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SEDIMENTOLOGICAL AND MINERALOGICAL ASPECTS OF KHOR ABDULLAH SUPRATIDAL SEDIMENTS, NORTH WEST ARABIAN GULF

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ABSTRACT

A total of thirty samples were collected from Khor Abdullah supratidal clastic sediments NW Arabian Gulf. These samples were firstly air dried, then clay fraction separated and the prepared oriented clay samples were X-rayed, the obtained diffractograms revealed the occurrences of the kaoilinite, palygorskite, chlorite, montmorillonite, montmorillinte–chlorite, illite, and montmorillonite-illite clay minerals . The textural analyses showed that the sediments investigated are siltyclay and clayeysilt in nature, the mechanical analysis illustrates that Khor Abdullah supratidal sediments are fine to very fine, poorly sorted deposited in quite aquatic environments which emphasized that the studied sediments were deposited in low energy environment. Heavy mineral analyses proved that Khor Abdullah sediments mostly derived from igneous, with subordinate amount of metamorphic and ancient sedimentary rocks, such diverse trend of rocks cropping out at north and northeastern parts of Iraqi terrain, and southeast Turkey, i.e. at the catchments area of Tigris and Euphrates Rivers and their tributaries.

INTRODUCTION

Iraqi coast of Khor Abdullah area is located at the north western part of the Arabian Gulf, bounded between Al-Fao city to the east and Khor Al-Zubair to the west (Fig. 1). This area characterized by a wide spread distribution of silt and clay deposits of recent origin. Khor Abdullah coasts represent the distal part of Mesopotamia. Owing to Lees and Falcon (1952), the Mesopotamia plain shows continuous subsidence to accommodate the huge quantity of sediments annually contributed. The recent sediments of Khor-Abdullah are considered to be resultant of different transporting factors, having various energies, tidal current could play an important role in transporting and sedimentation processes (Albadran, 2004). Multisources of

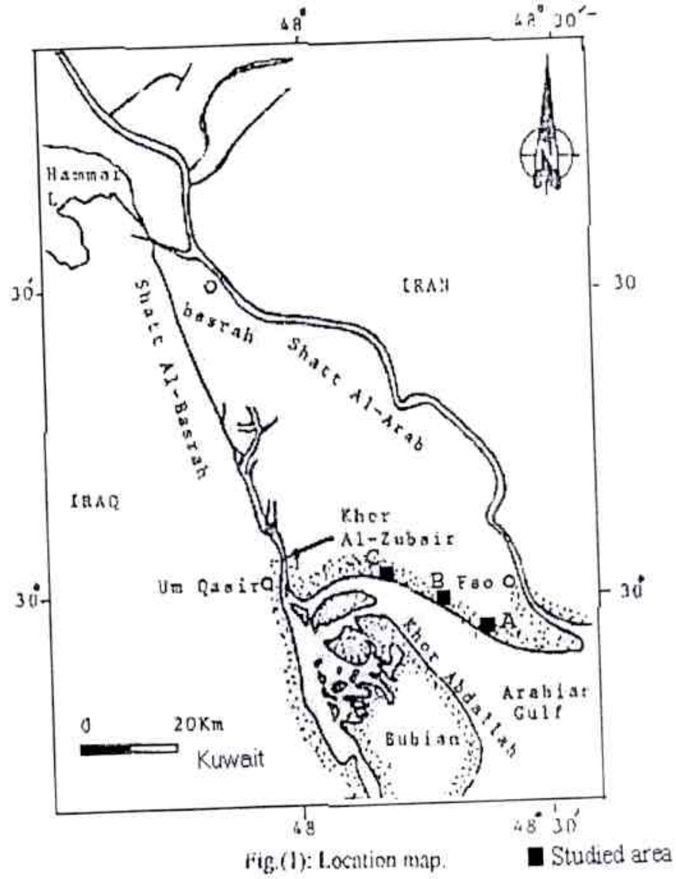


Fig. (1) Location map

sediments were contributed to the Khor Abdul-Allah area; the alluvial sediments as river budget contributed by Shatt Al-Arab (Darmoian and Lindqvist, 1988), and aeolian sediments as dust fallout contributed by the north western wind (Salman and Saddallah, 1986, and Foda *et al.*, 1988). Furthermore, detrital sediments (mainly sand) was also transported to the area under investigation from Dibdibba Formation (Miocene- Pliocene) (Darmoian and Lindqvist, 1988).

From meteorological point of view, the studied area is characterized by an extremely hot and dry summer (usually extends from May to October) with daily summer temperature of 45° C, and mild to cold weather in winter

(December-January). The rate of evaporation is higher than precipitation (Albadran and Albadran, 1993). The water table survives fluctuation due to above factors in addition to the tidal phenomena. The average depth of water table is less than 0.5 m (Al-Jabbry, 2005).

Basrah area has simple topographic features, the ground surface is almost flat slopping gently from northwest to southeast and from southwest to northeast. The regional slope is about 35cm/km with a general south east trend toward Arabian Gulf (Al-Khait, 2002). The northwestern part of the Arabian Gulf is located on the eastern boundary of Arabian Platform which dips to the northeast at 1-2° (Murris, 1980). The main structure features of Northwest Arabian Gulf have resulted from epirogenic movements. Most of the subsurface structures trend north –northwest and are thought to be produced by salt tectonism. The location of most Basrah oil fields coincides with this trend.

