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Morphology of Khawr Al-Batah, Sur: Sultanate of Oman

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Khawr, which is an Arabic term, is used to describe all types of coastal inlets such as lagoons, tidal inlets and embayments. Such khawrs are common along the Omani coastline. Khawr Al-Batah, which is located in Sur, is an embayment of a tidal inlet type. It served as a natural harbor for the traditional trade vessels (dhows) in the past, and for fishing boats in the present. The objective of this paper is to study the morphological features and coastal deposition problem in Khawr Al-Batah. In order to achieve this objective, the researcher analyzed panchromatic aerial photographs at a scale of 1:20,000 (1991), 1:25,000 (1979), the geological map of Sur Area scale 1:100,000, and the topographic maps of Sur, along with field observations, measurements and sediment analysis.

The study revealed that the Khawr under investigation is of a tectonic origin and was initiated during the middle part of the Tertiary. However, recent processes formed the present shape of the Khawr, and the processes of deposition have developed its morphological features by wadis and tidal currents in recent time. The main sources of sediment are the offshore marine sediment characterized by high percentage of shell fragment and terrestrial sediment transported by wadis which is characterized by fine to very fine sand. Due to the continuous deposition, a large area of the Khawr basin became very shallow and the Khawr, then, lost its traditional prosperity.

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1. Introduction:

Khawr, which is an Arabic term, is used to describe all types of coastal inlets such as lagoons, tidal inlets and embayments. Khawrs are common along the Omani coastline and some of them played an important economic role in Oman's maritime history. Khawr Al-Batah is a tidal inlet located in Sur. It served as a natural harbor for the traditional trade vessels (dhows) in the past, and for fishing boats in the present. The area surrounding the Khawr is going through processes of modernization and urban developments. Besides being a sheltered bay, the Khawr accommodates various types of birds, fish and other marine life. Mangrove trees in the mud-flats cover small areas where Wadi Shama and Wadi Sukaykirah enter the Khawr. Furthermore, there are coastal landforms related to the processes of deposition by wadis and tidal currents, which include: an offshore sand bar, inner sand bars, wadi delta, mud-flats and sabkhas.

Previous studies relevant to the Khawrs morphology include: Sayed Al-Hussaini (1988) on the Geomorphology of Al-Khairan Area in south Kuwait, Nabil Embabi (1982) who produced a morphological map for Khawr Al-Odaid in Qatar, and (Embaby, 1984) who studied the tidal channels and sea water intrusions in the coast of Qatar. However, on the morphology and processes at work on the Khawr Al-Batah and the surrounding area, previous studies are almost absent. There is, however, an engineering report by Sir Alexander Gibb and Partners (1993) prepared for the Ministry of Agriculture and Fisheries to design a fishery harbor at Sur. Although the physical setting of the Khawr under investigation is different from that of Khawr Al-Odaid in Qatar and Al-Khairan Area in south Kuwait, this study has benefited from them, particularly in the technique used as well as in producing the morphological map. Furthermore, this study, has adapted Embaby's (1982) approach to some extent, where the division of the Khawr body into three morphological units with distinctive micro-landforms.

2. Objectives and methodology

This research investigates the morphological features and coastal deposition problem in Khawr Al-Batah using panchromatic aerial photographs at a scale of 1:20,000 (1991), 1:25,000 (1979), from which a morphological map of the Khawr will be produced. The geological map of Sur Area scale 1:100,000 will assist in producing the geological map of the area surrounding the Khawr. Topographic maps of Sur scale 1:10,000, and 1:100,000, along with field observation and measurement, will help in

identifying features in the Khawr area. Bathometric charts will be used to identify different depths in the Khawr.

Sediment samples were collected from six locations representing different parts of the Khawr area, to be mechanically analyzed in order to help in understanding the processes involved in the development of the coastal features in the Khawr. The sites of samples are selected to reflect main morphological features in the Khawr.

3. Physical setting

3.1: Location:

The Khawr under investigation is located in the coastal city of Sur, some 200 kilometers southeast of Muscat (Figure 1). It extends between 59 15 and 59 50 east longitude and between 22 25 and 22 50 north latitude. The Khawr extends in an east to west direction and covers an area of approximately 5 square kilometers, hence large enough to form a sheltered bay suitable for fishing boats to use as a natural harbor and refuge from storms (Plate 1).

