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دراسة جيوكيميائية لترسبات العصر الرباعي في شمال مدينة سامراء – وسط العراق

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المستخلص:

تمت دراسة جيوكيميائية لترسبات العصر الرباعي في شمال مدينة سامراء وبالتحديد في مناطق بيجي والعباسية وأبو دلف وذلك لتحديد مصادرها SiO_2, Fe_2O_3, CaO, Al_2O_3, and MgO دلف، حيث شملت الدراسة تحديد نسبة الاكاسيد في المناطق المدروسة.

والحصى Claystones and Mudstonesفي الصخور الطينية وصخور الوحل Si, Al, Ca, Mg ان مصدر Fe فانه مصدره أيضا الحبيبات الكاربونانية، اما Caكان المعادن الطينية، وان Gypcretes وصخور الجبكريت

كان معدن الكوارتز بصورة رئيسية مع معادن Si مرتبط بمعادن اكاسيد الحديد. وفي الصخور الرملية.ان مصدر Ca فان المصدر كان هي القطع الصخرية الكاربوناتية وحبيبات الكربونات , Mg السيليكات الأخرى . واما بالنسبة الى Fe مرتبط بمعادن الكاولينايت والفلدسبار وان مصدر Al ، وان Carbonate and Cement والملاط الكابوناتيه كان معادن اكاسيد الحديد والمعادن الثقيلة الأخرى .

ان الاختلاف في نسب الأجزاء الخشنة والناعمة في كل من السحنات المدروسة مسؤولة عن الاختلاف في تراكيز العناصر في صخور المنطقة الواحدة وكذلك بين المناطق في شمال مدينة سامراء.

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Geochemical Study of The Quaternary Sediments in the North of Samara City in the Middle of Iraq

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Abstract:

A geochemical study of the Quaternary Sediments in Baiji, Al-Abbasyia, and Abu- Dalf localities north of Samarra City was performed. This study involved the determination of SiO_2, Fe_2O_3, CaO, Al_2O_3, and MgO. The study aims to interpret the sources of these contents in the studied localities. The source of Si, Al, Ca, and Mg in the claystone also, and mudstone, gravels, and gypcrets was clay minerals. The source of Ca was carbonate grains, while Fe was iron oxide grains in the sediments. In the sandstones, the source of Si was mainly quartz with other silicate minerals; Ca and Mg were carbonate rock fragments, calcite grains, and carbonate cement. For Al the source was kaolinite and feldspar, Fe related to the iron oxide minerals and other heavy minerals. The differences in the percentages of coarse and fine fractions in the studied sediments (facies) are most likely responsible for the variations in constituent concentrations in each locality and between the three localities.

Keywords: Baiji, Al-Abbasyia, Abo-Dalf, Quaternary.

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Introduction

A geochemical study of the quaternary sediments in the area between Samara and Baji cities were conducted. The study involves the analysis of Si, Al, Fe, Ca, and Mg elements. Three localities to collect the sediments were selected: these are Al-Abbasiya, Baiji, and Abo-Dalaf (Fig. 1). Each locality collects sediments primarily from five domestic pits. Additionally, engineers drilled boreholes in the area to collect some of the sediments. The aim of the present work is first to establish the concentration of Si, Al, Fe, Ca, and Mg in the studied sediments, as no previous geochemical study was carried out in these sediments of the area. The secondary goal is to determine the elements' sources and why sediment concentrations vary by locality.

The work is part of the laboratory activity performed and presented in a report by the state company of geological survey and mining for engineering purposes.

The quaternary sediments in the studied localities are considered Pleistocene and the Holocene in age (l, 2). The Pleistocene sediments consist of gravels, conglomerates, sandstones, clay stones, mudstones, and gypcretes. The Holocene sediments consist of valley fills, fluid deposits, sabkhas, eolian dunes, and sand sheets. The thickness of the quaternary sediments ranged from 2.8 meters at Beiji locality to 25.5 meters at Al-Abbassyia locality.

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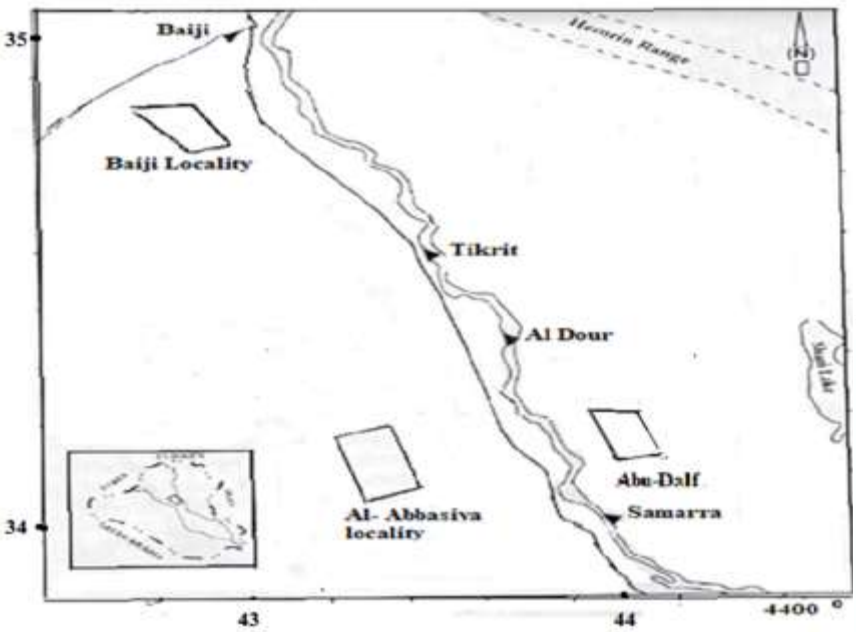

