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Hydo-geochemical study of the northern coastal sediment in Ras Al-khaimah Emirate and its economic importance .

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Abstract:.

The hydro-chemical study of the ground water of the basin of the researched area showed that the water is equivalent to a weak base, and the amount of dissolved salts is very high. This may be due to increased deposition of evaporation minerals and to its nearness to the sea. As for the geochemical analysis of soil deposits included a study of the major elements that fall in the mining industry exploited in the area under study, and the extent of the transition of these elements from soil to water. The soil of the region contains high levels of calcium oxide CaO, which indicates the impact of weathering and erosion of the limestone mountains in the region. The soil of the area contains a proportion of silicate SiO_2, which reflects the nature of the rocks of the coastal strip of the region being rich in gravel, sand and clay . Finally, geochemical analyses of the region's sediments and rocks emphasize their being economically feasible and an important reserve that plays a role in supporting the tributaries of the national economy in the United Arab Emirates through the optimal use of raw calcite and silica in the mining industry, especially in the cement industry – both Portland and white kinds – and glass industry besides other mining industries.

Key words: Hydro- geochemical ,sediments , Coastal part of Ras Alkhaimah Emirate, economic .

1. Introduction

The area under study is located in the emirate of Ras Al Khaimah (RAK) in the United Arab Emirates, between latitudes 25°- 26° North and longitudes 55° - 60° East. It's distinguished with a magnificent coastal strip and a wonderful mountain range for climbers. These mountains range in altitude above sea level between 100-250 meters and are also distinguished with their geological units and formations of sedimentary rocks that are highly rich in sedimentary limestone rocks and with normal rates of sandy and salty rocks like gypsum and anhydrates sediments of sea water or sometimes of running water and wind [2]. They belong to the geological period between the middle Permian Period and the upper Cretaceous Period .

This is to study of the properties of the hydro-chemical elements of selected water samples from the northern and coastal part of Ras Al Khaimah emirate and determine the impact of the their transition from soil to water and vice versa. And Study analysis of geochemical soil samples selected in the northern part and coastal Emirate of Ras al-Khaimah and the statement of their economic significance in the mining industry. And to study the geochemical analyses of selected soil samples from the northern and coastal part of Ras Al Khaimah emirate and demonstrate its economic significance for the mining industries.

The climate of Ras Al Khaimah is characterized by desert dry and humid tropical climate, and is characterized by high temperature throughout the year and especially in the summer which has an annual thermal range 35-40 degrees Celsius, and winds blowing on the area northerly and northwesterly soothing atmosphere and reducing the impact of high humidity in the summer.

The study area is free from forms of permanent surface water flows except for some small streams in mountain areas as well as rainfall floods, especially Bih Valley floods, so it is dependent on sources of fresh or salty underground water and very highly on sea desalinated water.

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2. Methods and Data

This study includes two elements:

1. Hydro-chemical analysis of chosen water samples from the studied area and around it.
2. Geochemical analysis of chosen soil samples taken from the studied area and around it.

1. Part one – analysis of chosen water samples :

This includes hydro-chemical analysis of the values of pH and the quantity of soluble salts, electro-connectivity, alkalinity, and total hardness, in addition to defining the values of ions of calcium, magnesium, sulphatein the water samples taken from and around the area under study(table 3). The study of the chemical inter-relations among the previous elements was also done, all analyses were done in the laboratories of Al Nakheel Station for Water Desalting Plant in RAK. Six samples of water were taken from the studied area, 2 marine water samples, and 4 ground water samples from coastal farms (figure 1). All measures were done as follows:

- Total Dissolved Solids were measured using the method of evaporation.
- Electro-connectivity was measured by the Electrical Conduct meter scale.
- The values of PH were measured using PH-Meter.
- Ions of calcium and magnesium were measured using EDTA.
- Chloride ion was measured using an Autoanalyzer.

2. Part Two – analysis of sediment soil :

This includes the geochemical analysis of the major elements in samples of soil sediments in and around the studied areas, and the study of the chemical inter-relations among them – Silica, aluminum oxides, iron, potassium, sodium, manganese, titanium, phosphorus, sulfur, chrome, strontium, and zinc in addition to the analysis of loses of burning (table 4). The number of studied soil samples is "4" distributed along the area under study. The chemical analysis was done using the XRD device of Al Etihad Cement Company in RAK.