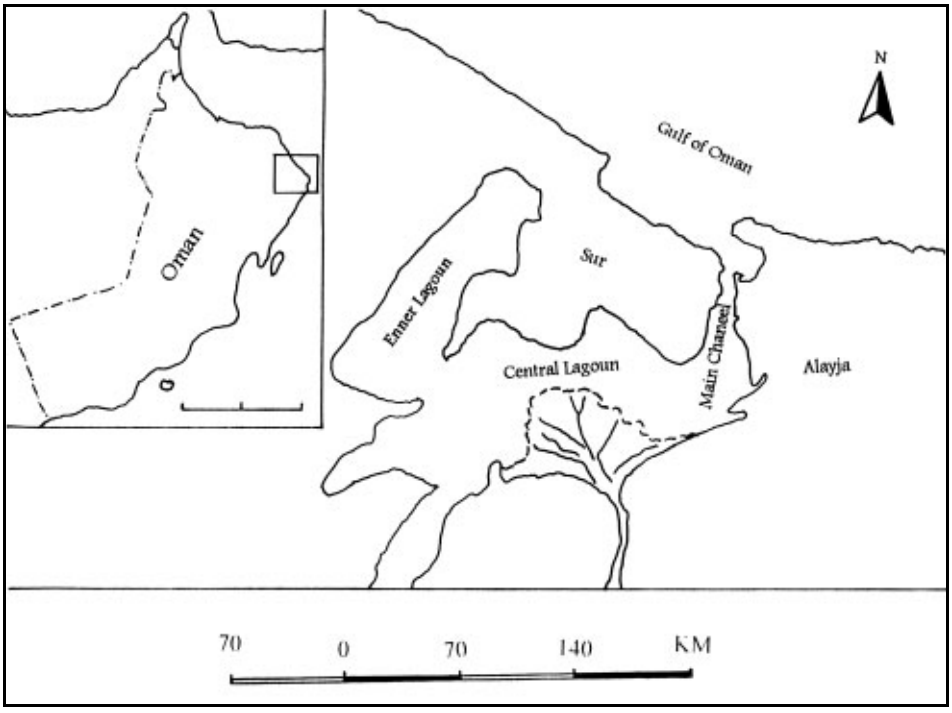

Figure 1: Location map of Sur and Khawr Al-Batah

Plate 1: In the present, Khawr Al-Batah serves as a natural harbor for fishing boats.

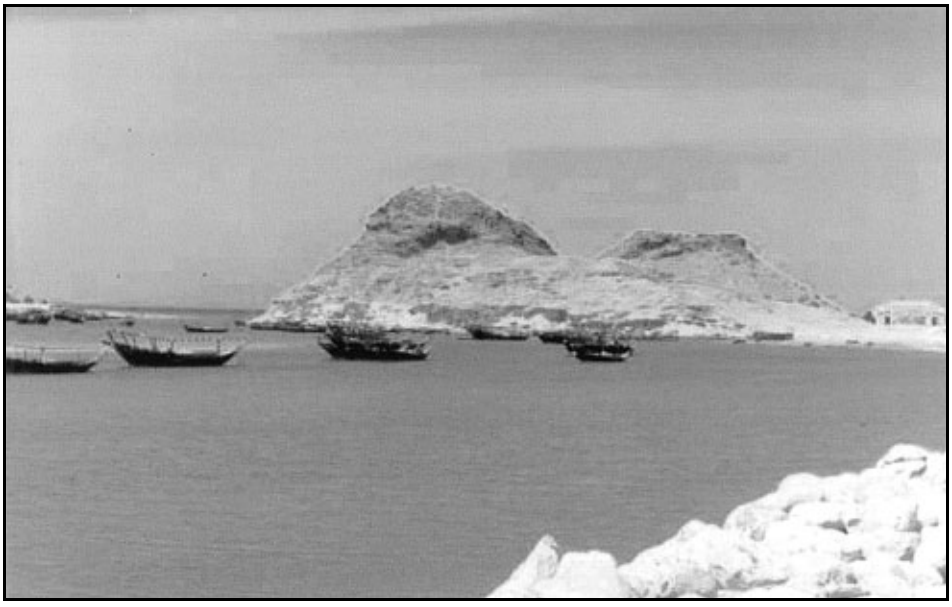

Plate 2: Sand bars stretching across the inner mouth of the channel

The Khawr, however, is shallow where its maximum depth of water at high spring tide in the main channel is approximately 2-3 metres above Chart Datum (lowest astronomical tide). Furthermore, the Khawr is semi-closed where it is connected with the Gulf of Oman by a narrow channel. Geomorphologically, the Khawr can be divided into three main parts: the main channel, the central lagoon and the inner lagoon in the west.

3.2: Geology:

The geological map of Sur area (Figure 2) shows that Khawr Al-Batah area is lithologically composed of Tertiary limestone mainly bioclastic sandy

