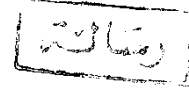


MINERALOGY OF BEACH SEDIMENTS ALONG THE
GULF OF SUEZ AND GULF OF AQABA,
ARAB REPUBLIC OF EGYPT



THESIS

Submitted to the Faculty of Science
Ain Shams University

BY

YUOSRIYA MOHAMED MAHMOUD SAMY

(M. Sc.)

FOR

THE DEGREE OF
DOCTOR OF PHILOSOPHY

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CHAPTER I

INTRODUCTION

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INTRODUCTION

The Sinai Peninsula covers an area of about 60,000 km², bordered from the North by the Mediterranean Sea and from the South by the Red Sea. At Ras Mohammed, the southern-most tip of Sinai, the Red Sea bifurcates into two embayments: the Gulf of Suez in the West and the Gulf of Aqaba in the East. From the geological point of view, the Sinai Peninsula is covered by various formations ranging from the Pre-Cambrian to the Recent. The Pre-Cambrian Basement Complex consists mainly of metamorphic and igneous rocks and is well exposed in the southern part of Sinai. The Basement Complex is covered with Paleozoic and younger sedimentary formations that extend and occupy the northern part of the Peninsula.

Extensive drainage lines cover most of Sinai (Fig. 1). In the West drainage systems originate from the relatively high sedimentary plateaux close to the Gulf of Suez and drain mainly westwards towards the Gulf of Suez and Suez Canal zone. In southern Sinai the drainage lines start from Pre-Cambrian Basement Complex mountainous area and drain towards the El-Qaa plain and eventually towards the Gulf of Suez and towards the Gulf of Aqaba.

The geological history and evolution of the Gulf of Suez and the Gulf of Aqaba differ significantly. The Gulf of Suez existed as a continuously subsiding basin of

sedimentation at least from the Cambrian (Said, 1962), whereas the Gulf of Aqaba was formed as a marine trough not earlier than the late Neogene (most probably the Pliocene).

The Gulf of Suez is essentially a taphrogeosyncline. It has a length of about 300 km and an average width of 40 km. The Gulf of Suez is rather shallow, with a maximum depth of about 70 m. The eastern coastal plain of the Gulf of Suez varies in width from North to South; in some areas it may reach several kilometres. The coastal plain is crossed in several parts by Wadi Fans which drain the Basement Complex in the South and the younger sedimentary formations in the North. Although the sediment supply to the coastal plain is not extensive, it is sufficient for the slow progradation of the coastal plain and formation of relatively narrow tidal flats with a tidal range of about 60-70 cm (Gavish, 1974). The latter author suggested that the sea level in the Gulf of Suez dropped by about one metre during the past 4000 years. This has led to the conversion of some subtidal areas into intertidal flats and shallow lagoons, causing general progradation of the supratidal zone.

The intertidal zone along the coastal plain on the eastern side of the Gulf of Suez varies in width from 400 to 800 m. Rippled flats and shallow channels characterize the higher landward intertidal zone, whereas sand waves (tidal bars) are the major features along the remaining parts of the intertidal zone (Sneh and Friedman, 1984). Intensive migration and accretion of sediments occur in several

places along the coastal plain. The most active areas are the spit complexes that protrude up to about one kilometre seaward.

The intertidal and supratidal sediments are composed of carbonate sand, mainly oolites in the North and of quartz- feldspar sand, ooids and pellets in the South (Sneh and Friedman, 1984). The subtidal sediments are mainly skeletal fragments of disintegrated coral reefs, which are sparsely distributed along the whole of the Gulf of Suez. Recent sabkhas occur generally in the supratidal zone and have a saline groundwater at shallow depth, thus fitting Kinsman's definition of modern coastal sabkhas (Gavish, 1974). These sabkhas are composed of clastic sediments with scattered interstitial evaporites suggesting that they are in early stages of development.

The Gulf of Aqaba is about 180 km long and varies in width from 15 to 25 km. In contrast to the Gulf of Suez, the Gulf of Aqaba is much deeper; its floor goes down to about 1850 m (Ben Avraham et al., 1979). The Gulf of Aqaba has a narrow coastal plain as the bordering cliffs rise abruptly from its waters. Most of these cliffs consist of the Pre-Cambrian Basement Complex. No Miocene or Pliocene sediments are known to occur along the coastal plain of the Gulf of Aqaba. The sediments that occur along the coastal plain belong mainly to the Pleistocene and Recent. They are found at the mouths of several of the wadis that drain into the Gulf. Besides gravel terraces, other Pleistocene deposits that border the coastal strip of the Gulf of Aqaba

are in the forms of coral reefs.