Figure 1 : Location map of the studied area and localities. (Scale 1:500 000)

Town Road River Locality Studied area

The clay, heavy minerals, and petrography were studied by (3, 4, and 5). They indicated that the clay minerals present in the claystones, mudstones, the matrix of gravels, and the sandstones are montmorillonite, chlorite, illite, kaolinite, and palygorskite. They also mentioned that the majority of the heavy minerals in the sandstones are opaque, pyroxene, and amphibole minerals. The petrography of the sandstones and the sands in the gravel matrix primarily consists of carbonate sedimentary rock fragments, along with quartz, feldspar, acidic rock fragments, and metamorphic rock fragments. The sandstones are immature, cemented mainly by carbonate, and classified as litharenite using the Folk classification. Basi (5) further suggested that the source of the quaternary sediments in the studied localities was They were sedimentary rocks, based on the heavy minerals and petrography of the sandstones and gravels.

Method of work

The investigations included the megascopic description of hand specimens in the field and the microscopic study in the laboratory. Folk classification (6) was used for sandstones, siltstones, and carbonate units. The determination of the percentage of the studied content is briefly presented as follows:

1) The samples were disintegrated and passed through a 2-mm sieve and then crushed.

2) 0.5 gram from the samples was fused with fusion mixture in the oven followed by the addition of HCL and drying the sample twice. Then SiO_2 was determined as insoluble residue and the filterrate was used to determine Fe_2O_3 and MgO by atomic absorption. The Al_2O_3 was determined by colorimetry. However, CaO is determined either by titration or atomic absorption.

The results

Tables 1-4 present the results of the chemical analysis, which computed each element as oxides in the studied localities. Table 5 shows the average concentrations of these constituents. Table 6 displays the average chemical analysis value across the three localities. Figures 7-10 show the variation of the constituent concentration in each type of sediment in the three localities.

SiO_2

The data indicated that the average concentration of silica (computed as SiO_2) is 35.06% in the clay stones and mudstones, 56.06% in the sandstones, 40.67% in the gravels, and 18.80% in the gypcretes. The highest value was in sandstones and the lowest value was in Gypcretes (Table 6 Figure 2).

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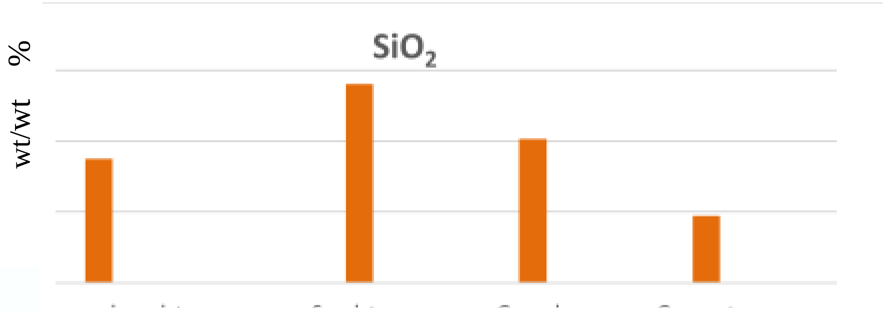

Figure 2: The average of SiO_2 content of the three localities

Iron Fe_2O_3

The average of F_2O_3 is 2.28 % in the claystones, and mudstones, 2.22 %, in sandstones 1.81 %, in gravels, and 1.25 % in gypcretes. The highest value was in the claystones and mudstones, while the lowest value was in gypcretes (Table 6), Figure 3.