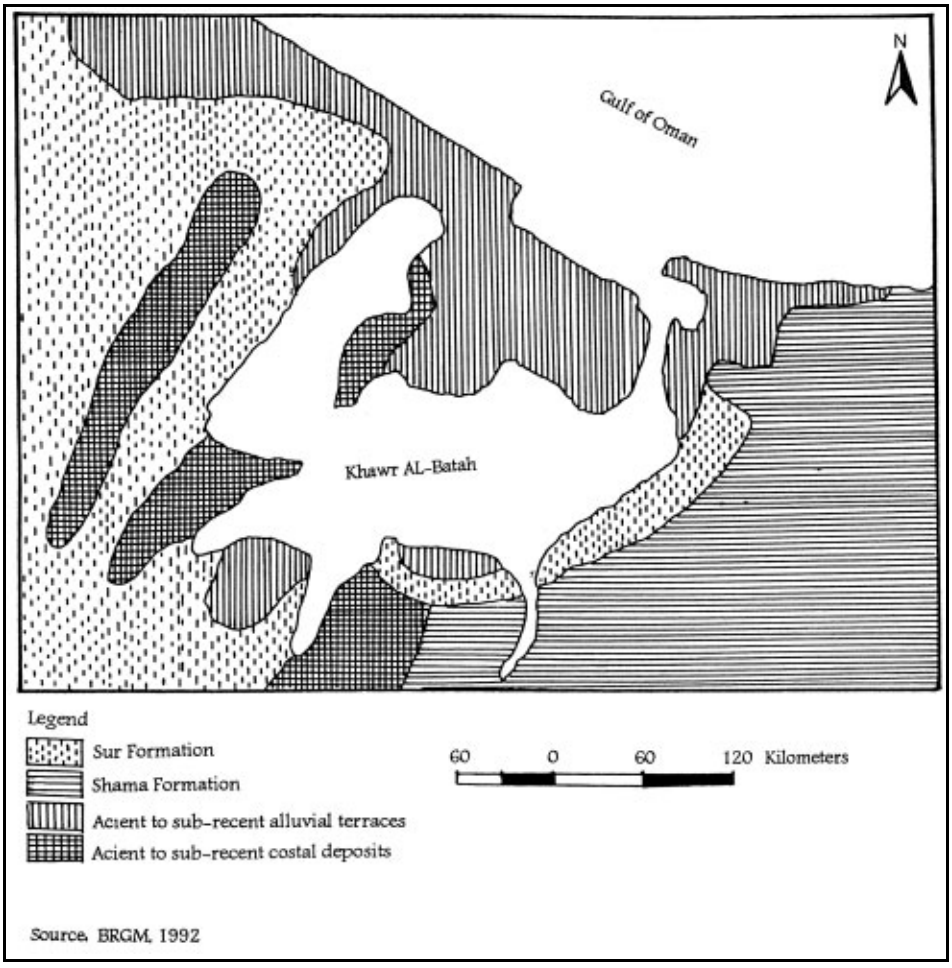

Figure 2: Geology of Khawr Al-Batah

limestone. In the east, there is Dhofar Group (Shama Formation) of late Eocene-Oligocene, and in the west Fars Group (Sur Formation) of Middle Miocene. The Khawr basin is situated in the contact area of these two groups; hence the Khawr might be lithologically controlled. It might be initiated during the middle part of the Tertiary (Miocene) which witnessed the deformation and uplift of the Oman Mountains and resulted in the present configuration of the existing structure of Oman. Therefore, the formation of the Khawr is related to geological factors.

Late Tertiary and Quaternary deposits overlie the Tertiary formations. They are mainly composed of ancient and sub-recent alluvial (gravel) terraces and ancient to sub-recent coastal deposits. The Khawr was flooded by water during the marine transgression that took place in the Holocene, when global sea level transgressed gradually to more or less its current level. Therefore, although the Khawr is believed to be of a tectonic origin, its present morphology is formed by the continuous change of global sea level during the Quaternary as well as the terrestrial sediment transported by wadis. The morphological features in the lagoon, thus, are depositional and have been developed by the processes of deposition by wadis and tidal currents in recent and sub recent times.

Topographically, the Khawr is surrounded by low hills from the east, west and south. Wadi Shama and Wadi Sukaykirah dissect the southern hills to drain in the southern side of the Khawr, hence an important source of terrestrial sediment. Wadi Fulayj, which drains in the Gulf of Oman about 5 kilometers to the northwest of the Khawr Al-Batah, might be another source of terrestrial deposit in Sur beach and in the Khawr as well.

3.3: Oceanography:

The climate of the coastal area of Oman is mainly dominated by two systems of winds; the southwesterly winds during the summer monsoon (June - September) and northeasterly winds during the winter monsoon (November - February). Winds generate waves and currents that in turn transport shoreline sediments.

3.3.1: Waves: waves and longshore currents are the primary driving force for sediment transport processes along the coastline of Oman. The prevailing wave conditions along the coast of Oman are closely linked to the monsoon seasons and their intensity. Wave conditions can be severe during the southwest monsoon along the Arabian Sea coast of Oman, while wave condition is less severe in the Gulf of Oman with wave heights of about one

meter in the vicinity of the Khawr under investigation. During winter months, waves are generated by the northeasterly winds. Wave heights in the Gulf of Oman and along the vicinity of the Khawr slightly exceed one meter (James Dobbin Inc. 1992)

3.3.2: Wave generated currents: Longshore currents and rip currents, which are wave generated currents, are the most important process responsible for longshore transport of sediment. In the Gulf of Oman, sediment transport direction is generally to the northwest. However, Sur area is believed to be a site of complex patterns of sediment transport, which are influenced to some extent by tidal currents.