Stratigraphicaly, Khor-Abdullah is mainly consist of soft silty clay tidal flat sediments, overlay Hammar Formation (Khan *et al*., 1992).

Few accounts were published on the quaternary sediments of Fao area due to previous critical war conditions, so, the purpose of this study is to provide some environmental interpretations based on textural and mineralogical criteria.

Methodology

Thirty surface sediment samples were collected from Khor-Abdullah coastal sediments during November, 2003, along three main traverses 10-12 km apart in direction perpendicular to the Gulf coast. The collected samples were placed in plastic bags. They were air dried, then analyzed for grain size distribution, and sieve analysis was done for sands, while the pipette analysis was employed for fine fractions. The procedures followed are given by Folk (1974).

For clay mineral determination, the carbonate contents were dissolved with solution of 5% acetic acid, then each sample was soaked in distilled water and washed several times to remove the dissolved salts. The clay fraction was separated according to the pipette method suggested by Folk (1974). Three oriented clay slides were prepared for each sample based on Grim (1968), then the oriented samples were x-rayed using Cu-kα radiation as follows; 1- as it was prepared,2-following glucolation for 24 hours, 3-after heating to 550°C for two hours. Owing to Cramo Sousa *et al*. (2000) cited in Al-Rashdi (2005), the 74, 88 and 149 micron size fraction of the studied sediments were choose for a heavy mineral (H.M) analyses.

Mineralogy

The XRD analyses revealed that the mud sediments understudy consist of the following clay minerals according to their abundance: kaoilinite (27.83%), palygoriskite (23.18%), chlorite (20.6%), montmorillonite (15.18%), montmorillinte–chlorite (8.4%), illite (2.85%), and montmorillonite-illite (1.65%) (Fig. 2), all these clay minerals were previously recorded in the recent sediments of selected areas of Iraq and neighboring areas of Khor Abdullah (Al-Jabbry, 2005). These different clay mineral species clarify the diversity of source rock types. The obtained clay minerals could be categorized into two groups; detrital (Kaolinite, montmorillonite, and illite) and authigenic (palygorskite and mixed-layer). The diffractograms (Fig. 2), and the percentage of clay minerals (Table,1) prove the dominancy of kaolinite mineral, Bassi and Al-Mussawy (1988), as well as Aqrawi (1993), recorded the presence of kaolinite in the northwest Arabian Gulf recent sediments. According to Grim (1968), it could be concluded that the kaolinite mineral is of detrital origin. The deposition of carbonate minerals in Khor-Abdullah recent sediments as mentioned by Al-Jabbry, 2005) means that Kaolinite does not form in place. Palegorskite presents in high percentage after the kaolinite, although palygorskite has common occurrence in Iraqi territories: Western Desert and Northeast areas (Kassim *et al.*, 1990), it could be deduced that this mineral of authigenic origin because palygorskite can not survive long period of river transportation, and the availability of arid climate, hypersaline, alkaline pH, and Mg-rich environments may induce the palygoriskite formation. On the other hand, under the conditions of high salinity, high pH, the availability of magnesium accelerate the alteration of montmorillonite into palygorskite (Mackanzie *et al*.1981 and Albadran and Hassen (2003). The montmorillonite-chlorite, and montmorillonite-illite mixed layers may represent an intermediate stage of clay minerals alterations, a similar results was reported by Chamly (1989) who attributed this phenomenon to the diagenetic formation of chlorite in shallow marine to brackish environments. Whereas, Grim (1968) suggested the formation of montmorillonite at the expanse of illite in aquatic environment rich in Ca, Na, and Mg.

The H.M fraction is found to compose of chlorite, opaque minerals , pyroxene, hornblende, and biotite forming about 84% of the recorded H.M within Khor Abdullah sediments (Table, 2).It is worth mentioning here that ,chlorite was recorded in Basrah recent sediments for first time in the present study. These H.M assemblages clarify the diversity of source rock types (basic and acidic igneous rocks). Whereas, the traces amount of

