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Geological, Mineralogical and Geochemical Studies of Kolosh Formation, Dokan Area, Kurdistan Region, Iraq

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Abstract

The geology, mineralogy and geochemical of The Kolosh Formation in Dokan area, northern Iraq has been studied. The formation sequence includes gray and dark gray marl that alternate from clastic submarine sediments represented by turbid deposits resulted from the last stages of the collision movement between the continental plates. The geochemical study showed that the Kolosh Formation is mainly dominated by detrital sediments (Clay) with a dominance of kaolinite illite, and albite with low amounts of quartz. The analysis revealed that the Kolosh Formation is dominated by relatively marginal marine sedimentation where shelf bay facies was deposited with carbonate facies deposited as shallow marine. In contrast, SiO_2 is strongly negatively correlated with CaO and MgO, this supports their derivation from terrigenous sources during the deposition of Kolosh sediments.

Keywords: Kolosh Formation, sequences, mineralogy, geochemistry.

دراسات جيولوجية ومعدنية وجيوكيميائية لتكوين كلوش، منطقة دوكان، اقليم كردستان، العراق

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الخلاصة:

تمت دراسة تكوين كولوش جيولوجيا ومعدنيا وجيوكيميا، في منطقة دوكان، اقليم كردستان العراق تتضمن الدراسة التتابعية الطباقية للتكوين من المارل الرمادي والرمادي الداكن الذي يتناوب مع الرواسب البحرية التي تمثلها رواسب عكرة ناتجة عن المراحل الأخيرة من حركة الاصطدام بين الصفائح القارية. أوضحت الدراسة الجيوكيميائية أن تكوين كلوش يغلب عليه بشكل أساسي الرواسب الفتاتية (الطين) مع غلبة الكاولينيت وإيليت، والألبيت بكميات منخفضة من الكوارتز. أظهر التحليل أن تكوين كلوش يهيمن عليه ترسيب بحري هامشي نسبيًا حيث ترسبت سحنات خليج الرف مع سحنات كربونية بحرية ضحلة.

على النقيض من ذلك، يرتبط SIO2 ارتباطًا سلبيًا قويًا بـ CAO و MGO، وهذا يدعم اشتقاقها من مصادر أرضية أثناء ترسيب تكوين كولوش.

الكلمات المفتاحية: تكوين كولوش، تتابعية طباقية، علم المعادن، الجيوكيمياء.

Introduction:

The Kolosh Formation (Early Paleocene–Late Paleocene) is one of the most widely distributed formations in northern Iraq. It was first named by **[1]** at a type of section in the Kolosh village north of Koysingak, Zagros basin, northern Iraq. It is mostly made up of stratigraphic sequences of clastic deposits of varied thicknesses, including dark green sandy shale rocks, sandstone layers with dark gray to black clay, and shale beds. It also has lenses that include siltstone and limestone units, as well as a few conglomerates.

The main aim of current study is to analysis of Mineralogical sediments of kolosh formation, Parent rocks of kolosh, Depositional Environment.

Geological background:

Tectonically, Iraq is divided into three major regions: the stable zone, the unstable zone, and the Zagros Suture Zone. The unstable zone is further subdivided into the Low Folded Zone, the High Folded Zone, and the Imbricated Zone **[3]**. The study area is located within the boundary between the high and low folded zones. The unstable range is also a part of the Iraqi Western within the unstable shelf's high folds range, and it is characterized by the presence of an asymmetrical double plunging anticline, whose axes extend northwest-southeast, where the Lower Cretaceous layers are exposed in the core of the folds and the Upper Cretaceous-Tertiary layers are exposed in the folds' periphery. In comparison to rocks and clastic sediments, Tertiary limestone rocks form ridges with high resistance to erosion processes **[4]**.