3.3.3 Tidal currents: Along the coasts of Oman, the tide is semi-diurnal (high and low water occur twice a day). The Gulf of Oman has a typical tidal range of 1.7 to 2 meters (James Dobbin Inc. 1992). The tidal currents are the most important geomorphological agent in modifying sediment transport near tidal inlets and lagoons, hence, the Khawr under investigation.

Previous reports on tidal currents in the vicinity of the Khawr reveal normal tidal currents flowing in opposite directions parallel to the coast with speeds of 0.2 meters per second and up to 0.28 meters per second. The flood tide flowing from southeast to northwest parallel to the coast is offset by the ebb tide flowing from northwest to southeast. Therefore, sediment transport in Sur area and in the Khawr in particular is influenced by the inflow of water into the lagoon during the flood tide and the outflow of the water from the lagoon during the ebb tide.

4. Grain size analysis:

Sediment samples were collected from six locations representing different parts of the Khawr area (Figure 4), to be analyzed in order to help in understanding the processes involved in the development of the coastal features in the Khawr. The locations of the samples are as the following:

1 - The major sand bar
2 - The north bank at the center
3 - The entrance of the inner lagoon in the west
4 - The south bank at the Wadi Shamah Delta
5 - The off shore bar at Ras al Mayle
6 - The Wadi Sokykerah mud-flat in the southwest

The samples were washed and oven-dried out. About 100 grams of each sample was placed on an electric sieve shaker. The sizes of the sieves range from 2 to 4⊘ at 1⊘ intervals. The data were analyzed statistically using the formula suggested by David Briggs (1977).

Table 1
Characteristics of the grain size of samples from Khawr Al-Batah

Size ⊘	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5	Sample 6	Mean ⊘
- 2	12	_	_	_	_	_	12
-1	19	5	_	_	7	_	13
0	26	10	3	_	13	_	10.5
1	24	23	10	_	37	_	23.5
2	14	23	32	5	24	4	17
3	3	21	27	52	11	55	28.2
4	2	18	28	43	8	41	21.7
Mean ⊘	-0.36	1.46	2.23	2.96	0.86	3	1.69
Median ⊘	-0.3	1.5	2.2	2.9	0.8	3	1.68

4.1: Results:

1 - The mean of the grain size in the Khawr sediments range from 0.36 to 3⊘, which means that the grain size range from coarse sand to fine sand. This result coincides with the median of the grain size as shown in (Table 1) and (Figure 3).

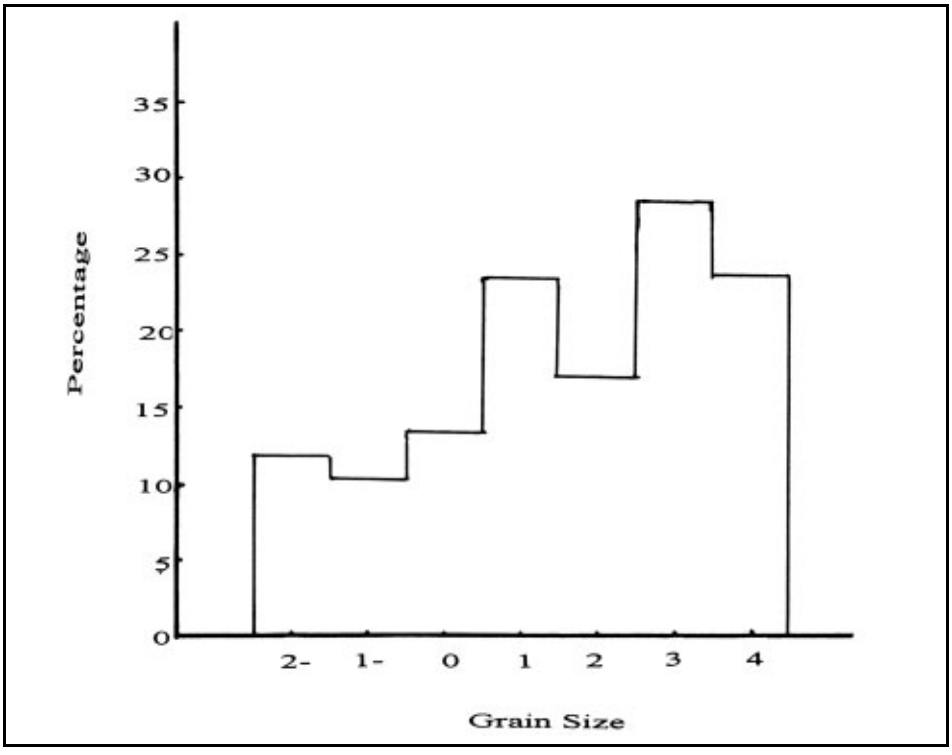

Figure 3: Histogram of Grain Size of Sediments From Khwar Al-Batah

2 - For sample # 1 collected from the main channel, the mean of the grain size is -0.36⊘, which means coarse sand. Grains that range in size from 0 to 1 ⊘ make about 50% of the sample size, while fine sand that range in size between 2 to 4⊘ make 19% of the sample, and the very coarse sand make 31% of the sample.

