TRACE ELEMENT IN DIFFERENT MARINE SEDIMENT FRACTIONS OF THE GULF OF TUNIS: CENTRAL MEDITERRANEAN SEA

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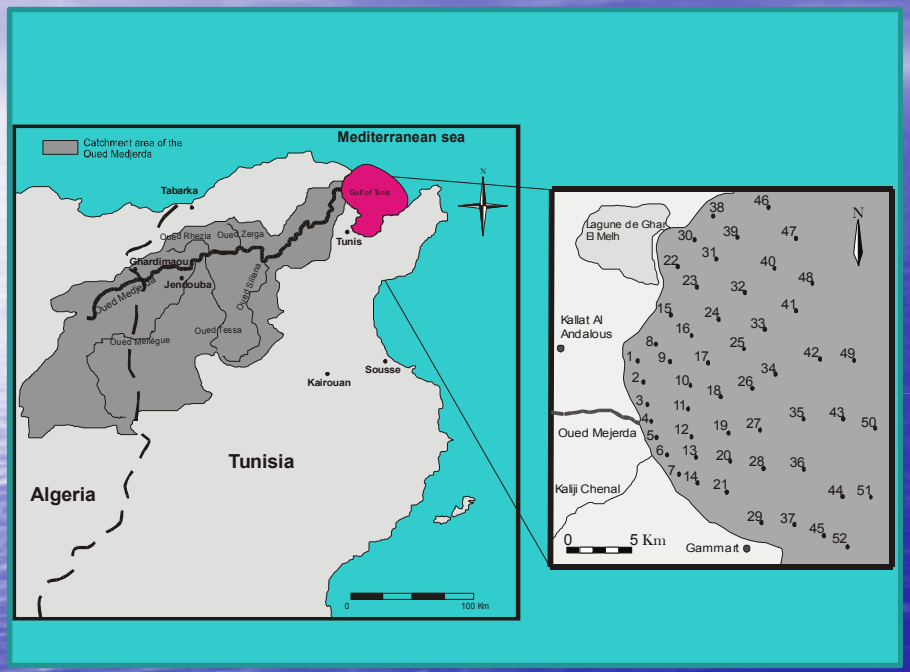
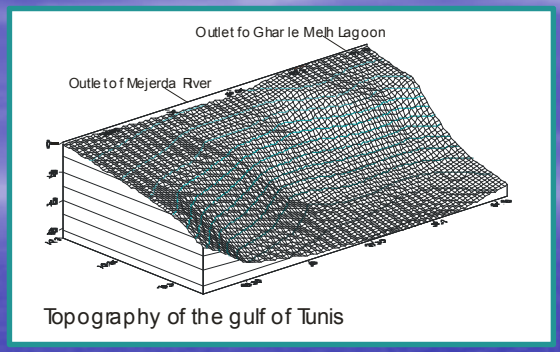


Fig1: Study area and sampling sites of surface sediment in the north of Tunisia



Topography of the gulf of Tunis

In the North of Tunisia the major wind period is marked by strong and frequent North West direction.

This wind engenders littoral currents, gyrating current anticlockwise forms in the centre of the gulf, forming weak current in the central part.

Sediment dynamics along a littoral zone is closely dependent on the direction and the intensity of the littoral currents.

The Gulf of Tunis is connected to two principal water flows, the Mejerda River and the Ghar el Melh lagoon.

Grain size distribution of surface sediment

The clayey silt and the sandy silt represent the main fractions.

We are interested in the fraction which is <63µm that is often selected for geochemical analysis.

Three surface sediment fine fractions are separated (<2µ, 2-20µ, 20-63µ) for Major and trace element.

The particles that are less than 2 µm constitute the clay fraction, a fine silt fraction (2–20 µm) and a mixture of fine and coarse silt fractions (20-63 µm).