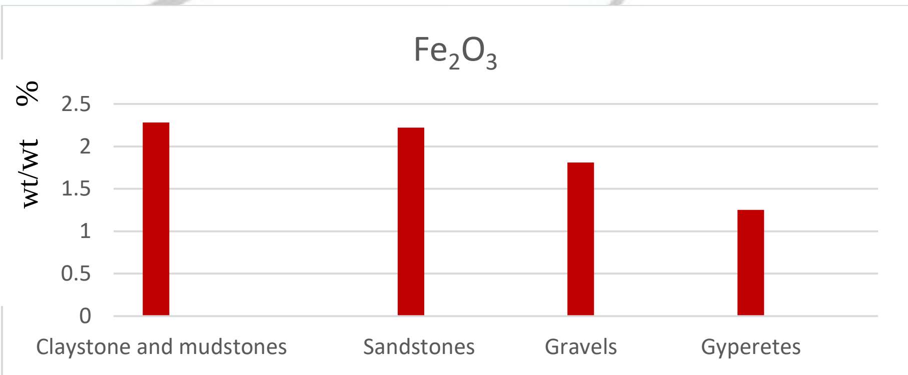

Figure 3: The average of Fe_2O_3 content of the three localities

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Aluminum (Al_2O_3)

The average concentration of Al_2O_3 is 5.44 % in the claystones and mudstones, 7.27 %, in the sandstones, 4.9 % in gravels, and 2.71 % gypcretes. The highest value was in Sandstones and the lowest value was in gypcretes (Table 6, Figure 4).

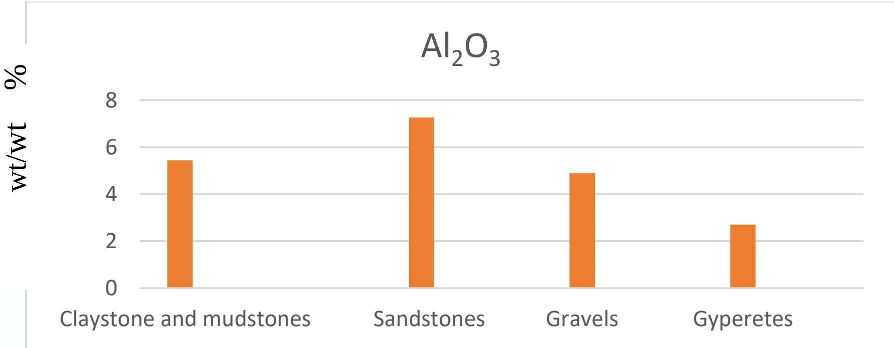

Figure 4: The average of Al_2O_3 content of the three localities

Calcium (CaO)

The average concentration of CaO is 21.67 % in claystones and mudstones, 14.16 % in sandstones, 19.61 % in gravels, and 26.39 % in gypcretes. The highest value was in gypcretes and the lowest value was in sandstones (Table 6, Figure 5).

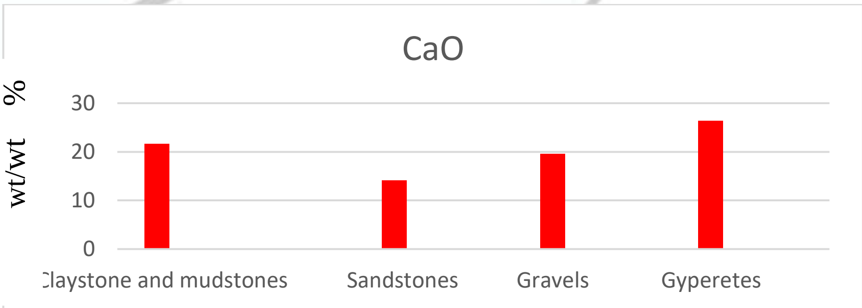

Figure 5: The average of CaO contentof the three localities

Magnesium (MgO)

The data revealed that the average content of MgO is 2.44 in claystones and mudstones, 1.83 % in sandstones, 1.98 % in gravels, and 1.77 % in

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gypcretes. The highest value was in the claystones and mudstones and the lowest value was in gypcretes (Table 6, Figure 6).

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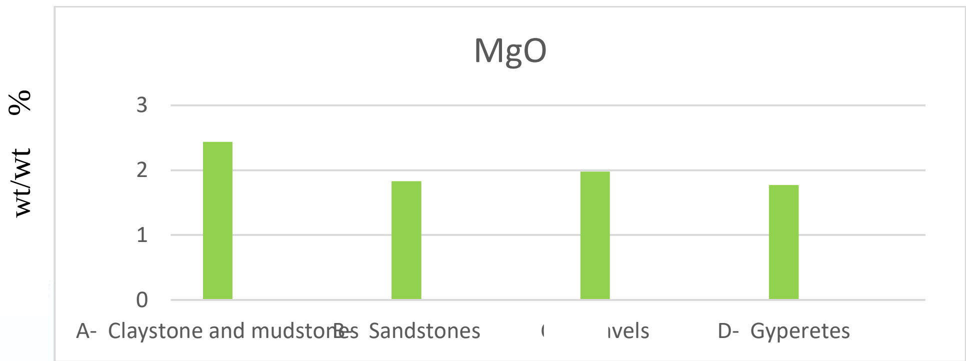

Figure 6: The average of MgO content of the three localities

Table -1: The chemical analysis of Claystones and Mudstones for each oxide in the studied localities.

