Chemical composition of marine sediments in the Pacific Ocean from Sinaloa to Jalisco, Mexico

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3rd INCC
Palermo, Sicily, Italy
18-23 September 2011

INTRODUCTION

- During the last decades, Mexican shorelines have presented increasing anthropogenic activities related to agriculture, fishing, industry and tourism. Because of their organic and inorganic waste and the related environmental changes they provoke, such activities have an impact on the coast line in a similar way to impact on some places in the Gulf of Mexico coast.
- The presence of trace elements is linked to both anthropogenic sources and natural ones.
- Elements present in marine environment are generally classified as major elements –those found in percentage (%) concentrations and trace elements in concentrations lower than 10 mg g^{-1}. Some of them are Mn, Cu, Zn, Pb, Ni, Ga, and La

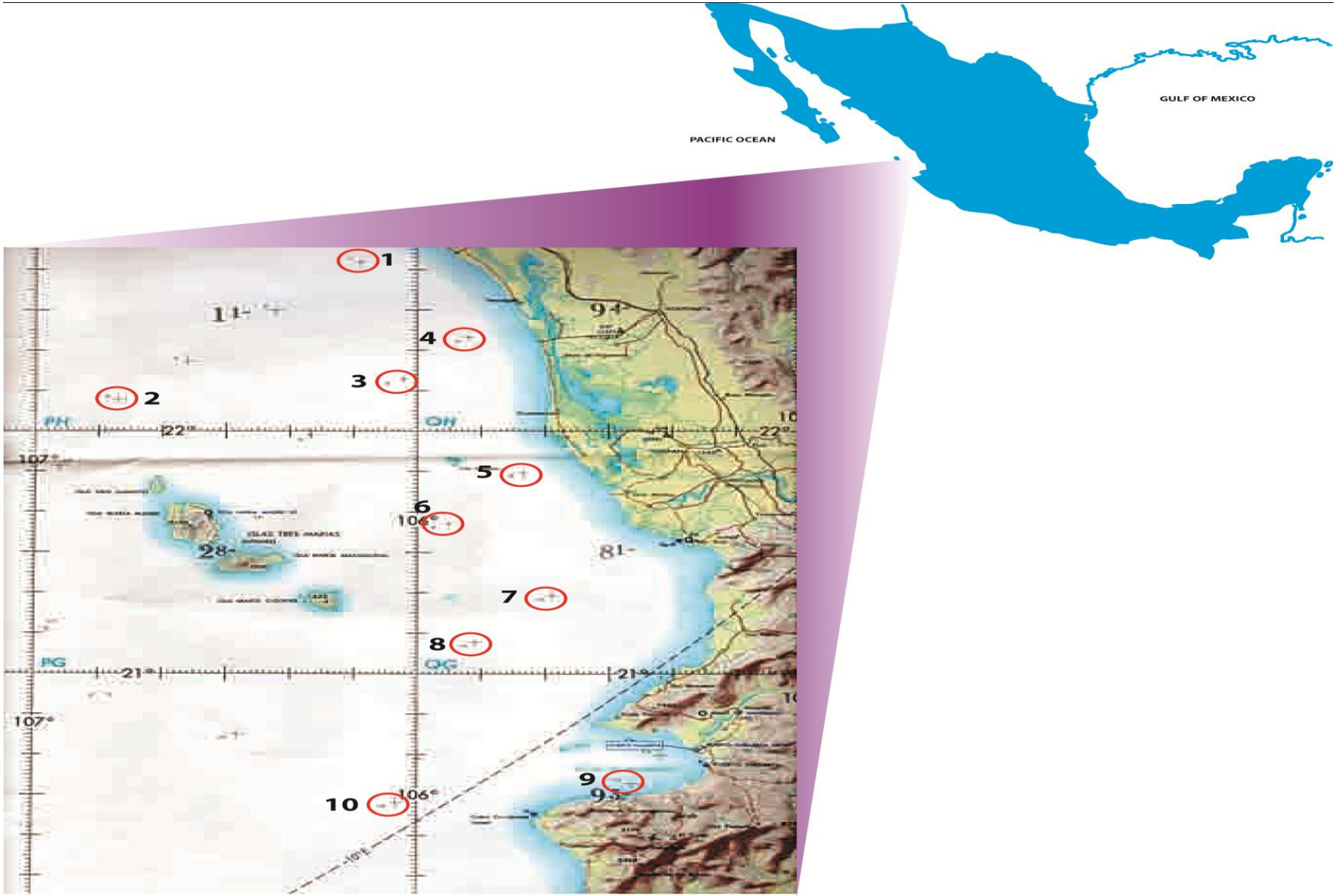


Fig. 1.- Distribution of the ten sampling sites in the Pacific Ocean from Sinaloa to Jalisco in Mexico

Aims

- The aim of the present work is to determine concentration and spatial distribution of major components (carbonates and organic carbon), major elements (Fe, Ca, K) and trace elements in sediments from the middle coast of Pacific Ocean in Mexico.

- The results are compared to both Environmental Protection Agency (EPA) and Ontario Ministry of the Environment[14] (MOE) reference values.

- Geochemical association between major components, major elements and trace elements is also characterized. In interpreting results, enrichment factors were used. These results and others previously reported can also be used to establish a base data line for the studied region.