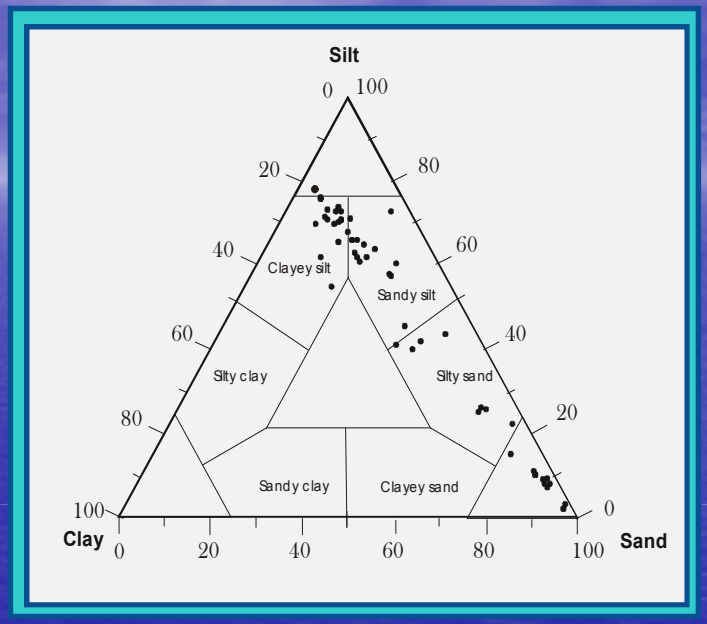


Fig 2: Ternary diagram of particle size fractions of surface sediment

Table 1: particle size fractions of surface sediment less than 63µm

µm	< 2	2-20	20-63
Max	25	80	80
Min	5	30	2
Average	16	60	19

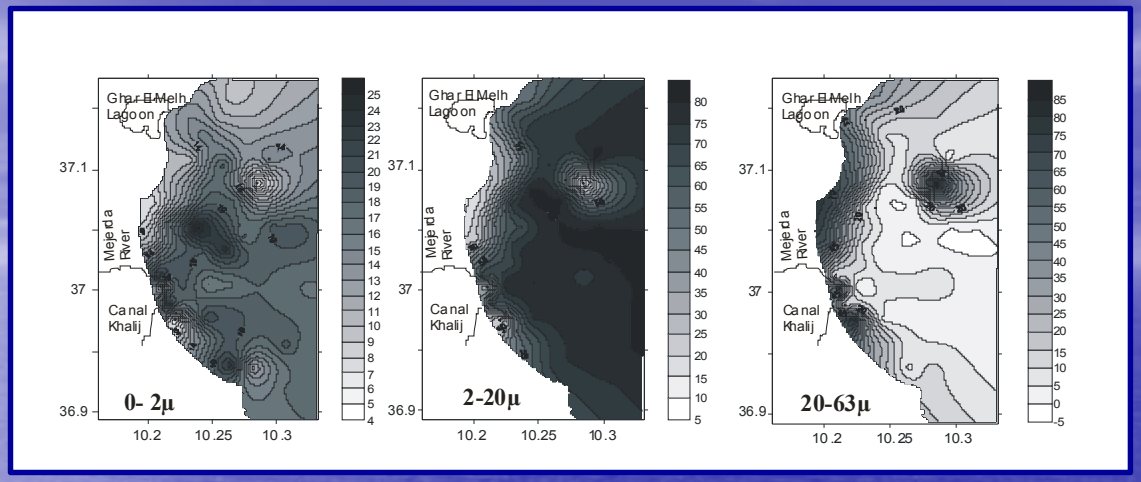


Fig3: Distribution of fine fractions of surface sediment in the outlet of Mejerda River

In the central zone, the clay and the fine silt fraction are dominant 75-95%.

The fine and coarse silt fraction is dominant in the coastal zone. However, in the central zone there is a punctual accumulation by the presence of a region of offshore outcrops.

Mineralogy of different sediment fractions

Table 2: average of clay minerals and quartz in surfacial sediment

	Coastal zone					
	smectite	Illite	Kaolinite	Chlorite	I- S	quartz
< 2 µm	28	25	34	5	8	7
2-20 µm	30	24	34	6	6	13
20-63 µm	18	33	32	6	11	29
	Central zone					
	smectite	Illite	Kaolinite	Chlorite	I- S	quartz
< 2 µm	23	25	40	5	8	7
2-20 µm	24	25	39	6	6	15
20-63 µm	12	34	37	6	11	30

Dominant phases are dioctahedral smectite, illite and kaolinite. Chlorite and interstratified illite-smectite are also present.

Smectite percentage is higher in the coastal zone compared to the central one.

Quartz percentage is almost the same in the coastal zone and the central zone.

Smectite and fine Quartz grain size are accumulated in littoral zone and in the central part of the Gulf.

The distribution of smectite and fine particles of Quartz follow the principal coastal drift directions.

