Journal of African Earth Sciences 95 (2014) 22–40

Contents lists available at ScienceDirect

Journal of African Earth Sciences

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

Physiographic discontinuity along the Levant-Margin hinge-belt of the Arabian Plate (Late Cenomanian, northern Israel)

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ARTICLE INFO

Article history:
Received 8 September 2013
Received in revised form 26 January 2014
Accepted 26 February 2014
Available online 12 March 2014

Keywords:
Levant Margin
Hinge-belt
Mid-Cretaceous
Northern Israel
Mass transport

ABSTRACT

The paleo-depositional hinge-belt of the Levant is a zone of rapid proximal-to-distal carbonate facies transitions that defined the western edge of the passive Mesozoic Levant Margin of the Arabian Plate. It was striking parallel to the present day Mediterranean coastline, from northern Sinai to northern Lebanon, but in the mid-Cretaceous a "gap zone", in which the facies transitions are unclear, extended from northern Israel to southern Mt. Lebanon. This study examines the paleo-physiography and sedimentary evolution in this "gap zone" in the Late Cenomanian of northern Israel. The sedimentary evolution in this region is reflected by five genetic–stratigraphic units representing systems tracts, which were proximal in the Galilee region to the north and distal to the SSW in the Carmel region. During the early Late Cenomanian a carbonate ramp sloped gently from the Galilee towards the Carmel region. Later in the Cenomanian the Galilean part of the ramp was strongly uplifted and faulting enhanced the topography of this region. A steep SSW-facing slope was formed in the Galilee, subdivided into extensional basins tens to hundreds of meters in length. Carbonate sand filled these small basins and was mass-transported further downslope, forming sheeted calciturbidites to the south in the Carmel region. This depositional phase terminated in sea-level fall and subaerial exposure. During the latest Cenomanian, faulting was renewed in the Galilee region, muddy carbonate was deposited on the slope and shelf, and debrites and slides were mass-transported downslope as far as the Carmel region. This depositional phase ended by a second episode of subaerial exposure that was followed by Early Turonian sea-level rise. The direction of mass transport in this region and the trend of proximal-to-distal facies transitions, as well as the strike of the Cenomanian faults, indicate that the depositional strike of the Levantine hinge-belt shifted in this region toward the east, departing markedly from the general NNE–SSW Levantine trend.

1. Introduction

The Mesozoic Levant Margin of the western Arabian Plate was shaped by Late Permian, Middle to Late Triassic and Early Jurassic extensional faulting related to rifting (Garfunkel and Derin, 1984; Garfunkel, 1998). During the Mid-Jurassic to Late Cretaceous a passive margin tectonic regime prevailed in the Levant and the western side of the Levant Margin was bounded by the Levantine hinge-belt (Fig. 1A), a paleo-depositional zone of NNE–SSW striking facies belts across which rapid E–W platform-to-basin facies transitions occurred. Gardosh et al. (2011) recently showed that the width of this transitional zone in the southern coastal plain of Israel is 10–20 km. This major tectono-sedimentary zone governed facies transitions on the western edge of the Levant Margin during most of the Mesozoic (Gvirtzman and Klang, 1972; Bein and Gvirtzman, 1977; Walley, 1998).

During the Albian–Cenomanian, sharp facies transitions from proximal carbonates of the Judea Group to the east, into basinal marls, chalks, and calciturbidites of the Talme-Yafe Group to the west, occured across the Levant hinge-belt (Bein and Weiler, 1976). Walley (1998) recognized two segments in the hinge-belt (Fig. 1A). A southern segment extended parallel to the path of the present day coastline from northern Sinai to the Carmel region (Gvirtzman and Klang, 1972; Bein and Weiler, 1976; Bein and Gvirtzman, 1977; Sass and Bein, 1982; Ross, 1992; Bauer et al., 2003) and a northern segment extended along the present western Lebanon flexure sub-parallel to the central and northern Lebanees coast. In between these segments the NNE–SSW striking facies belts typical of the Levantine hinge-belt, are absent in the sector north of the southern Carmel region that includes the Galilee and southern Mt. Lebanon. Mid-Cretaceous carbonates in this region

