Interrelation between coastal sabkha belts and dune migration (rate and trend): bearing on developing N. Sinai, Egypt.

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The coastal area of North Sinai (El-Bardawil lagoon, Fig. 1) is characterized by three strips of sabkha having NE-SW direction, oval to rectangular in shape, and orthogonal to the prevailing NW-SE wind.

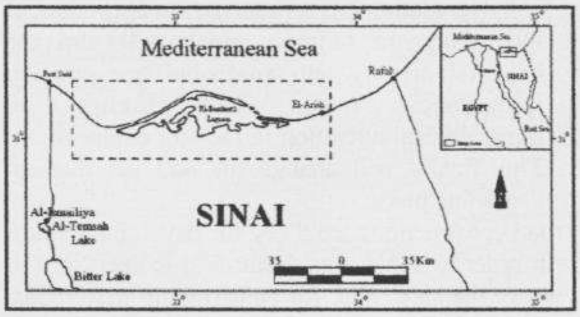

Fig. 1- Location map.

Coastal sabkhas were formed by the deflated sands blown southwards, forming interdunal sabkhas. The largest are the closest to the shore, while farther south on a higher altitude the smallest ones are located. The coastal dunes are of transverse type with a NNW-SSE direction, while farther southward, they turn into linear type with a predominant W-E direction, due to the change in the wind direction from winter to summer. The pressure difference between the saline bodies (+ve) and the surrounding dune areas (-ve) enforces the wind to change its local direction with hot air flowing from the sabkha sites toward the dunes.

This led to avoiding overriding the sabkha sites by the migrated dunes, and moreover, to change dune direction and type (Fig. 2).

Three main parameters were proven to control the migration rate(s):

1- capillary action of saline waters and cementation processes. These cause limitation of the sand migratetion due to cementation processes as marine and phreatic types. The directions of the migrated dunes are controlled by the pressure difference due to sabkha areas, where even small amounts of soluble salts could cause a significant increase in fluid threshold velocity. Soluble salts will reduce sand flow [1,2].

2- salt spray will hinder the sand grains from blowing with wind. When wind crosses the water bodies it becomes saturated with water vapor leading to increase in moisture content of the sand dunes and consequently reduces the capacity of windblown sand [3,4]. Also, the movement of the coastal dunes will be slower due to salt precipitation [5], and spring high tides and its effect on both sabkha area, salinity increase in summer and its consequent effect on pressure difference, which in turn will affect migration trend [6].

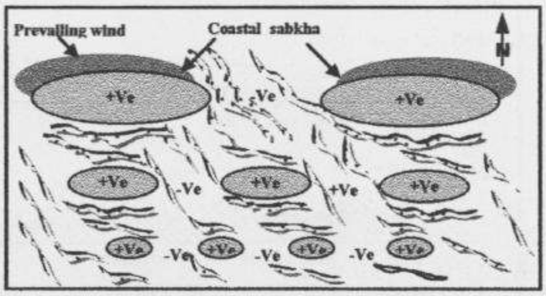

Fig. 2- Effect of sabkhas on dune trend and type. (+Ve = low pressure & -Ve = High pressure).

3- Capillary rise plays a major role in cementing dunes, where the process can be achieved through one of the following three ways: a- a higher cohesiveness of damp sand as a result of increased intergranular surface tension [7]; b- the influence of near-surface groundwater as a limit to wind scour through cementation of sediments in vicinity of the water table [8)] and c- the influence of shallow water tables which enable the establishment of a permanent vegetation cover as opposed to acting as an erosional base level [9].

Sediment transport will continue if the wind velocities remain above threshold and evaporation exceeds the rate at which capillary water can move to the surface [1]. The continued evaporation of capillary water, however, in many cases will lead to the precipitation of dissolved salts near the surface. Thus, more permanent salt ponds may replace the rather transient stabilizing effect of the surface moisture over the long term. This can significantly affect threshold velocities and the sediment transport rate. The fine and dry sand at the dune surface is only moving by wind, leaving the coarse grained sand armoring a dune surface and the underlying damp sand that form the dune body inhibiting dune growth [10].

The three parameters were confirmed during field survey and their main products are formation of linear, barchanoid dunes, and sand sheets, in addition to changing the dune migration trend(s). These are from north to south: Phase I, denoting a linear dune type (~ 18.000 yr.); Phase II, including new dune generation overriding the oldest phase and leading to compound dune types (~ 2Ka); and Phase III, including the recent dunes arising obliquely at the end of phase II and indicates local change in wind direction (Fig. 3).

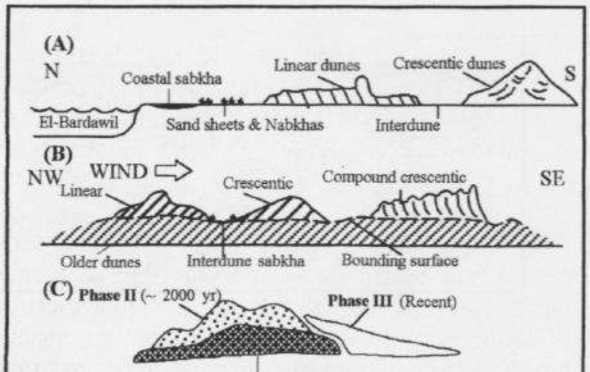

Fig. 3-A schematic diagram showing (A) profile south El-Bardawil in N-S direction, (B) landward development in dune types with NW-SE prevailing wind, and (C) several dune generations in the northern Sinai sand sea.

The interdunal sabkha strips in N. Sinai poses some environmental hazards impeding the development programs, such as:

1- heaped sand on houses and irrigation canals whereas new development programs depend on cultivating wide areas through El-Salam Canal. A study of the anticipated directions of dune migration is a necessity as to avoid hazards of heaping.
2- hazards for the recently constructed touristic villages. Development requires building of tremendous amounts of houses and its associated necessities including schools, markets, etc.., which requires tentative studies as to assure negative hazards. Also, recent increase in tourist rates invoked for building new tourist coastal villages which lies with or parallel to the coastal sabkhas.
3- soil degradation is a serious hazard byproduct of increasing soil salinity, which will turn the bacterial activity into anaerobic one creating fermentation cycles and leading to mineralogical alteration in the soil composition. This finally will change the soil pH through degrading phase.
4- road constructions are a key for developing areas. In order to avoid dune hazards it is necessary to study the safe route for constructing new roads, particularly the coastal ones.

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