Baiji locality						
Ser. No.	Sample No.	SiO_2 %	Fe_2O_3 %	Al_2O_3 %	CaO %	MgO %
1	250 BP_6pet_3	35.68	1.43	4.72	23.55	1.54
2	250 BP_9Pet_3	35.6	1.48	4.14	24.15	1.31
3	250 BP_9pet_4	35.22	1.69	4.62	23.27	1.56
4	250 $BP_{15}pet_1$	36.77	1.34	4.62	24.39	1.35
Al-Abbasiyia locality						
Ser. No.	Sample No.	SiO_2 %	Fe_2O_3 %	Al_2O_3 %	CaO %	MgO %
1	250 $AP_{20}pet_5$	26.88	2.57	4.78	23.08	1.86
2	250 $AP_{30}pet_4$	31.46	2.73	5.20	22.43	3.30
3	250 $AP_{30}pet_5$	48.42	3.43	7.24	15.98	3.25
Abu-Dalaf locality						
Ser. No.	Sample No.	SiO_2 %	Fe_2O_3 %	Al_2O_3 %	CaO %	MgO %
1	250 DP_3pet_3	16.52	1.05	3.12	26.7	1.34

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2	250 DP_3pet_5	33.76	2.20	5.90	21.6	1.82
3	250 $DP_{17}pet_3$	27.75	1.67	5.38	22.7	2.14
4	250 $DP_{17}pet_4$	37.5	2.52	6.61	19.7	3.11
5	250 $DP_{17}pet_5$	46.8	2.70	8.22	16.7	3.60
6	250 $DP_{34}pet_2$	36.9	3.3	6.42	17.9	3.44
7	250 $DP_{34}pet_5$	39.95	3.6	7.32	18.8	3.1
8	250 $DP_{44}pet_5$	31.22	2.65	5.66	21.1	6.18

Table - 2: The chemical analysis of sandstones for each oxide in the studied localities.

Baiji locality						
Ser. No.	**Sample No.**	**SiO_2 %**	**Fe_2O_3 %**	**Al_2O_3 %**	**CaO %**	**MgO %**
1	250 BP6pet1	43.7	1.1	4.72	19.4	0.94
2	250 BP6pet5	54.1	2.4	7.08	16.5	1.55
3	250 BP9pet1	39.0	2.26	6.73	23.69	1.51
4	250 BP9pet5	53.2	2.27	7.43	16.5	2.04
5	250 BP26pet1	53.4	2.15	8.14	15.1	1.39
6	250 BP26pet2	53.6	2.22	8.02	15.9	1.53
7	250 BP26pet3	33.9	1.24	4.82	24.11	1.2
8	250 BP26pet4	28.9	1.0	3.77	26.8	1.07
9	250 BP26pet5	49.7	2.19	6.6	18.73	1.67
10	250 BP34pet1	44.2	1.8	6.6	19.63	1.53
11	250 BP34pet2	52.8	2.0	7.31	14.86	1.71
12	250 BP34pet3	45.9	2.25	7.21	18.72	1.85
13	250 BP34pet4	38.2	1.37	5.05	20.8	1.39
14	250 BP34pet5	56.9	2.48	7.4	13.88	1.83
15	260 BBH2/2	49.7	2.16	8.22	17.32	2.38
16	260 BBH3/2	49.8	2.88	8.42	16.26	2.62
17	260 BBH6/1	99.0	1.53	5.64	14.02	0.78
Al-Abbasiyia locality						
Ser. No.	**Sample No.**	**SiO_2 %**	**Fe_2O_3 %**	**Al_2O_3 %**	**CaO %**	**MgO %**
1	260 ABH1/2	53.48	2.51	9.91	13.32	3.02
2	260 ABH2/2	64.66	1.85	8.49	6.87	1.00
3	260 ABH3/1	67.48	1.97	7.84	9.25	0.96
Abu-Dalaf locality						

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Ser. No.	Sample No.	SiO_2 %	Fe_2O_3 %	Al_2O_3 %	CaO %	MgO %
1	250 $DP_{33}pet_1$	58.91	2.60	6.44	14.32	2.00

Table-:3 The chemical analysis of Gravels for each oxide in the studied localities

