ppb	ppb	ppb
1	< .05	< .05	< 10	< .01	< .01	0.15	4.5	0.17	0.02	< .01	30.9	0.07
2	< .05	< .05	< 10	< .01	< .01	0.28	6.9	0.02	0.03	< .01	28.0	0.06
3	< .05	< .05	< 10	< .01	< .01	0.39	5.3	0.02	0.04	< .01	16.8	0.14
4	< .05	< .05	< 10	< .01	< .01	0.38	4.9	< .02	0.04	< .01	18.4	0.08
5	< .05	< .05	15	< .01	< .01	0.35	7.9	0.08	0.07	< .01	25.7	0.19
6	< .05	< .05	33	< .01	< .01	0.45	7.2	0.73	0.07	< .01	26.4	0.50
7	< .05	< .05	< 10	< .01	< .01	0.18	7.3	< .02	0.18	< .01	19.3	0.04

Plate 6: Wastewater is discharged directly into the river streams without appropriate treatment.

The results of water analysis in 2004 confirmed that the mercury and other heavy metals contamination was not only for sediment but for stream water. It was again alarming results. In particular, the concentration of mercury is quite high level. It is probably caused by the direct discharge of industrial wastewater into river streams without appropriate treatment.

4. Industrial Wastewater – October 2004

Industrial wastewater was collected directly from factory facility (Baba Ali) under the cooperation with the Direction of Environment of Wilaya d'Alger.

Plate 7: Joint inspection of industrial wastewater between the Direction of Environment of Wilaya d'Alger and ONEDD, to the chlorine factory, Baba Ali