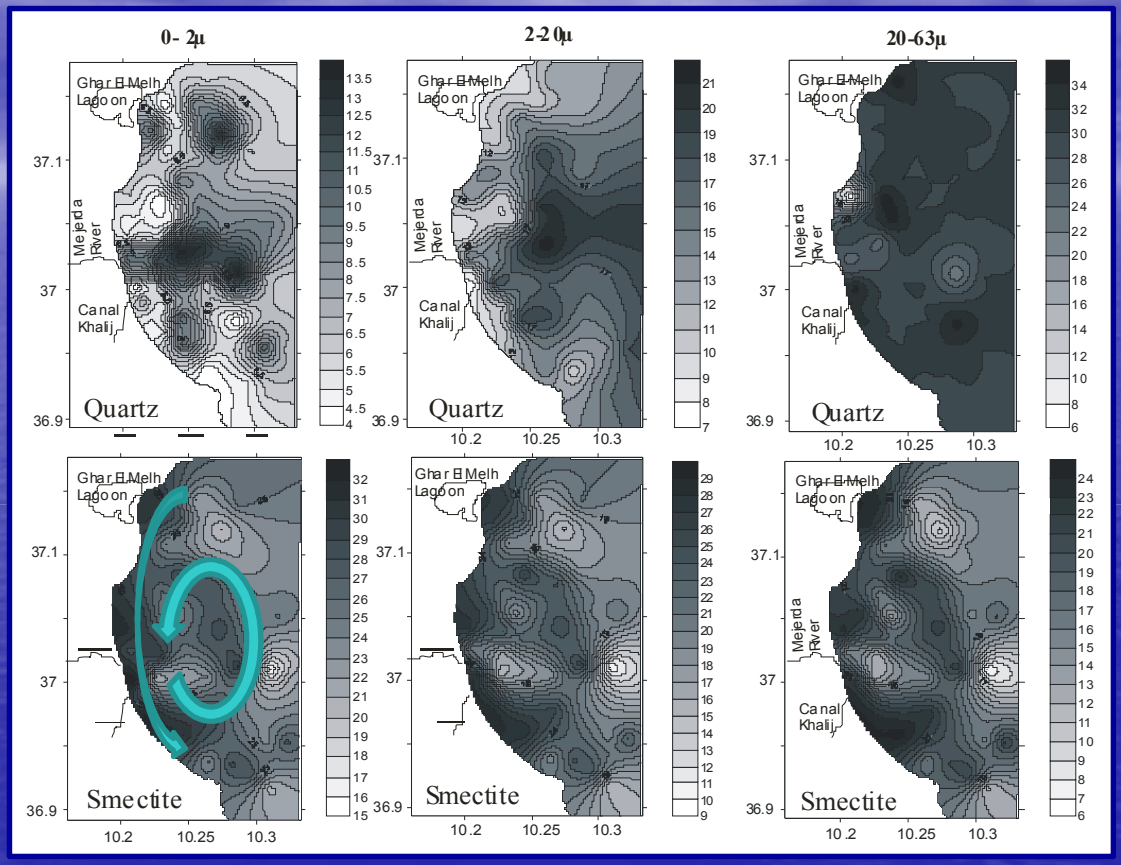


Fig 4: Distribution of quartz and smectite in different grain size fration of surfacial sediment

Geochemistry of surface sediment fine fraction

Total organic carbon shows a low accumulation in front of Mejerda River and Ghar El Melah Lagoon.

Most part of total organic carbon is concentrated in the south part of the gulf.

The C/N ratio shows a terrestrial organic matter influence mainly in front of Ghar El Melh lagoon (16), Mejerda River (12) and in the south part of the gulf (17).