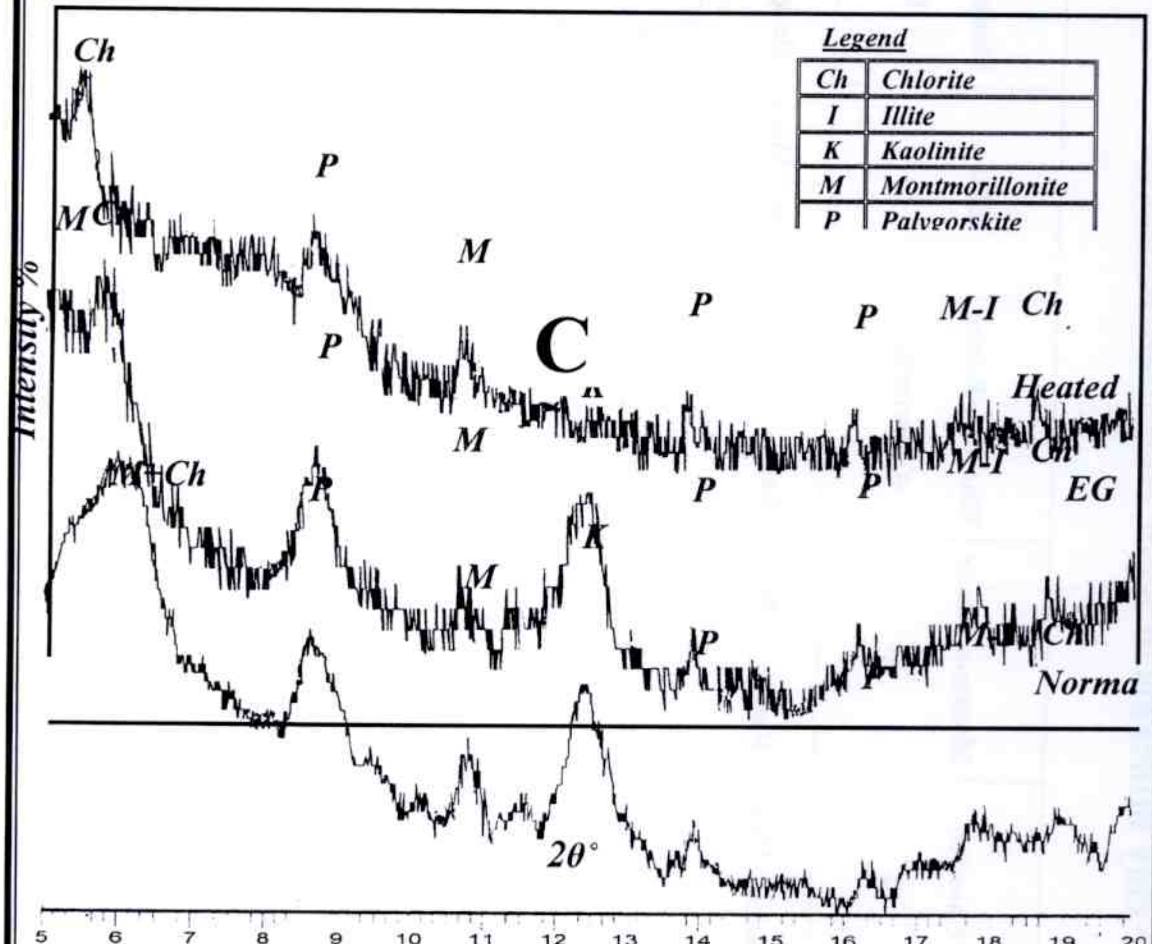


Fig. (2) X-ray diffractgrams for Khor Abdullah Sediments at location A,B and C.

Table (1) Range and mean of the clay minerals in Khor Abdullah sediments.

Area	Kaolinite %		Palygorskite %		Chlorite %		Montmorillonite %		Montmorillonite -Chlorite%		Illite %		Montmorillonite-Illite %	
	Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean
A	24-29	26.85	20-24	22	18-22	20.28	14-19	16.28	5-10	8.71	3-5	3.71	2-4	2.5
B	24-35	26.88	21-26	23.85	19-23	20.85	11-17	13.85	5-11	8.9	2-4	2.42	2-5	2.64
C	24-35	28.42	22-26	23.71	18-23	20.7	10-19	15.42	6-10	7.57	2-4	1.42	2-4	2.57
Mean	-	27.83	-	23.18	-	20.6	-	15.18	-	8.4	-	2.85	-	2.52

Table(2) The percentages of heavy minerals detected in Khor Abdullah sediments.

Samp. No.	Op.	MonoPy	OrthoPy.	Horn.	Bas.-Horn.	Chl.	Biot.	Ep.	Garn.	Ky.	Staur.	Cele.	Zir.	Tour.
A-1	17.3	11.8	8.8	11.3	2.7	28.2	2.5	2.3	2.7	3.4	1.7	1.9	1.4	1.9
A-2	18.3	5.2	13.5	10.8	-	26.2	7.3	3.9	2.8	2.8	-	-	2.2	2
A-5	19.2	10.8	8.3	6	3.1	24.8	10.3	2.8	1.9	2.3	1.7	3.2	3.8	1
A-10	14.4	9.6	13.2	4	2.4	31.6	8.7	1.3	2.3	2.1	1.8	2.9	1.9	2.8
B-1	16.3	10.7	12.5	1.2	11.3	22.8	8.2	2.4	2.6	1.9	-	2.1	3.8	2
B-2	10.5	8.5	9.3	3.2	11.7	33.8	7.3	-	3.7	1	-	-	1	-
B-3	18.5	13.8	8.3	8.2	3.8	32.5	6.8	2.1	2.4	1.8	-	-	1.8	-
B-5	15.5	12.9	11.3	8.8	2	33.2	7.1	3.3	1.6	-	1.8	1.8	1	-
B-10	14.3	11.2	7.8	8.7	1.5	28.9	6.3	3.9	2.6	2.4	2.3	2.3	3	2.8
C-1	12.8	10.9	9.8	6.3	7.3	33.7	9.2	2.8	3.4	-	-	-	2.1	1.7
C-2	10.3	12.2	10.1	6.2	4.1	25.7	10.8	3.1	3.1	1.4	1.9	1.9	1.3	-
C-5	16.6	12.8	7.9	9.3	3.4	28.3	9.4	2.2	3.5	2.9	-	-	1	1.8
Mean	15.3	10.8	10	6.95	4.6	29.4	7.82	2.5	2.7	1.83	1.69	1.69	2	1.33