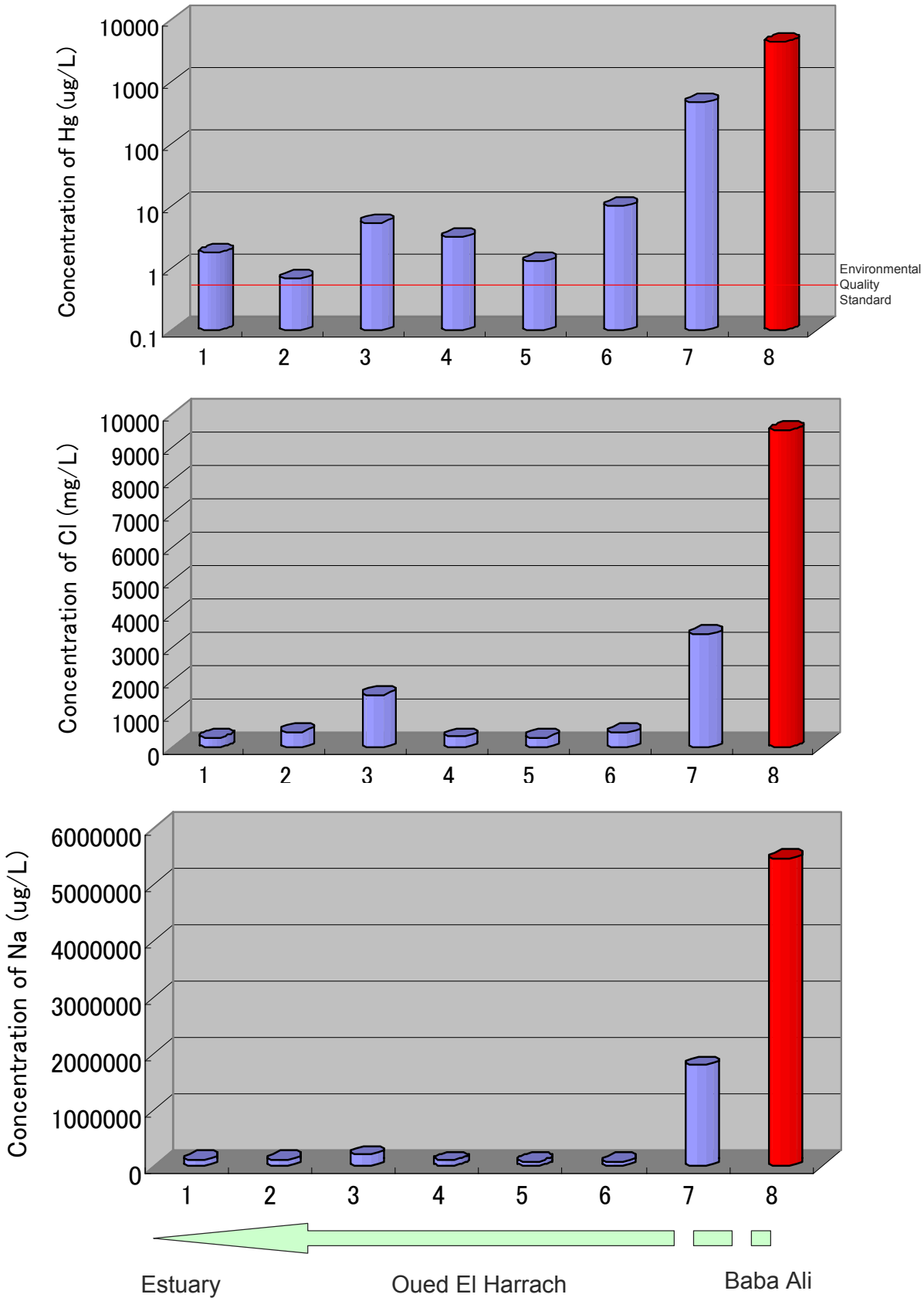

Figure 7: Variation of Concentrations of Hg (top), Cl (middle), Na (bottom), in stream water from Baba Ali factory to the estuary of Oued El Harrach.

The results of analysis of the wastewater collected from the chlorine factory, Baba Ali is shown in Table 5. The concentration of mercury is abnormally high that is probably contaminated from the mercury electrode plant in the factory. The variations of Hg, Cl, and Na concentration in water are also illustrated in Figure 7. The wastewater is gradually diluted toward downstream, while the level of concentration of mercury is still very high at the estuary of Oued El Harrach in comparing with the environmental quality standards. The concentrations of Na and Cl show similar trend of variation, these are contaminated by the wastewater. Arsenic contamination also observed.

Table 5: Results of wastewater and water analysis collected in October 2004.

	Ag	Al	As	B	Ba	Br	Ca	Ce	Cl	Co	Cr	Cs
	ppb	ppb	ppb	ppb	ppb	ppb	ppb	ppb	ppm	ppb	ppb	ppb
OEH-02R	0.33	339	7.3	278	61.92	385	124326	0.32	1586	0.74	13	0.11
Baba Ali	0.33	7	12.7	200	28.34	560	107642	0.01	3399	0.96	17	0.09
Cl Factory	4.32	4	30.3	60	43.33	342	42994	<.01	9511	0.32	4.8	0.08

	Cu	Fe	Hg	Ir	K	La	Li	Mg	Mn	Mo	Na	Nb
	ppb	ppb	ppb	ppb	ppb	ppb	ppb	ppb	ppb	ppb	ppb	ppb
OEH-02R	1.8	2744	5.5	<.05	19331	0.22	17.5	34748	182.6	0.3	2E+05	0.04
Baba Ali	24.3	263	471.4	10.66	24129	<.01	18.9	56267	33.59	2.1	2E+06	0.26
Cl Factory	46.5	81	4420	0.43	10931	<.01	24.8	14390	5.38	0.9	5E+06	0.01

	Nd	Ni	Os	P	Pb	Rb	Rh	S	Sb	Se	Si	Sn
	ppb	ppb	ppb	ppb	ppb	ppb	ppb	ppm	ppb	ppb	ppb	ppb
OEH-02R	0.21	<.2	<.05	6168	5.4	14.53	<.01	40	0.17	2.9	9265	0.10
Baba Ali	0.02	0.2	1.25	4186	<.1	15.55	0.26	39	0.76	4.4	12728	0.14
Cl Factory	0.02	6.7	0.51	69	<.1	1.8	0.03	88	0.12	2.4	8490	<.05

