The Enjefa Beach Exposure in Kuwait, Northern Gulf: Evidence of Late Holocene Regression*

Saifullah Khan Tanoli¹, Abdulaziz Al-Fares¹, and Ghaida Al-Sahlan¹

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¹Kuwait Oil Company, Kuwait (STANOLI@kockw.com)

Abstract

Four sedimentary facies were recognized in exposures along Enjefa Beach, Salwa, Kuwait. They are: a) Horizontally laminated, b) Trough cross bedded, c) Planar wedge shaped and ripple cross bedded, and d) Bioturbated calcareous sandstone. Facies “a” consists of horizontally laminated beds which generally display a coarsening upward trend. These beds resulted from stacking of beach faces, with top of the beds marking the shelly beach top. A fining upward gradation in a few beds is also observed, which attests to the occurrence of more than normal energy events. The trough cross bedded facies makes up the middle part of the exposure and is interpreted to be tidal channel or tidal inlet deposits. The planar wedge shaped and ripple cross bedded facies display variable orientation with a northward dominated current direction. It was likely formed in the shallower part of the channel with relatively lower energy levels, or is the ebb tidal delta deposits. The uppermost facies “d” consists of a large network of Ophiomorpha burrows and is interpreted as coastal sand flat deposits.

Following Walther’s Law, the vertical sequence observed in this exposure from facies “a” to “d” was formed in laterally adjacent coastal sub-environments. This facies stacking pattern from beach, to tidal channel, to sand flat reflects a seaward shift in facies and therefore progradation. Nevertheless, during Holocene time from around 20 kyr bp, the melting of ice of the Late Pleistocene resulted in eustatic transgression. The present Gulf was the result of flooding associated with this transgression. After 7 kyr to present, transgression continued globally but at a much slower pace. The Enjefa Beach exposures on the contrary depict progradation. The glacio-isostatic adjustment cannot explain it since there was no glaciation in this region during the Pleistocene. However, there is evidence of present day active tectonism associated with the northeastern movement of the Arabian Plate under the Zagros fold belt. As a consequence, Kuwait’s coastal areas and interior are experiencing structuring, creating uplift. This uplift possibly outpaced transgression, resulting in regression and the development of progradational sequences in coastal areas of the northern Arabian Plate during the latter Holocene.
Four sedimentary facies were recognized in exposure along Enjefa Beach, Salwa, Kuwait. They are; a) horizontally laminated, b) trough cross bedded, c) planar wedge shaped and ripple cross bedded, and d) bioturbated calcareous sandstone. Facies “a” consists of horizontally laminated beds which generally display coarsening upward trend. These beds resulted due to stacking of beach faces with top of beds marking the shelly beach top. Fining upward trend in a few beds is also observed which attests to the occurrence of more than normal energy events. The trough cross bedded facies makes middle part of the exposure and is interpreted tidal channel or tidal inlet deposits. The planar wedge shaped and ripple cross bedded facies display variable orientation with northward dominated current direction. It is likely formed in shallower part of the channel with relatively lower energy levels or is the ebb tidal delta deposits. The uppermost facies “d” consists of big network of Ophiomorpha burrows and is interpreted the coastal sand flat deposits.

Following Walther’s Law, the vertical sequence observed in this exposure from facies “a” to”d” was formed in laterally adjacent coastal subenvironments. This facies stacking pattern from beach, tidal channel to sand flat reflects seaward shift in facies and therefore progradation. Nevertheless, during Holocene time from around 20kyr bp the melting of ice of Late Pleistocene has resulted into eustatic transgression. The present Gulf was the result of flooding associated with this transgression. After 7kyr to present although transgression continued globally but at a much slower pace. The Enjefa Beach exposure on the contrary depicts progradation. The glacio-isostatic adjustment alone cannot explain it since there was no glaciation in this region during Pleistocene. However, there is evidence of present day active tectonism associated with the northeastern movement of the Arabian Plate under the Zagros fold belt. As a consequence, Kuwait’s coastal areas and interior are experiencing structuring creating uplift. This uplift possibly outpaced transgression resulting in regression and the development of progradational sequences in coastal areas of northern Arabian Plate during later part of Holocene.
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**Ripple cross-bedded lithofacies**
- Megaripples; planar wedge shaped cross-beds
- Dominant current Northward; parallel to the coastline
- Variable current direction
- Lithology mixed quartz and carbonate (peloids)
- Mixed or shallow tidal channel/ebb tidal delta/coastal dune environments

**Bioturbated lithofacies**
- Uppermost facies; intensely burrowed
- Locally sharply based overlies facies “c”.
- Tube network of horizontal, inclined, and rarely vertical burrows of Ophiomorpha and Parmaichnus.
- Burrow fill; fecal pellets (peloids) with intergranular mirtic cement
- Protected sand flat environments

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**Conclusions**
- The Enjefa Beach exposure was deposited in foreshore-beach, tidal inlet, possibly dune and sand flat subenvironments.
- Lower part of the exposure was deposited during Holocene transgression and the upper part during late Holocene regression.
- This regression could be partly due to isostatic adjustment resulting from sea bed lowering due to the weight of access water. Local tectonics could be important contributing factor as well.
- The terrace and runnel physiography displayed in the intertidal area may suggest renewed present day transgression.

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