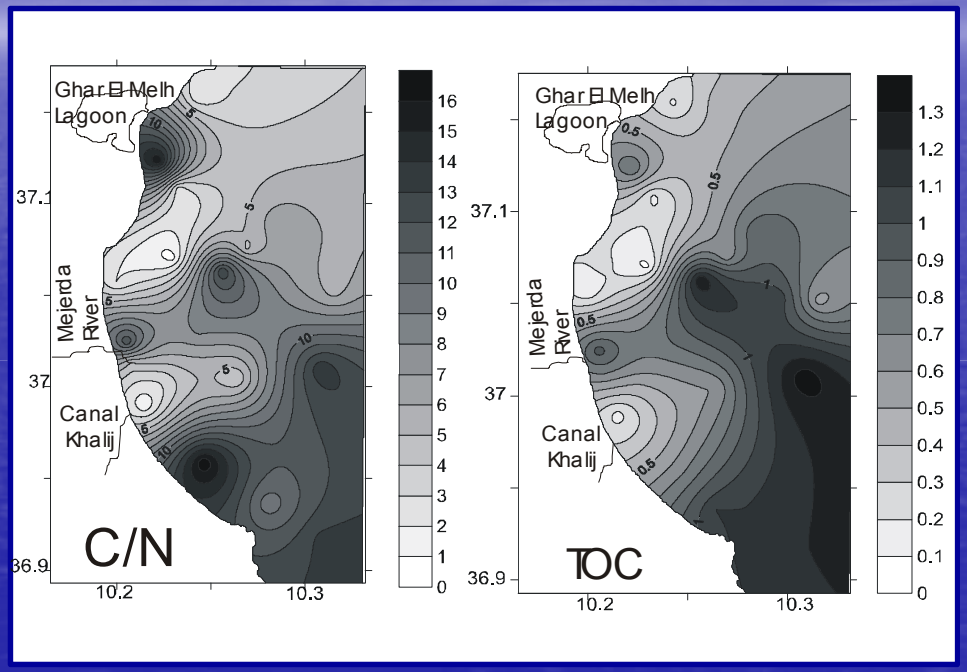


Fig 5: Distribution of TOC and C/N in the surfacial sediment

Table 3: Average of major element in surfacial sediment

(%)	SiO_2	Al_2O_3	Fe_2O_3	MnO	MgO	CaO	Na_2O	K_2O	TiO_2	P_2O_5	SO_3
< 2µm	45.91	22.69	8.87	0.02	2.08	0.95	0.29	2.55	1.22	0.17	0.23
2-20µm	51.33	20.32	7.88	0.02	1.85	0.85	0.26	2.26	1.09	0.15	0.25
20-63µm	59.62	17.35	6.39	0.02	1.61	0.75	0.23	1.97	0.95	0.13	0.21

The coarse fraction (20-63µm) in comparison to fine fraction (<2µm) is richer in SiO_2 signifying the presence of non-clay minerals such as quartz confirmed by X-ray diffraction.

The reverse trend is noticed in Al_2O_3 and Fe_2O_3. The weight percentage of MnO remains constant in both fractions with an average of 0.02%.

Table 4: Average of trace element in surfacial sediment

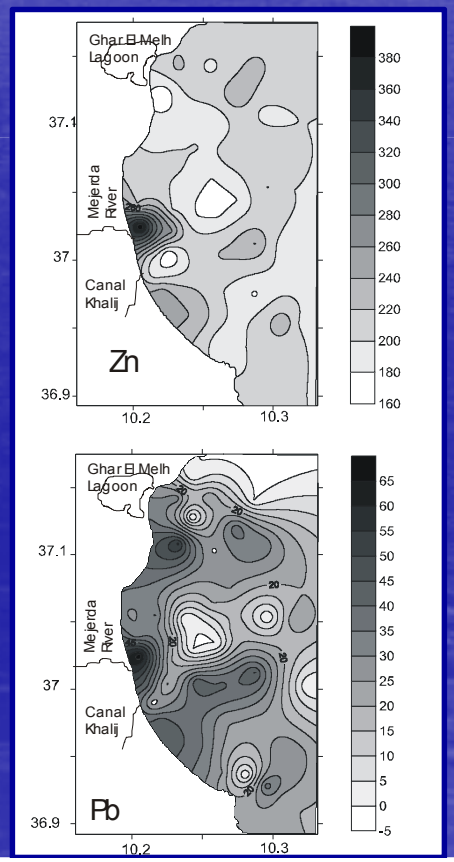
ppm	Cl	V	Cr	Co	Ni	Cu	Zn	Ga	Br	Rb	Sr	Y	Zr	Nb	I	Ba	Pb
< 2µm	429	223	218	5	72	62	209	31	47	120	196	14	300	28	45	271	25
2-20µm	380	197	192	4	64	55	184	27	42	106	173	12	266	25	40	239	22
20-63µm	333	172	167	4	56	48	160	24	36	93	151	11	230	22	35	208	19

