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Environmental Degradation in Albu Tarfa Area Thi-Qar Governorate Southern Iraq

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Abstract

Albu Tarfa area had and still enduring desertification conditions during the last fifty years ago. This area located in the Mesopotamian Zone (Thi-Qar Governorate) and may represent an isolated past marsh in the area.

This area surrounded by a network of river channels and other means of water supply, as result this area is well vegetated. During the past 50 years ago and due to the climatic changes aridity revolved and the area began to loss its water supply, in which sand dunes occupied most of this area. The main types of sand dunes are of the barchans type, occurring within a barchanoid field. The dimensions of these dunes reach as high as 10m, with later extension of about 20m.

The direction of these dunes is North West – South East as related to the major wind direction in the area.

Mineralogy of the dunes consists mainly of Quartz, Carbonate rock fragments, feldspar, in addition to smaller amount of rock fragments (igneous and metamorphic). The main heavy minerals consist of opaques, chlorite, pyroxene, amphibole, zircon, garnet, rutile, and tourmaline.

This area represent religious tourism location which a tracks visitors from inside and outside of Iraq.

Our recommendations to revive this area is to fix the dunes by vegetation such as *Hedysarum Scoparium* and organizing the area by constructing roads and maintaining water and electricity supplying to the area.

Keyword: Desertification, Sand Dunes, CCD, XRD, XRF, Dikaka, Cross Stratifications, Molluscs

1-Introduction

The Iraqi Marshlands were once the largest wetland in southwest Asia, extending across more than 20,000 km2.1 Vast in size and abundance of resources, the Marshlands represented an ecosystem of fundamental importance to natural and human life in the region, providing local communities with an essential source of habitat and livelihood. Host to an extraordinary biodiversity and cultural richness, the Marshlands used to provide a permanent settlement and migratory flyway point for numerous bird species, as well as a central habitat for the Gulf's freshwater fish (UNEP, 2005). Desertification is a term that has been in use since 1949 when Aubreville, a perceptive and well informed botanist and ecologist, published a book on"Climate, Forest,et Desertification de l'Afrique Tropicale" (Aubreville,1949in Dregne,1986). Desertification, defined by the 1994 United Nation (UN) Convention to Combat Desertification (CCD) as the "degradation of land in arid, semi-arid, and dry sub-humid areas caused primarily by human activities and climatic variations," is a global phenomenon. According to the CCD, "over 250 million people are directly affected by desertification. In addition, some one thousand million (or one billion) people in over one hundred countries are at risk.

The Mesopotamian (Mesopotamia means "between the two rivers ") marshlands constitute the largest wetland ecosystem in the Middle East and Western Eurasia, as shown in Fig.(1-1) (UNEP, 2001; Maltby, 1994; Nicholson and Clark, 2002). These wetlands which located at the confluence of Tigris and Euphrates Rivers in southern Iraq was covering (before destruction) an area of some 8,800 square kilometers, extending to some15,000 -20,000 square kilometers when large tracts of dry or desert land were seasonally inundated (UNEP, 2001). This area supported a marsh Arab of 350000-500,000 person as well as numerous endemic species of birds, mammals, amphibians, reptiles, fish and invertebrates (Dehghanpisheh, 2003).

The area is influenced by aeolian activity in which the presence of barchan dunes which occupy an area of 15 square kilometers is very evident and active. Decades ago, the area was well vegetated, and many evidences point to the fact that the area was a low land of 2-5 meters deep with water or more precisely a marsh area, which constitute a part of the vast marshes of southern Iraq. Nowadays, the area is merely a small field of barchans dunes.

2- **Location and Physical Conditions**

The area of study represents a part of Mesopotamian Plane. They located in Thi-Qar Governorate north of Al-Nasiriyah City (Fig. 1).

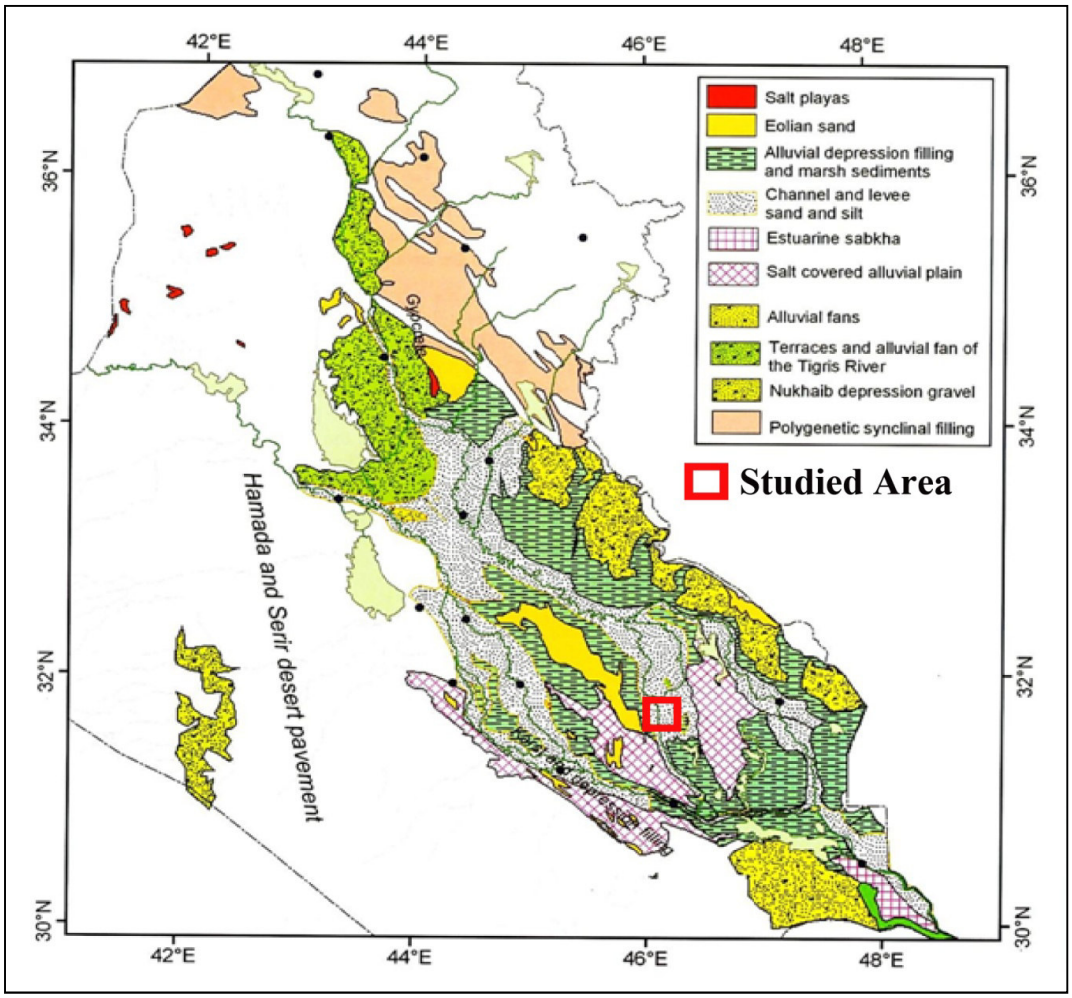

Figure1. Distribution of major Quaternary units and older formations (Aqrawi et. al.; in Jassim and Goff, 2006).