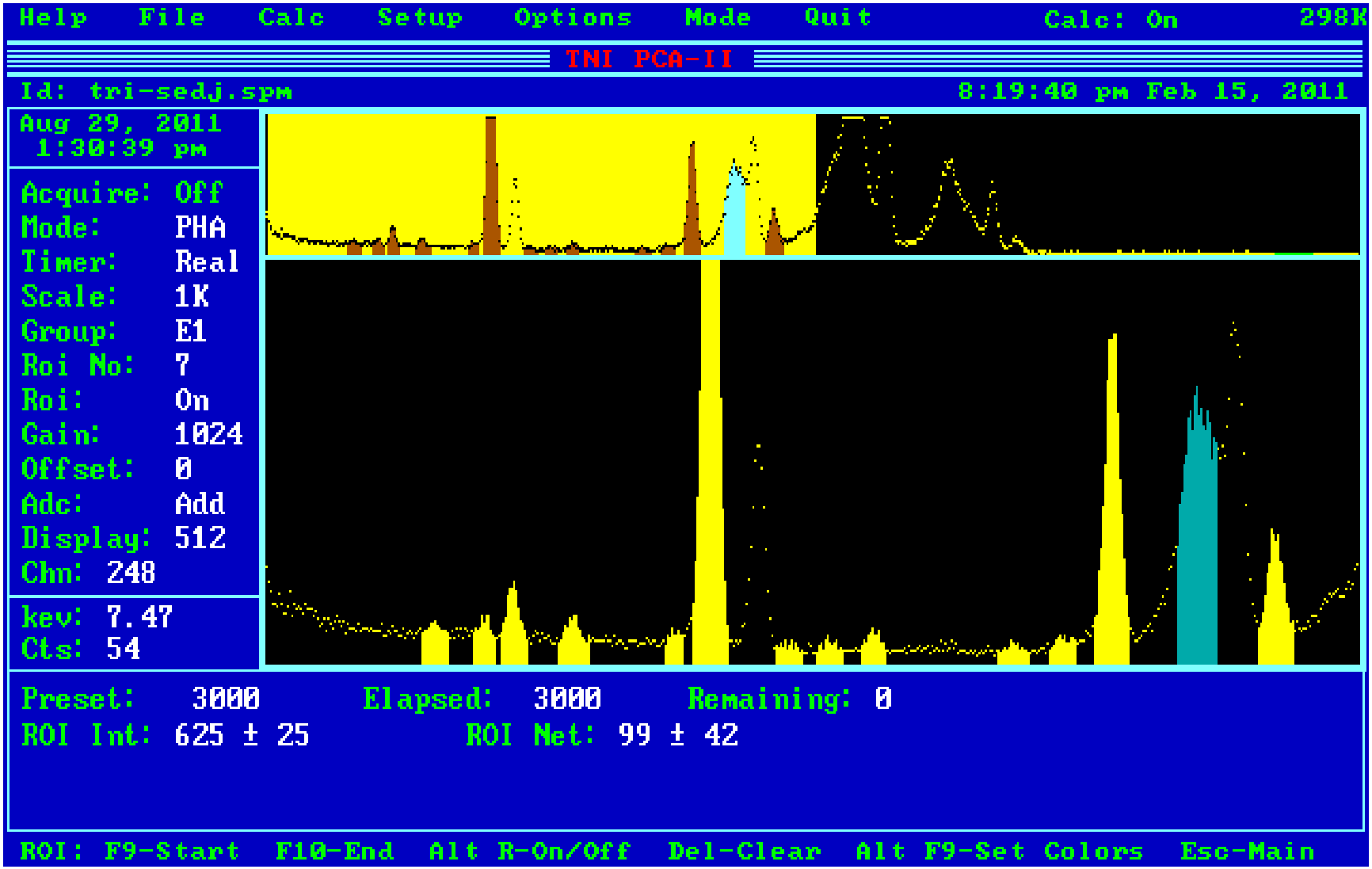
Experimental

- Total sample was carefully mixed and dried at room temperature during a 120 hours period and then fractioned for granulometric, physical and chemical analysis. Physical and chemical properties of sediment samples were determined by standard methods.
- Granulometric analysis
- pH
- Conductivity
- Elemental analysis by EDXRF (bulk and <100 μm)
- XRD
- Total and organic carbon, $CaCO_3$.
- Generated data was processed by means of various statistical tests with Stat graphics V.5 Plus (Manugistic 2000)α=0.5. Pearson multiple correlations were applied to data results.

Table 1. Geographical localization, bathimetry of sampling sites and granulometric analyse of sediments.

Sampling Sites	Depth m	North latitude	West latitude	% Clay and silt x<62.5µm	% Very Fine Sand 105µm<x>62.5µm	% Fine coarse and very coarse sand 1650µm<x>105µm	% Gravel and boulder x>1650µm
1	55.4	22º42’176’’	-106º09’949’’	6.87	5.04	86.77	1.31
2	1650	22º07’756’’	-106º46’118’’	21.68	15.76	62.54	0
3	51.8	22º13’	-106º02’	24.54	9.8	65.65	0
4	30.8	22º23’303’’	-105º52’136’’	8.28	4.35	66.88	20.48
5	25	21º49’674’’	-105º43’184’’	44.11	17.99	37.17	0.73
6	73.5	21º37’208’’	-105º55’403’’	6.61	5.08	82.92	5.38
7	359.5	21º19’546’’	-105º39’06’’	10.26	25.01	64.72	0
8	457	21º08’	-105º51’	7.14	25.11	65.74	0
9	1269	20º33’037’’	-105º26’062’’	3.57	1.96	13.85	80.6
10	2377	20º28’452’’	-106º03’007’’	*	*	*	*