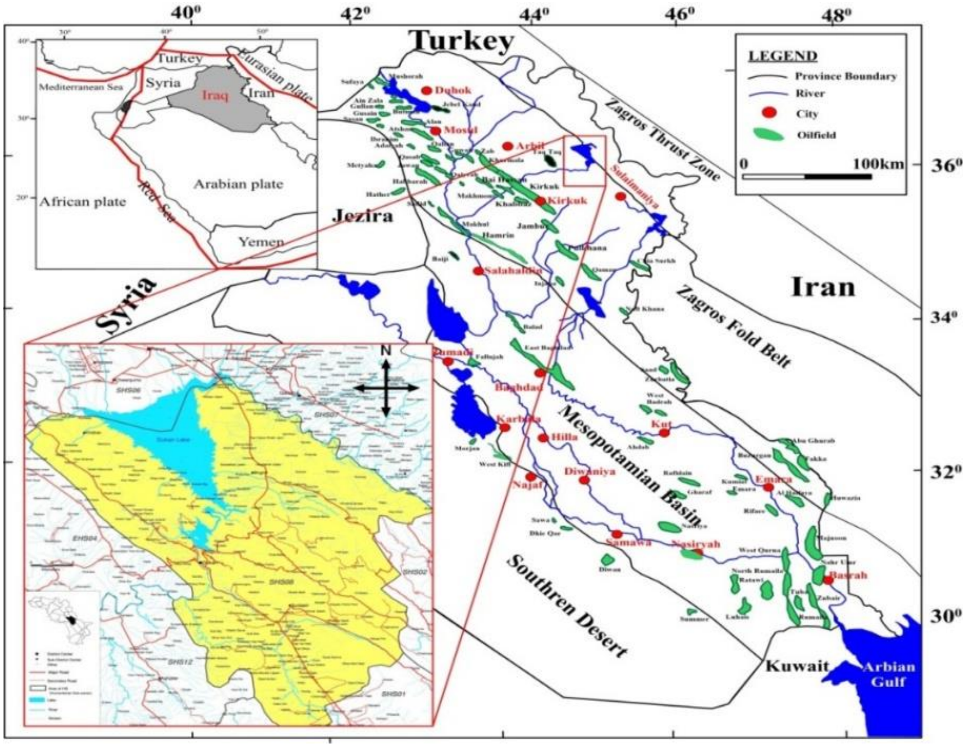

Fig. 1, Location map of Kolosh Formation Zagros basin, Northeastern Iraq.