The study area represents a part of Mesopotamian Plane, the Mesopotamian plane mainly composed from quaternary deposits. Quaternary sediments are characterized by their inhomogeneous nature vertically and laterally, especially within the upper parts of these sediments due to the presence of different layers of silt and clay at a depth that may reach to 20 to 25 m (Krasny, 1982 in Jasim and Goff, 2006). One of the important part of the Mesopotamian plane especially in the southern part are the marshland. The studied are represent an small marsh area between the two river Tigris and Euphrates and the area named as *albu-Tarfa area*, and its represent part of Iraqi marshland. These marshes began to decline in the 1950s as dam-building upstream the two Rivers in Turkey, Syria and Iraq attenuated the river flows (the Slow phase) (UNEP, 2001; Peter and Sean, 2001; UNEP ,2003 ; Lowi , 1995 ; George , 1993).By the late 1980s the draining of the marshlands was accelerated by the former regime who built dams and massive canals to drain the swamps, setting fire to the sea of reeds and arresting and killing residents(UNEP,2001;HRW,2004;IMET,2006).

Because of the dramatic changes between 1991-1995 wich including drying the marshland in, the area became under desertification conditions, and represent an arid land, therefore this small marsh trap for the aeolian deposits and the sand dune occupy this small marsh, now the area represent a small field of sand dunes field (Fig. 2,3).

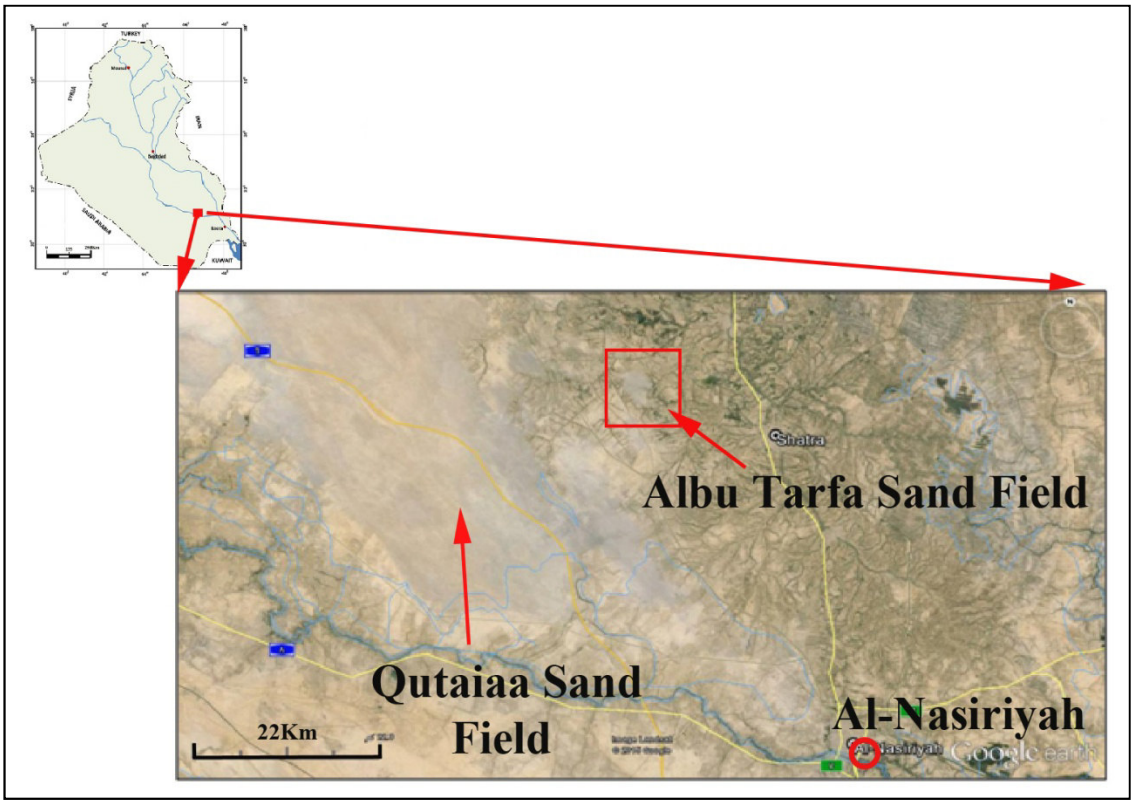

Figure 2: Albu-Tarfa Marsh Occupy by sand dune field.

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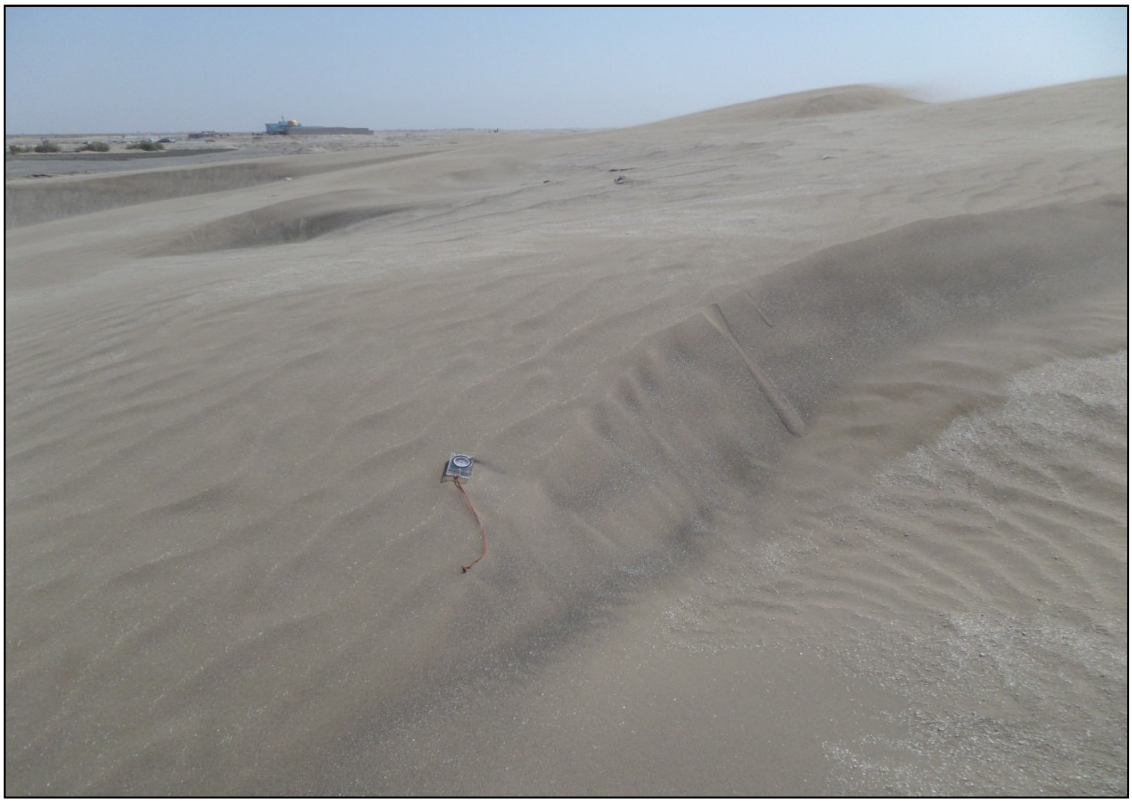

Figure 3: Sand dune field in AlbuTarfa area.