*Not determined



EDXR spectrum of one sedimen sample

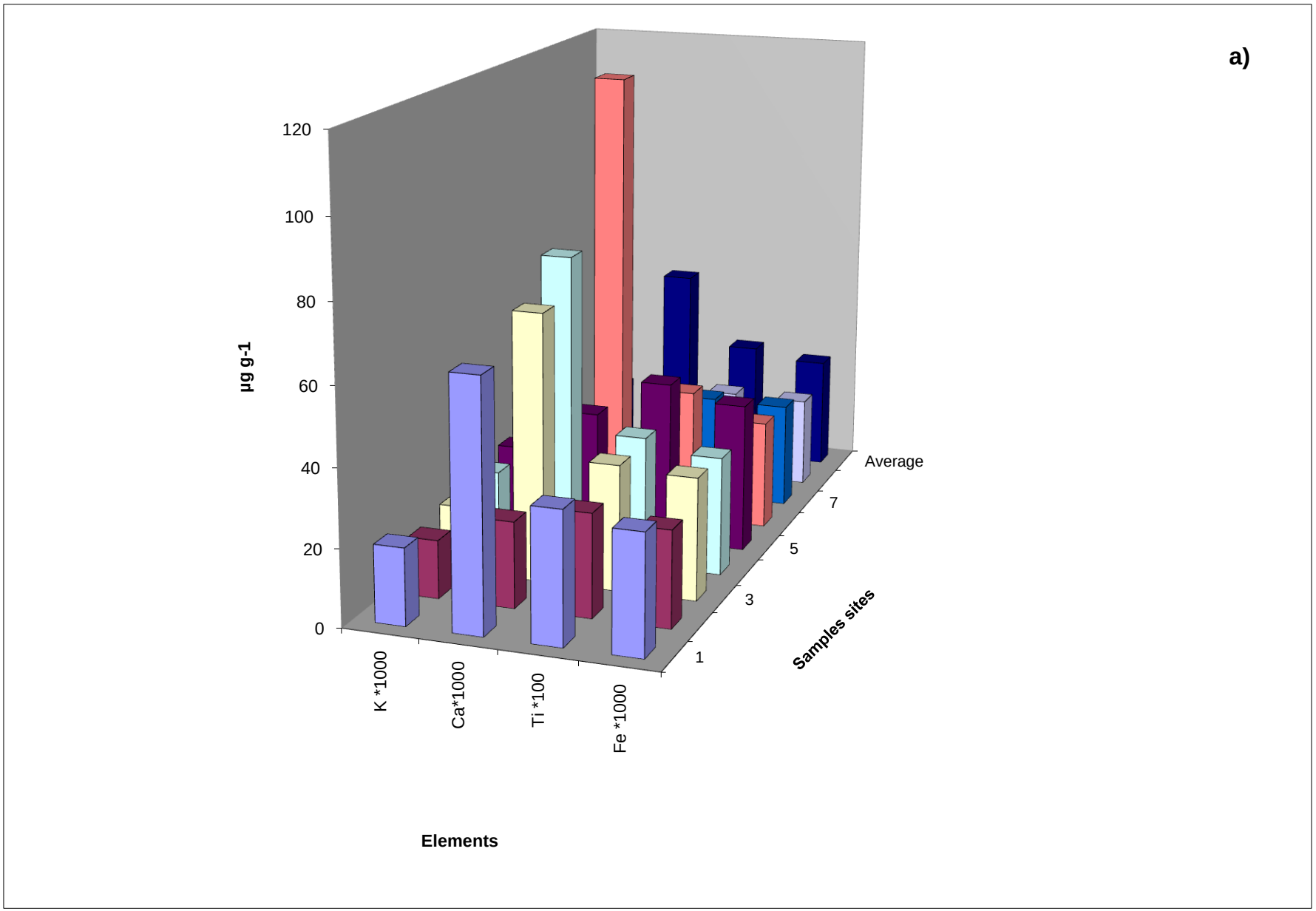


Fig. Concentration of major (a), in fraction <100 µm in each sampling site.

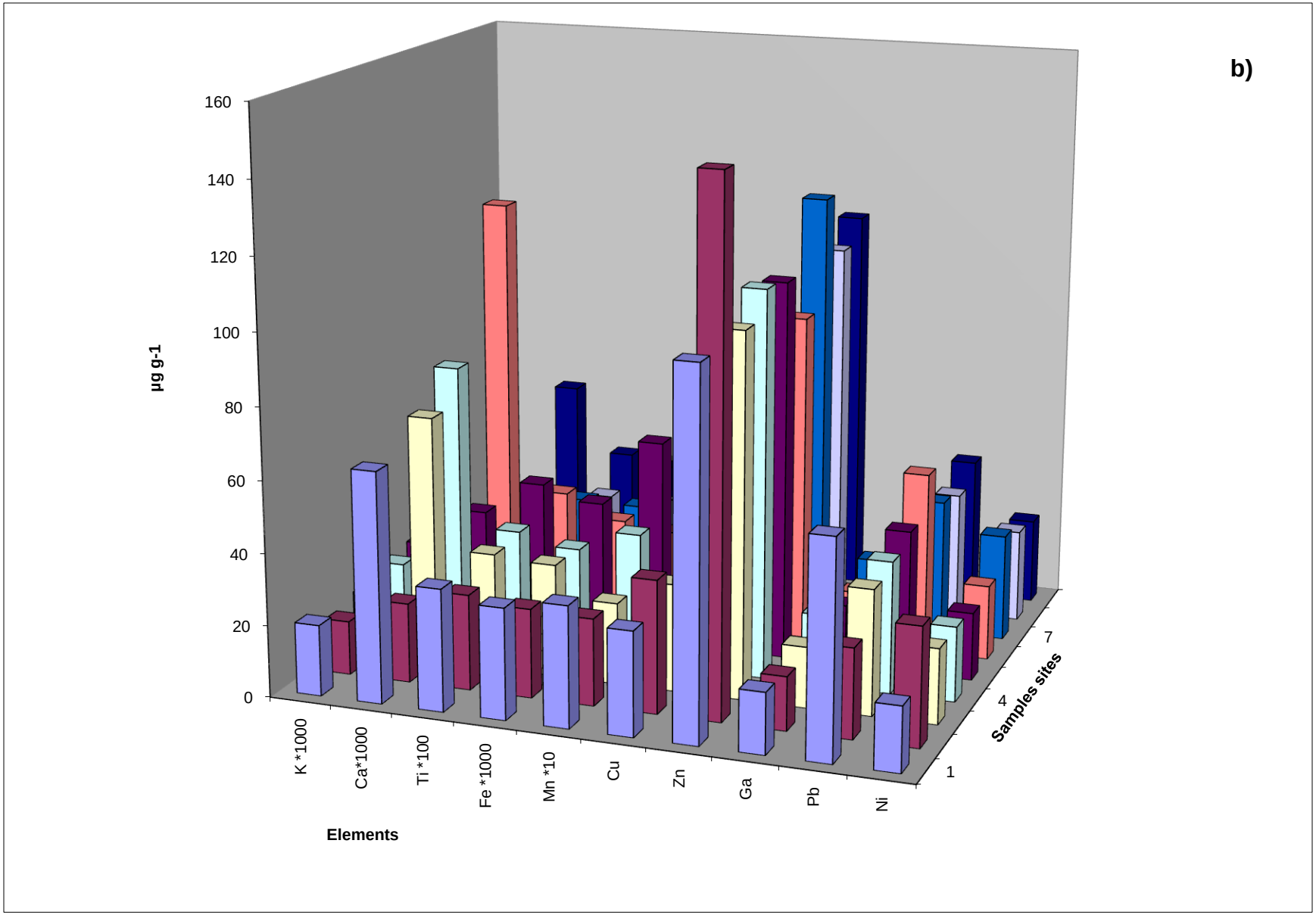


Fig. Concentration of minor elements (b), in fraction <100 µm in each sampling site

Table 2.- Average elemental concentration (µg g^{-1}) and enrichment factors in sediments (<100µm and Bulk fraction)