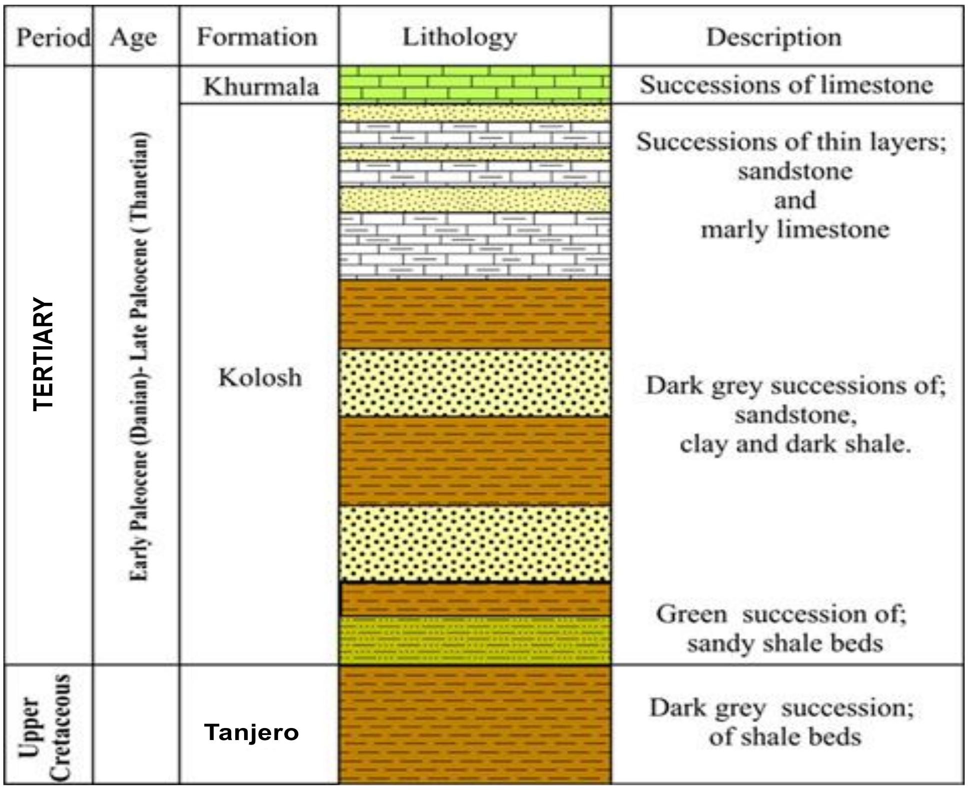

Fig. 2. Composite stratigraphic column of the Kolosh Formation

Tanjero Formation represents the lower boundary of the Kolosh Formation, which consists of green and yellowish green - olive-colored rocks consisting of sandstone, mudstone, shale, and aggregates, as sandstone is the main component, and mudstone and shale are loose and crushed. As for the compactions, they are found in the form of lenses with a thickness of up to (8) meters with soft pebbles. Also, at the boundary, the floating foraminifer's genera, indicate the upper Cretaceous and the emergence of new ones indicating the Paleocene, the upper boundary of the Koloh Formation is stratigraphically consistent with the Khurmala Formation.

An ideal formation section in the Kolosh area, north of the city of Koysinjak in northern Iraq is selected for the current work. It appears on both sides of the fold in the low areas in the study area. It is made up of dark gray sediments and thin brown layers that range in facies from shale to silt to clay to sandy rocks and contain rocky fragments. And different types of minerals, and the formation's lower boundary is stratigraphically incompatible with Tanjero, as evidenced by differences in the rocky facies, where limestone and marl sediments end and sand layers emerge, as well as the presence of a layer of basal compactions at the formation's lower limit. The sediment source of the Kolosh Formation is from the erosion of the Qulqula, Tanjero and other Jurassic to Cretaceous formations **[2]**. The formation is primarily composed of successive shale and sandstone grains of varying size and origin. **picture (2-5)**. The Kolosh Formation is distinguished by rapid and distinct lateral and vertical variations, which are gradual and overlapping with the Sinjar limestone formation as well as the Khurmala formation. The lower boundary of the Kolosh Formation is incompatible with the Tanjero Formation, and it is represented by a complete biological change with no transitional elements between them, while the upper boundary is compatible with the Khurmala Formation **[6]**. Kolosh formation is thin in studied area and thick in north Iraq so this depositional basin in margarine in studied area.

Materials and methods:

1. **XRD analysis:** X-ray diffraction analysis has been carried out on 10 rock powdered samples from the Kolosh rocks in order to determine the whole mineral constituents. X-ray diffractometer type PW3710 with Cu Kα radiation was used at the Metallurgy Institute of Minerals, Cairo. The scanning range was between 2θ 3º- 60º at scan speed

2θ 2 min-1. The X-ray diffractometer is computerized to measure the peak diffraction in 2θ and d spacing (Å). The computer software was used for calculating the percentages of minerals .

2. **Geochemical analysis:** Major oxides (SiO2, AL2O3, Fe2O3, CaO, MgO, MnO, Na2O, K2O, P2O5, SO3, and Cl) have been determined from 10 powdered samples retrieved from the Early Paleocene Late Paleocene Kolosh Formation. The X-ray fluorescence spectrometer Cu-Kα radiation type (AXIOS, WD-XRF-SEQUENTIAL spectrometer, PA Analytical, 2005) was used at the Metallurgy Institute of Minerals, Egypt.

Results and discussion:

1. XRD analysis

A total of and cutting samples from the Early Paleocene Late Paleocene Kolosh Formation has been analyzed. The XRD analysis **(Fig. 3)** showed that the Kolosh Formation is mainly dominated by detrital sediments (Clay) with a dominance of kaolinite illite, and albite with low amounts of quartz **[7]**. Calcite is recorded in small amounts at the top of the formation. The analysis revealed that the Kolosh Formation is dominated by relatively marginal marine sedimentation, where shelf bay facies was deposited.