3. Results

Part I – A Study of Hydro chemical analysis of water for the area under study.

Field work:

- After taking soil samples, we had other tours of the study area to take water samples. Field work has been divided into six study sites along the study area (see figure 1).

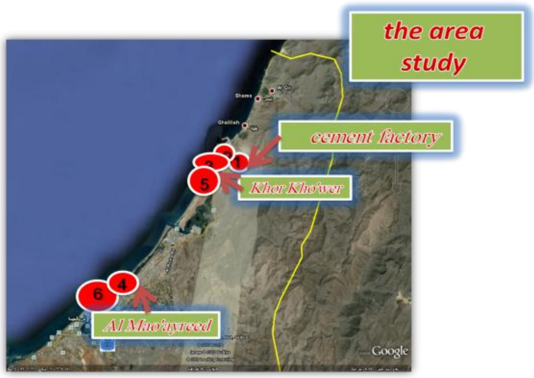


Figure 1.location map of the study areas.

- We have been careful to put water samples in well-sealed plastic containers from each site of the study area with the necessary information of the site written on them.

Table 1: Water samples were distributed as shown in the following

Area	Type of water	No.of sample
Al Mao'ayreed	***Sea - salty***	1
Al Mao'ayreed	***Wild underground***	1
Khor Kho'wer	***Sea - salty***	1
Farms near cement factory	***Wild underground***	3

Table 2: In order to compare the chemical analysis of the studied samples, the UN table of specifications of drinking water was depended on. The following is according to the specifications of international bodies (mg / L). (WHO, 1995)

Element	PH	EC (Electric Connectivity)	Hardness	Na	Ca	Mg	Cl	P	SO_4
Amount (ml/l)	6,5-8,5	8,5	500	200	75	More than 125	250	12	400

Table 3: The following is the chemical analysis of the studied water samples:

	Sp#1	Sp#2	Sp#3	Sp#4	Sp#5 Khor- Khower sea water	Sp#6 Al Mao'ayreed sea water
PH	7.05	7.75	7.45	8.15	7.8	7.6
Amount of soluble salts	8700	6840	1595	745	37960	40150
Electric conductivity	14500	11400	2900	1350	52000	55000
Chloride	5000	3750	600	320	21500	22600
Alkaline Na	215	230	400	50	135	138
Alkaline k	0	0.5	0	0.5	6	4
Total Hardness	1870	1300	600	170	6300	6800
Calcium Hardness	930	650	150	160	1010	1020
Sulfate	775	575	280	175	3000	3400
Calcium ion	327	260	60	64	404	408
Magnesium ion	226	156	108	2.4	1270	1387

4. Discussion

The following diagram (figure 2) shows the relationship of water components in the study area with each other.

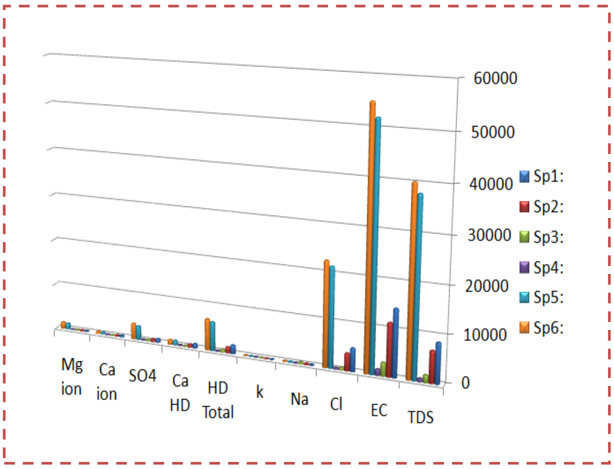


Figure 2.

- Values of pH of samples of the studied area have ranged between "7.05 - 8.15", and as such the water ranges from neutral to low base. Sample number "4" has recorded the highest rate, and the reason may be the impact of soil acidity on the water sample (figure3).