Op.= Opaque minerals, MonPyx.=Monopyroxene, Orth.Pyx.= Orthopyroxene, Horn.=Hornblede, Bas.-Hoern.= Basaltic hornblende Chl.= Chlorite, Biot.= Biotite, Ep.= Epidote, Garn.= garnet, Ky.= Kyanite, Staur.= Staurolite, Cele.= Celectite, Zir.= Zircon, Tour.= Tourmaline epidote, garnet, staurolite, kayanite, clecestite, zircon, and tourmaline confirm the partial role of metamorphic and sedimentary rocks in heavy mineral contribution to the area understudy. Furthermore, the common occurrences of unstable H.M stressed the dominancy of mechanical weathering in the source areas. It should be considered that the light minerals observed in the present sediments include quartz, carbonate, and feldspar.

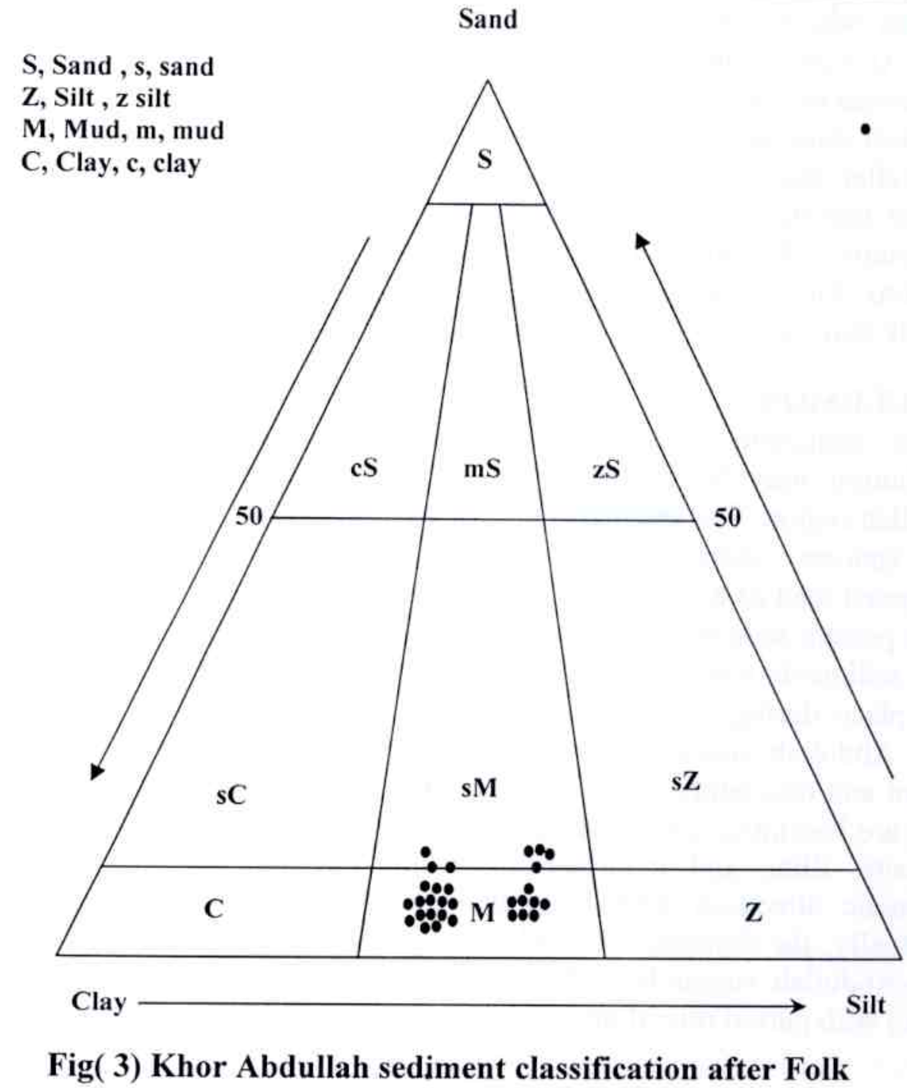
Grain size analysis

The textural analyses of the Khor Abdullah sediments revealed the occurrence of the following fractions; clay, silt and sand, with different percentage (Table 3), the plotting of obtained results on Folk (1974) triangle (Fig 3), showed that most of the samples were concentrated in mud zone(M) i.e. they are either siltyclay or calyeysilt. According to Folk (1974), the abundance of silt grains (47%) in the studied samples considered as a sound evidence of a dust fallout deposition. Data concerning graphical mean size (Median) shows that the phi graphic mean size ranges between 6.0-8.5 Ø with an average value of 7.83 Ø (Table, 3). This result clarifys that the sediments understudy are of fine-very fine size (silt and clay). The mean size (Mz) is preferable in determining the overall grain size in the sample which lateron used in cumulative frequency curve construction (Pettijohn *et al*., 1973). The obtained results reveled, that the value of Mz ranges between 6.5-8.8 with an average of 7.79 Ø. According to the sorting classification scale giving by Folk (1974), the studied samples have sorting values that ranges between poorly sorted to very poorly sorted (σ values range between 2.3 and 3.7 Ø), however, the average sorting value for the samples is 2.92Ø falling within the very poorly sorted class. Owing to Tucker (1985), the poorly sorting of the fine and very fine sediments understudy related to the difficulty in transporting these sediments, and therefore, less sorted by wind and water. The value of graphic Kurtosis obtained for the studied samples range from 0.70 to 0.90 indicating that all the studied samples are platy kurtic as suggested by Folk (1974). Regarding the skewness , the studied samples have inclusive graphic skewness value ranging between 0.01 and 0.15 with an average of 0.085 , according to skewness class limits suggested by Folk (1974), the majority of the samples is near symmetrical (location one and two) and fine skewed with ten samples in traverse three.

The textural analyses showed that siltyclay and clayeysilt form about 57% and 30% of the studied samples respectively. This could be attributed to the closeness of Khor Abdullah to the Shatt Al-Arab River which consider as the source of sediments that contributed to the Arabian Gulf. As