The middle and upper part of the kolosh Formation witnessed a drop in sea level, accompanied by relatively shallow marine sedimentation, where carbonate facies was deposited.

2. Distribution and significance of geochemical elements

The original installation of rock is mostly affected by the depositional environment and the post-diagenetic processes **[8]**. Major elements geochemistry gives more or less a coherent picture of the geochemistry of carbonate rocks and the distribution of mineral of major elements-forming elements **[9]**. In this regard, a total of ten core and cutting samples retrieved from kolosh Formation at Dokan region, northern Iraq that geochemically analyzed using X-ray fluorescence spectrometer instrument of Cu-K_α radiation Oxides such as SiO_2, Al_2O_3, Fe_2O_3, CaO, MgO, MnO, Na_2O, K_2O, P_2O_5, SO_3 and Cl. Major elements are expressed in percentages and the results are summarized in **Table 1**.

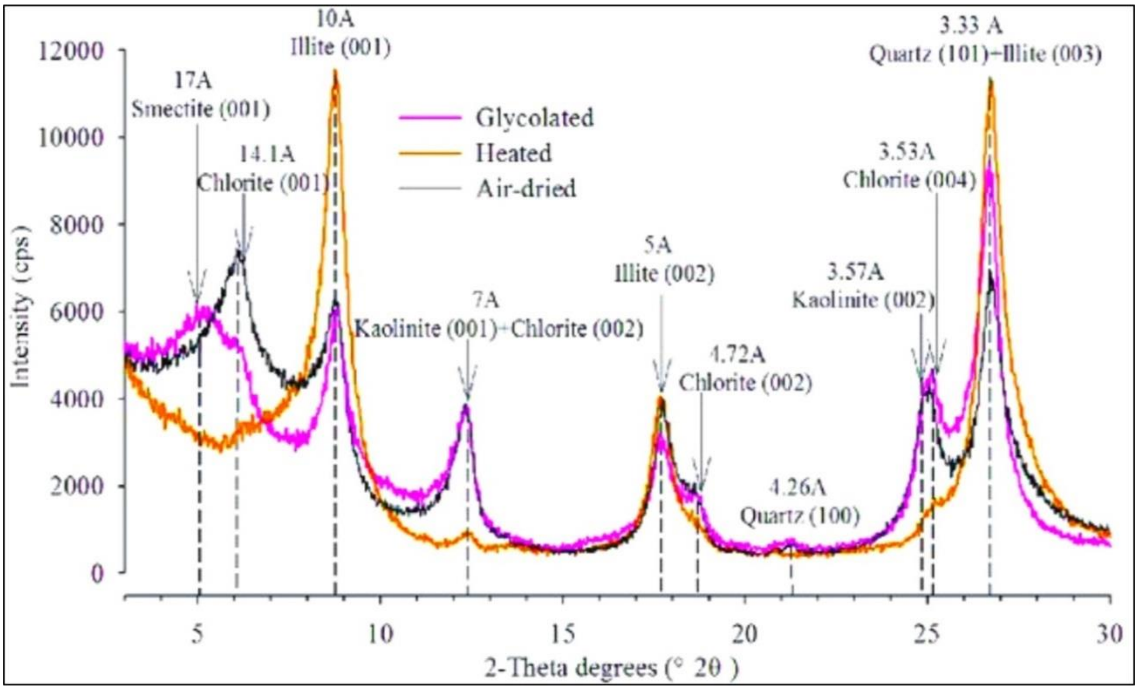

Fig. 3 Typical X-ray diffraction pattern showing the abundance of clay minerals within Kolosh Formation.

A marked variation in the clay content is seen in the analyzed samples **(Table 1; Fig. 4)**. It ranged between 0.53 - 43 % with an average of 28.81 %. Calculations of correlation coefficients of major element concentrations in the studied samples are shown in **Table 2**. High positive correlation exists between SiO_2 and Al_2O_3, TiO_2, Fe_2O_3, P_2O_5 (r = 0.58, 0.744, 0.79 and 0.69, respectively), **[10]**. Weak positive correlations existed between SiO_2 and Na_2O, K_2O and MnO (0.15, and 0.61 respectively). In contrast, SiO_2 is strongly negatively correlated with CaO and MgO (-0.77 and -0.84). This supports their derivation from terrigenous sources during the deposition of Kolosh sediments. Iron and manganese compounds are precipitated partly in the form of coatings on mineral particles **[11]**.