3 - The mean of sample # 2 collected from the north bank at the center (Khawr beach) is 1.46⊘ (medium sand). The fine and medium sand makes the highest percentage of the sample. The grain size range from 1 to 4⊘ makes about 85% of the sample, while the coarse sand makes the remaining 15%.

4 - The medium and fine sand make the highest percentage in sample # 3 from the entrance of the inner lagoon in the west. Grain size ranging from 2 to 4⊘ makes about 81% of the sample size, while the medium and coarse sand make only 19% and no granule or very coarse sand in this sample.

5 - Samples # 4 and 6 collected from Wadi Shamah delta and Wadi Sokykerah mud-flat in the southwest are similar in grain size of the deposit. The size of the grains ranges from 2 to 4⊘, which is classified as medium to fine sands. The distribution of the grain size in the sample shows that the sands ranging from 3 to 4⊘ makes 95% and 96% of the samples consecutively, while the remaining percent is medium sand.

6 - In sample # 5, collected from Ras al Mayle, the coarse and medium sands ranging from 0 to 2⊘ make 74% of the sample, and granule, -1⊘ makes 7%. Fine sand ranging from 3 to 4⊘ makes about 19% of the sample size.

5. Landforms and processes in Khawr Al-Batah:

The morphological map of Khawr Al-Batah (Figure 4) shows that the configuration of the Khawr is not in one direction, which in turn makes it possible to divide the Khawr into three morphological units, which are:

1 - the main channel with a direction from north to south.

2 - The central lagoon with a direction from east to west.

3 - The inner lagoon in the west with a direction from south and southwest to north and northwest.