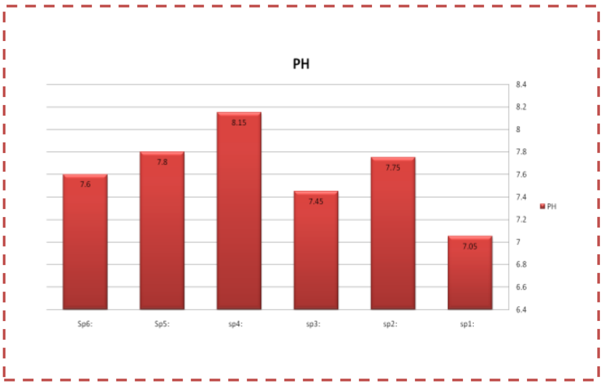


Figure 3: values of pH.

- **Salinity (T.D.S.)** in the four terrestrial underground samples is specified as shown in Figure below. Ranging from "745 - 8700" c. m. m the water is classified as fresh water to brackish and it is noted that sample number "1 " records the highest level possibly due to increased consumption of water by the excessive pumping in the location of the sample within the period studied, which led to the increased mobility of dissolved salts from the deposits through irrigation and possibly from environmental contamination at the site of the sample (figure 4).

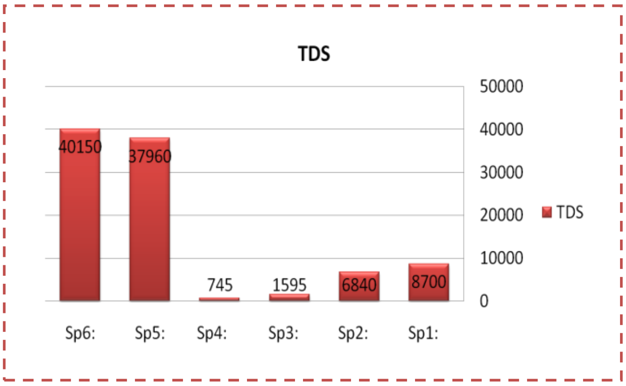


Figure 4: values of TDS

- **Electrical conductivity** (EC) in the four farm-water samples identified as shown in the figure below ranged between "14500 - 1350" Micromhose / cm. It is noted that sample number "1" is the highest, possibly due to a similar behavior to that of changes taking place in raising the concentration of salinity in the samples studied that were explained earlier(figure5).

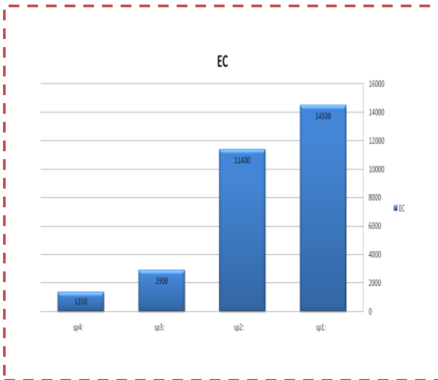


Figure 5: values of EC

- It is noticeable that sample number "1" recorded a strong positive relationship between water hardness and both calcium and magnesium ions. The rate ranged between ten "170 - 1870" c. m. m and thus the water is classified as relatively to highly hard according to the classification of [5] .This is a clear indication of the interconnection of magnesium and calcium ions with water hardness(figure6).

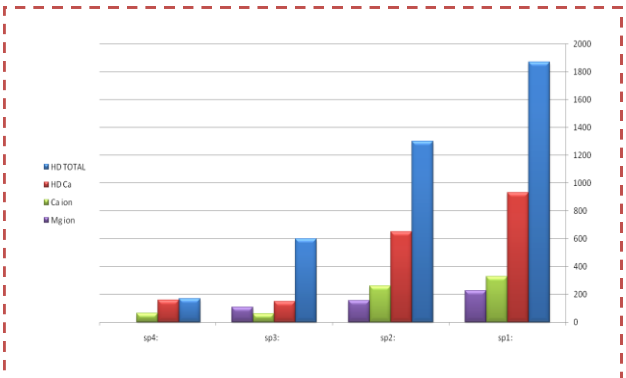


Figure 6

- It is noted that sample number "1" recorded a high proportion of the presence of chloride ion as represented by "5000" c. m. m; perhaps the increase is due to the association of ions with the reservoir high-salinity water, in addition to the ease of leaching of salts of halite in the location of the sample(figure 7).