Baiji locality						
Ser. No.	**Sample No.**	**SiO2 %**	**Fe2O3 %**	**Al2O3 %**	**CaO %**	**MgO %**
1	**250 BP9pet2**	**34.7**	**1.64**	**4.53**	**24.4**	**1.51**
Al-Abbasiya locality						
Ser. No.	**Sample No.**	**SiO2 %**	**Fe2O3 %**	**Al2O3 %**	**CaO %**	**MgO %**
1	**250 AP12pet1**	**46.72**	**2.08**	**5.26**	**17.67**	**4.00**
2	**250 AP20pet1**	**45.82**	**2.06**	**5.00**	**15.7**	**1.87**
3	**250 AP30pet1**	**49.02**	**2.55**	**5.66**	**15.98**	**2.75**
4	**250 AP39pet1**	**43.86**	**1.23**	**4,48**	**16.82**	**1.46**
5	**250 AP46pet1**	**45.86**	**1.77**	**5.56**	**15.07**	**1.49**
6	**250 AP46pet2**	**21.56**	**1.25**	**4.00**	**26.08**	**2.28**
Abu-Dalaf locality						
Ser. No.	**Sample No.**	**SiO2 %**	**Fe2O3 %**	**Al2O3 %**	**CaO %**	**MgO %**
1	**250 DP3pet1**	**45.5**	**1.56**	**4.92**	**16.26**	**1.83**
2	**250 DP3pet2**	**20.72**	**1.20**	**3.55**	**23.55**	**1.79**
3	**250 DP17pet1**	**50.5**	**2.30**	**5.70**	**15.28**	**1.77**
4	**250 DP33pet2**	**57.62**	**2.40**	**6.13**	**13.7**	**1.59**
5	**250 DP34pet1**	**42.86**	**2.25**	**5.38**	**17.67**	**1.88**
6	**250 DP44pet1**	**54.0**	**2.24**	**5.50**	**12.9**	**4.00**

Table – 4 : The chemical analysis of Gypcrete is computed as oxides in the following table at
the studied localities.

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Al-Abbasiya locality						
Ser. No.	Sample No.	SiO2 %	Fe2O3 %	Al2O3 %	CaO %	MgO %

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1	250 AP12pet2	17.96	1.04	2.50	26.2	2.77
2	250 AP12pet3	8.90	0.50	1.04	31.3	0.87
3	250 AP12pet4	15.66	1.00	2.01	27.3	1.88
4	250 AP12pet5	22.84	1.41	3.07	24.1	2.7
5	250 AP20pet2	15.6	1.48	2.36	26.4	1.34
6	250 AP20pet3	15.96	1.57	2.50	26.4	1.39
7	250 AP20pet4	14.5	1.27	2.12	26.6	1.02
8	250 AP30pet2	12.46	0.78	1.27	28.6	0.68
9	250 AP30pet3	12.30	0.88	1.65	30.0	0.82
10	250 AP39pet2	12.68	0.60	2.34	30.6	0.88
11	250 AP39pet3	15.36	0.77	2.26	30.3	1.15
12	250 AP39pet4	29.56	1.44	5.05	24.7	1.54
13	250 AP39pet5	12.86	0.84	2.54	31.3	1.18
14	250 AP46pet3	18.03	1.04	3.07	28.7	1.82
15	260 ABH1/1	40.92	1.35	5.10	19.9	1.33
16	260 ABH3/3	38.42	0.98	3.20	19.9	0.80

Abu-Dalaf localities

Ser. No.	Sample No.	SiO2 %	Fe2O3 %	Al2O3 %	CaO %	MgO %
1	250 DP33pet3	28.9	2.00	4.42	20.3	2.03
2	250 DP33pet4	16.94	1.27	3.16	30.1	1.55
3	250 DP33pet5	10.04	0.67	2.27	27.1	0.81
4	250 DP34pet3	23.84	1.9	4.01	24.68	1.88
5	250 DP34pet4	16.16	1.3	2.50	26.08	1.30
6	250 DP44pet3	17.28	1.61	3.07	25.8	4.73
7	250 DP44pet4	17.14	1.38	0.20	26.4	2.88

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Types of sediments	Localities	Metals concentration				
		SiO_2 %	Fe_2O_3 %	Al_2O_3 %	CaO %	MgO %
and Claystones Mudstones	Baiji locality	35.82	1.49	4.54	23.84	1.44
	Al-Abbasiyia locality	35.59	2.91	5.74	20.5	2.8
	Abu-Dalaf locality	33.81	2.46	6.08	20.7	3.09
Sandstones	Baiji locality	47.4	1.96	6.66	18.37	1.59
	Al-Abbasiyia locality	61.87	2.11	8.75	9.81	1.66
	Abu-Dalaf locality	58.91	2.60	6.44	14.32	2.00
Gravels	Baiji locality	34.7	1.64	4.53	24.4	1.51
	Al-Abbasiyia locality	42.14	1.82	4,99	17.89	2.31
	Abu-Dalaf locality	45.2	1.99	5.20	16.56	2.14
Gypcretes	Baiji locality	-----	----	-----	-----	-----
	Al-Abbasiyia locality	19.00	1.06	2.63	27.0	1.34
	Abu-Dalaf locality	18.61	1.45	2.80	25.78	2.17

Table 5 -: The average of chemical analysis of the oxides for the studied localities

Table - 6: The average of chemical analysis of the three localities

Types of sediments	Metals Concentration, %				
	SiO_2	Fe_2O_3	Al_2O_3	CaO	MgO
A- Claystone and mudstones	35.06	2.28	5.44	21.67	2,44
B- Sandstones	56.06	2.22	7.27	14.16	1.83
C- Gravels	40.67	1.81	4.90	19.61	1.98
D- Gyperetes	18.82	1.25	2.71	26.39	1.77