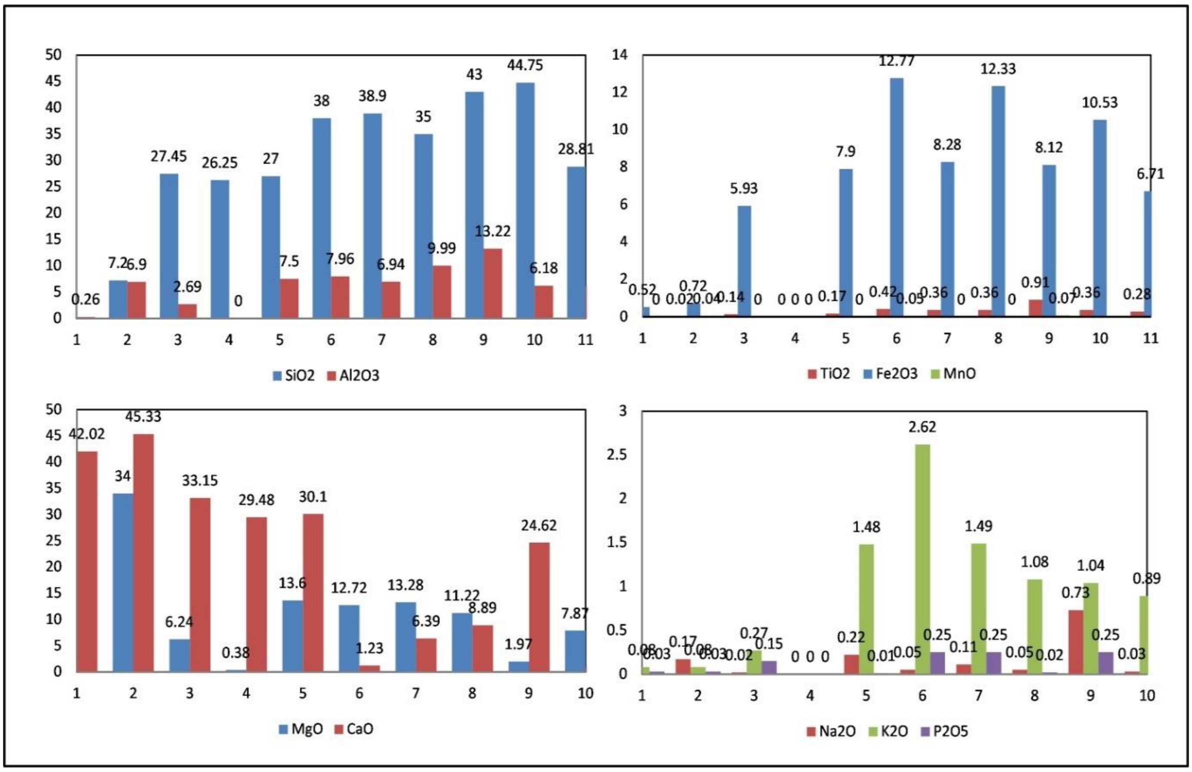

Fig. 4 Correlation of major oxides percentages for Kolosh Formation, Zagros Basin, NE Iraq.

The content of Al_2O_3 in the analyzed samples varied from 0.26- 13.22% with an average of 6.85%. Alumina has a strong positive correlation coefficient with TiO2, Fe_2O_3, MnO, Na_2O, K_2O, and P_2O_5 (r = 0.82, 0.67, 0.63, 0.62, 0.58, and 0.43, respectively), indicating its association with terrigenous argillaceous materials as evidenced by [13].