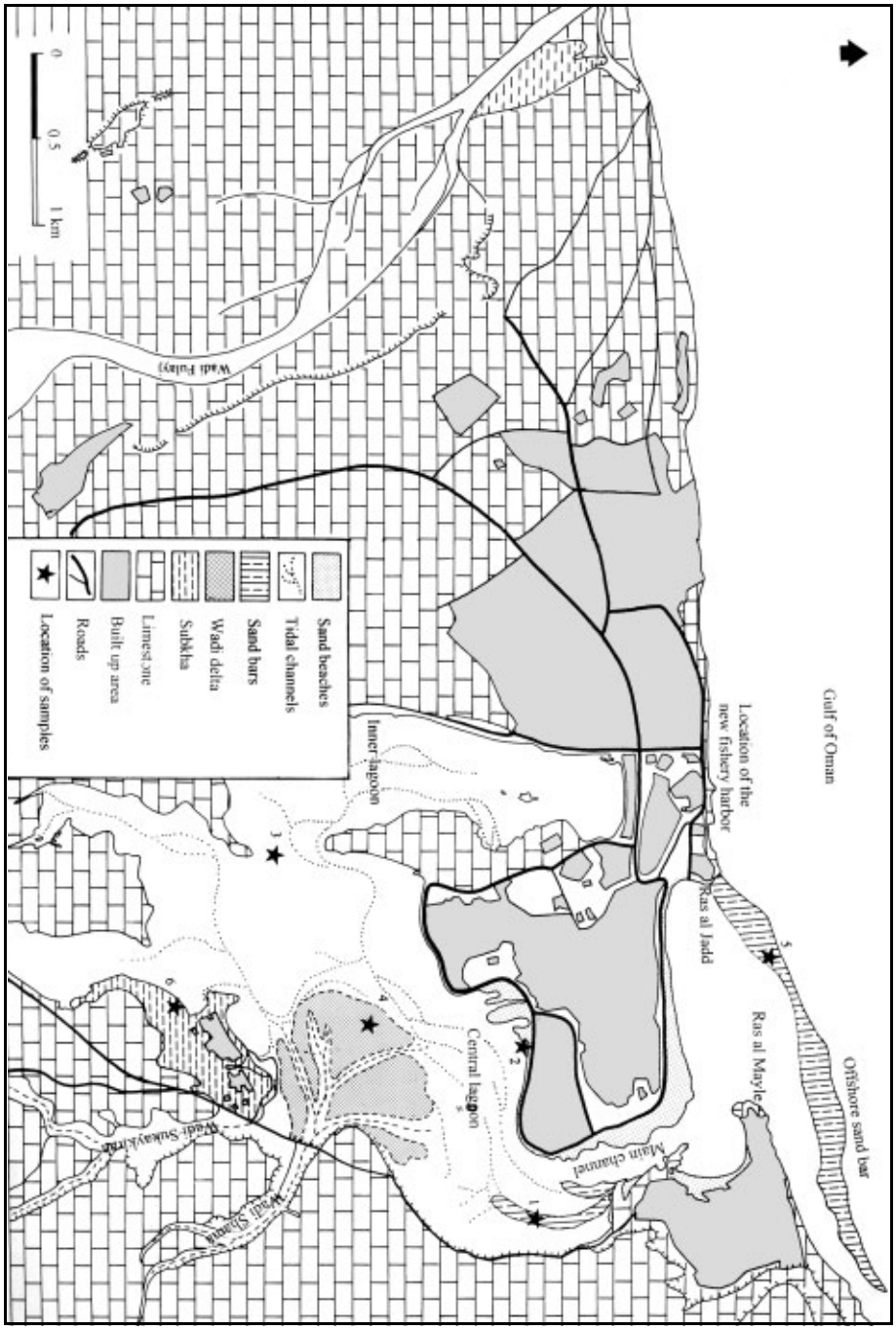

Figure 4: Morphological map of Khawr Al-Batah (based on arial photograph scale 1:20.000

Each morphological unit has micro-landform of its own which distinguishes it from the other units. In the following sections these micro-forms (landforms) will be discussed in detail.

5.1: The Main Channel:

This unit connects the inside lagoons with the Gulf of Oman. It extends in a north to south direction for about 1.2 kilometers from the entrance at Ras al Mayle to the main sand bar where the main channel enters the central lagoon. The channel is very narrow particularly near the ferry crossing where its width doesn't exceed 150 meters. The maximum depth of the channel, according to the bathometric charts, where it enters the sea is about 3 meters above the Chart Datum (lowest astronomical tide), or about 1.21 meters above main sea level since the mean sea level for Sur area is 1.79 meters.

The topography of the channel varies in its two banks. While the eastern bank of the channel is rocky, its western bank is sandy with low relief. Based on the morphological map, drawn from aerial photographs scale 1:20000, the following micro-landforms in the main channel can be identified:

5.1.1: The offshore sand bar:

It has been mentioned that the general direction of sediment transport in the Gulf of Oman is to the northwest, and the Sur area is the site of complex patterns of sediment transport, which are influenced to some extent by tidal currents. The ebb tidal current, which flow is superimposed with the predominant current, is to the southeast and sediment transport pattern is in the same direction. As a result, a sand bar has been developed offshore of the Khawr entrance extending from Ras al-Jadd eastward. The outflow of water from the lagoon during the ebb tide is great, thus modifying the sand bar particularly at the entrance of the channel. The sand bar is wholly submerged, hence difficult to measure. It faces seaward and owes its existence to deposition in the sea by the combination of the ebb tidal current parallel to the coastline and the great outflow of water from the lagoon in a fan shape during the ebb tide.

It seems that wave breakers (about 50 meters long for each) constructed in Sur beach in the middle of the 1970's trapped the sediment in the

beach which in turn grew and extended for about 50 metros at least (in about 15 years period) to cover all the wave breakers.

Grain size analysis for sample #5 collected from this site (the offshore sand bar) shows that the coarse to medium size sediments, ranging from 0 to 2⊘, make 74% of the sample. Granule (-1⊘) makes 7%, while fine sand ranging from 3 to 4⊘ makes about 19% of the sample size. Microscopic examination revealed that the sands are very poorly sorted and the shape of the grains varies from angular to subrounded. The calcium carbonate shell materials comprise about 80% of the grains. This means that the primary source of sediment for the offshore sand bar is marine derived sediment. Terrestrial sediments make about 20% of the sample size and probably transported by Wadi Fulayj, which drains in the Gulf of Oman about 5 kilometers to the northwest of the Khawr (Figure 4).

It worths noting that the wave breakers (1.485 kilometers and 0.430 kilometers long) of the new fishery harbor constructed offshore of Ras al-Jadd is expected to modify sediment transport process alongshore, and might restrict or eliminate sediment transported to the shoreline, and deprive Sur beach from one of its major sources of sediment. Thus, the offshore sand bar as well as Sur beach is probably expected to witness beach erosion and coastal retreat in the near future.

5.1.2: The inner sand bars:

There are two other sand bars stretching across the inner mouth of the channel. The longest extends for about 700 - 750 meters in a north to south direction. This sand bar is a major one and gets completely exposed (emerged) in the low tide as shown in Plates 1&2.

The second sand bar is a minor one, which is also located at the internal side of the channel, but more to the center of the channel. It extends for about 300 meters in a north to south direction and only 100 metros away from the west bank of the channel. The width of the two sand bars is less than 100 metres for each.

It seems that the two sand bars have the tendency to grow and extend northward across the channel, making a threat to close the channel. However, it is believed that the strong tidal currents (inflow and outflow of water in and out of the lagoon) keep a narrow passage in the channel open for navigation for fishing boats.

Recent aerial photographs (1991) show that the major long sand bar is extending for 800 meters and curving slightly to the northwest following the direction of the outflow of water from the lagoon. The minor sand bar has slightly migrated northward to join the major sand bar at its northern end.