Table (3) the textural and mechanical properties of Khor-Abdullah coastal sediments.

	Sand %	Silt %	Clay %	Mean size Ø	Median Ø	Sorting Ø	Kurtosis Ø	Skewness Ø
Min.	2	26	29	6.5	6.0	2.3	0.7	0.01
Max.	12	60	68	8.8	8.5	3.7	0.9	0.15
Mean	7	46	47	7.79	7.83	2.92	0.8	0.085



Fig(3) Khor Abdullah sediment classification after Folk (1974).

mentioned above, the present sediments are fine to very fine, poorly sorted, positively skeweed, and platy kurtic. All the results suggest that the depositional environment is of quite type, this quittance provided during the slack water period (i.e. during Tidal-Ebb current inversion). This confirms the conclusion of (Albadran and Albadran, 1993), which pointed out that the depositional environment is agitated at the entrance of Khor Abdullah and calm toward the south of the Khor entrance. This calmness of Khor Abdullah environment make it suitable for receiving fine grained clastics sediments from Shatt Al-Arab River, as well as the flow directed toward the west side due to the corrioless effect, which anticlock wise in the northern hemisphere (Albadran, 2004). These sediments were deposited as very thin lamines, whereas, the fine clastics sediments, which washed away from Khor Al-Zubair during ebb current delivered by Khor-Abdullah where redeposited during the next quite periods. To confirm these conclusions, the statistical data were plotted on Stewart's diagrams (1958) (Figs. 4 and 5), and Buller and Mc Maunus (1972) (Figs. 6 and 7). All these diagrams showed that the studied sediments laid down in quite water environment, furthermore, the projection of the obtained data on Sly *et al.*, (1983) diagrams (Figs. 8 and 9), illustrates that the sediments understudy subjected to weak currents and oscillatory wave with minimal erosion velocity.

CONCLUSION

The sediments of Khor Abdullah are widely distributed; such distribution may be controlled by the hydrodynamic system of Khor Abdullah region. The sediments understudy are clastics in nature, there are three sources shared their contribution ; Shatt Al-Arab river budget, suspended load of Khor Al-Zubair ebb current and dust fallout. The texture of the present sediments is siltyclay, clayeysilt, and sand. This indicates that these sediments was laid down in low energy environment. The deposition took place during the tidal-ebb current inversion. The poorly sorting of Khor Abdullah supratidal sediments most probably attributed to weak current and oscillatory wave. The clay minerals assemblages in descending order are kaoilinite, palygorskite, chlorite, montmorillonite, montmorillinte –chlorite, illite, and montmorillonite-illite. Detrital, neoformation, and diagenetic alteration were suggested for the origin of these minerals. Eventually, the diversity of H.M species revealed the ultimate source of Khor-Abdullah supratidal sediments would be igneous rocks (basic and acidic) with partial role of metamorphic and ancient sedimentary rocks.