3-Climate

Climate of the area is semi-arid characterized by a very hot, dry, long summer, with average maximum temperatures of 32.3 C and a short, dry, cool winter with average minimum temperatures of 17.8"C, and an average annual temperature of 25.5 C. The annual precipitation is 133.2 mm/yr, mostly occurring from November to March. The prevailing wind is generally dry in a northwesterly direction known as the "shamal" winds, these winds last for about (300 days) of the year then turning to southwesterly and humid for about 50 days. The relative humidity is 28%-32% in summer and 59%-77% in winter (Iraqi Metrological Organization, Al-Nasiriyah Station, 1960 -2015).

4- Methods of Study

6 Samples of dune sands were collected from the studied area, and shell content in the studied area were collect from the floor of the studied area that represent the floor of the dry marsh (Albu Tarfa), and shells contents from the sand dunes. This study is to cover the following aspects:

A- Morphology and distribution of sand dunes that occur in the studied area which the visual size and shape of the sand bodies are investigated, along with the prevailing sedimentary structures. This was done in the field work.

B- Mineralogical composition of sand samples was determined. The whole mineralogy of the samples is determined by X-ray Diffraction using Broker D2 Phaser instrument in the Iraqi German Lab in the Geology Department / University of Baghdad while the very fine and fine sand fractions were separated into light and heavy minerals using the standard bromoform method. The mineral composition of both light and heavy minerals was determined by using the standard counting technique by using the polarizing microscope.

C- Identification and classification of the Molluscs Shells that collected from the floor of the studied area and within the sand dunes.

5- Result and Analysis

5-1 Sand Dunes and sedimentary structures

5-1-1 Morphology of Sand Dunes

The area of study represent a small shallow swamp or small marsh land, and as result this area is well vegetated. During the past 50 years ago and due to the climatic changes aridity revolved and the area began to loss its water supply, in which sand dunes occupied most of this area (Fig, 5).

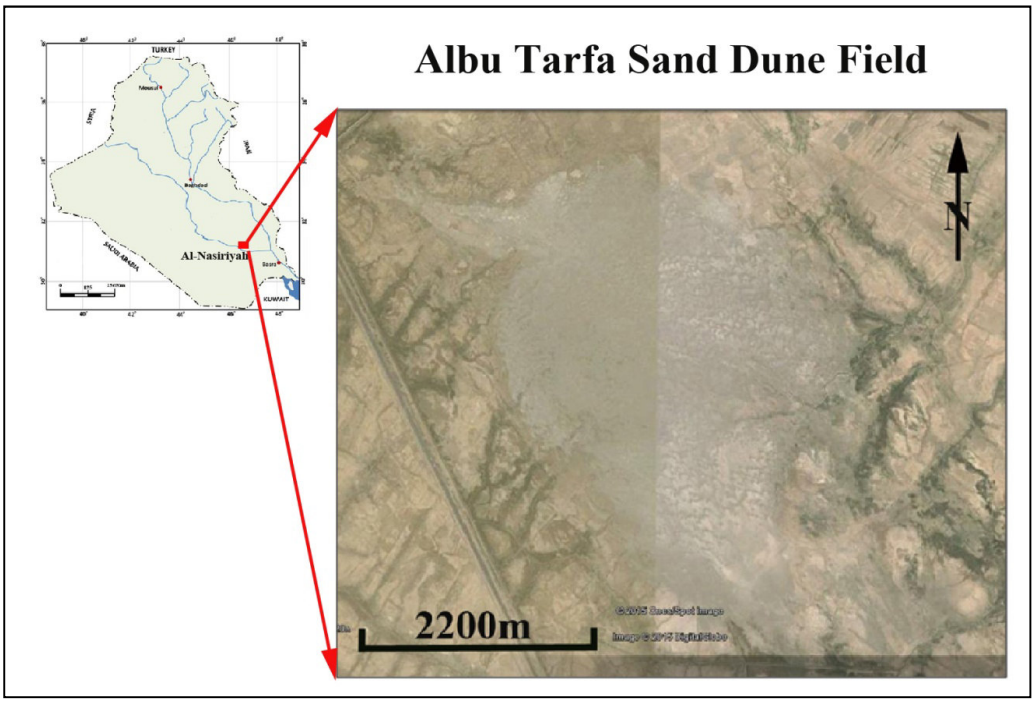

Figure 4. The studied area surrounded by a network of river channels and other means of water supply, and occupy by sand dunes.

It is generally agreed that the primary determinant of dune formed in any given area is the nature of the wind

regime of that area , most dune classification schemes are based primarily on the direction (s) and intensity of the winds carrying the sand, although other factors, such as abundance of sand, presence or absence of vegetation, topography, the nature of surface material and the dominant grain size of the sand are also contributing factors and most be taken into consideration (Borsy, 1976; Fryberger and Ahlbramdt, 1979).

Barchan dunes are crescent shaped sand mounds which occur as isolated bodies, which is formed by a unidirectional wind. The barchan dune migrates by avalanching of sand on the slip face. The extremities (horn) of a barchan dunes extend forward downwind because the horns migrate more rapidly than the main body (Mckee, 1966).

The main type of sand dunes in the studied area are brachan types (Fig. 5). The sand dunes in the studied area from barchans type, and represent a good example of this event, the average highest of these barchans about 7m, and the laterally width of the horns about 15m (Fig. 3).

The brachan dunes in the studied area because of the high speed and in some time reverse the direction of the wind especially in the summer the barchans became as barchanoid belt (Fig. 6).

Figure 5. Barchan dunes in the studied area.

The direction of these barchans dunes is northwest- southeast; this direction is similar of the wind direction of this area (Iraqi Metrological Organization, Al-Nasiriyah Station, 2015).

Barchanoid ridges dunes form in the same wind regime as barchans dunes in regions where more sands are available and winds are variable (Wasson and Hyde, 1983). As more sand becomes available, barchans merge into wave-like shapes to produce barchanoid ridge (Cooke et,. al, 1993) or transform into transverse dunes in regions where greater sand supply is available (Araya –Vergara, 1987). The barchanoid ridge were observed in the studied area (Fig. 6).

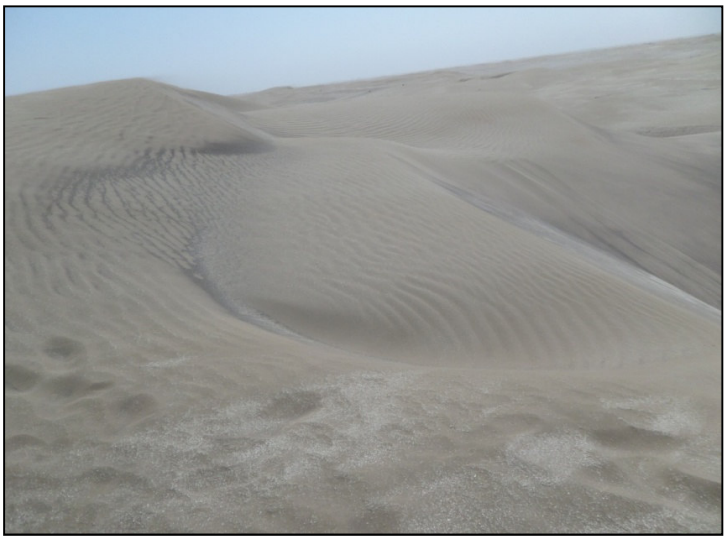

Figure 6. Barchanoid ridge in the studied area.