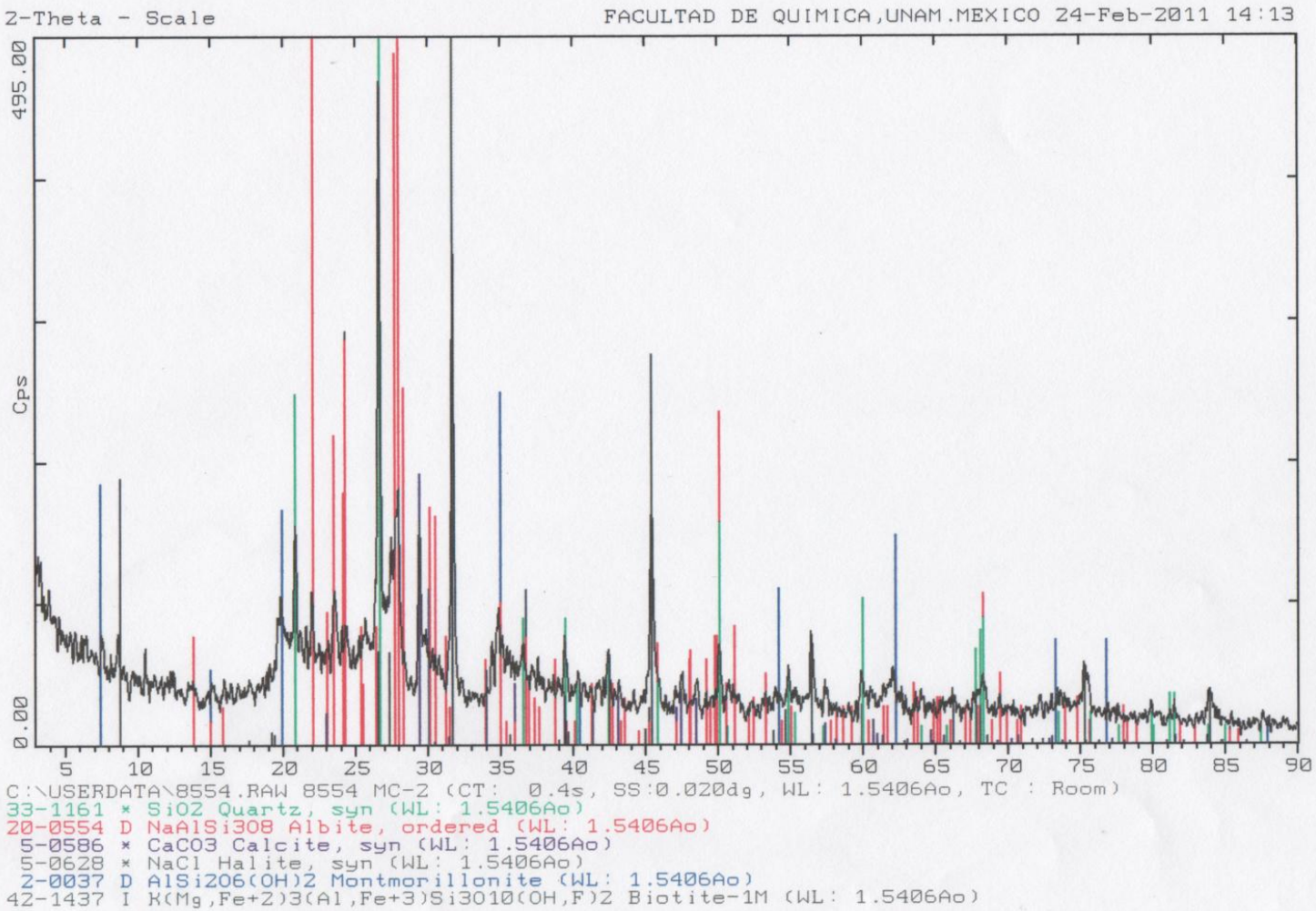
	<100µm fraction (µ gg^{-1})			Bulk (µ gg^{-1})			EF (<100µm)			EF(Bulk)		
	Min	Max	Av	Min	Max	Av	Min	Max	Av	Min	Max	Av
K	11952	21112	17261	16000	24000	20311	0.7	0.9	0.8	0.83	1.4	1.0
Ca	7263	117589	51208	13000	74700	59620	0.6	2.9	1.3	0.6	4.8	1.7
Ti	2379	4239	3197	2300	4600	3287	1	1	1	1	1	1
Mn	186	578	305	400	450	406	0.4	0.7	0.5	0.5	0.9	0.8
Fe	23502	38604	29502	18000	42000	29670	0.9	1.1	1.0	0.8	1.5	1.0
Cu	14	41	28	42	83	53	0.4	1.8	1.1	1.4	3.4	2.0
Zn	92	146	110	49	142	104	0.8	1.7	1.1	0.6	1.3	1.0
Ga	12	20	17		*		1.1	1.6	1.3	-	-	-
Pb	25	60	40	52	133	74	2.2	4.2	3.0	3.4	9.9	5.8
Ni	18	33	24		<LD		0.4	1.0	0.6	-	-	-
Sr		*		192	947	388				0.7	3.2	1.6
Br		*		84	853	349				27.2	289	113.4

*Not determined, EF=Enrichment Factor, LD Detection limit.

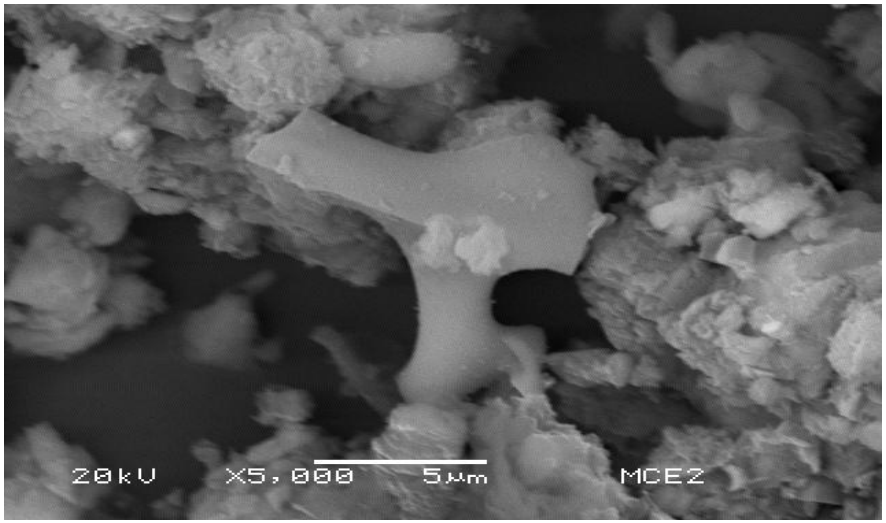
Table 3. Percentage of total and organic Carbon, Calcium Carbonate, pH and Electrical conductivity in bulk sediments samples.