	Sr	Ta	Te	Ti	U	V	W	Y	Zn	Zr
	ppb	ppb	ppb	ppb	ppb	ppb	ppb	ppb	ppb	ppb
OEH-02R	1076.89	<.02	0.11	24	0.25	5.1	0.04	0.22	82.4	0.6
Baba Ali	1256.00	0.07	0.26	16	0.15	10.7	3.91	0.02	9.3	0.03
Cl Factory	676.50	<.02	0.07	<10	0.02	19.1	0.17	0.01	17.8	<.02

5. Mineralogical and Electron Microscopic Studies

In order to observe the state of contaminants deposited in the bottom sediments of Oued El Harrach, mineralogical study was carried out using X-ray diffraction method. The result indicates a presence of mica-smectite mixed layer minerals that possess adsorption capacity (Figure 8).

The electron microscopic observation proved that cemented texture and a presence of sulfide (pyrite?) mineral (Plate 8).

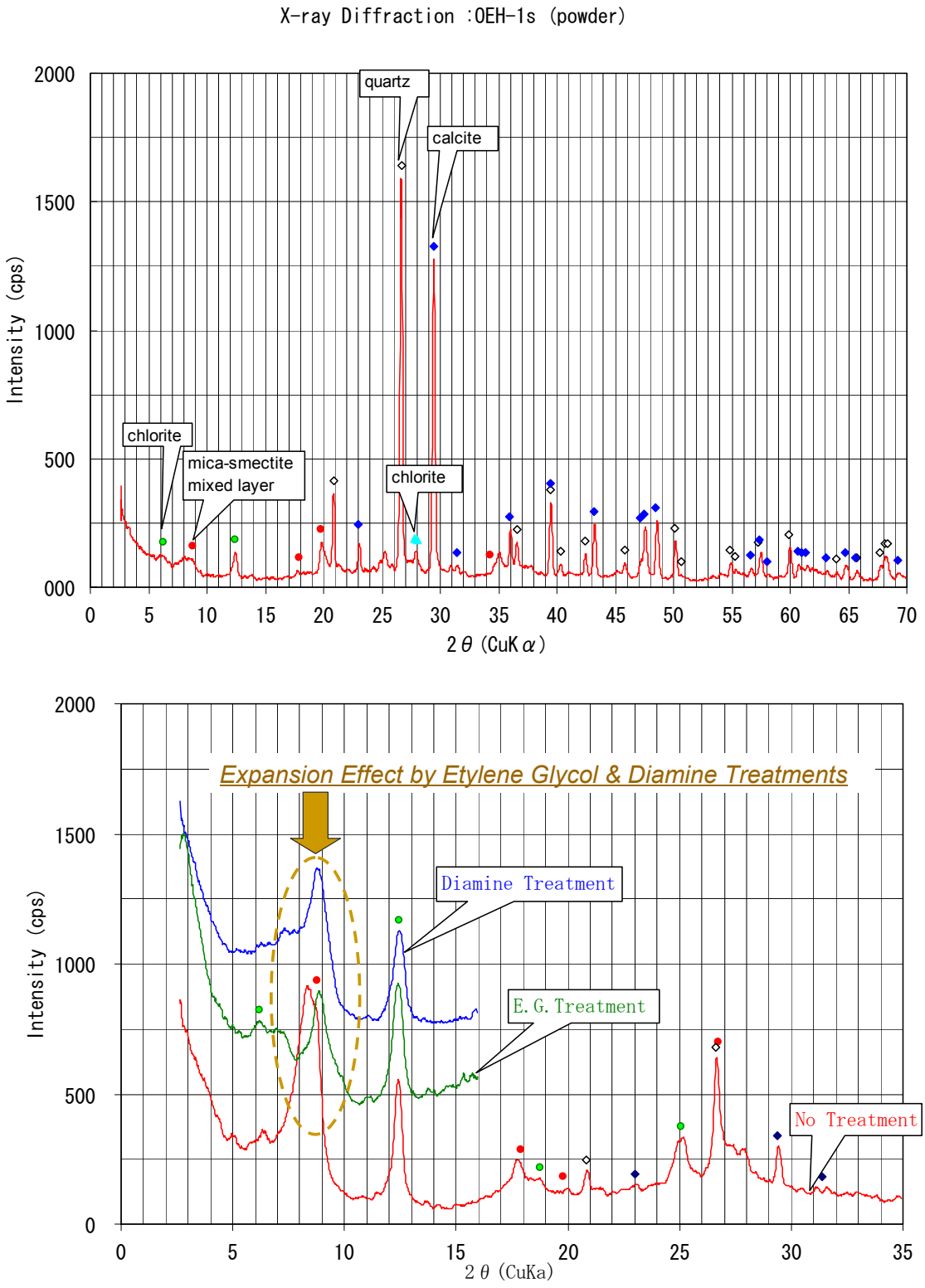

Figure 8: X-ray diffraction of sediment samples OEH-01, for non-oriented (upper) and oriented (lower) specimens. Etylene glycol treatment (lower) proved a presence of mica-smectite mixed layer.