Furthermore, the iron (Fe_2O_3) content ranged between 0.02- 12.77% with an average of 10.53%. Strong positive correlations between Fe_2O_3 and Na_2O, K_2O and P_2O_5 (r = 0.608, 0.82 and 0.56, respectively) suggest that the iron content was brought to the carbonates and shale samples generally with the terrigenous argillaceous materials. Thus, the iron content increased landward toward the source of terrigenous materials. The oxidation process took place during the subaerial exposure of these carbonates as is the case for goethite, which points to a near-shore environment for the upper part of the formation. The calcium (CaO) content varied between 0.88-45.33% with an average of 22.21% lower than the world average (42.3%) given for carbonates [12]. MgO fluctuates between 0.38 and 34% with an average of 12.92% higher than the average given for carbonates as of 7.79%. CaO and MgO exhibit a negative correlation with other major oxid indicating shifting of the depositional environment toward the land, where evaporation allowed precipitation of carbonate and/or anhydrite.

Moreover, Titanium oxide is detected in 10 samples with values ranging from 0.02-0.91%, average 0.31%. TiO_2 has strong positive correlation with Fe_2O_3, MnO, Na_2O, K_2O, P_2O_5 and Cl (0.64, 0.67, 0.60, 0.7, 0.53, 0.71 and 0.06, respectively) indicating detrital origin.

Clay minerals derived of ancient sedimentary rocks and the acidic igneous evidence is Illite clay minerals. [13]. Digenetic processes and affecting shale and mudstone metamorphism compaction clay minerals are modified [14]. Igneous and metamorphic rocks are parents' rocks.

Sample no	sample code	Formation	Age	SiO_2	Al_2O_3	TiO_2	Fe_2O_3	MnO	MgO	CaO	Na_2O	K_2O	P_2O_5	SO_3	Cl
1	RR1	Kolosh	Early Paleocene - Late Paleocene	0.53	0.26	0.02	0.52	—	27.87	42.02	0.15	0.08	0.03	22	0.15
2	RR2			7.2	6.9	0.02	0.72	0.04	34	45.33	0.17	0.08	0.03	1.53	0.15
3	RR3			27.45	2.69	0.14	5.93	—	6.24	33.15	0.02	0.27	0.15	22	0.15
4	RR4			26.25	—	—	—	—	0.38	29.48	—	—	—	41.38	—
5	RR5			27	7.5	0.17	7.9	—	13.6	30.1	0.22	1.48	0.01	12	—
6	RR6			38	7.96	0.42	12.77	0.05	12.72	1.23	0.05	2.62	0.25	19	0.15
7	RR7			38.9	6.94	0.36	8.28	—	13.28	6.39	0.11	1.49	0.25	22	0.15
8	RR8			35	9.99	0.36	12.33	—	11.22	8.89	0.05	1.08	0.02	20	0.15
9	RR9			43	13.22	0.91	8.12	0.07	1.97	24.62	0.73	1.04	0.25	1.03	—
10	RR10			44.75	6.18	0.36	10.53		7.87	0.88	0.03	0.89	0.22	26.4	1.2
	Average			28.81	6.85	0.31	7.46	0.05	12.92	22.21	0.17	1.00	0.13	18.73	0.30

Table-1, Distribution of major oxides in the studied Kolosh rock samples, Zagros Basin, NE Iraq.

	SiO_2	Al_2O_3	TiO_2	Fe_2O_3	MnO	MgO	CaO	Na_2O	K_2O	P_2O_5	SO_3	Cl
SiO_2	1.00											
Al_2O_3	0.58	1.00										
TiO_2	0.74	0.82	1.00									
Fe_2O_3	0.79	0.67	0.64	1.00								
MnO	0.27	0.63	0.67	0.21	1.00							
MgO	-0.77	-0.14	-0.47	-0.38	-0.01	1.00						
CaO	-0.84	-0.41	-0.51	-0.85	-0.10	0.46	1.00					
Na_2O	0.15	0.62	0.71	0.02	0.68	-0.11	0.20	1.00				
K_2O	0.61	0.58	0.53	0.82	0.32	-0.20	-0.73	0.07	1.00			
P_2O_5	0.69	0.43	0.71	0.56	0.54	-0.35	-0.63	0.27	0.56	1.00		
SO_3	0.09	-0.70	-0.43	-0.12	-0.66	-0.41	-0.26	-0.70	-0.17	-0.15	1.00	
Cl	0.32	-0.02	0.06	0.30	-0.15	-0.06	-0.47	-0.29	0.01	0.33	0.22	1.00

Table 2: Correlation coefficients of major oxides for the studied Early Paleocene-Late Paleocene Kolosh rock samples, Zagros Basin, NE Iraq.