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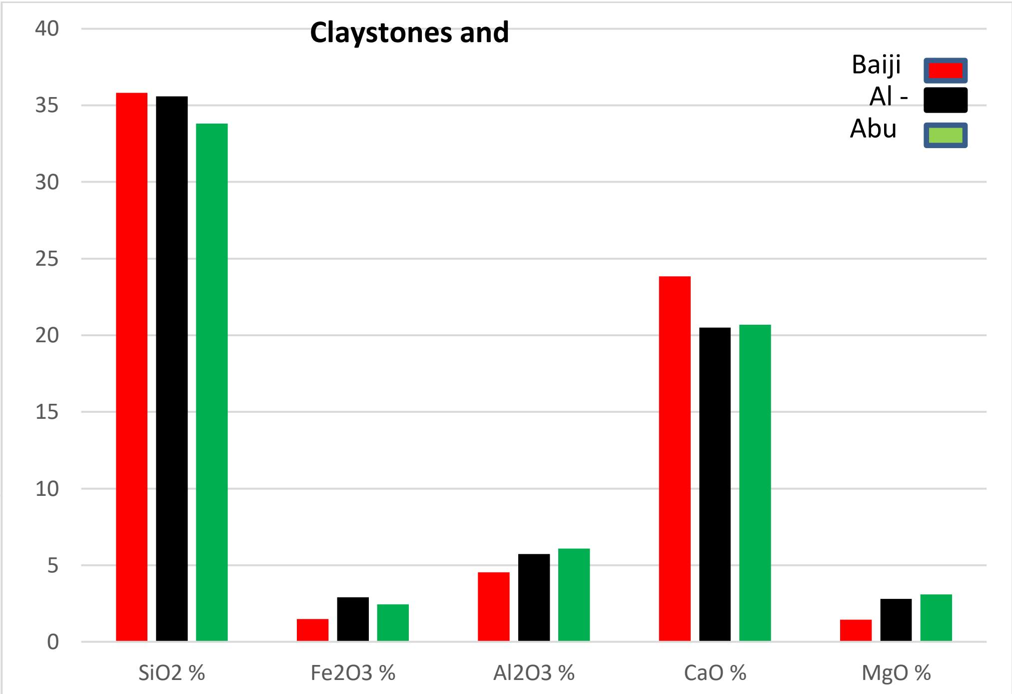

Figure 7: The average concentration of the oxides in Claystones and Mudstones

for the three localities

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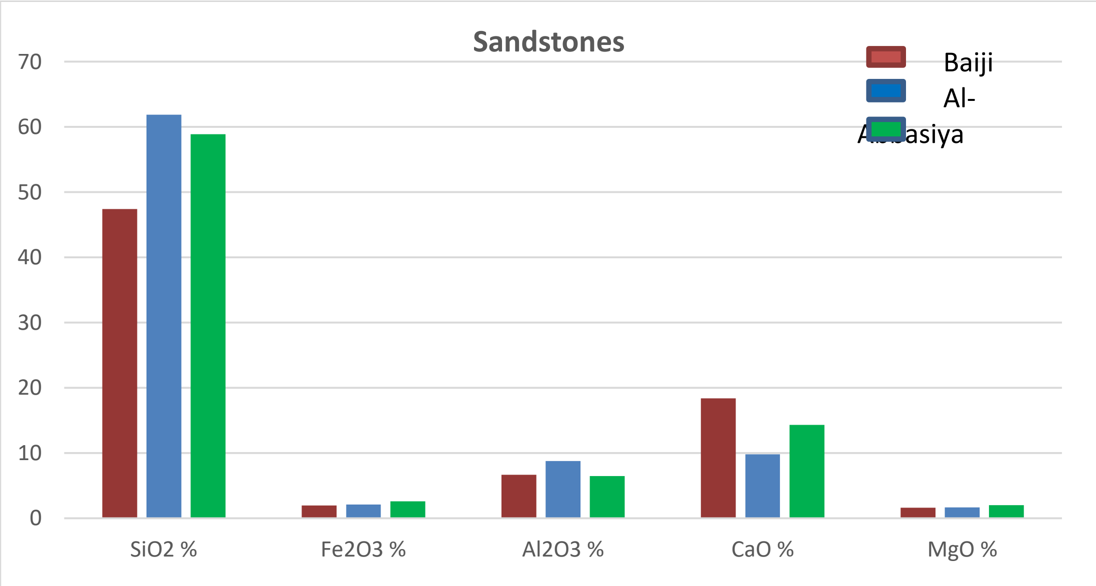

Figure 8 : The average concentration of the oxides in Sandstones for the three localities