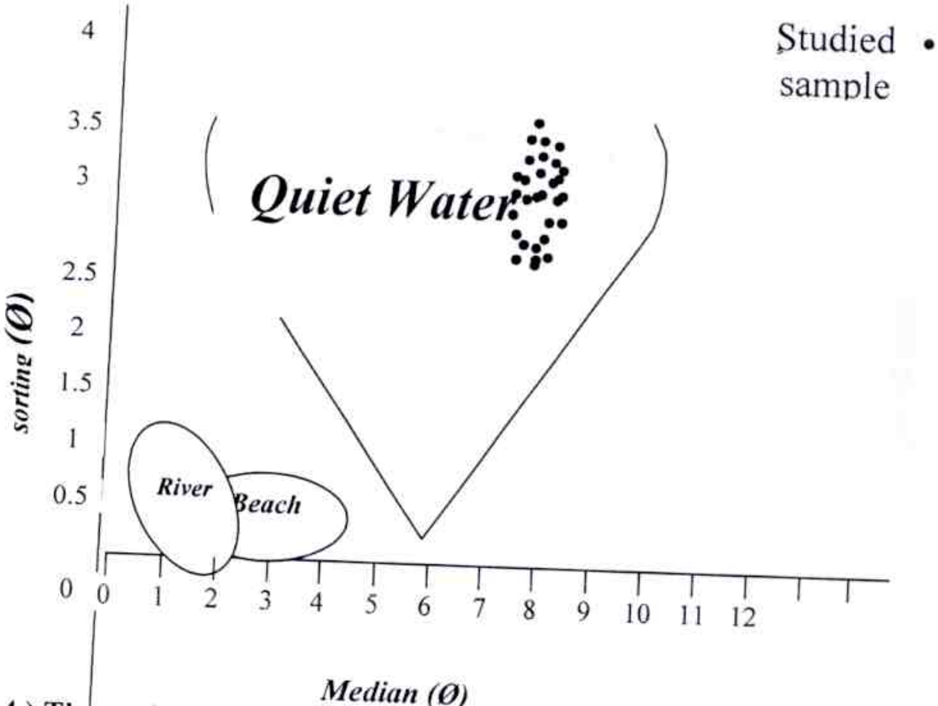


Fig. (4) The projection of sorting versus median(after Stewart, 1958).

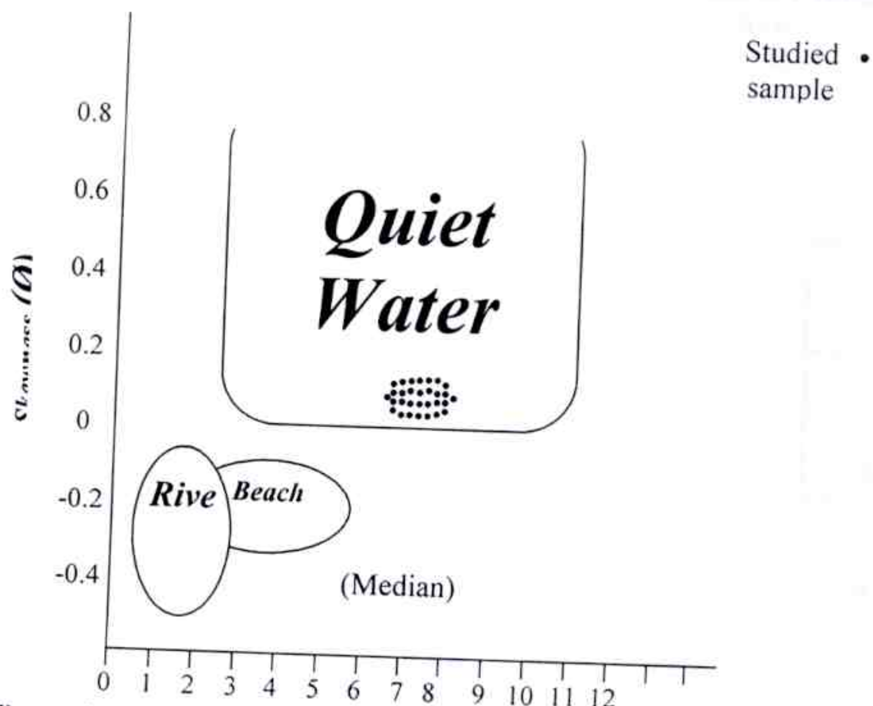


Fig. (5) The projection of Skewness versus Median of Khor Abdullah coastal Sediments (after Stewart, 1958).

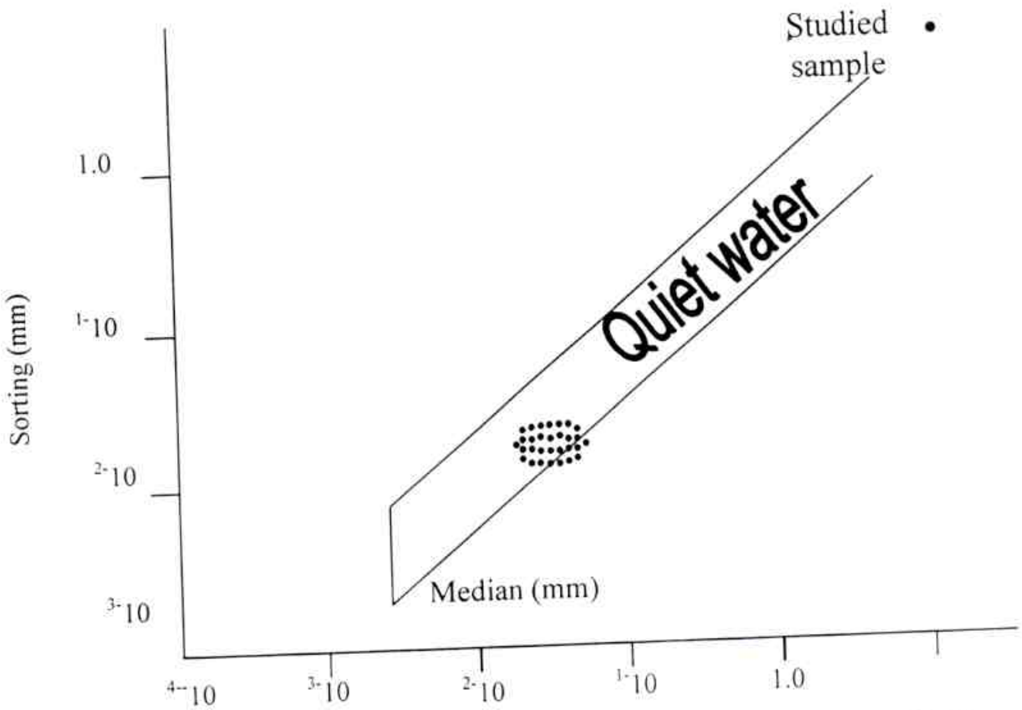


Fig. (6) The logarithmic correlation between sorting and median (Buller and Mc manus, 1972).