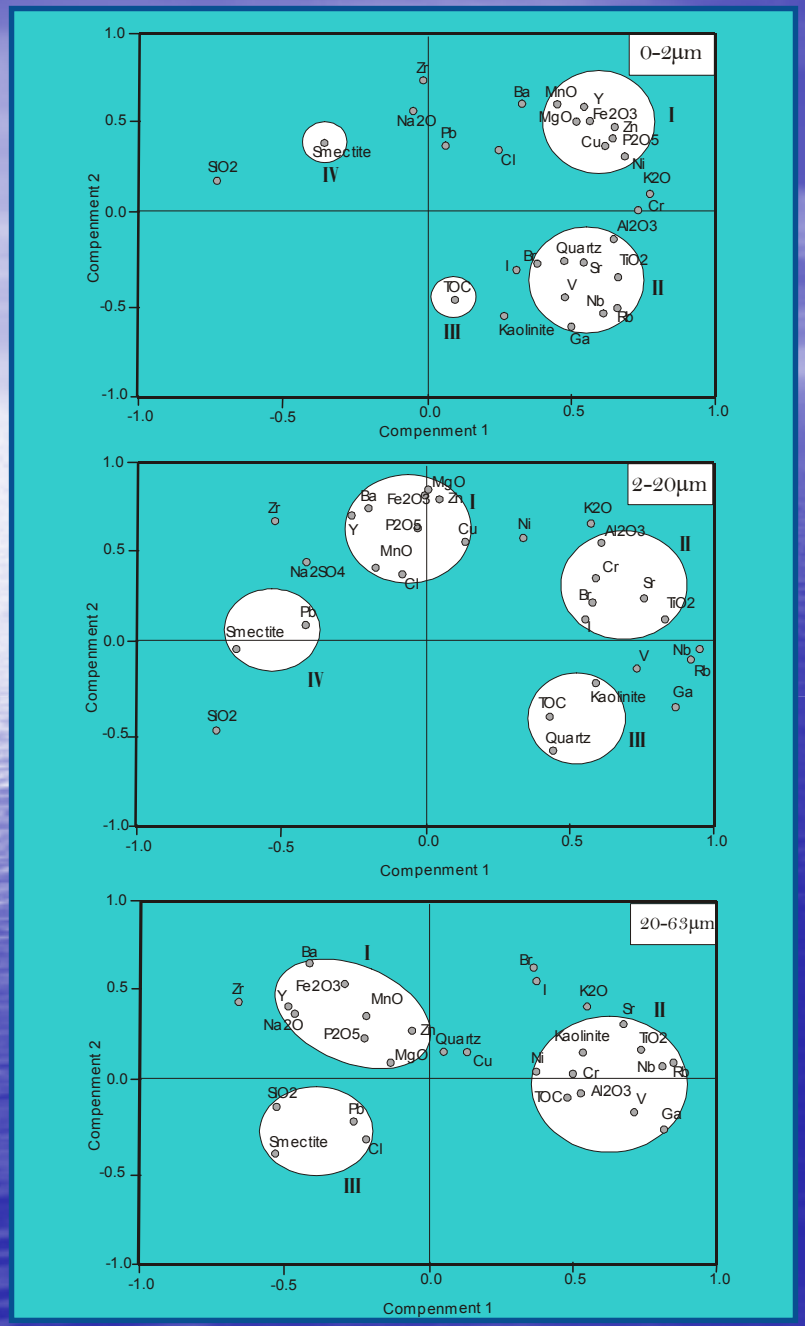
The distribution of Pb is homogenous in the three fractions.

A little accumulation of Pb is observed in the fine fraction (<2µm) in the outlet of Mejerda River (65ppm).

The repartition of Cu, Zn and Zr represent a relative accumulation in the fine fraction (<2µm).

Spacial distribution shows an accumulation of Zn in front of mejerda river.





Statistical analysis

PCA statistical analysis, identified three components that explained 67%, 94% and 64% of the total variance respectively in the three fractions <2µm, 2-20µm and 20-63µm.

There is a clear affinity between total iron and a group of trace elements except Pb (Group I). This element is in association with Smectite in 2-20 and 20-63µm fractions in respectively Group IV and III.

The association phenomena took place in the Mejerda river and Ghar el Melh lagoon.

Mlayah and al [2009] have shown that suspended particles in rivers scarvege trace elements by ferrous, manganese and phosphorous hydroxides.

A second group of trace element is associated to alluminosilicates in the three fractions (GroupII).

