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Seasonal wave changes and the morphodynamic response of the beach–inner shelf of Abu Qir Bay, Mediterranean coast, Egypt

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Abstract

High resolution beach–inner shelf bathymetric profile surveys combined with wave data and sediment samples have been used to examine short-term morphological changes of the seabed at the eastern part of Abu Qir Bay. The profile survey covered ~4.5 km alongshore and ~9.5 km offshore to a 15-m water depth. These profiles were surveyed seven times between October 2001 and October 2002, showing changes during storms and the following recovery periods. Significant wave heights of storm waves (blown from the N and NNW) and fair weather waves (coming from the NW and NNE) were recorded between 2.0–5.0 m and <2.0 m, respectively. During storm periods, waves move sand from north to south and from the beach face and surfzone seaward to the upper shore face. The intervening periods between storms (swells of fair weather condition) are characterized by sediment redistribution from the northern or the southern parts toward the center of the bay. Mapping of computer-generated bathymetric surveys is used to interpret vertical seabed changes (erosion/accretion patterns) and to delineate sediment transport pathways. Linking this information with the spatial concentration of high intensity magnetic minerals (ilmenite and magnetite) in beach and seabed sediments helps to detect reversals in the directions of sediment transport to the north and to south, but with a general southward net pattern. The recognized outcrops of submerged rocks provide documented evidence that the shore-parallel late Pleistocene carbonate ridges, now subaerially exposed along the shore of Alexandria, extend further eastward on the seabed of Abu Qir Bay.

Keywords: sediment transport; wave seasonality; Nile delta; grain sorting; coastal processes; beach erosion; morphodynamics

1. Introduction

On sandy beaches, profile changes are induced by seasonal changes of wave climate (e.g., Winant et al., 1975). Storms tend to move sand rapidly offshore, while under fair weather conditions, sand moves onshore, causing gradual beach accretion (Komar, 1976). These changes in time and space involve sediment transfer alongshore and across the shore face. The influence of storm waves and fair weather conditions on profile evolution has been widely documented on sandy beaches (e.g., Wright et al., 1985; Dail et al., 2000). In the Nile delta, short-term changes have received less attention than long-term ones. Earlier studies in this area dealt with seasonal morphological variations in sand bars at the Nile Delta coast (Manohar, 1979; Naffa and Frihy 1993).

This paper presents results of the first systematic examination of short-term (1 yr) profile variability using beach and inner-shelf bathymetric profile data combined with wave data collected at the study area. These combined

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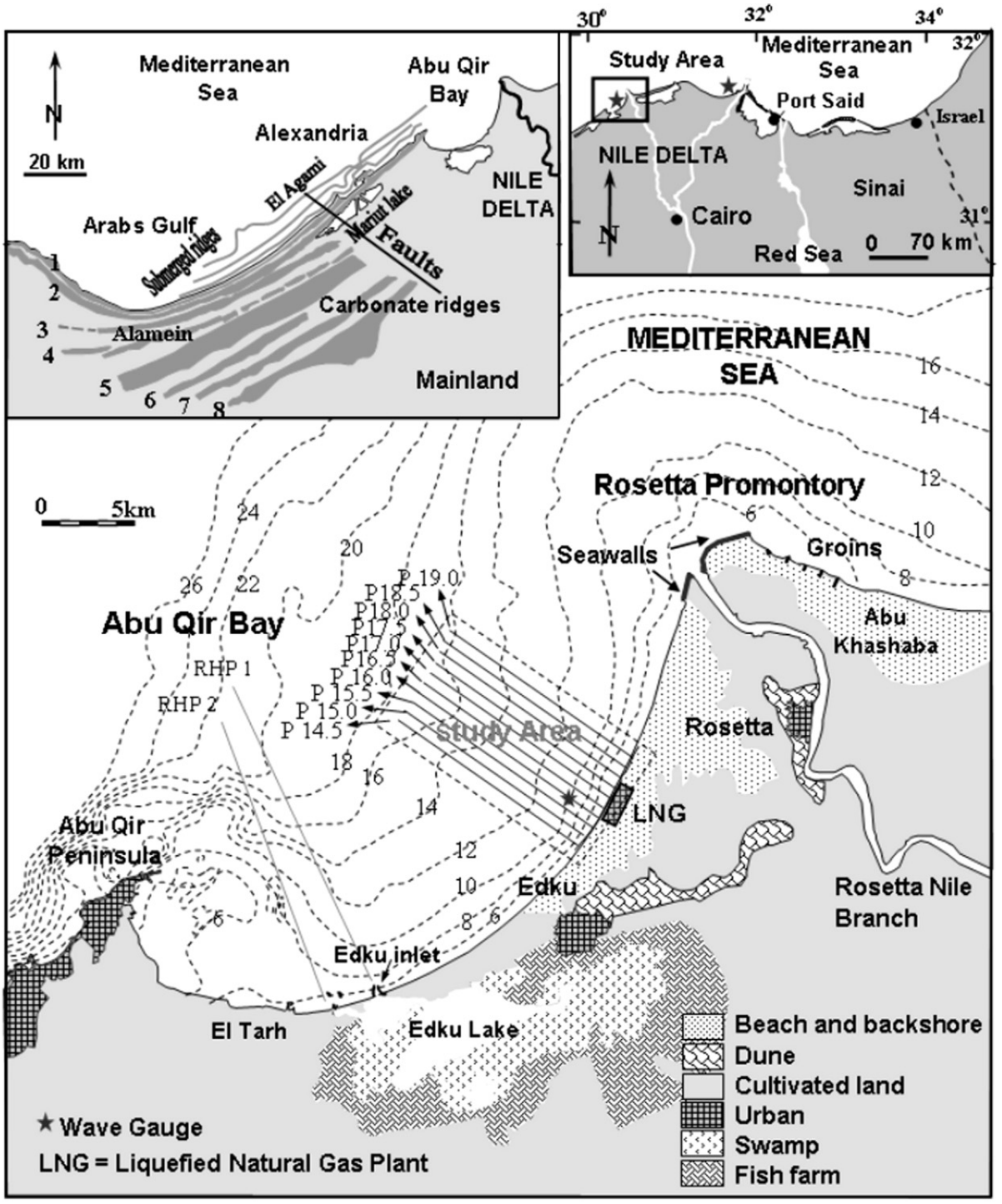

Fig. 1. Study area east of Abu Qir Bay on the northwestern Nile delta coast, showing position of the beach–nearshore profiles (labeled P14.5 to P19.0, and RHP1 and RHP2), location of measuring wave gauges and main geomorphological units. The upper left inset shows location of the coastal ridges (modified after Butzer, 1960). Depth contours are in meters below MSL.

with sediment particle size and magnetic mineral content as a natural tracer of sediment dispersion in the beach and seabed samples. Therefore, the first objective is to examine profile changes (volumetric changes, vertical seabed changes) during groups of storms and the intervening fair weather period. The second objective was to delineate