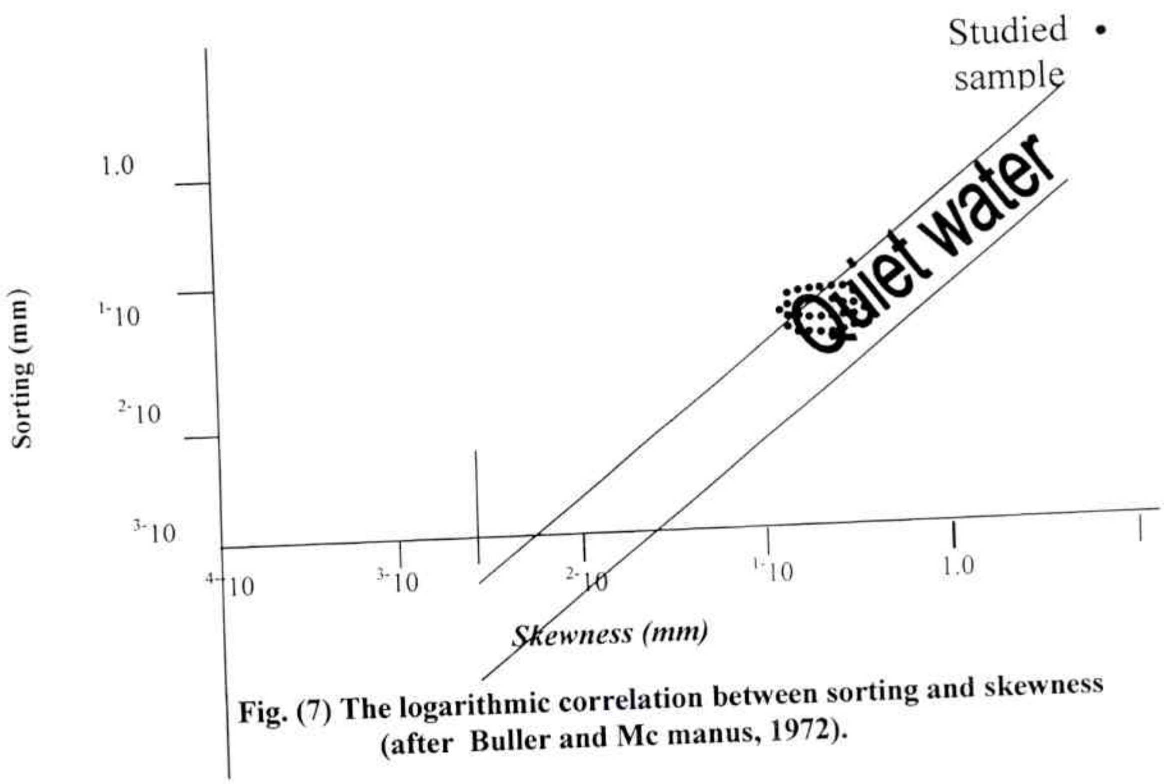


Fig. (7) The logarithmic correlation between sorting and skewness (after Buller and Mc manus, 1972).

