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Recycling of Coastal Dredged Sediments from the Northern Nile Delta, Egypt, for Heavy Minerals Exploitation

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Mineralogical and textural analyses of 45 undisturbed short cores and 80 grab sediment samples, collected from five frequently dredged navigational areas within harbors and water pathways of the Nile delta littoral system, were utilized for evaluation of these sediments as potential source of economic heavy minerals (EHMs). Results of mineralogical characterization indicate that the average total heavy mineral (HM) concentrations are as follows: Abu Qir Bay (1.7%), Rosetta estuary (3.1%), Burullus fishing port (4.5%), Damietta Harbor (2.9%), and El Gamil lagoon inlet (1.9%). Assessment of HM grades indicates predominance of magnetite, ilmenite, hematite, leucoxene, garnet, zircon, and rutile. Results of the feasibility analysis indicate that dredged sediments at these study areas are considered as a potential source of EHMs and economically promising to be mined for HMs. The present study suggests a practical operative plan of two successive phases for HMs recycling: (1) in-situ initial separation of HMs on the dredger deck using wet-gravity spirals, then (2) transportation of the recovered HM concentrates to an onshore processing plant to selectively separate individual HMs via wet and dry magnetic and electrostatic separators. Alternatively, dredged sediments can be directly pumped to a nearby onshore area as stockpile to be recycled afterward in inland processing plant.

Keywords: feasibility analysis, heavy mineral processing, offshore mining, sediment recycling, waterways dredging, wet gravity separation

Introduction

The channel-maintenance dredged sediments that resulted from deepening of the harbor's navigational channels and other pathways of the Nile delta (rivers estuaries, coastal lagoon inlets, channels) are still considered a waste material and being disposed in a designated offshore area without any recycling or beneficial use. Sedimentation in these pathways is not the only problem occurring along the Nile delta coast. Coastal erosion is also very actively ongoing along the delta coastline due to a deficit in the sediment budget and long-term losses of sediments by predominant waves and long-shore current (Figure 1). Delivery of sediment to the delta coast began to decrease in the late twentieth century as a result of controlling of the river flow and construction of a series of barrages and dams along the river (Figure 2) in the upper and lower Nile delta (UNESCO/UNDP 1978). This resulted in aggravation of the erosion problem in long tracts along the Nile delta coastline.

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Water pathways and navigation channels along the Nile delta coast are periodically dredged using hopper dredgers to maintain continuous water exchange and adequate shipping channel depth for safe navigation of sailing vessels and fishing boats. Currently, more than $3.0 \times 10^6\,m^3$ of sediments per year are being dredged from these pathways. They are eventually dumped back in the sea as waste material in designated disposal sites without any recycling or beneficial use. The cost and economic loss of this process is very high, ranging between 20 and 25 million Egyptian Pound (1 US$ = 7 EGP) per cubic meter. Dredging and maintenance of the navigational channel of Damietta Port in the NW Nile delta, for instance, costs about 30 million EGP each year. Worldwide, dredged sediments are being utilized for many beneficial environmental and industrial uses, such as nourishment of eroded beaches, landfill, and manufacturing bricks and low-quality glass bottles (Demir et al. 2004; EPA 1992).

The present study deals with the economic-mineralogical aspect of sediment cores collected from periodically dredged navigational areas along the Nile delta coast. It is part of a larger integrated interdisciplinary research project to evaluate the feasibility of exploiting these waste sediments for economic and environmental applications. The environmental application of these sediments and feasibility of its use as borrow sand for nourishment of eroding beaches is