Grain size analysis for sample collected from the major sand bar (sample #1) revealed 50% coarse sand (-0.36⊘) and 31% granule (-1 to 2⊘), while fine sand that range in size between 2 to 4⊘ make 19% of the sample. The grains are mainly composed of angular to subrounded shell fragments which makes about 80% of the grains, which in turn reflects the domination of the offshore source of sediments in this part of the Khawr. 5.1.3: Sandy beaches:

A relatively long stretch of sandy beach exceeding 1.8 km is found in Sur outside the Khawr and extending along the western bank of the main channel. A small enclosed sandy beach with length not exceeding 500 metres is also found in the eastern bank of the main channel.

5.2: The Central Lagoon:

This part is considered to be the main body of the Khawr Al-Batah. It extends for about 2.6 kilometers in an east to west direction. It covers an area of about 3.25 square kilometers (65% of the total area of the Khawr). It is very shallow because of the in fill by sediment from wadis draining into the lagoon at its southern bank. The depth at the northern bank, the deepest, doesn't exceed 2 meters above the Chart Datum.

The main micro-landforms of the central lagoon includes the Khawr beach at the north bank, and those landforms associated with Wadi Shama and Wadi Sukaykirah, such as Wadi Shama Delta, Wadi Sukaykirah mud-flat and mangroves associated with it, and sabkhas.

5.2.1: Sandy Beaches:

There is a narrow strip of beach bordering the central lagoon at its northern bank. Its length extends for approximately 1 kilometer in an east to west direction, while its width doesn't exceed 10 meters. Grain size analysis for sample #2 collected from this beach, revealed mean of 1.46⊘, which is classified medium sand. The fine and medium sand makes the highest percentage of the sample. The grain size range from 1 to 4⊘ makes about 85% of the sample, while the coarse sand makes the remaining 15%. The grains are composed of a combination of carbonate and quartz sand.

This suggests that the sediment sources are a combination of terrestrial and marine sediments.

5.2.2: The Wadi Shama Delta:

Wadi Shama is the major wadi that drains in the southern side of the lagoon. There is also Wadi Sukaykirah, which developed no delta except submerged channels and mud-flats. The Wadi Shama Delta has a fan shape like projection in the lagoon, and gets totally exposed during the low tide. The delta is about 1km long and 1km wide, so it covers an area of about 500 square meters. Although the 1991 aerial photographs show a man-made structure at the mouth of the wadi, there is no significant decrease in the size of the area of the delta; in other words the delta experienced no retreat, when compared with 1979 photographs.

Grain size of sample #4, collected from Wadi Shamah delta in the southwest showed a grain size of medium to fine sand, ranging from 2 to 4⌀, reflecting the narrow range of grain size. The distribution of the grain size in the sample shows that the sands ranging from 3 to 4⌀ makes 95% of the sample size, while the remaining 5% is medium size sand. Microscopic examination revealed that the sands are moderately to well sorted. The sediments were predominately comprised of quartz sand grains, which suggests that the sediments derived by running water via Wadi Shamah.

5.2.3: Tidal channels:

By reexamining the aerial photographs very closely along with field observations, a complex network of tidal channels stretching all over the lagoon, can be identified (Figure 4). These tidal channels are totally submerged and are only exposed during the low tide when water flowing out of the lagoon makes a network of small streams. These tidal channels, however, do not follow any stream patterns and do not have a permanent course. It is believed that they are formed by the water coming out of the lagoon during the low tide, and the water coming in during the high tide.

5.2.4: Mud-flats:

A mud-flat refers to a low-lying surface exposed at a low tide and submerged at a high tide and composed of silt and clay. Mud-flats of the Khawr Al-Batah occurred around the margin of the central lagoon and are characterized by loose silt to fine sands. These flats are submerged by

seawater during high tide and are exposed at low tide. Normally, these flats are 0.5-2 meters above the low tide level. The mangrove trees grow on these flats.

5.2.5: Mangrove stands:

They are small growth of mangrove trees of Avicennia marina (Plate 4). The only species of mangrove in Oman is observed in the mud-flats at Wadi Sukaykirah mouth and Wadi Shama Delta. The tree size, here, is small where it doesn't exceed 2 meters in height. The density of trees is low and scattered. Compared to other mangrove areas of Oman (Qurm, Mahout and Shinas) studied by Fouda and Al-Muharrami (1996) where the heights of trees reach 5 meters in Qurm, 8 meters in Mahout and 6.5 meters in Shinas.

That, maybe, due to the high salinity of the water in the lagoon due to the shortage or lack of fresh water input from Wadi Sukaykirah and Wadi Shama. It is also observed that the mangroves concentrate in the center (middle) of the Wadi Sukaykirah mouth, which maybe due to the availability of ground water seepage supply.

