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An evolutionary model for sabkha development on the north coast of the UAE

A. Al-Farraj*

Geography Department, UAE University, P.O. Box 17771, Al Ain, UAE

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Abstract

The north coast of the United Arab Emirates (UAE) provides a typical example of coastal sabkha (supratidal flat) formation. Various stages of sabkha development can be recognized along this coast. This paper combines previous studies of sabkha environment with the results of field investigation of sabkha geomorphology, sedimentology, and stratigraphy on the north coast of UAE, to formulate a model of sabkha evolution.

The model has six stages in the evolution of coastal sabkhas following the early Holocene sea-level rise. These are: Stage 1: sea-level rise results in the formation of an embayment. Stage 2: involves subsequent spit development and progradation across the bay as a result of sediment availability. Stage 3: coincident with spit evolution is the development of a khor (tidal inlet) with or without mangrove. Channel depth of Khors varies from 4 to 6 m. Stage 4: sediment accumulates in the khor reducing the khor depth, turning it into a lagoon. There are three sub-stages of the lagoon stage. (a) With lagoon depths of 1–2 m, (b) with lagoon depths 0.5 m or less, (c) when the lagoon floor is exposed at low tide. Stage 5: is sabkha formation; development occurs in two sub-stages. In the first the sabkha is immature and flooded during rain storms and spring tides (0.1 m above present sea-level). Later the sabkha is only flooded after rainstorms, when it reaches an elevation of about 1 m or more above present sea-level. Stage 6: in sabkha development is the coastal plain, which results when large sabkhas are linked together.

Keywords: Coastal geomorphology; Coastal evolution; Khor; Lagoon; Sabkha; Northern UAE

*Tel.: +971 5 06622909; fax: +971 3 7679199.
E-mail address: asma@uaeu.ac.ae.

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1. Introduction

A sabkha is defined as a flat area that is prone to periodic inundation and evaporite deposition, dominated by carbonates or sulphates. Sabkhas may occur inland or as coastal sabkha, which are common in arid shallow-shelf environments. Sabkhas develop in response to two environmental conditions: deflation of sediment surfaces, or sediment accumulation in a lagoon, or by a combination of both processes (Evans, 1970). Coastal sabkha environments can be divided into three (i) subtidal flats which in this study include khors (tidal inlets) and intertidal channels, (ii) intertidal flats including lagoons, and (iii) supratidal flats, which are the sabkhas themselves (Shinn, 1983). All these environments are present along the northern United Arab Emirates (UAE) coastline.

From the point of view of 'the present is the key to the past', sabkha geology has been studied intensively, especially in the Arabian Gulf area, as sabkhas in the geological past are believed to be one of the environments important for the formation of oil (Kendall et al., 1968, 1998, 2002; Alsharhan and Kendall, 2002).

Within the UAE there are only a few studies relating to the sabkhas on the north coast. Some are general and descriptive (Purser and Evans, 1973); others relate to archaeology but include consideration of the coastal geomorphology (e.g. Vogt, 1994; Dalongeville and Sanlaville, 1997; Dalongeville and Medvecki, 1997). Some studies relate only to parts of the coast (e.g. Bernier et al., 1995, Umm Al Qiwen; Goudie et al., 2000; Al-Farraj 2002a, b, northern Ras Al Khaimah), and other studies relate to coastal and inland environments (Kirkham, 1998).

Despite a large literature on coastal evolution (e.g. Carter and Woodroffe, 1994; Roy et al., 1994 Hansom, McGlashan, 2004) few studies deal with sabkha environments as a part of this process. Some studies have investigated the geomorphology of coastal features individually, many of which occur in relation to sabkha development. For instance, some studies have investigated spit development (e.g. Evans, 1942, 1970; Price, 1951; Shepard, 1952; Glennie, 1970; Cowell and Thom, 1994; Goudie et al., 2000), subtidal flat size, morphology and depth (Bajorunas and Duane, 1967; Shinn, 1983), and tidal channels and their deltas (Price, 1963). Cooper (1994) illustrated lagoon evolution, without considering relationships to sabkhas or coastal plain evolution. Although there have been some studies of sabkha environments (Kendall et al., 1968, 1998, 2002; Alsharhan and Kendall, 2002), they have tended to focus only on the processes of sedimentation rather than their evolution.

This study considers tidal flats as a part of an evolving coastal sabkha system. Thus, a model of sabkha evolution in response to sediment accumulation will be presented. This study uses data from the north coast of the UAE combined with previous studies of sabkha geomorphology, sedimentology and stratigraphy of the region.

In other coastal environments evolutionary coastal plain sequences have been proposed (e.g. Boyd, et al., 1987; Vott, et al., 2004), but Evans et al. (1969) have studied sabkha history. However, even they focus on sedimentation rather than on sabkhas as part of coastal plain evolution. In general, sabkha environments in the