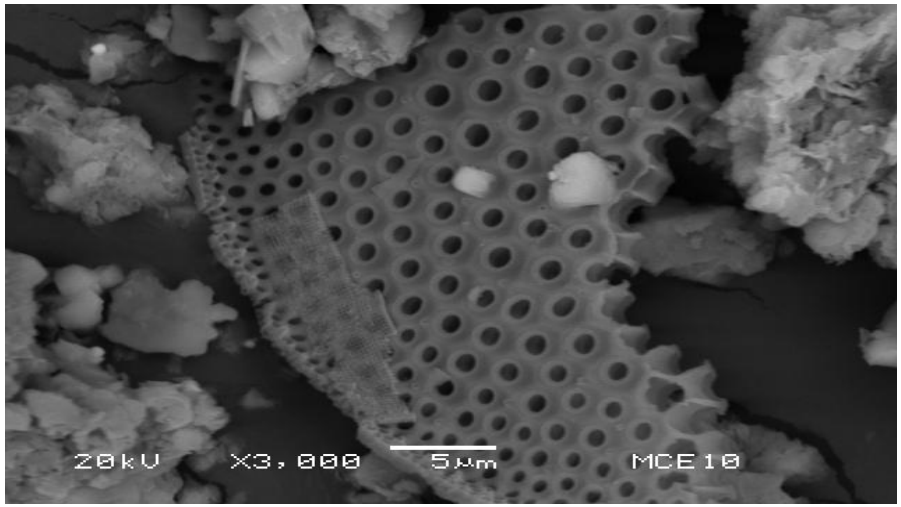
Sampling Site	**%TC[1]**	**%OC[2]**	**%$CaCO_3$**	**pH**	**EC[3] µscm^{-1}**
1	2.01±0.02	0.765±0.05	9.79±0.1	8.3±0.1	16.9±0.3
2	6.42±0.01	4.396±0.05	4.26±0.1	7.6±0.1	47.6±6.9
3	3.53±0.06	2.13±0.05	10.2±0.1	8.1±0.1	25.5±3.5
4	6.08±0.08	0.731±0.1	38.43±0.1	8.5±0.2	19.4±0.4
5	2.48±0.01	0.886±0.1	11.39±0.1	8.1±0.0	20.0±0.6
6	3.52±0.04	0.541±($5x10^{-4}$)	21.68±0.1	8.4±0.0	20.4±0.4
7	6.04±0.04	4.503±0.05	2.19±0.1	7.1±0.1	70.5±6.2
8	6.74±0.02	6.225±0.05	3.41±0.1	7.5±0.1	70.0±8.3
9	1.90±0.02	1.87±0.05	1.4±0.1	*	*
10	2.03±0.03	1.68±0.11	0.51±0.1	*	*

*Not determined. [1.-] Total Carbon . [2.-] Organic Carbon [3.-] Electrical conductivity



Difractogram of one sediment





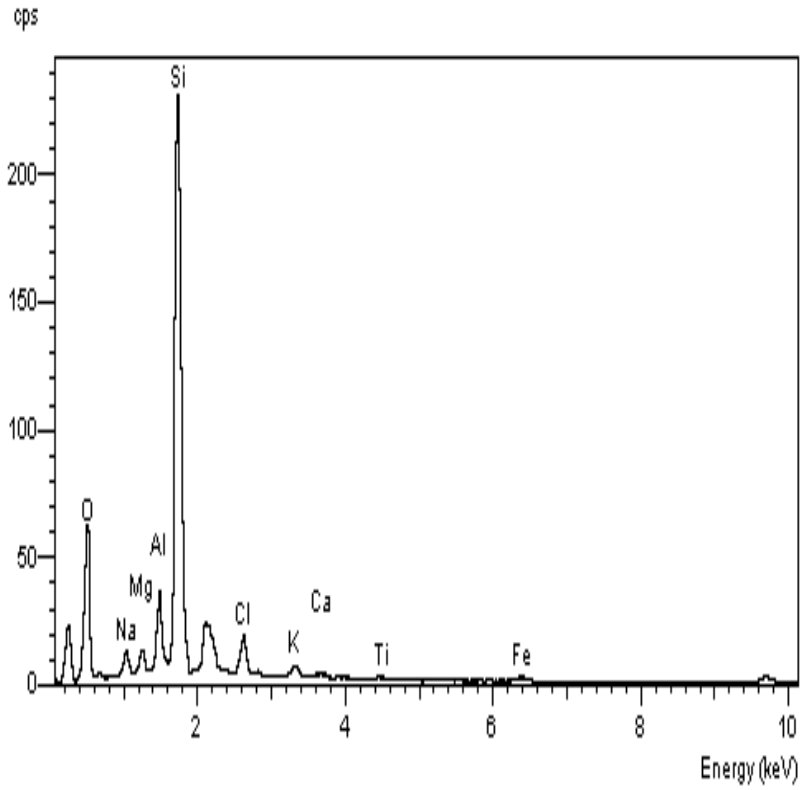
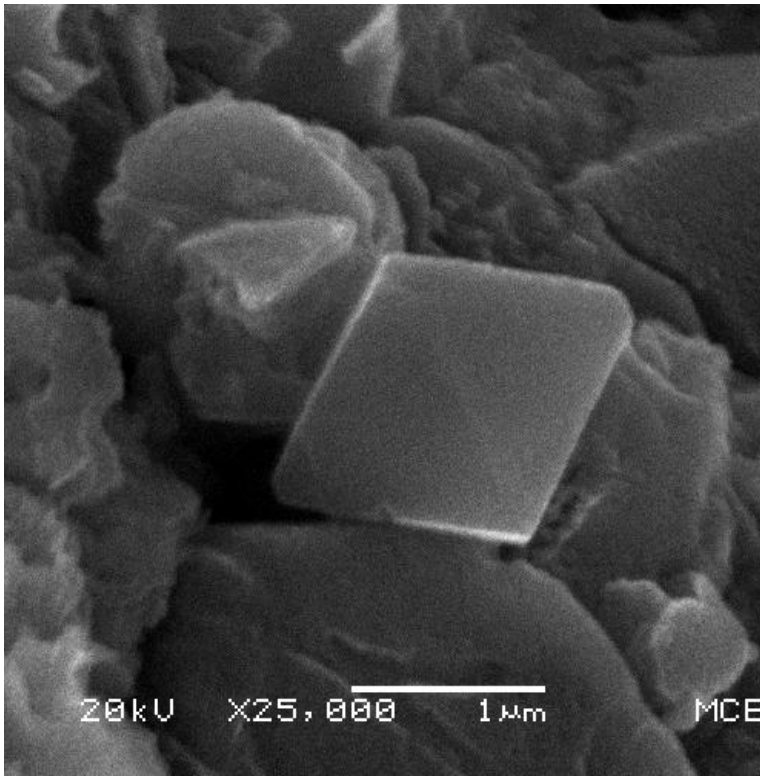