5.2.6: Sabkha (Supra-tidal flats):

Sabkhas are present in the southern part of the lagoon in two areas: southwest of Wadi Shama Delta and around the wadi Sukaykirah mud-flats. The surface of the sabkhas rises only 0-2 meters above water level. Mechanical analysis for a sample (#6) from the sabkha shows that the sands ranging from 3 to 4⊘ makes 96% of the sample. The sample consists predominantly of fine deposits especially fine to medium, where the fine sands (3 to 4⊘) makes 96% of the sample.

Field observation showed that sabkhas are not frequently inundated by seawater; they are only submerged totally or partially by the spring tide especially when it is accompanied by stormy winds. Thus, a thick gypsiferous crust covers the surface. The area covered by the sabkhas is about 1.5 square kilometers. The old town of Sur, to the north of the lagoon, is located on sabkha. However, the expand of urban development and structures in the town have modified its form.

Plate 3: A large area of the Khawr basin become very shallow.

Plate 4: Mangrove trees (Avicennia marine) in the mud-flat

5.3: The Inner Lagoon:

This part of Khawr Al-Batah is located at the western end. It extends in a north to south direction, and covers an area of about 1.4 square kilometers, and connected with the central lagoon by a 400 meters wide entrance. This part of the Khawr is the shallowest due to its location in the inner side (sediment trap). Seawater floods it twice daily during the high tide, thus sediment transported by tidal currents get trapped inside the lagoon. There are no significant micro-forms in this part of the Khawr except the small rocky island at its northern part, and the mud-flat around the margin of the lagoon. Particle size analysis for sediment sample from the inner lagoon (sample #3) revealed a relatively small range in grain size, where medium to fine sand makes about 81% of the sample size, while medium to coarse sand makes 19% of the sample.

From studying landforms and coastal processes in Khawr Al-Batah, it appears that the Khawr is going through steady and extensive coastal deposition processes such as silting and accretion of mud. This is clear from the continuous growth of the off shore sand bar and, the inner sand bars that stretch across the Khawr. The appearance of wadi delta, mud-flats and sabkhas are other examples. Such processes have resulted in the shallowness of the Khawr.

Due to these processes the Khawr, which used to shelter large traditional trade vessels (dhows), has become so shallow that its maximum depth at its deepest point (at the main channel) does not exceed three meters above the chart datum. Furthermore, the largest area of the Khawr's body, which has become shallow, is getting exposed in the low tide.

6. Conclusion:

From the discussion above, it has been established that the basin of the Khawr Al-Batah, is of a tectonic origin, and was initiated during the middle part of the Tertiary. The sea flooded the Khawr basin during the marine transgression in the Holocene. The morphological features in the Khawr are depositional and have been developed by the processes of terrestrial sediment transported and deposition by wadis and marine sediment transported and deposited by wave and tidal currents in recent time.

Tidal currents (flood tide and ebb tide) are the most important processes responsible for sediment transport in the Khawr. The main sources of

sediment are the offshore marine sediment characterized by high percentage of shell fragment while terrestrial sediment transported by wadis, which is characterized by fine to medium sands. Due to the continuous deposition, a large area of the Khawr basin became very shallow.

The morphological map of the Khawr Al-Batah shows that the Khawr comprises three morphological units: the main channel, the central lagoon, and the inner lagoon. The micro-landforms of the main channel include the offshore sand bar, and the inner sand- bars, which are growing and extending northward with the direction of outflow of water from the lagoon. These sand bars owe their existence to the continuous deposition by the combination of wadis and tidal currents. The central lagoon is the main body of the Khawr and its main morphological features include Wadi Shama Delta, mud-flats and mangroves associated with it, and sabkhas. The inner lagoon in the west end is the shallowest and it is more like a large tidal flat (mud-flat) flooded by seawater during the high tide and exposed during the low tide.

7. Recommendations

It has been concluded that the depth of the Khawr has been decreased in recent years and has become very shallow through siltation because it acts as a trap for sediment transported by wadis and tidal currents. This is reflected in the existence of depositional features such as sand bars, wadi delta, mud-fats and sabkhas. The Khawr, thus, can not be used as a harbor for large vessels unless its channel widens and basin is dug. Since digging the Khawr and widening its channel is costly and difficult for some natural concerns, a new fishery harbor has been built offshore of Ras al-Jadd about 2 kilometers to the west from the Khawr. Thus Khawr Al-Batah lost its traditional prosperity and position to the new harbor. However, the Khawr and ship yards for traditional boats in its vicinity constitute one of the significant aspects of the natural and cultural heritage and source of historical values that link Sur with its past. Therefore, the Khawr can be developed as a place of tourist attraction.

Stands of mangroves in Wadi Sukaykirah can be studied in detail and their size and density can be increased. The school of birds that use the lagoon can be protected, and the marine life in the lagoon can be of great value in terms of fish resources. Therefore, the natural beauty of the Khawr

can be restored, developed as a natural scenic area and exploited as a source for recreation and tourism.

In addition to tourism, other activities could be developed in the Khawr such as building fishing bonds, which will increase its economic and ecological potential. All such developments will require detailed economic and environmental studies, so that to guard against any future damages to the Khawr ecosystem.

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