Fig6:Loading of the variables on the first two principal components

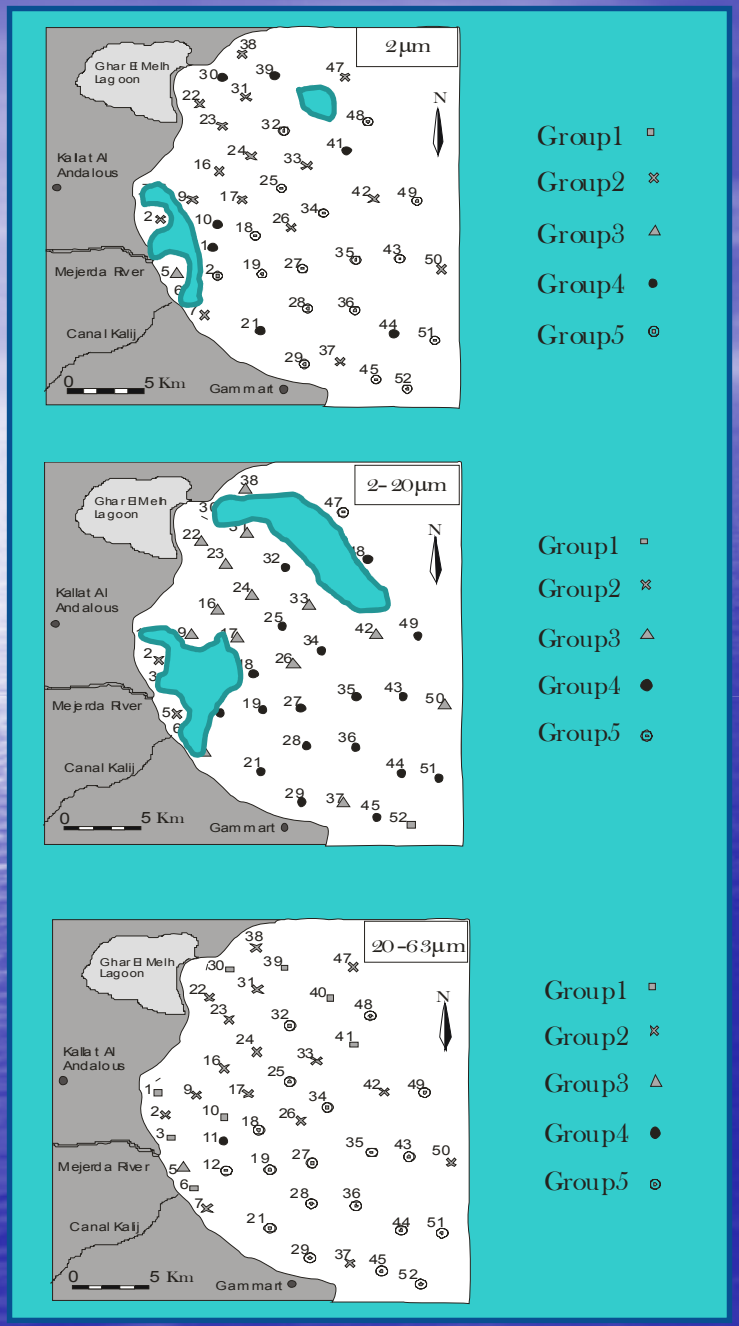


Fig7: Classification of the sites based on the cluster analysis

The cluster analysis allows us to classify the sediments in terms of their inter-metallic and composition ratios.

In the fraction < 2µm, Group 1 is characterized by a relatively highest average metal concentrations Fe, Pb, Zn, Ni and Cr. Most of the sites of this group are in front of Mejerda river.

In coarser grain size sediment (2-20µm), Group 1 contains an extended area of potential sources of metals contaminants in the region, mainly Zn, Cu and Pb.

In grain size fraction between (20-63µm) there are Group 2 and 5 which form two areas: the northern area (lowest metal average) and the southern one (high metal average).

Conclusion

Trace element reflects mining in the gulf of Tunis.

In the different fractions <2µm, 2-20µm and 20-63µm traces elements are associated to hydrogenous fraction from water source outlet.

There is a week degradation of TOC, mainly in front of Ghar el Melh lagoon and in the Southern part of the Gulf.

Trace element areal accumulations are clearly Distinguish according to their grain size fractions by cluster analysis in coastal sites in front of Ghar el Melh lagoon and in front of Mejerda River.