Fig. 4. SEM Micrograph (magnification 3000X) and XRF spectrum showing the presence of silicon oxide. Diatom plants make mineral hard parts with SiO_2



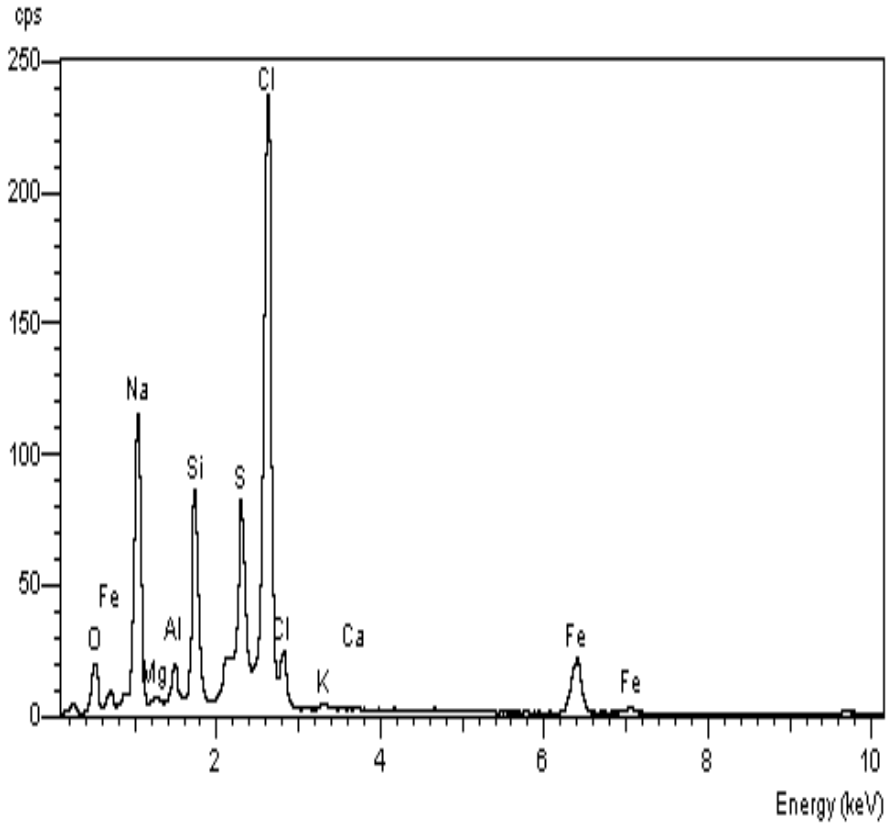
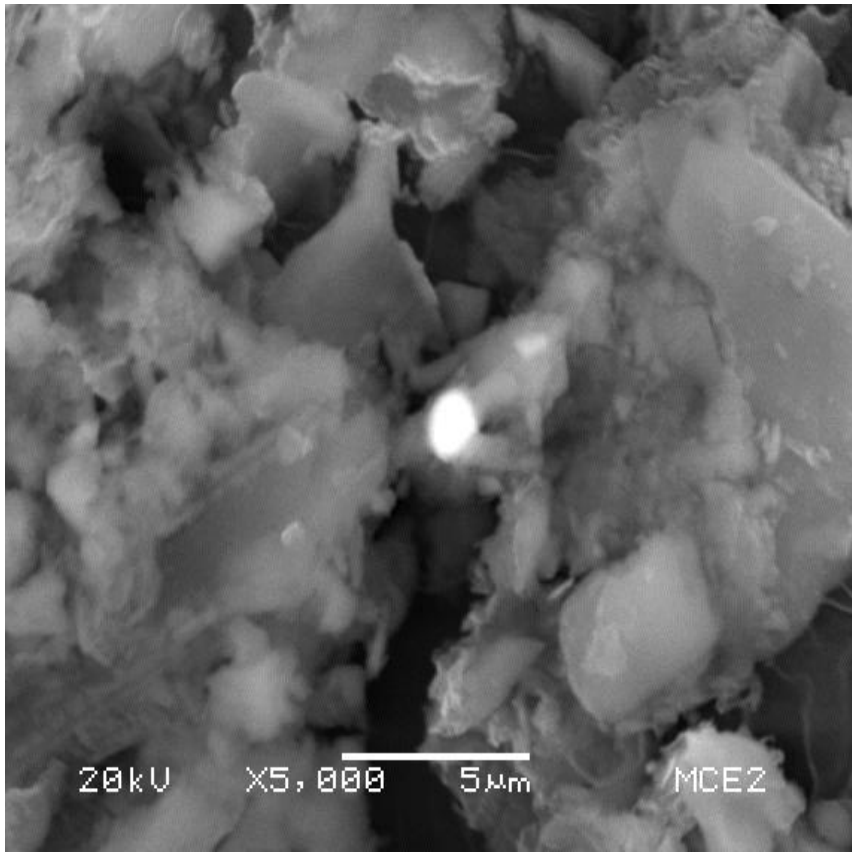


Fig 5. SEM micrograph (magnification 25000X and corresponding XRF spectrum showing the presence of Halite (Na Cl)