Sample OEH-01 (SEI)

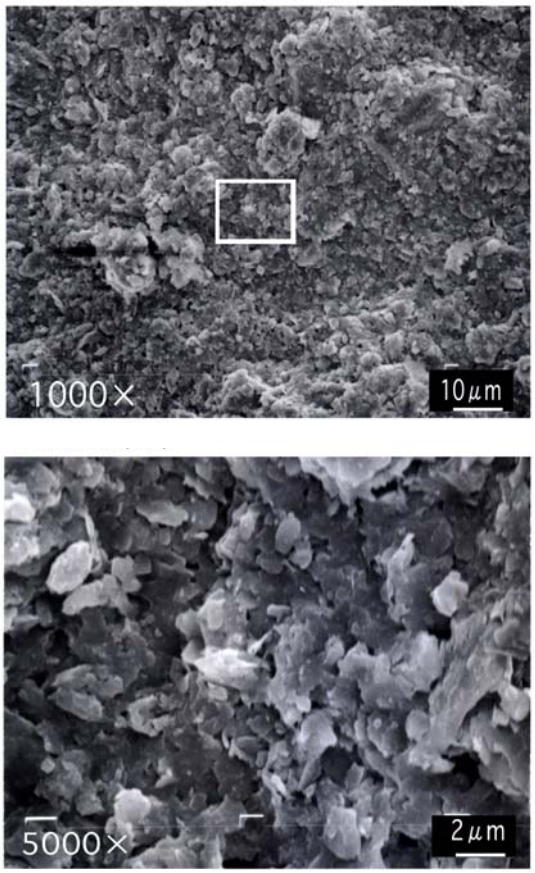

Plate 8: Observations of Particles using a Scanning Electron Microscope（SEI).

According to chemical, mineralogical and electron microscopic studies, there are possible six contributors for 'Natural Buffer' effect in Oued El Harrach, as follows:

- Hg is probably bonded with abundant organic matters and settled in the river bottom, however the bonding state is probably not very stable.
- Most of dissolved Hg is adsorbed and/or cation-exchanged by clay minerals such as smectite-mica mixed layer.
- Under an anoxic condition, Hg is precipitated as a sulfide (HgS), which partially immobilize the Hg.
- Biomineralization by cyanobacteria(?) also contributes the immobilization of Hg, where Hg is mineralized as a impurity of iron oxides.
- The sediment particles, in the aggregate, are cemented and partly fixed.