Conclusion:

1. The Kolosh Formation is dominated by relatively deep marine sedimentation, where marginal shelf bay facies were deposited as the thickness and facies reduced -Parent rocks acidic, and basic igneous, metamorphic, and sedimentary rocks.
2. Thrusting and controlled lateral and vertical abundance clay minerals in the Kolosh Formation.
3. SiO2 is strongly negatively correlated with CaO and MgO، this supports their derivation from terrigenous sources during the deposition of Kolosh sediments .
4. Major oxid indicating shifting of the depositional environment toward the land, where evaporation allowed precipitation of carbonate and/or anhydrite.

References:

[1] Dunnington, H.V., Generation, migration, accumulation, and dissipation of oil in northern Iraq. In: Weeks, L.G. (ed.). Habitat of Oil. American Association of Petroleum Geologists, Tulsa, 1958. p. 1194-1251.

[2] Jassim, S.Z., Buday, T. Tectonic Framework. In: Jassim, S.Z. and Goff, J.C. (eds), Geology of Iraq. Dolin, Prague and Moravian Museum (Brno), Czech Republic. 2006a p.45-55.

[3] Jassim, S.Z., Buday, T. Units of the Stable Shelf. In: Jassim S.Z. and Goff, J.C. (eds), Geology of Iraq. Dolin, Prague and Moravian Museum (Brno), Czech Republic. 2006b p. 57-70.

[4] Thorze.j. phyiiosilieate and clay minerals; a laboratory hand book for their X-Ray diffraction analysis. G Le Lette(ed).Dison. Belgique. 1975. 578pp

[5] Jassim, S.Z., Goff, J.C. Geology of Iraq. Dolin, Brno, Prague and Moravian Museum, 2006. 352 p.

[6] Bellen,R.C.Van Dunnington ,R.Wetzel and D.M.Morton eds, Lexique stratigraphic international ,Paris,VIII,Asia Fascicule 10a Iraq, 1959. 333 p.

[7] Dymond, J. and Kelund W., A microprobe study of metalliferous sediment components. Earth Planet. Sci. Lett. 1978.40: 243 – 251.

[8] Folk, R.L., Petrology of sedimentary rocks, Hemphill, Texas, 1974. 182pp.

[9] Murray, H.H., Applied clay mineralogy, occurrences, Processing and Application of Kaolins, Bentonites, Palygorskite, Sepiolite, and Common Clays. Developments in Clay Science, 2007.2. Elsevier,

[10] Reynold, R.C., Interstratified clay minerals, in Brindley, G.W., and Brown, G. (eds.), Crystal structures of clay minerals and their X-ray identification, Chapter 4., Mineralogical Society, London, 1980. 249 – 303.

[11] Meunier, A., Clays. Springer-Verlag Berlin Heidelberg, 2005. 472pp.

[12] Reynolds, R.C., Jr., Mixed layer chlorite minerals. In: Bailey, S.W., (edit.), hydrous phyllosilicates (exclusive of micas): Reviews in Mineralogy, 1988.19: 601 – 629.

[13] Potter, P.E, Maynard, J.B. and Depetris, P.J., Mud and Mudstones. Springer-Verlag, Berlin, Heidelberg, 2005. 297pp.

[14]Abdullayev E, Leroy SA. Provenance of clay minerals in the sediments from the Pliocene Productive Series, western South Caspian Basin. Marine and petroleum geology. 2016, 1; 73:517-27.

[15] Tucker, M.E. Sedimentry petrology,An Introduction .Black Scientific puplucation,Oxford, 1981.252pp.