5-1-2 Sedimentary Structures

Sedimentary structures are an important attribute of sedimentary rocks. They occur on the upper and lower surface of beds as well as within beds. They can be used to deduce the processes and conditions of deposition, (Tucker, 1998).

Many types of sedimentary structures was recognized some of these due to the marshland activation and other due to the sand dunes activation, the sedimentary structures that recognized in the studied area are:

A- **Cross stratification:**

Cross stratification is very important and helps to determine the trends of sand transportation and dune types (Mckee, 1966). Cross stratification units of sand dunes are made up of avalanche laminae of the slip face. Forest lamenae are steeply inclined, and the angle of slope usually varies between 25 to 34. Near the base of the slip face , forest laminae tend flatten out and resemble in nature, a horizontal laminae (Inman, et,a,1966; Sharp, 1966). Cross stratification was observed in the studied area (Fig. 7)

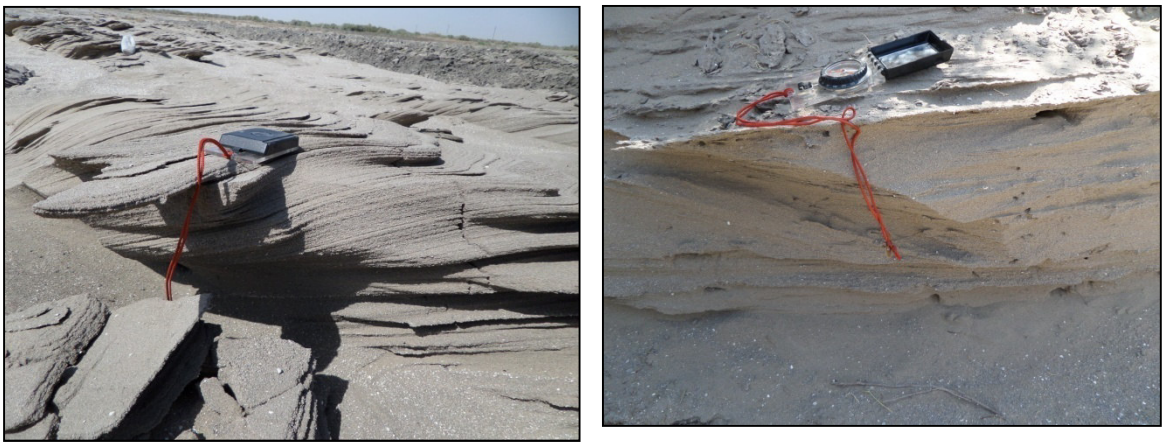

Figure 7. Cross stratification in the studied area.

B- Ripple Marks.

Ripples are wave like bedform that occurs in fine sand subjected to gentle traction currents (Selly, 2000).Ripples, dunes and sand waves are bed-forms developed chiefly in sand size sediments; ripples are very common and occur on bedding surfaces (Tucker, 1998). Ripple mark are symmetrical or slightly asymmetrical undulations produced by the action of waves on a noncohesive surface (Reineck and Singh, 1980)

Ripple marks cover most dry, bare, sandy surface in deserts. They are absent only under certain conditions: where the sand is very coarse, where the drag velocity is high, where sand is dropped into hollows because of low wind velocities, and in active dune slipfaces. Most ripples are sinuous, with wavelength ranging from centimeters to ten of meters; ripple of fine sand are less curved than those formed from coarse sand. Stronger winds also result in greater sinuosity. Most ripples develop quickly (from minutes to hours) and travel rapidly (around 5m/day in moderate breezes), they also tend to be short –lived (Cooke,et al., 1993).

Ripple marks are common in the studied area, they cover most surfaces of the dunes with asymmetrical shape , they are found in the windward side of the dunes (Fig. 8).

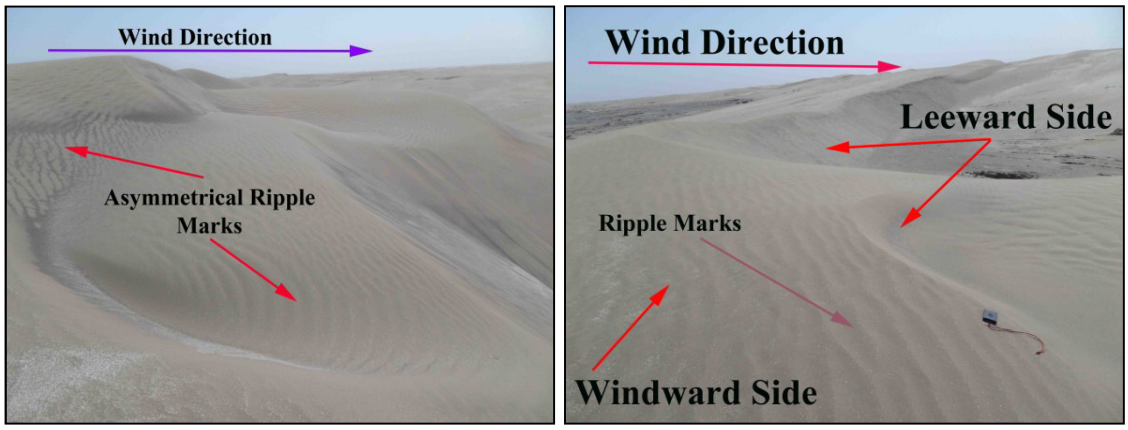

Figure 8. Ripple marks in the study area.

C- Organic Sedimentary Structures:

Tracks, trails, burrows and other structures made by organisms on bedding surfaces or within beds are known collectively as trace fossils or **Ichnofossils**, although geologists have long been aware of the pleasance of burrows, trails and other biogenic structure in sedimentary rocks (Boggs, 2001).Trace fossils (Ichnofossils) are often abundant where true fossils are scare or missing, these provide clues to depositional environment as well as to sedimentation rate these processes (Crimes and Harper, 1970; and Frey, 1975). Burrows varying from simple vertical tubes to U-shaped burrows, oriented vertical, sub vertical or horizontal to the bedding (Tucker, 1998).

Boring are another type of trace fossil, they are distinguished from burrows by being made into hard substrata, such as a hard ground surface (Tucker, 1985).Borings was observed in study area in some location, the diameter of boring ranging between (0.4 - 2 cm), these borings refers to the organisms activity of the old dried marsh in the stdy area (Fig. 9).

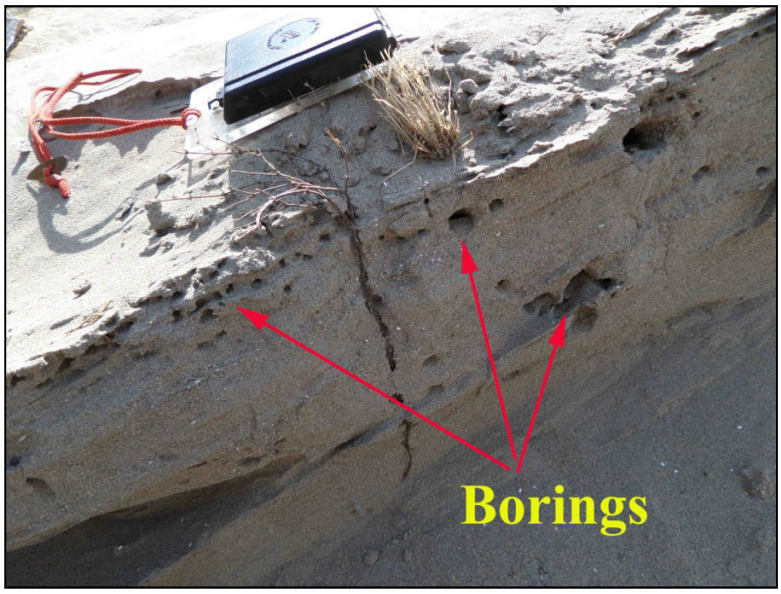

Figure 9. Borings of organisms in the studied area.