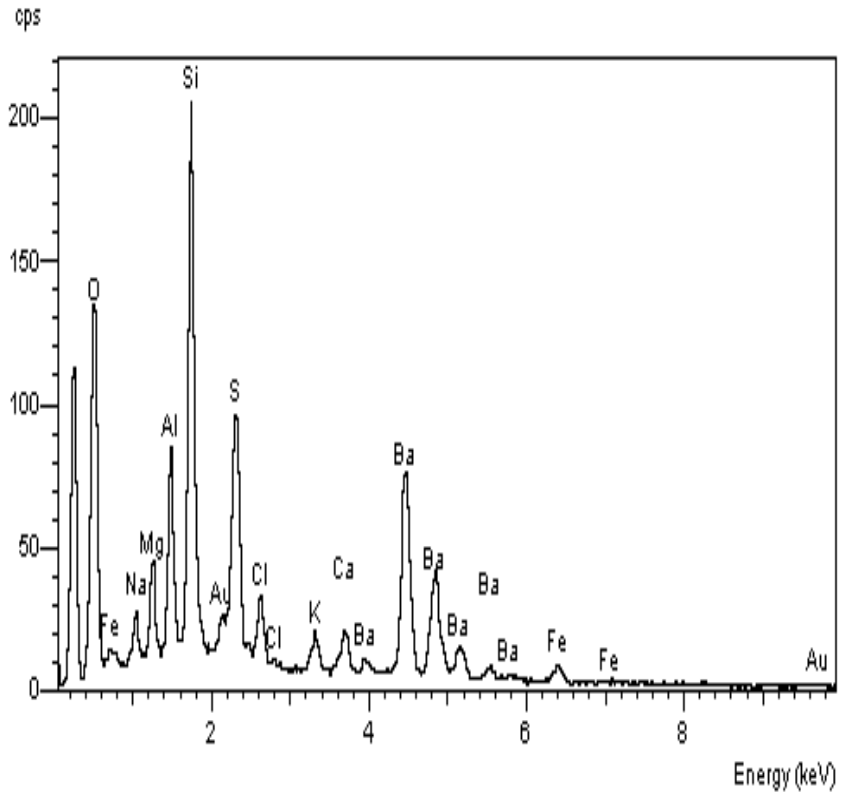
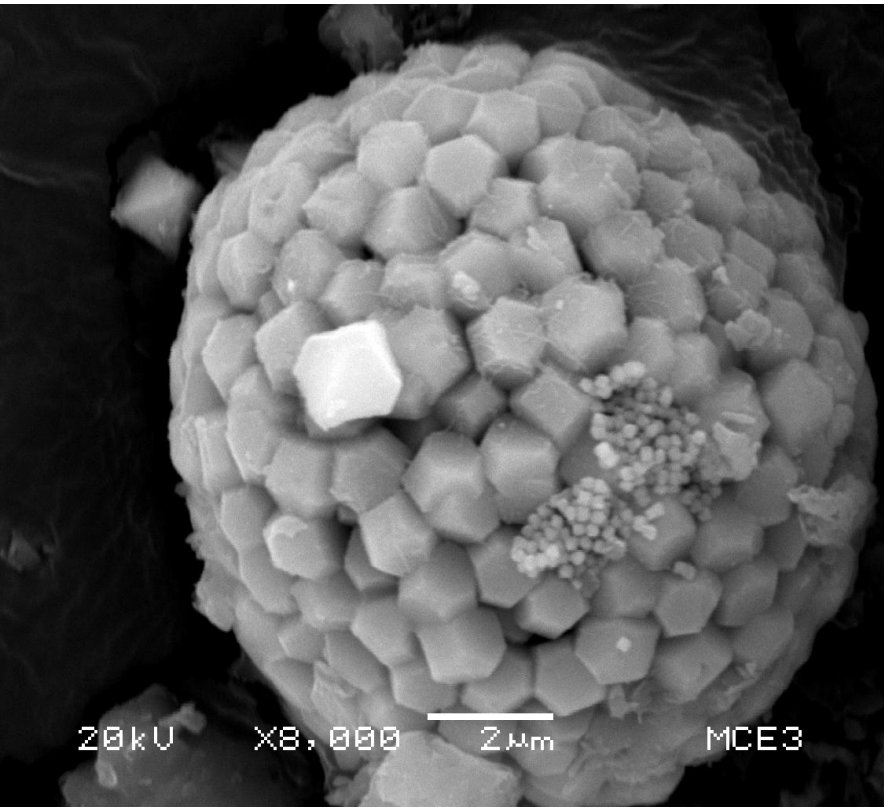


Fig. 6. SEM micrograph of spherical particles (magnification 5000X) showing high conten of Ba and S mixed with (Al-Si-O-Na-Mg)