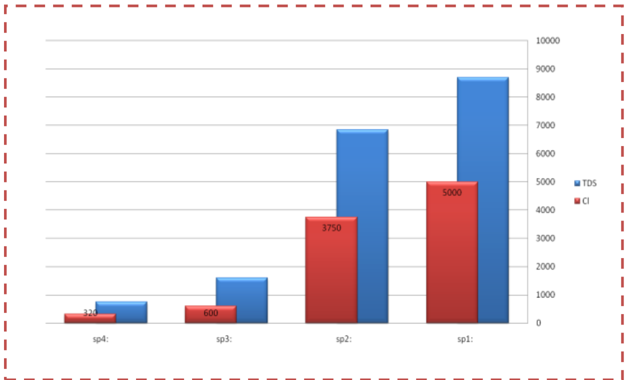


Figure 7

- It is noticed that sample number "1" recorded a high proportion of the presence of sulfate ions as represented by "775" c. m. m; and thus the rate exceeded the globally permissible limits, and this is probably due to the viability of melting metal of sulfates in the studied area as gypsum and sodium sulfate and anhydrate and perhaps it is in return to the air pollution that worked to raise the concentration of sulfate in the soil [4].noted that 30% of the sulfate component of the rainwater is the result of air pollution in industrial areas(figure 8).

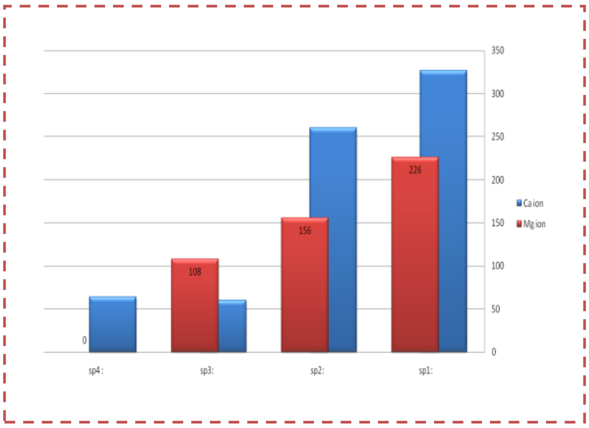


Figure 8

- It is noticeable that sample number "1" recorded a high proportion of the presence of calcium and magnesium ions as represented by "327" c. m. m and "226" c. m. m respectively and thus the proportion exceeded the globally permissible limits. This may be due to an increase in vulnerability of melting minerals containing them as calcite, dolomite, and gypsum in the underground water where the sample was taken from as the studied area is rich in lime stones(figure 9).

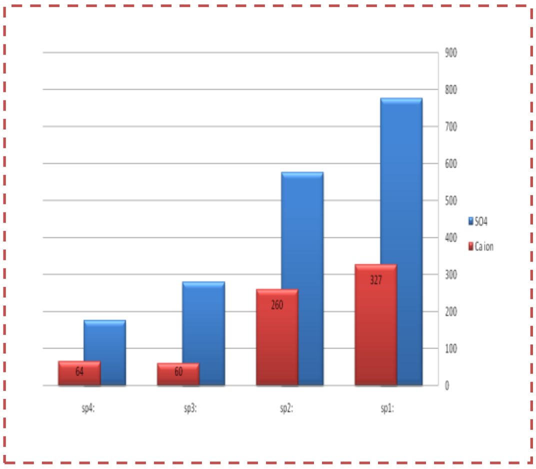


Figure 9

Bilateral linkage between the elements of soil and water located within the study area :

- It is noted from the study of water analysis that the percentage of calcium and magnesium ions has increased in water samples due to their association with the presence of the CaO which is plenteous in the soil of the area studied, and therefore laundering soil worked to melt non-silicates minerals such as gypsum, dolomite, calcite and others and thus moving to the groundwater. [1]

- Also, when comparing the results of analysis of terrestrial ground water samples for magnesium and calcium ions, it is noticed that Magnesium ion rate of "123" c. m. m is lower than the rate of Calcium ion "189" c. m. m which is due to the slow solubility of minerals containing magnesium by groundwater, and on the contrary sea-water samples , indicate an increase in the rate of magnesium ion "1328.5" c. m. m compared to a rate of calcium ion "406" c. m. m which is due to the deposition of gypsum salts in the sea water by high rates.

