Sedimentary Geology 307 (2014) 34–46

Contents lists available at ScienceDirect

Sedimentary Geology

journal homepage: www.elsevier.com/locate/sedgeo

Facies analysis and sequence stratigraphy of the Cenomanian–Turonian mixed siliciclastic–carbonate sediments in west Sinai, Egypt

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ARTICLE INFO

Article history:
Received 22 January 2014
Received in revised form 25 April 2014
Accepted 28 April 2014
Available online 9 May 2014

Editor: B. Jones

Keywords:
Facies analysis
Sequence stratigraphy
Cenomanian–Turonian
Mixed siliciclastic–carbonate
West Sinai
Egypt

ABSTRACT

The unconformity bounded Cenomanian-Turonian succession in west Sinai is subdivided into three formations: the Raha, Abu Qada, and Wata. These rock units were deposited in a mixed siliciclastic-carbonate system on a ramp setting. The studied ramp only includes inner and mid-ramp facies, whereas the outer ramp facies occurs in northern Sinai.

Four sequence boundaries (SB) were recognized in the studied formations due to the presence of subaerial exposure or flooding events in the facies stacking pattern. The first and last sequence boundaries (SB1 and SB4) might be considered as Type 1 sequence boundary attributable to the presence of widespread erosion. It is difficult to determine type of the second and third sequence boundaries (SB2 and SB3) because of their minor unconformity and minimal erosion. Determination of systems tracts within the Wata Formation is debatable owing to the action of dolomitization that has destroyed both original components and sedimentary structures.

The lowstand systems tracts of the recorded sequences are characterized by sandstones, siltstones, and sandy shales, while fossiliferous shale and limestone with oysters prevailed during sea level rise. The highstand systems tracts are generally characterized by shallow intertidal and subtidal deposits that are made up of abundant oyster wackestones with benthic foraminifera and ostracods.

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1. Introduction

Sinai is subdivided into a tectonically unstable shelf (northern part) and a tectonically stable shelf (central and southern parts) that is characterized by flat-lying strata (Said, 1962). In the Middle and Late Cretaceous, Sinai was a broad carbonate shelf with episodic intercalations of siliciclastic rocks on the passive margin of the southern Tethys Sea (Bauer et al., 2001). Subsidiary alternating advances and retreats of the southern Tethys characterized the Cretaceous period of Egypt and the adjacent areas (Flexer et al., 1986), providing evidence for multiple smaller scale frequencies in sea level change in the study area. According to Ghorab (1961), the Upper Cretaceous rocks in the Sinai and Gulf of Suez region are classified into five formations: the Raha and Abu Qada formations (Cenomanian), the Wata Formation (Turonian), the Matulla Formation (Coniacian–Santonian) and the Sudr Chalk (Campanian–Maastrichtian).

In Egypt, the Cenomanian rocks were generally deposited in a transgressive sea. In northern Sinai, these rocks are mainly represented by carbonates, whereas in the southern parts, siliciclastics are present (Kora et al., 1994). The Turonian rocks conformably overlie the Cenomanian succession and unconformably underlie the Coniacian rocks.

Saber (2002) subdivided the Raha and Abu Qada formations in west central Sinai into four depositional sequences. Four depositional sequences have also been recognized for the Cenomanian–Turonian rocks in Wadi Feiran, southwestern Sinai (Ismail, 2002). Bachmann et al. (2003) studied the Upper Aptian–Middle Cenomanian carbonates of northern Sinai. They picked sequence boundaries by the presence of rhizoliths, karstification emergence horizons and characteristic facies changes that indicated flooding events.

Saber et al. (2009) studied the Middle Cenomanian–Turonian rocks in northern Sinai and determined five transgressive–regressive sequences that represent a shallow carbonate shelf. Anan et al. (2013) recognized four depositional sequences in the Raha and Abu Qada formations. They stated that the main factor controlling the lateral and vertical distributions of facies tracts was likely changes in the relative sea level.

The present work aims to investigate the depositional environments of the Cenomanian–Turonian succession, determines sequence boundaries, and improves sequence stratigraphy on the basis of detailed sedimentological investigations.

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http://dx.doi.org/10.1016/j.sedgeo.2014.04.006
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2. Material and methods

Two complete sections were selected at the well-developed Cenomanian–Turonian succession of Gabal Esseilah and Gabal Nezzazat (Fig. 1). The studied sections were sampled and described bed by bed for lithological changes (Fig. 2) and sedimentary structures. Macrofossils were collected from the well-defined oyster banks (Fig. 3). Two hundred and seven rock samples were obtained; detailed petrographic examination of 75 thin sections allowed the determination of microfacies. Limestone microfacies were described following the classification of Dunham (1962) with the modifications of Embry and Klovan (1972). The sandstone microfacies were described following the classification of Pettijohn et al. (1987).