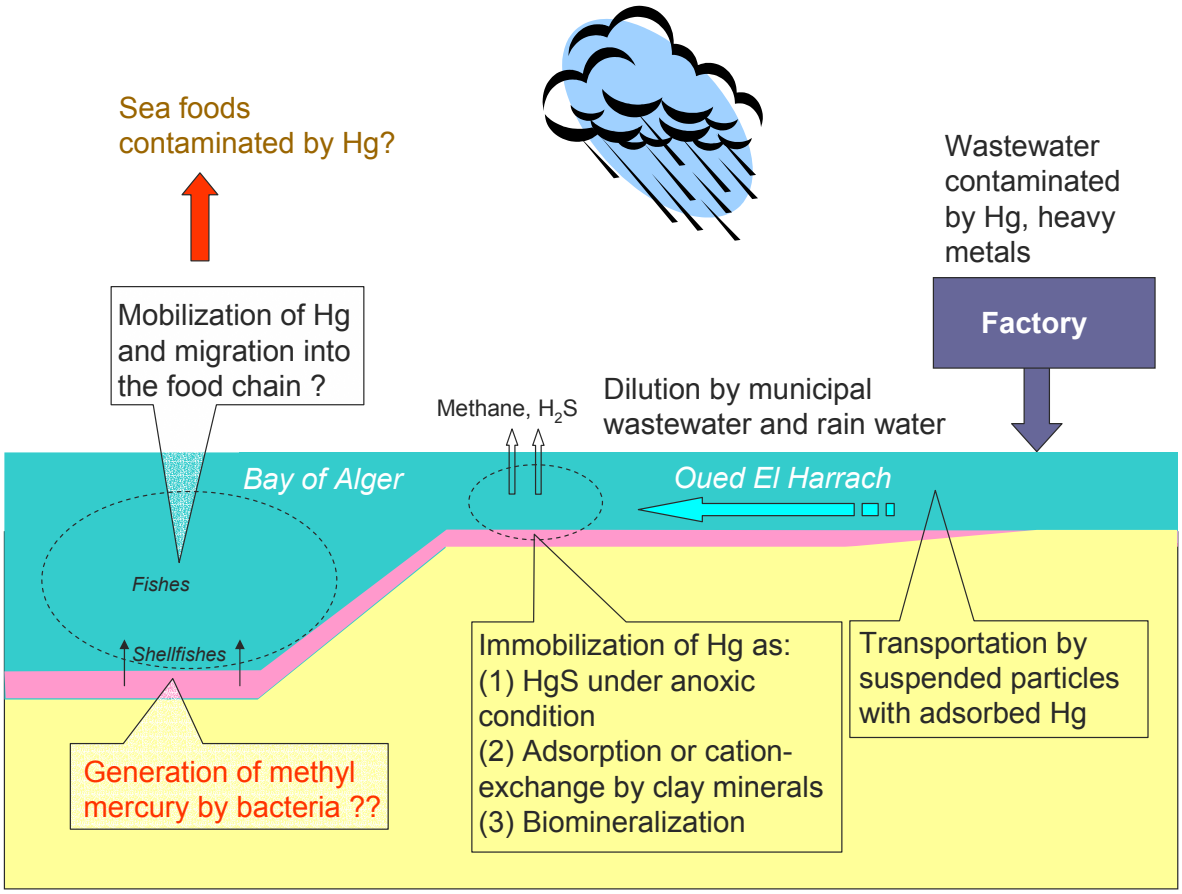

Figure 9: A model of mercury transport, migration, and immobilization. The part of offshore area is still unknown due to a lack of information.