Origin of groundwater in the area studied according to the function rNa \ rCl

- This function is one of the best to use to determine the origin of the water.
- The value of the function "rNa \ rCl" of the studied samples ranges from between "0.043-0.667" and by reference to the classification of . [3] , it is clear that all values are less than '1' and this means that they are of a marine origin.

- This is due to the high salinity of the wells, which refers to the contamination of ground water by leaching from water of marine origin. [1] , [3] .

Evaluation of water samples farms for agriculture and irrigation

- Concentration of dissolved salts for the purposes of evaluation of water for agriculture & irrigation was adopted according to the reference of [5] . Therefore, the concentration of dissolved salts ranged between "745 - 8700" c. m. m, and according to the previous classification it is located within the mid-limits of bearing of the local crops to salts dissolved in water, and according this category, the area's water is suitable for the irrigation of the following crops: radishes, celery, green beans, tomatoes, cucumbers, onions, lettuce, watercress, in addition to the crops which are cultivated in the study area like palms and mangrove trees and other perennials that bear this concentration of salinity.

Part 2 – Study of geochemical analysis of soil sediments:

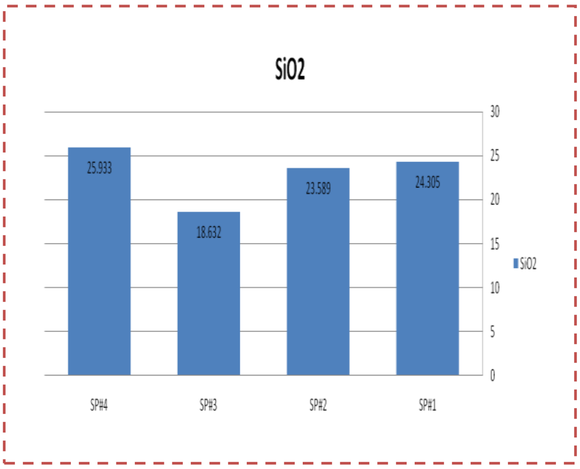
- **Field work:** as a start, we visited Al Etihad Cement Factory to see the process of work in the chemical laboratories and watch the geochemical analysis steps in the factory and meet responsible staff there. We also had a tour in the various sections of the factory to see preparation steps and the burning of the raw materials. We also had tours to know in general about the area under study. We divided field work on the specified area into 4 study sites along the northern part of RAK coastal strip (see figure10) , we then collected samples of soil from about 20cm deep of each site of the studied areas, they were put in plastic bags with the required information of the sites written on them .

Figure 10.location map of the study areas.

Table 4: showing the chemical analysis of soil samples measured in ppm (part per million)

Sp#4: 14km	Sp#3: 400m	Sp#2: 200 m	Sp#1: 10 m	
25.933	18.632	23.589	24.305	SiO_2
1.84	3.389	1.49	4.598	Al2O3
1.054	1.644	0.914	2.252	Fe2O3
0.082	0.217	0.073	0.274	TiO2
0.09	0.045	0.172	0.158	P2O3
35.41	36.27	37.36	32.31	CaO
1.795	2.645	1.804	2.85	MgO
0.244	0.38	0.271	0.164	SO3
0.486	0.577	0.365	0.725	K2O
31.77	32.91	32.65	30.75	L.o.i
0.534	2.454	0.386	0.592	Na2O
0.038	0.037	0.028	0.039	Cr2O3
0.218	0.045	0.246	0.067	SrO
0.028	0.044	0.023	0.058	Mn2O3
0.001	0.001	0	0.006	ZnO

- When comparing the results of geochemical analysis of the rates of distribution of silica – as the following chart shows – it is observed that there is a marked increase in the rate as we head north and near the coastline. This probably refers to the apparent disparity of the content of the clay minerals of Silica; or perhaps to environmental contamination of soil with increasing rates of silica resulting from the dust particles coming from the area of Awafi or because of mining uses in quarries



of the ore(figure11).