D- Dikaka Structure.

The Arabic word "dikaka", meaning scrub-covered dune sand, has been chosen to designate the latter type of plant structure. Such structures are common only in Tertiary and younger dune sands and represent desert environments having at least a sporadic supply of water. Plant-root structures, which are normally associated with low-lying swamp like environments, have locally been found in the dune sands of arid deserts (Glennie and. Evamy, 1967). Dikaka structure were observed in the studied area in many location (Fig. 10).

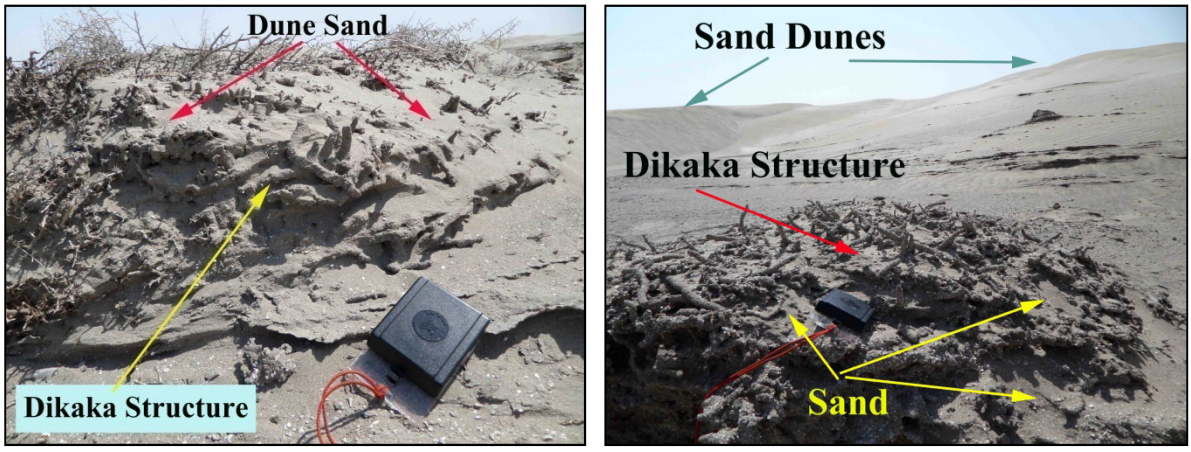

Figure 10. Dikaka structures in the studied area.

6- Mineralogy

Mineralogy of the sediments offers reliable inputs on the provenance and subsequent history. Heavy Minerals though present in small quantity are resistant to weathering and abrasion and therefore represent the parent lithology even after many cycles of erosion and deposition. Lighter minerals have this potential to a limited extent. Quartz being the most important (Saini, 2003).

The 2-4 phi fraction of the 15 samples are treated with 10% HCL, washed and dried, then 5 grams of each sample was gravity settled in bromoform. Light and heavy fractions were separated. The heavy minerals were weighed to obtain the weight percent. Both fractions were mounted on petrographic slides and were examined and counted using the petrographic microscope.

6-1 Light Minerals

The light mineral fraction of Albu Tarfa dunes samples comprise more than (98%) of the total mineralogy, with an average of 61.81 % quartz (including chert fragments), 4.90% feldspar, 26.43% carbonates, 2.50% igneous, and metamorphic rock fragments, 1.23% evaporites, and 1.60% clay coated grains (Table.1).

Table 1: Percentages and average of the light fraction in the studied samples.

Light Components								Average
Components		Samples Number						
		NN1	NN2	NN3	NN4	NN5	NN6	
Quartz	Monocrystalline Quartz	43.4	47.4	48.7	47.6	44.8	48.8	46.78
	Polycrystalline Quartz	2.9	2.8	2.7	1.2	2.3	2.6	2.48
Feldspar	Orthoclase	1.8	2.5	1.5	2.2	1.5	1.6	1.85
	Microcline	0.6	0.8	1.2	1.6	1.9	1.2	1.27
	Plagioclase	2.9	1.5	1.7	1.8	1.3	1.5	1.78
Rock Fragments	Evaporites	0.7	1.6	1.5	0.5	1.7	1.4	1.23
	Carbonate Rock Fragments	27.7	25.0	26.6	25.7	28.4	25.2	26.43
	Chert Rock Fragments	14.5	12.6	10.5	13.5	12.9	11.3	12.55
	Igneous Rock Fragments	1.9	0.7	1.3	1.3	1.2	1.5	1.37
	Metamorphic Rock Fragments	0.4	0.8	1.4	1.1	1.4	1.7	1.13
	Coated Grain by Clay	1.8	1.6	1.5	2.0	1.4	1.3	1.60
	Others	1.4	1.7	1.4	1.5	1.3	1.9	1.53

These mineral types and their relative abundances agree well with data gathered from the XRD analysis of the total samples (Fig.11).

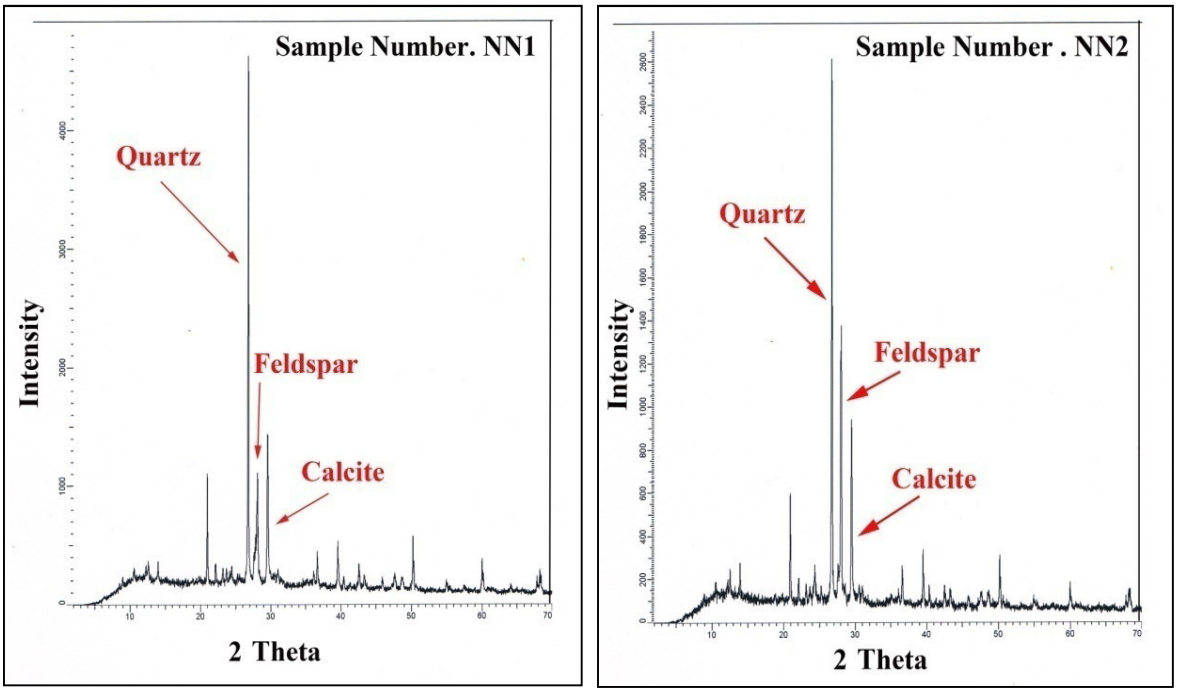

Figure 11. X-Ray Diffractograms of two Sample (NN1, NN2) representative samples.