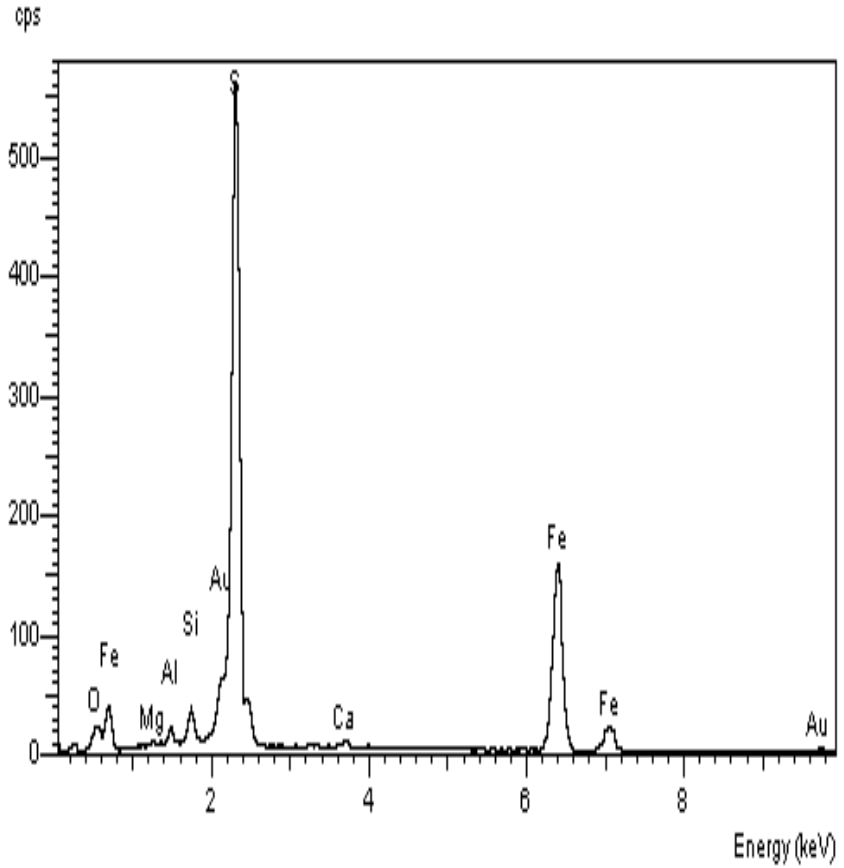
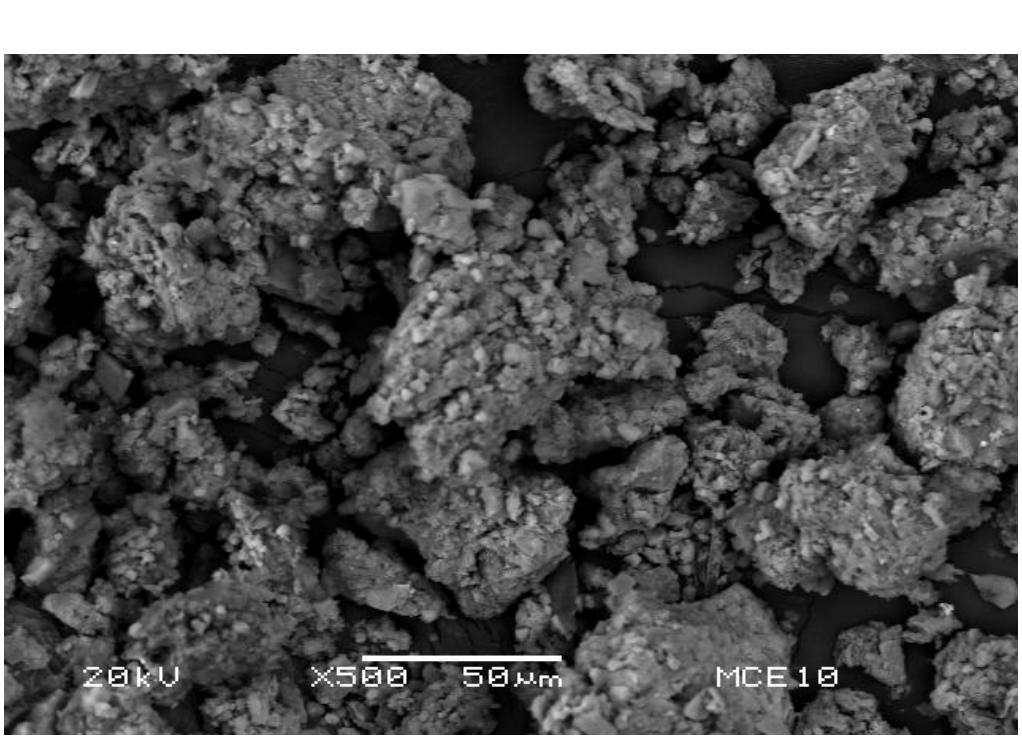


Fig. 7. SEM micrograhp (magnification 8000X) and XRF spectrum showing a the presence of Fe-S



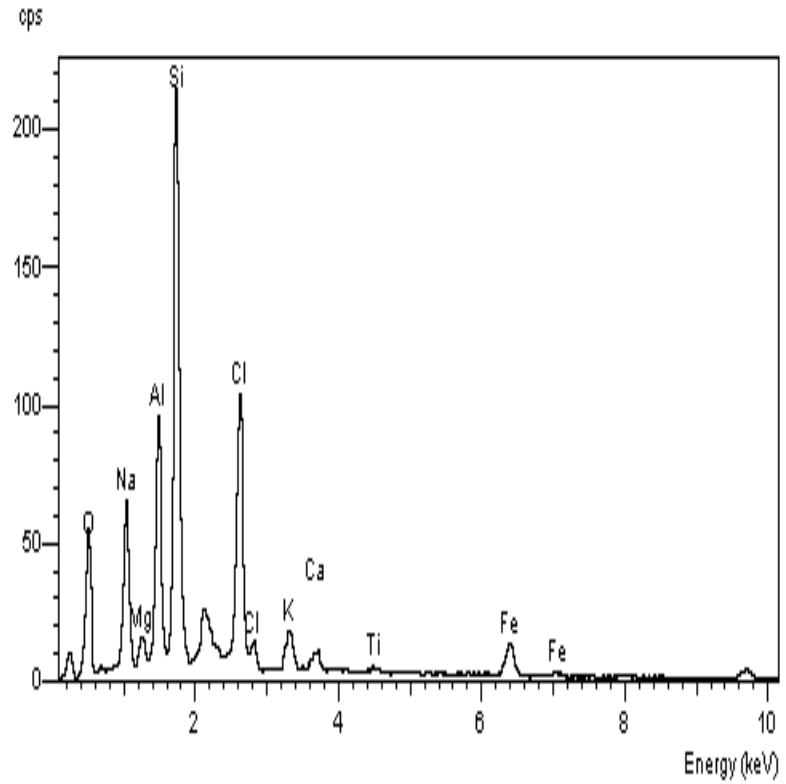


Fig. 8. SEM micrograph (magnification 500X) and XRF spectrum of agregate particles from the alumninosilicates group also showing the presence of Ti and Fe

Conclusions

Enrichment factors for K, Ca, Ti, Mn, Fe, Cu, Zn, Ga, Ni and Sr show that they are conservative elements with concentrations in the range of unpolluted sites, which sets a sampling zone base line. In spite of moderately enrichment factors in the size <100 µm and bulk fractions, Pb concentration of the first fraction was similar to those found in not-anthropogenic influenced sites nearby Mazatlan Harbor. Bulk fraction concentration (52-133 µg g^{-1}) and enrichment factor show the influence of anthropogenic sources with values between LEL (lowest effect level) and a third part of 250 µg g^{-1}value, which is considered to have severe effect levels (SEL) for aquatic life. Besides that, bioavailability is a function of a particular geochemical fraction, generally between 30%-40% of total Pb.