Figure 11

- When comparing the average of the three samples (totals 22.175) with the 4th sample which is 25.933, a high rate of Silica is noticed in the 4th sample compared to that of the other samples. This may point to the high percentage of quartz minimal in the mud part of the 4th sample .

- The "CaO" oxide is considered one of the main oxides as it exists in concentrations ranging between 32.31 – 37.36 % in sample and rates 35.33 % this indicates the high concentrations of limestone available in RAK mountains and soil; and when its ratio in (sample 1) is compared with other samples, we notice the decline in its ratio. This refers to the washing operations the site of the sample is exposed to(figure12).

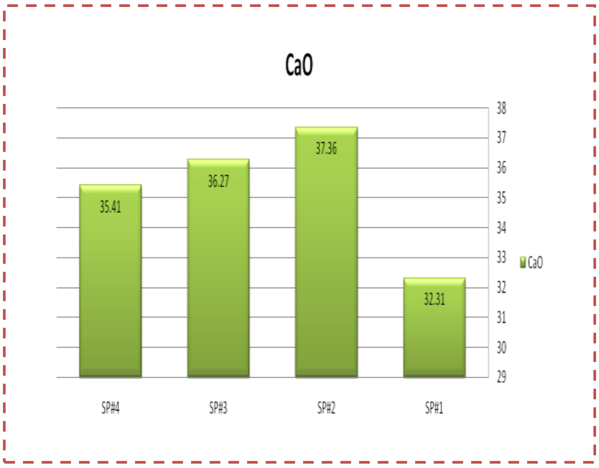


Figure 12

- When comparing the rates of the soil of the researched area with the global average of the rates of clay which is 3.09%, it is noticed that the ratio of the studied area is very high; this increase is interpreted by the high richness of RAK soil with high concentration of mineral calcite resulting from the impact of weathering and erosion of limestone mountains.
- when comparing the existence of Na_2O in the 3rd sample (which is 2.454) with other samples ratios , its high rate is quite noticeable which indicates that the soil is rich in "NaCl"(figure13).

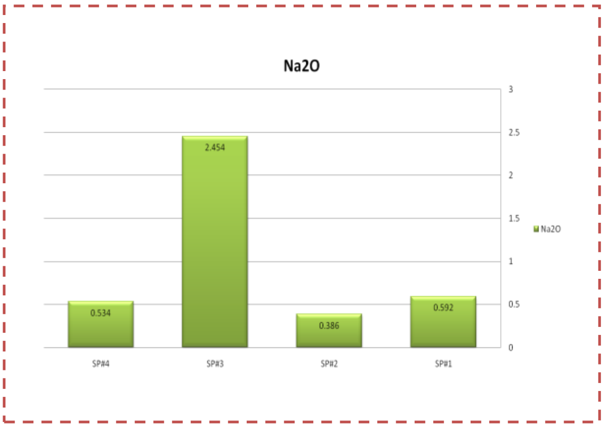


Figure 13

- When comparing this rate with its worldwide one in clay (which amounts to 1.29%), its high rate existence is also noticeable in the 3rd sample.
- It is noticed that sample (#1) recorded the highest rate of ZnO compared with all the other samples. This is attributed to the positive relation with the oxides K_2O, MgO, TiO_2, Fe_2O_3, in the sample. This is explained on the basis of the existence of this oxide adsorbed on the clay surface of the sample(figure14).

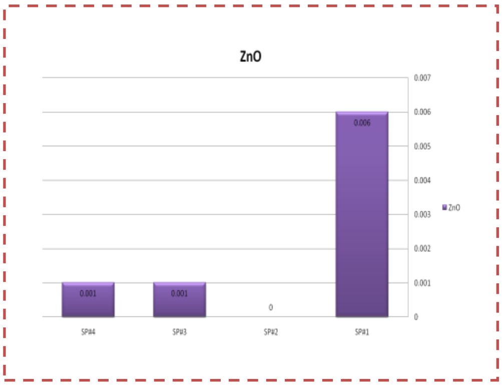


Figure 14

- As for the "loss on ignition", it alternated between 30.75 – 32.91% with a high percentage (32.103) which is ascribed to the nature of the studied samples that are muddy, fragmented and loose(figure15).