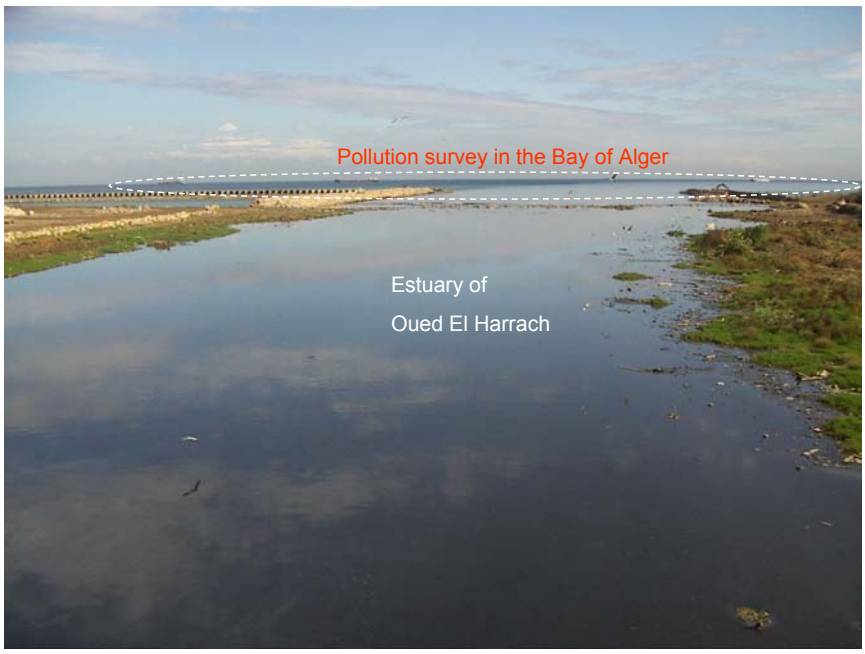

Plate 9: Estuary of Oued El Harrach and Bay of Alger. Offshore sampling survey was carried out in March 2005.

6. Conclusions

(1) The preliminary study of our collaboration unveiled extraordinary high concentration of Hg in Oued El Harrach sediments and water.
(2) Other heavy metal pollution, such as Cu, Pb, Cr, and Cd, was also detected in the river water and sediments.
(3) Mercury and chromium pollution are particularly non-permissible levels. Immediate counter-measure is required.
(4) These heavy metal pollutions are probably caused by the discharge of un-treated industrial waste/wastewater.
(5) If the mercury forms organic mercury such as methyl-mercury, its toxicity is very high like in the Minamata case.

(1) L'etude preliminaire de notre collaboration a dèvoilè une concentration extraordinairement elevée de Hg,dans les sédiments et les eaux de Oued El Harrach.
(2) Une autre pollutionpar des metaux lourds comme le Cu,Pb, Cr, et Cd a été détéctée dans les eaux de l'Oued.
(3) Pollution par Hg et Cr est à des niveaux l'inacceptables.
(4) Ces pollutions par des métaux lourds sont probablement causees par la décharge des dechets : eaux de rejets industriels.
(5) Si le mercure forme le mercure organique sa toxicité est tres élevée et des mesures doivent etre immediatement prises.

7. Recommendations

(1) Analyze more samples of industrial wastewater, sludge, onshore & offshore sediment/water, for a better understanding of the pollution state.
(2) Analyze fishes, shellfishes, and shrimps from the Bay of Alger, in particular about methyl mercury.
(3) Epidemiological study is recommended for the factory labors and people who are taking fishes.
(4) Based on the analytical results of industrial wastewater samples, take necessary measure for the polluter.
(5) Develop the capacity of enforcement of measure by D. E. Wilaya d'Alger.

(1) Analyser les rejets d'eau industriels ,onshore et au large ; echantillons eau sediments.

(2) Analyser le poisson les coquillages et les crevettes dans la baie d'Alger (pres de l' estuaire de l' Oued El Harrach).

(3) Il est recommande d' entreprendre une etude epidemiologique chez les travailleurs de ces unites industrielles et les consommateurs de poisson.

(4) Sur la base des resultats des analyses des echantillons d' eaux de rejets industriels , des mesures doivent prises à l'encontre des pollueurs.

(5) Renforcer la capacite de mise en œuvre des mesures dans l'Administration de l'Environnement.

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