The majority of the quartz grains are monocrystalline , with dominant straight extinction and no inclusions. Subordinate amounts of polycrystalline and chert fragments making the silica content more than 62% of the light fraction. Feldspars content more than 4.9 % of the light fraction and include sodic-plagioclase, microcline and orthoclase, many of these grains show different degrees of alteration. Carbonates make up between 25 - 28%, and constitute mainly of calcite occurring as rock fragments of the older formations that show their distinct micritic and recrystallized components, and to a lesser extent as clear crystals or biogenic shell fragments. Evaporates range in abundance between 0.5 – 1.7% of the light fraction, they mainly composed of gypsum. The clay coated grains could be either intensely altered feldspar grains or clay mineral coatings that are very fragile and are easily abraded away during eolian transport which will result in decreasing the mean particle size of the sand grains. These minerals are shown in (Fig. 12).

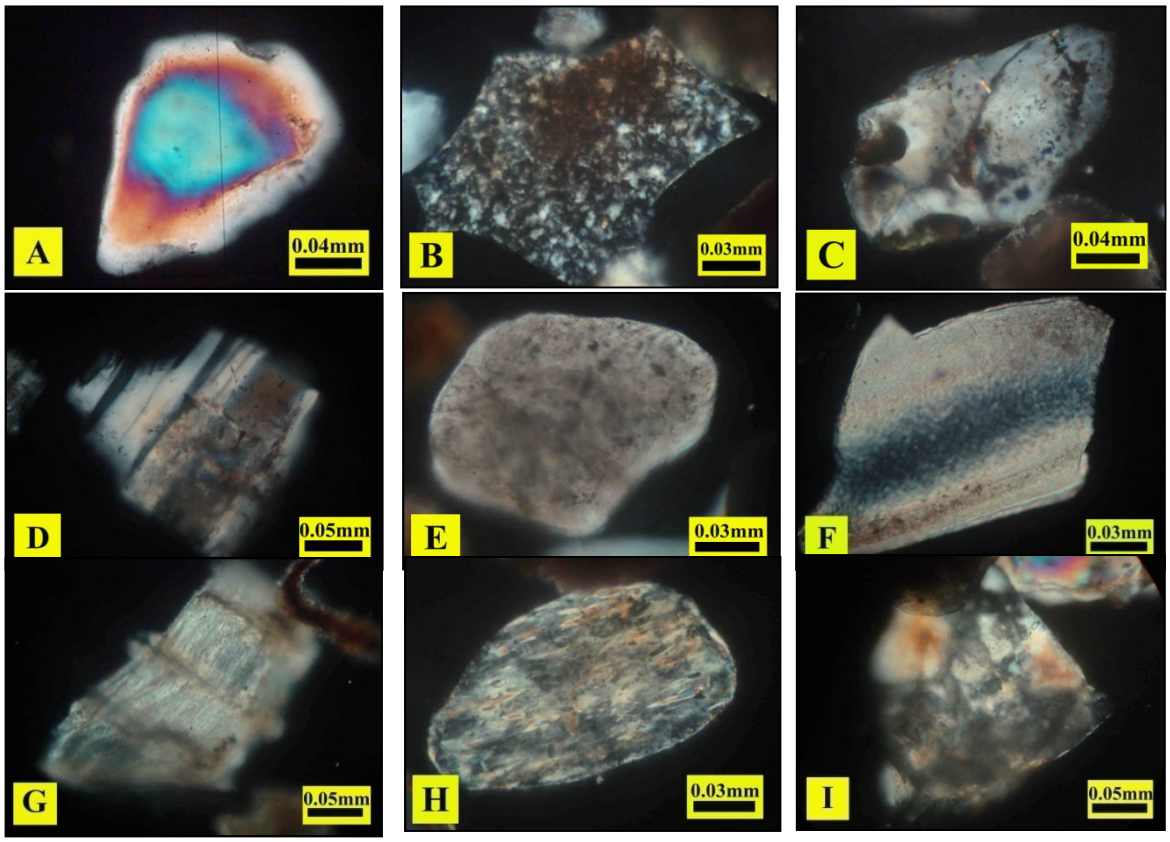

Figure 12. Images of the light minerals the in studied samples. where by A; Monocrystalline quartz, B: Chert rock fragment, C: Orthoclase feldspar, D: Plagioclase feldspar, E: Carbonate rock fragment, F: Aragonite shel fragment, G: Shel fragment, H: Metamorphic rock fragment, I: Igneous rock fragment.

6-2 Heavy Minerals

The heavy mineral residue of the studied samples is composed of opaque minerals as a main component 42.08% and non-opaque minerals.The non-opaque mineral assemblage is mainly composed of chlorite 7.58%, mica (muscovite and biotite) 10.60%, epidote 4.77 %, garnet 3.65%, pyroxenes 7.75%, amphiboles 6.08%, zircon 6.60%, tourmaline 4.07%, and rutile 1.52%, staurolite 1.47, kyanite 1.38 arranged in a decreasing order of their average content (Table. 2). The minerals grains vary in shape from prismatic to spherical and are mainly subrounded to rounded (Fig. 13).

Table 2- Percentages and average content of the heavy minerals in the studied samples.

Heavy Minerals	Heavy Minerals						Average
Heavy Minerals	Samples Number						
	NN1	NN2	NN3	NN4	NN5	NN6	
Opaques (Iron Oxides)	42.6	39.8	40.5	42.3	44.4	42.9	42.08
Chlorite	7.4	8.6	6.8	7.6	6.9	8.2	7.58
Zircon	7.7	5.4	7.6	6.8	6.3	5.8	6.60
Garnet	3.7	3.9	4.1	3.8	3.3	3.1	3.65
Epidote	4.2	5.5	4.4	5.4	4.8	4.3	4.77
Pyroxene	8.2	7.3	8.5	7.5	7.2	7.8	7.75
Amphibole	5.6	6.3	6.8	4.2	7.0	6.6	6.08
Biotite	4.7	5.9	4.7	5.3	5.2	6.5	5.38
Muscovite	5.1	5.8	6.5	4.5	4.9	4.5	5.22
Tourmaline	4.6	4.6	3.4	4.2	3.7	3.9	4.07
Rutile	1.7	1.7	1.4	1.4	1.5	1.4	1.52
Staurolite	0.9	1.2	2.0	2.8	1.1	0.8	1.47
Kyanite	0.9	1.2	1.6	1.8	1.0	1.8	1.38
Others	2.7	2.8	1.7	2.4	2.7	2.4	2.45