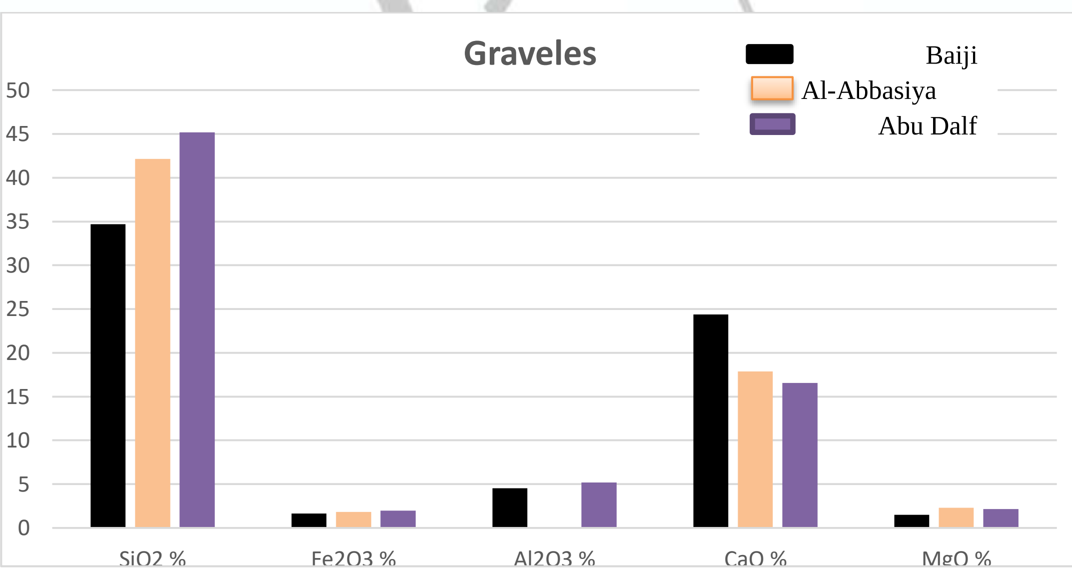

Figure 9: The average concentration of the oxides in Graveles for the three localities

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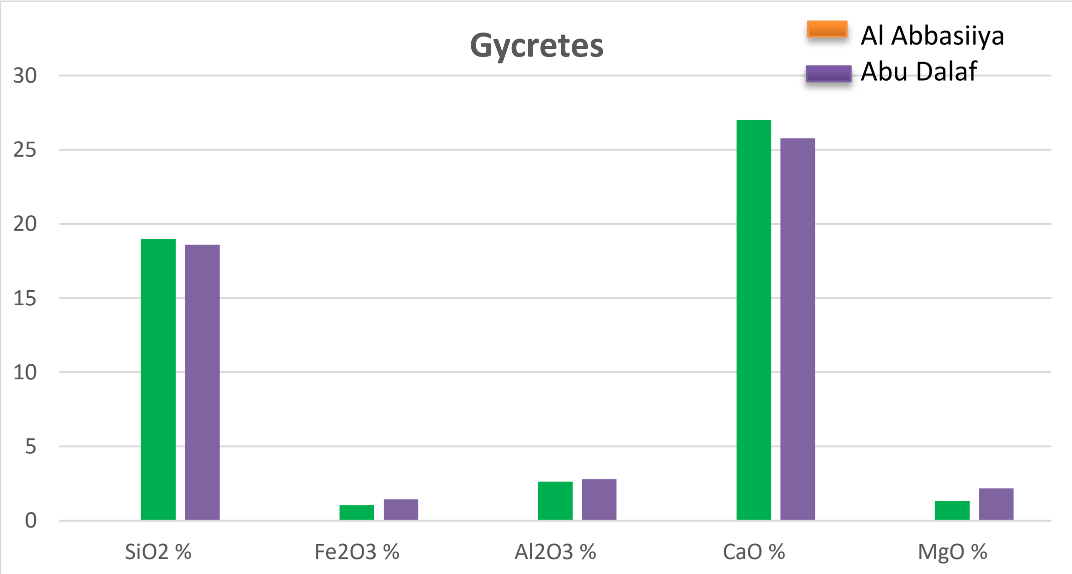

Figure 10: The average concentration of the oxides in Gycretes for the three localities

Discussion

The concentration of the analyzed oxides is presented in Tables (1-6). The concentration of these oxides with the data are compared following Pettijohn (7). This study considers his values, sourced from various parts of the world, as a baseline for SiO_2, Fe_2O_3, Al_2O_3, CaO, and MgO concentrations in the studied areas.

The discussion about the source and variations of the analyzed oxides in various lithologies of the studied localities is presented hereafter. The matrix of gravels are analyzed, revealing different compositions of clay, silt, and sand fractions. The gypcretes contain mainly clay and gypsum minerals, similar to the claystons and mudstones but differ in the presence of more than 50% gypsum. As a result, tthe origin and fluctuations of oxides in gravel and gypsum discussed, compared with clay stone and mudstone. Basi et al. (3) reported the illite, kaolinite, montmorillonite, chlorite palygorskite as the main minerals in the clay stone and mudstones.