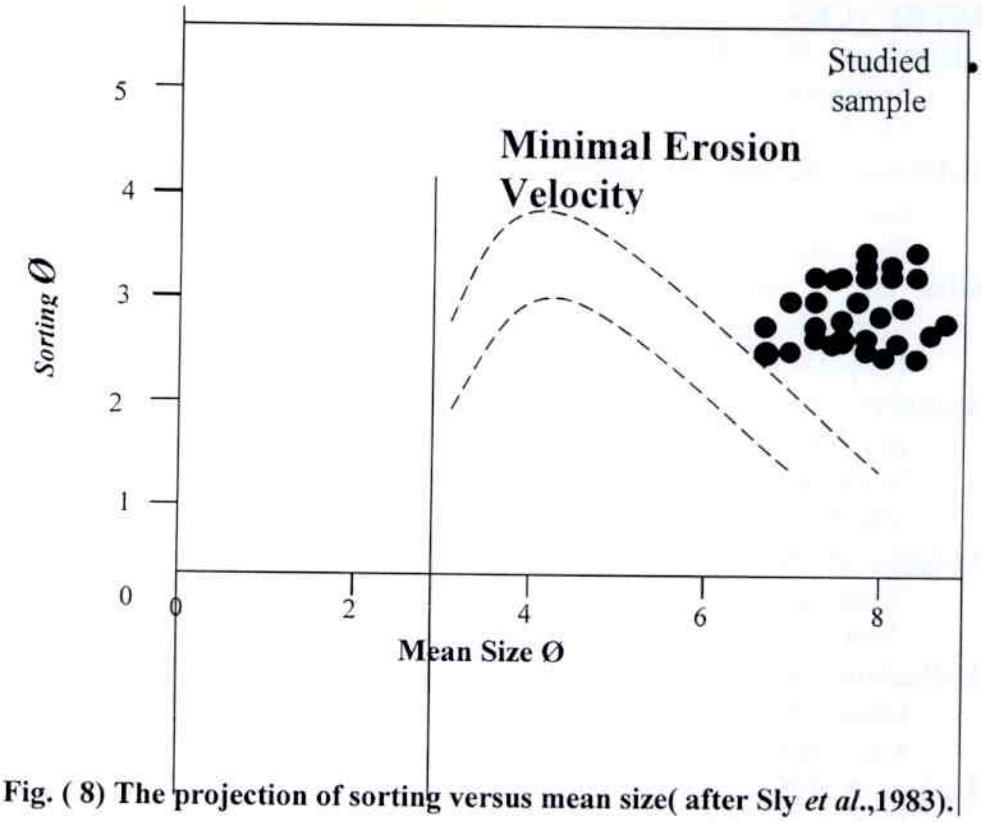


Fig. (8) The projection of sorting versus mean size(after Sly *et al.*,1983).

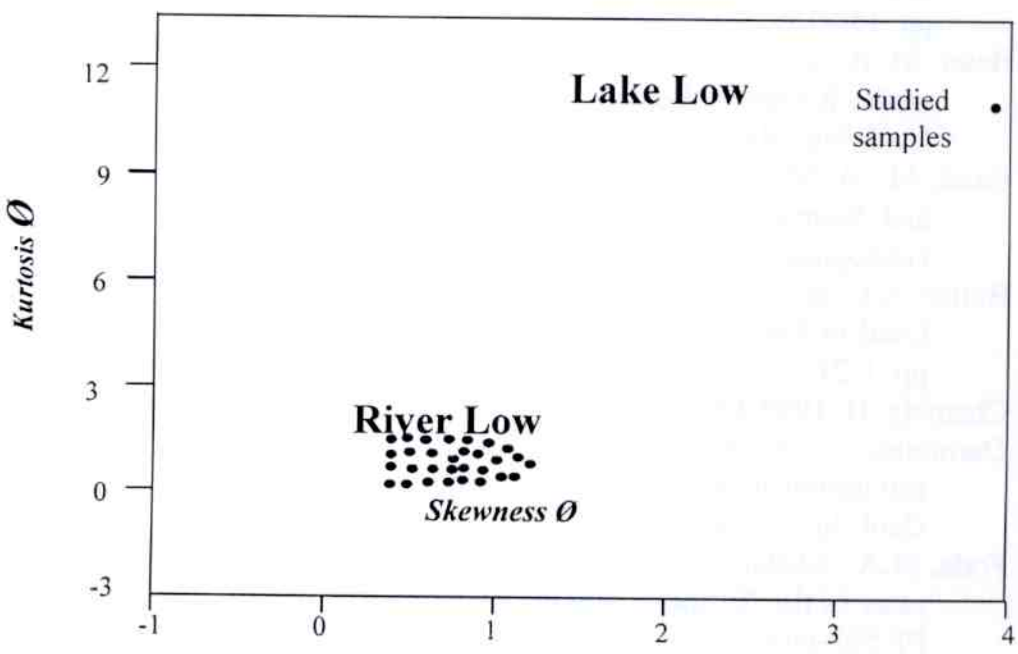


Fig. (9) The projection of Kurtosis versus Skewness (after Sly *et al.*, 1983).

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الملامح الرسوبية والمعدنية لرسوبيات فوق المد لساحل خور عبدا لله، شمال غرب الخليج العربي

عبدالمطلب حسون ألمرسومي   ستار جبار الخفاجي   مهند حامد عبود الجابري

قسم علم الأرض-كلية العلوم-جامعة البصرة

الخلاصة

ثلاثون عينه فتاتيه جمعت من سواحل خور عبدالله شمال غرب الخليج العربي، جففت هذه النماذج ثم فصل الجزء الطيني منها لتحضير نماذج طينية موجه منها وتم فحصها بالاشعه السينية الحائدة. بينت مخططات الأشعة السينية وجود المعادن الطينية الآتية: الكاوؤلينايت و الباليغورسكايت والكلورايت و المونتمورلونايت و المونتمورلونايت-كلورايت و الالايت والمونتمورلونايت- الالايت. التحليل النسيجي اظهر ان الرسوبيات قيد الدراسة ذات طبيعة طينية غرينية و غرينية طينية، التحليل الميكانيكي أوضح أن رسوبيات ساحل خور عبدالله ناعمة إلى ناعمة جدا رديئة الفرز ترسبت في بيئة هادئة ذات طاقة واطئة. أثبت التحليل المعدني للمعادن الثقيلة أن رسوبيات ساحل خور عبدالله اشتقه أساسا من صخور نارية مع مساهمة قليلة للصخور المتحولة والصخور الرسوبية القديمة، هذا التنوع في الصخور المصدرية متوافر في شمال العراق وجنوب شرق تركيا، أي في مناطق حوض نهري دجلة والفرات وروافدهما.