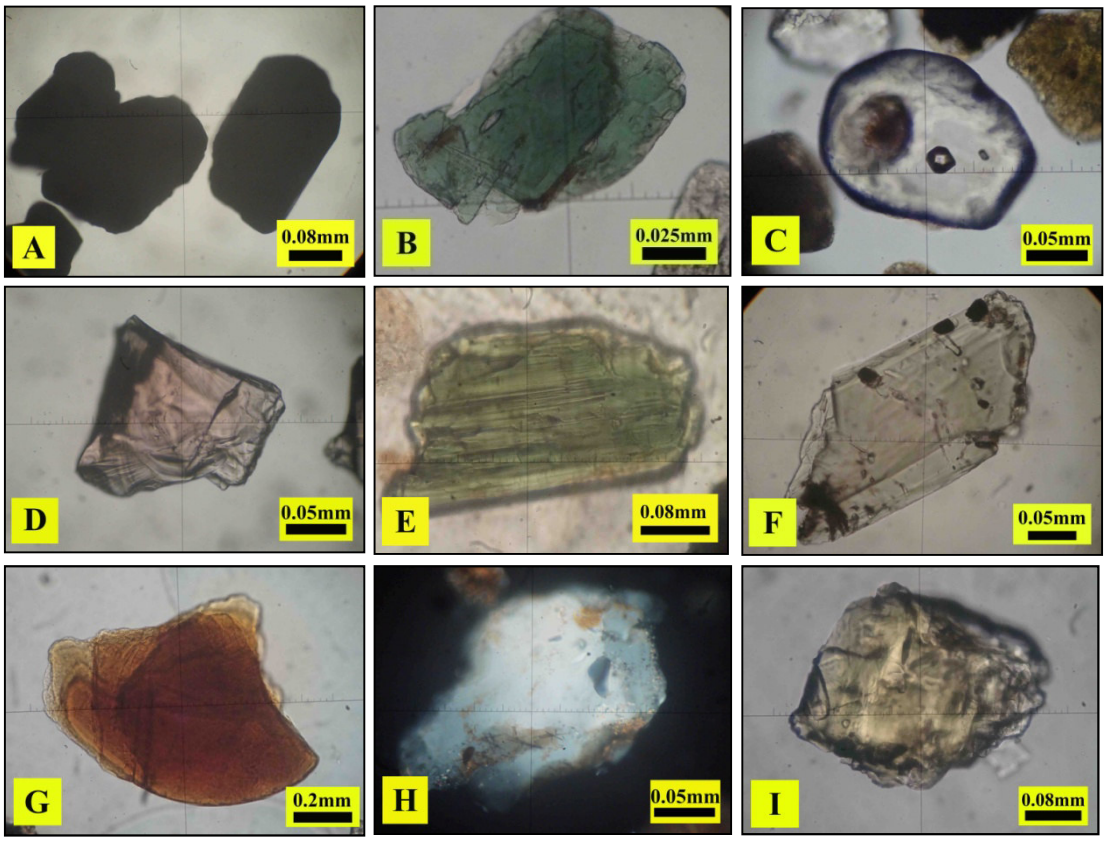

Figure 13: Images of heavy mineral in the studied samples of the studied area where by A:Opaques, B: Chlorite, C: Zircon, D: Garnet, E: Pyroxene, F: Amphibole, G: Biotite, H: Muscovite, I Epidote..

6-3 Source of Sediments

Albu-Tarfa dune sands represent residues produces by the destruction of pre-existing the basement of old marsh and and rocks in which they are dispersed by wind until they came to reset as sediments. The wind direction in the studied area which is mostly northwest to southeast (Iraqi Metrological Organization, Al-Nasiriyah Station, 2015). The main source of the sediment in the studied area came from the Mesopotamian plane which represent the basin of Tigris and Euphrates rivers and the basement of the ancient marsh in the

studied area.

7- Shells Remains

One of the conspicuous features observed in the area of study is the sporadic white patches of Molluscs shells occurring in different shapes and sizes.

Two main locations were observed, one include the basement of the old dried marsh area in which the shells are intact and preserved, while the lee-side of the sand dunes represent the other location, and in which the shells are mostly oblirated and broken and concentrate along wind direction as indicated by ripply accumulation in connection with the ripple marks orientation (Fig. 14).

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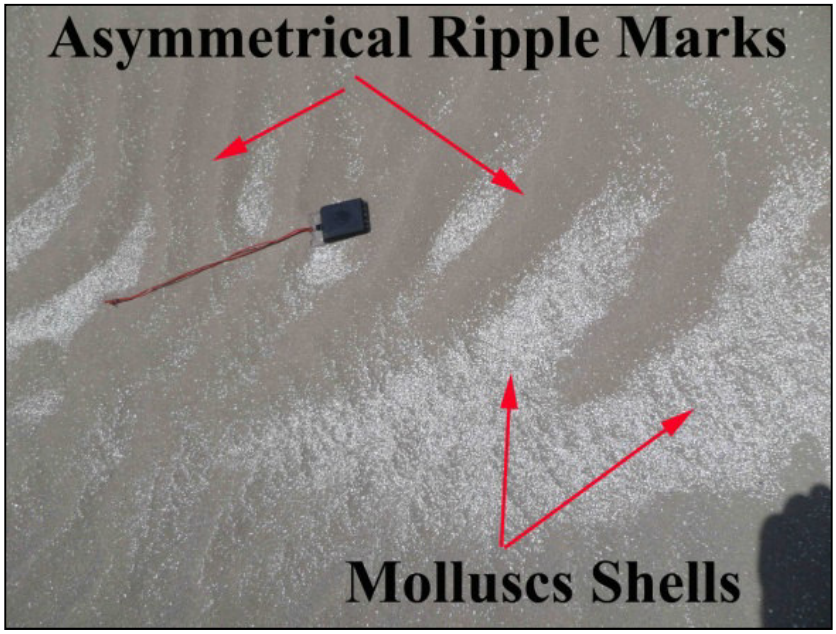

Figure14. Accumulation of shells in connection with the ripple marks.

Many samples were collected from the above two locations, these were separated by sieving first and then using a binocular microscope were classified and identified.

Molluscs represent the second among the animal kingdom in distribution and diversity. Their ages extend from Cambrian to Recent. They are divided into Pelecypods, Cephalopods, and Gastropods (Seddon, 2007).

Most molluscs are usually characteristic by a soft body and an outer hard shell. These shells represent the basic tools in identification and interpretation of the various classes and providing valuable environmental information about the nature of growth and habit (Dauphin, et al., 2003).

7-1 Types of Molluscs

Two of the three classes of molluscs were identified, namely Gastropods and Pelecypods.

7-1-1Gastropoda Class

Many types of this class were identified in the studied area, the predominance existence and diversification nature indicate a direct proof of the past ecology of the area which is mostly a swampy environment (Mauthan, 1999, in Seddon, 2007).

Three types of gastropods were identified and recognized these are"

A- *Lumnaea (Padix)gr.Guricularia*

This type was found both in the dune and basement areas. It show different sizes ranging from macroscopic to macroscopic dimensions such shells usually dwell in coastel area and deltas (Plaziat and Younis, 2005) (Fig.15. A, B, C)

B- Gyraulus intemixtus

This is a fresh water gastropoda, and was found in both the basement and dunes of the studied area this type usually dwell in fresh water environment (Black, 1973), (Fig 15, D, E).