These clay minerals are considered the main source of Si, Al, Ca, and Mg elements in the analyzed claystones and mudstones. The carbonate grains may also contain Ca, while the iron oxide minerals in the silt and sand fractions of the studied claystones and mudstones may contain Fe.

For the claystones and mudstones, the SiO_2 is lower than Pettijohn's value. The gypsum and calcite minerals may primarily contribute to the low concentration. Gypsum and calcite are considered the primary sources of Ca, as evidenced by the high amount of CaO in the analyzed claystones and mudstones. For this reason, the concentration of CaO in the studied sediments is higher than Pettijohn's value.

The values of Fe_2O_3 and MgO are well compared with. Pittijohn's value. However, Fe_2O_3 is slightly lower in concentration than Pittijohn's value. Al_2O_3 being lower in concentration might be related to the lower percentages of Kaolinite minerals.

Mg is considered to be concentrated in chlorite, montmorillonite, and palygorskite and also in carbonate rocks substituted with Fe. Kaolinite clay minerals and feldspar minerals are the main sources of Al2O3, while iron oxide minerals and other heavy minerals are the source of Fe in the studied fine-grained sediments.

The sandstones are classified as Litharrenite and contain mainly quartz, rock fragments (sedimentary, igneous, and metamorphic), and feldspar in addition to the clay minerals in the matrix (3,4). Quartz and other silicate minerals are the primary sources of Si. Carbonate rock fragments, calcite grains, and carbonate cement are the main sources of Ca and Mg. Moreover, Mg might be related to carbonate grains and clay minerals such as montmorillonite.

Kaolinite and feldspar are considered the main sources of Al. The Fe is mainly related to iron oxide minerals and other heavy minerals, as the heavy minerals studied indicate the predominate of iron oxides (3, 5).

Silica content computed as SiO_2 ranged from 47.4% to 61.87% in the sandstones, and it's lower than Pettijohn's value (7). The CaO ranged from 9.81% to 18.37% (Table 5), which is higher than Pettijohn's value (7). The low amount of Si and the high amount of CaO is most probably related to the high amount of carbonate sedimentary rock fragments, calcite grains, and carbonate cement.

The Al_2O_3 is slightly lower compared with Pettijohn's value. The low amount of Al is most likely related to the low amount of clay minerals in the sandstone matrix.

Al Bassam and Yousef (9) suggested a possible relationship between Al and the fine fractions (clay minerals) found in recent Iraqi sediments.

The Fe_2O_3 and MgO are well compared with Pettijohn's value (7). The concentration of Fe in the present study is mainly related to iron oxide minerals and other heavy minerals, as heavy minerals studies indicate the predominate of iron oxides (3,5). Al-Khalidi (8) reported that the source of Fe in the sandstones of the Mukdadiya Formation (L. Pliocene) in northern Iraq, which is similar to the studied quaternary sandstones, is iron oxide cement and other opaque grains. The Mg can substitute also for Fe in these grains and might be related to carbonate grains and clay minerals such as montmorillonite.

The studied sediments were deposited in an alluvial fan environment (3,4). The sediments consist of 3 facies, coarse-grained sandstones and gravels, fine-grained claystones, mudstones, and gypcretes. Tables 1-6 and Figures 7-10 show a certain variation in the concentration of oxides in each type of sediment (facies) for each locality and between localities..

It is expected that in the alluvial fan environment, the coarse sediment facies mostly contain a significant amount of fine-grained sediment is produced when the stream flow decreases in the fan's stream channels, and vice versa. Selley (10) pointed out that it is impossible to correlate elastic sediments in more than 300 meters.

For chemical analysis in the studied localities (Tables 1-6 and Figures 7-10), the variations in the amount of coarse and fine-grained sediments in each facies might be responsible for the variation of the studied elements. Therefore, the variation in concentration of each element in the studied localities (Tables 1- 6) is controlled by the types of its facies and its sub-environment in the alluvial fan deposits. Most probably, for this reason, there are variations in the concentration of the oxides in each locality and between the localities (Baiji, Al-Abbasiya, and Abu-Dalaf).

Conclusion

The following conclusions have been developed based on the geochemical data in the three types of sediments (facies). Thus, the matrix in the gravels are analyzed.

- In the clay stones and mudstones, the clay minerals are the main source of Si, Al, and Mg elements. The carbonate rocks correspond to Ca, whereas the iron oxides in the silt and sand fractions correspond to Fe.
- In sandstones, the source of Si is primarily quartz and other silicate minerals. Carbonate rock fragments, calcite grains, and carbonate cement may be associated with Ca. The carbonate rocks, and cement are also considered the sources of Mg in addition to the montmorillonite. Scientists interpret the kaolinite and feldspar minerals as the sources of Al. Iron oxides and other heavy minerals may have a relationship with Fe.
- Most likely, the variation in coarse and fine fractions in each sediment (facies) causes the variation in oxide concentrations in each locality and between the three localities.

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