3. Lithostratigraphy

3.1. The Raha Formation

The Raha Formation is well exposed in the two studied sections, ranging in thickness between 47 m in Gabal Esseilah and 60 m in Gabal Nezzazat. The Raha Formation overlies the continental Lower Cretaceous Malha Formation (Kora and El-Beialy, 1989) and underlies the Abu Qada Formation. A pronounced unconformity exists between the Raha Formation and the Malha Formation (Fig. 3a, b). The Raha Formation comprises two members, lower (Abu Had) and upper (Mellaha Sand). The Abu Had Member is the major constituent of the Raha Formation. Its thickness ranges from 38 m in Gabal Esseilah to

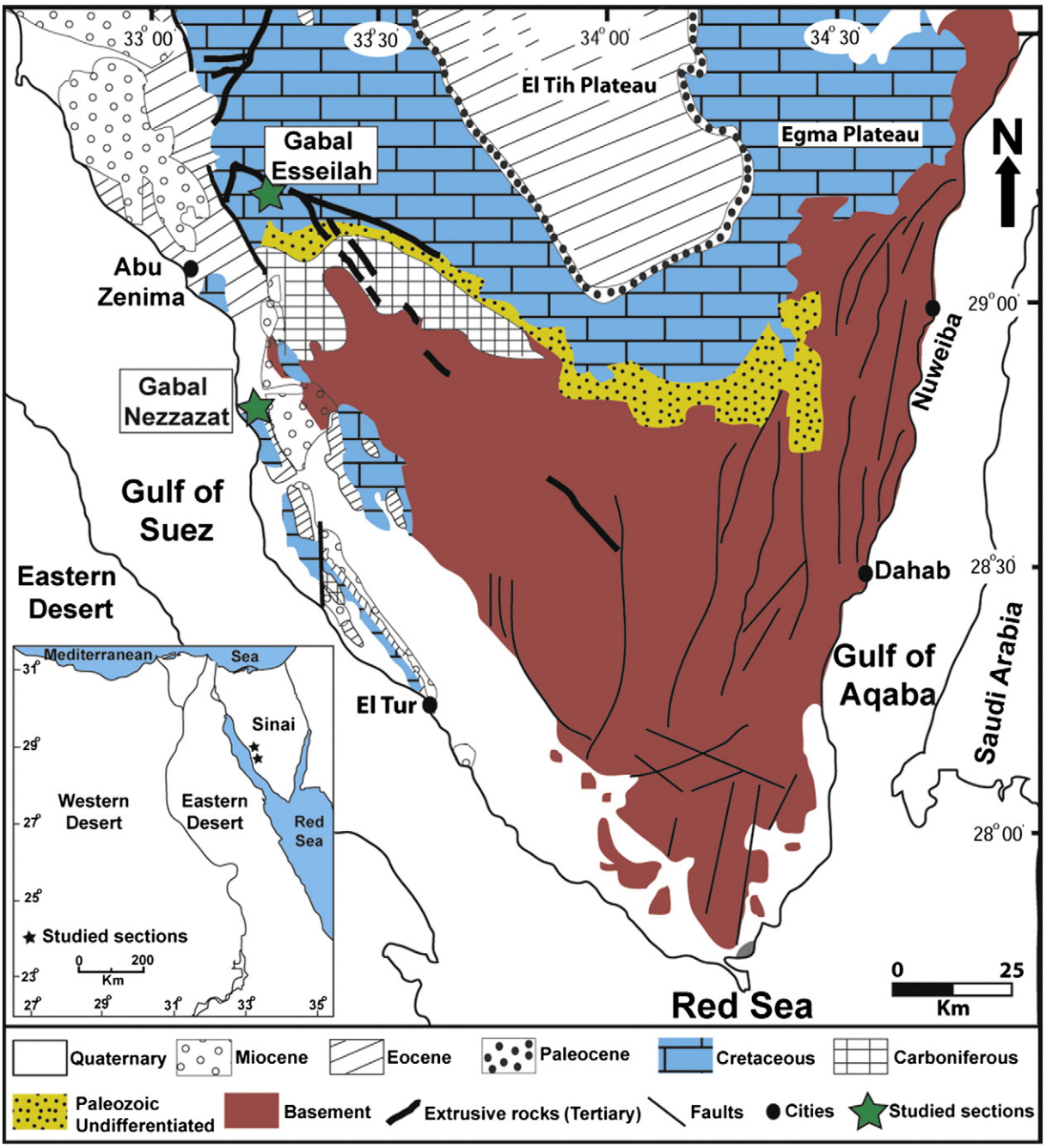

Fig. 1. Geologic map of central and southern Sinai showing location of the studied sections. Modified after the Geological Survey of Egypt (1994).

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