C- Melanoides tuberculata

The shells of these molluscs were found mostly within the basement, due to a laser extant in the dunes,

they occur in sizes up to 6cm. the ecology of these molluscs is a characteristic of fresh to low-salinity water (Black, 1973), and their light weight shells are easily floated and thus accumulated and transported along the beaches of lakes, rivers, and swamps (Plaziat and Younis, 2005), (Fig 15, F).

7-1-2 Pelecypoda Class

These molluscs have the ability to accumulate their wide range of environments, their special shapes guids to especial living conditions.

One major type namely *Uniotigridis bourguinat* was found to occur in the sediments of the basement and within the sand dunes.

The characteristic features of these pelecypods is the elongated hard shell that usually drills obliquely within the soft sediments, its length ranges between 1-7cm (Black, 1973., and Plaziat and Younis, 2005), (Fig 15, H, I).

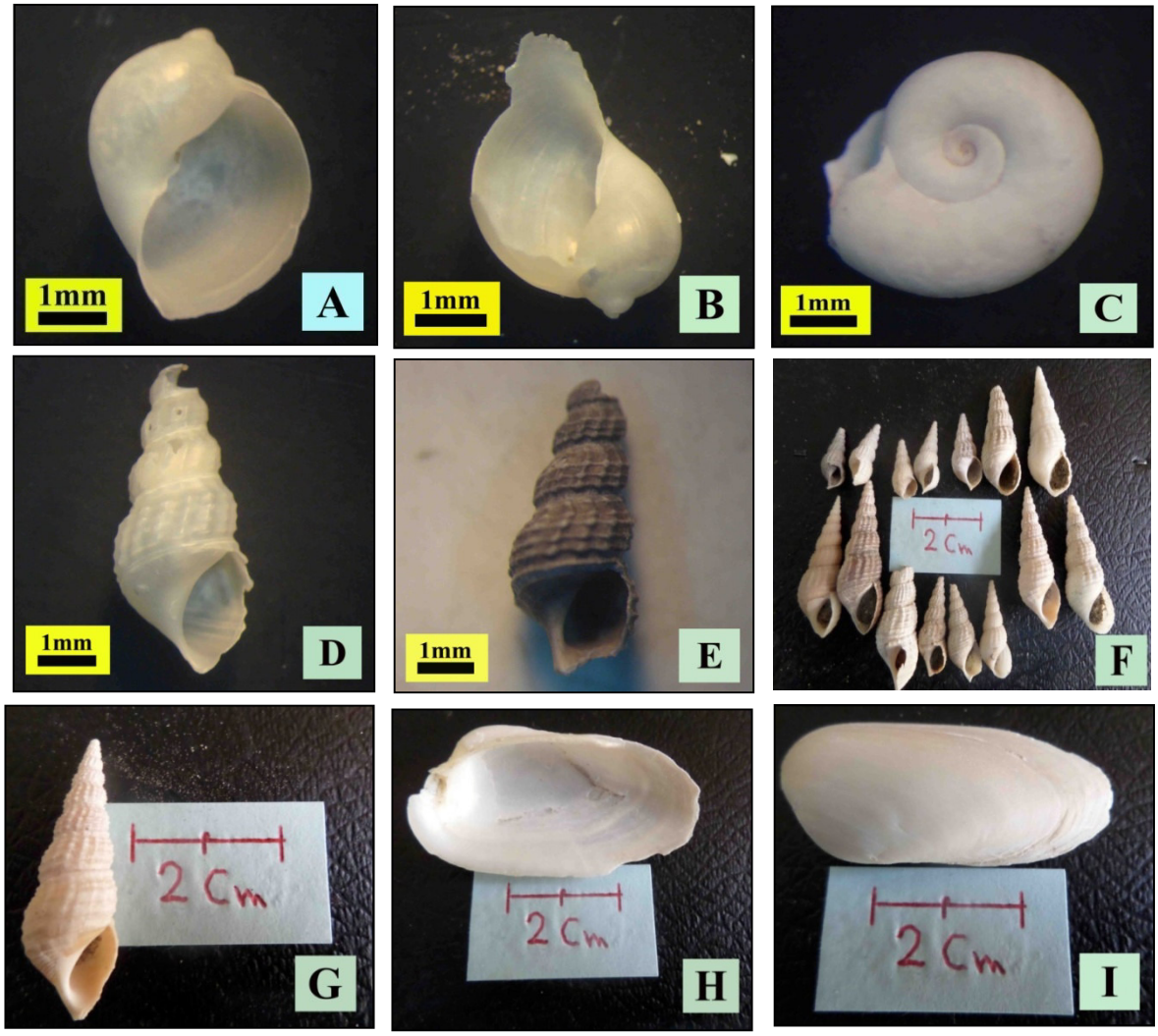

Figure 15: Images of shell remains that observed in the studied area.

7-2 Mineralogy of molluscs shells

Chemically the shells of molluscs composed from calcium carbonate, mineralogically, however three main minerals may be present, namely low-mg calcite, calcite, aragonite minerals (Milliman, 1974), depending on the prevailing chemistry of both water and sediments of their habitat.

The different types of shells of both the pelecypods and gastropods were examined by XRD method, the result indicates that these molluscs are composed solely of aragonite (Fig. 16). This indicate that the environment which is mostly a low salinity to fresh water. The ages of these shells are recent, as the less stable aragonite mineral transforms to the more stable mineral calcite (Jackson et.,al,2007)..

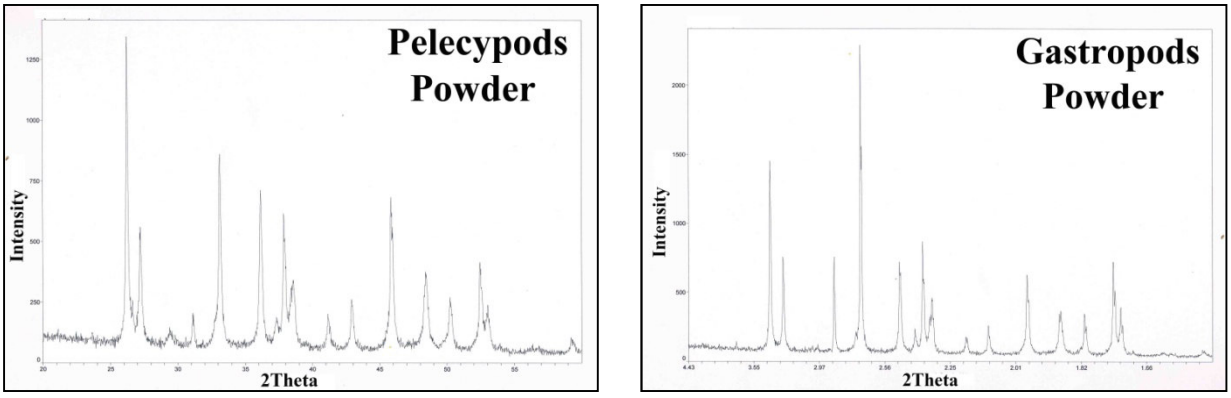

Figure 16: XRD scan of gastropods and pelecypods shells.

8- Conclusion

This study shows a clear indication of how an area of various affinities such as alluvial depression filling, marsh, channel, and levee sediments are transformed into large dune fields due to the degrading water supply for the area. The former marsh Albu Tarfa is now a small barchans field which will increase the dunes area. Appropriate measures should be commenced to preserve the area from further deterioration.

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