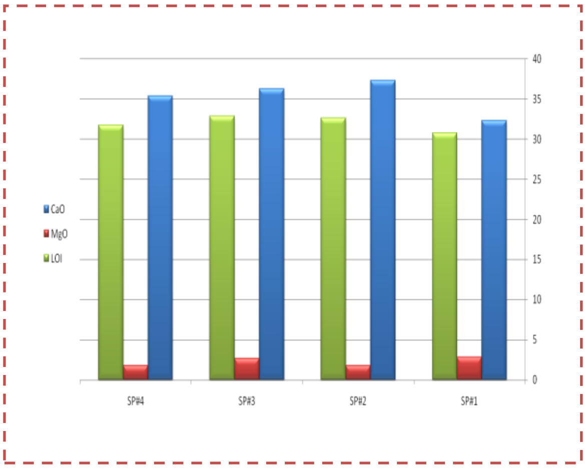


Figure 15

- It is noticed through the results of the chemical analysis that there is a positive bilateral relationship among the losses on ignition, CaO and MgO, which indicates that the control of mineral calcite and dolomite and gypsum on the distribution of losses among them. In addition, part of the losses on ignition is caused by the water in the composition of clay minerals .
- It is also noted from the results of chemical analysis that there is also a negative correlation between (losses on ignition, MgO, CaO) with silica interpreted on the basis that by increasing the proportion of calcite and dolomite, gypsum, the content of quartz and mud becomes less in the rock(figure16).

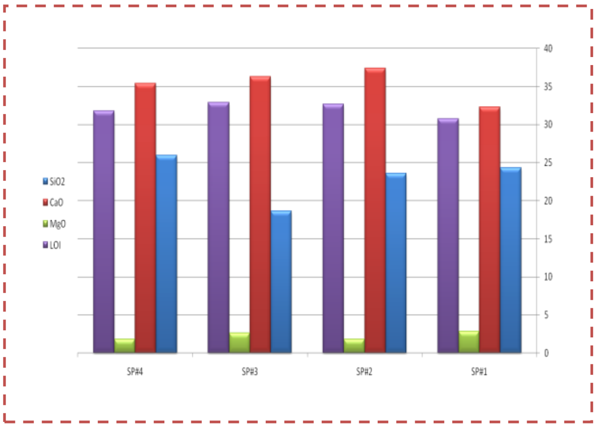


Figure 16

5. Conclusions

- Through **geochemical analysis** of soil samples, we stress the here necessity for optimal exploitation of mineral ores and rocks in the researched area, especially for limestone and dolomite as they are a rich source of calcite which a keystone in the industry of cement.
- We also draw attention to the necessity to exploit fragmental sand which is rich in silicate that plays an important role in the glass industry, and it is a resource for other economic tributaries owned by our dear country.
- Moreover, we should not forget that **mining** sector in the region has achieved great successes embodied in the opening of several factories of Portland and white cement; and a glass factory which is the biggest in the Arabian Gulf region; in addition to plants to exploit limestone in several sectors of development.

6. Recommendations :

1. Carrying out a detailed study of the components and the mineralogy of the soil.
2. Exploiting geographic information systems and the global model system to study the geological conditions and terrain of the researched area.
3. Work on studying the causes of increased rates of accumulation of elements according to global averages in parts of the coastal strip and finding ways of treatment for prevention of soil degradation in the future.
4. Despite the commitment of the owners of mining plants to legislations and environmental and safety standards established by the Ministry Water and Environment, the area is still suffering from air pollution that affects the components of the soil, which in turn seep into groundwater and destroy it.
5. Preparation of plants and feasibility studies for exploitation of the mineral wealth of the area and its role in supporting the national economy.
6. Encourage the owners of the quarries to work no beautifying the territory of the quarries and the retrieval of the beauties of the environment, such as setting environmental mountain parks and other similar uses.

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