Along the western coast of the Gulf of Aqaba some hypersaline ponds (sea-marginal ponds) are known to occur. One of these ponds (known as the Solar Lake) occurs about 18 km South of Aqaba. The Solar Lake extends for about 140 m and has a width of 65 m and a depth of about 5 m. The pond is separated from the sea by a barrier consisting of sand and pebbles of igneous and metamorphic rocks (Aharon et al., 1977).

The beach sediments along the eastern coastal plain of the Gulf of Suez and the western coastal plain of the Gulf of Aqaba attracted the attention of few workers. Some of these sediments, for example coral reefs, have been described more than a century ago (Walther, 1888). Hume (1906) and others described in general terms the occurrence of Pleistocene and Recent sediments along the coastal plains of the Gulf of Suez and Gulf of Aqaba.

Sass et al. (1972) studied the oolite formation in Ras Matarma Lagoon in the northern part of the Gulf of Suez. They pointed out that the Lagoon was formed on a partly eroded raised Pleistocene terrace. The lagoon is now being gradually filled with sediments. The fill consists of wind transported ooids from the open sea beaches West and North-West of the lagoon, locally formed ooids, skeletal fragments, aragonitic mud, and a minor contribution of alluvial material from the East. Sass et al. mentioned that the oolites accumulating in the lagoon are of both high

and low energy levels. They have suggested that smaller ooids were formed in suspension, whereas the larger ones were formed by rolling and saltation on the bottom at higher energy levels. They determined the age of the oolitic sediment as 1740 years B.C.

Gavish (1974) described the characteristics of a Recent sabkha near Belayim on the eastern coastal plain of the Gulf of Suez. He found that the sediments of the sabkha consist mainly of coarse sand with a high concentration of pebbles at the surface. The sand consists of quartz, feldspars and few carbonate minerals. In contrast to the sabkhas of the Persian Gulf - where anhydrite is a major evaporite mineral - the Belayim sabkha contains only subordinate amounts of gypsum.

Sneh and Friedman (1984) studied the formation of spit complexes along the eastern coastal plain of the Gulf of Suez. They pointed out that each spit complex displays several environments: its backbone is an exposed spit from which subaqueous extensions continue over the tidal flat, extensions that are fed by the migrating sandwaves. Landward, the spit protects a seasonal sabkha which is flooded during the winter, and a sabkha lying above the winter high tide level. Eolian dunes develop both on the exposed spit and across the sabkha. As the complex continues to grow, the lagoons are filled with sand and mud and new spits are further developed seaward. All the spit environments are characterized by ooids in the northern Gulf of Suez; towards the South ooids become progressively less abundant. Sneh and Friedman pointed out that spits are developed seaward at

the rate of several tens of metres.

Ayalon (1976) studied in detail the mineralogy of the coastal sands along the western coast of the Gulf of Aqaba, from Elat in the North to Sherm El-Sheikh in the South. He dealt mainly with the quantitative estimation of the main heavy minerals encountered in the 0.062-0.100 mm heavy mineral fraction. Ayalon identified four main heavy mineral provinces along the coast of the Gulf of Aqaba. He mentioned that the distribution pattern and trends of heavy mineral assemblages are correlated with the mineralogy of the source rocks. Ayalon pointed out that high percentages of ultrastable heavy minerals (zircon, tourmaline, and rutile) are associated with clastics derived from sedimentary rocks, particularly the Paleozoic Nubian Sandstone. On the other hand, wadis draining crystalline rocks are relatively impoverished in the same minerals. The more common rock-forming heavy minerals of the crystalline rocks (e.g. amphiboles, pyroxenes, and micas) are present in the alluvial fans in large amounts in a relatively fresh state.

Omara (1959) studied the geology of Sherm El-Sheikh area, South of Sinai, and referred to the occurrence of flat-topped Pleistocene raised beaches consisting mainly of coralline limestone with abundant conglomerates. Youssef (1988) pointed out that the beach rocks in Sherm El-Sheikh area (Sherm El-Moiya) consist of carbonate-cemented rocks of varying composition and of unconsolidated beach sediments. He found that the sediments consist mainly of quartz, feldspar and different skeletal fragments. The carbonate cement in the beach rocks consists

mainly of aragonite, high magnesian-calcite, dolomite and traces of celestite. The raised beaches in the area consist of coral-algal biolithite platforms and coral-algal biostrome banks. Nawar (1989) described the texture and mineralogy of beach sediments from Mersa El-Aat embayment near Sherm El-Sheikh. He mentioned that the sediments consist of moderately sorted, medium to fine sand. The heavy minerals encountered include opaque minerals, amphiboles, zircon, pyroxenes and sphene. Nawar concluded that the sediments were provided through Wadi El-Aat which drains the Basement Complex North of the area.

The present study has been carried out to provide a systematic and more detailed analysis of the texture and mineralogy of the beach sediments along the eastern coast of the Gulf of Suez and the western coast of the Gulf of Aqaba. The results obtained have been used to explain the origin of such sediments.