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http://dx.doi.org/10.1016/j.jafrearsci.2014.02.013
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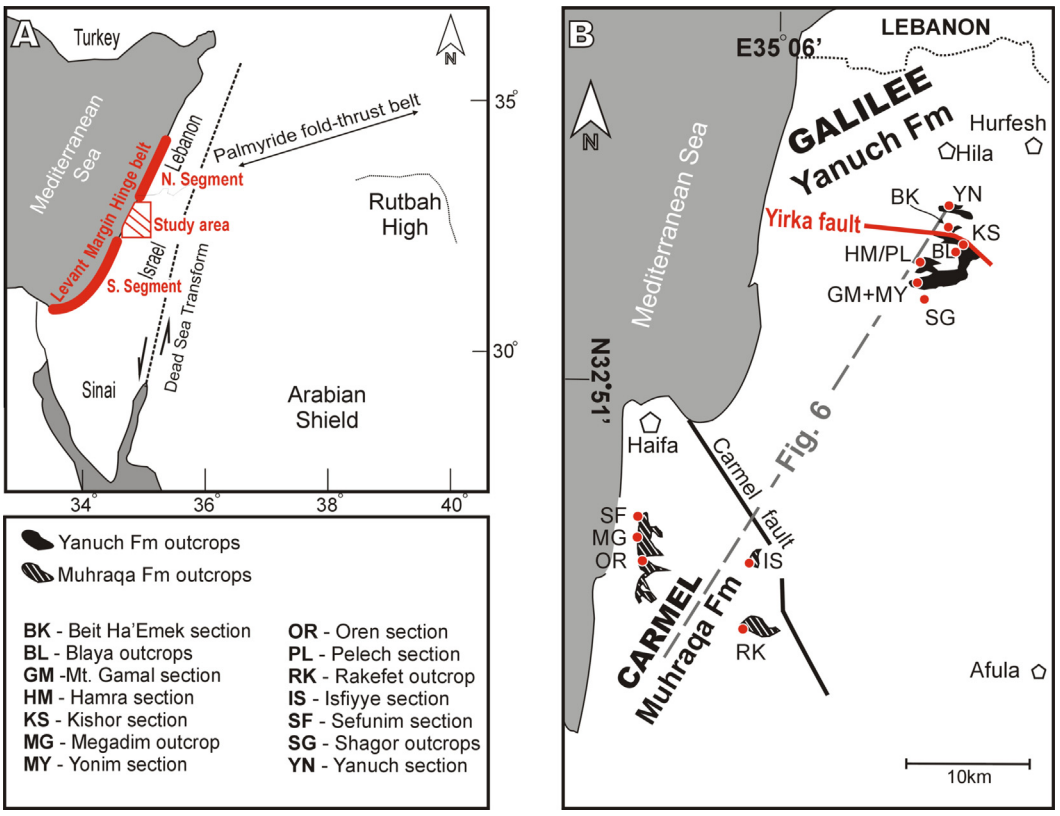

Fig. 1. (A) Location of the study area in the framework of the Levant Margin and the Arabian Plate. The paleo-depositional hinge-belt of the mid-Cretaceous Levant Margin is marked red. (B) Map of the Galilee and Carmel regions with location of studied outcrops and measured sections of the Yanuch and Muhraqa formations. Dashed line marks the traverse shown in Fig. 6. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

(Freund, 1965; Kafri, 1972; Saint-Marc, 1974; Sass and Bein, 1982) were described as a broad, shallow-water carbonate platform traversed by narrow intra-platformal basins. For this region, Walley (1998) introduced the concept of a "gap" in the paleo-depositional trend of the hinge-belt, but no sedimentological and genetic stratigraphic studies have verified it. The goal of the present study is to reconstruct the paleo-physiography and the sedimentary and structural evolution of this postulated gap zone in northern Israel during the Late Cenomanian.

The Late Cenomanian succession of northern Israel is largely represented by the Yanuch Formation in the Galilee region and the Muhraqa Formation in the Carmel region (Fig. 1B). These formations are rich in grainstone (calcarenite) that form steeply dipping clinoformal bodies, horizontally-bedded grainstone successions, and discordant internally deformed limestone megablocks. Accordingly, we hypothesize that the genesis and sedimentary evolution of the carbonate system in this region involved mass movements of carbonate grains, accumulation of allodapic carbonates (*sensu* Meischner, 1964), and faulting. Mass movement deposits would mark the location and trend of the depositional slope and could have formed in response to Cenomanian faulting affecting the configuration of the Levant Margin paleo-depositional hinge-belt in this region.

In order to test this hypothesis, the Cenomanian depositional pattern was reconstructed by defining the variety of mass-transport and autochthonous facies-types. Secondly, the genetic stratigraphy and cyclic patterns were explored. Thirdly, the relationships between the genetic units were defined in the field, and the effect of Late Cenomanian faulting on the sedimentary system was determined. Lastly, regional data were integrated in order to reconstruct the mid-Cretaceous paleo-physiography in this region.

2. Procedure and methods

2.1. Field sedimentology and microfacies of carbonate rocks

Fourteen stratigraphic sections in the Galilee and Carmel regions form the sedimentological database for this study (Fig. 1B). The stratigraphic sections were described in the field, measured bed by bed, and sampled for thin-section and microfacies analysis. The Yanuch Formation of the Galilee region was sampled in outcrops in the Yanuch Valley (YN), Beit-Ha'Emek Valley (BK), Kishor (KS), Blaya (BL), Hamra Valley (HM), Pelech (PL) and near Mt. Gamal (GM) (Fig. 1). The Muhraqa Formation of the Carmel was sampled in roadcuts at Isfiyye (IS), in the Sefunim quarry (SF), Oren Valley (ORN), Rakefet Valley (RK) and Megadim Valley (MG) (Fig. 1). The high quality of the outcrops facilitated detailed documentation of stratal geometries including identification of sedimentary structures. The laboratory procedure included microscope-based identification of skeletal and non-skeletal grains from about 350 thin sections. Limestone classification followed Dunham (1962) and Embry and Klovan (1971). Microfacies terminology broadly followed Tucker and Wright (1990) and Flügel (2004). Beds were classified by their sedimentological attributes into facies-types, and ascribed to paleoenvironments following Read (1985) and Burchette and Wright (1992). The definition of facies types set the stage for the sequence stratigraphic analysis.

2.2. Sequence stratigraphy

The sequence stratigraphic analysis used in this study stressed "model independent aspects" (Catuneanu et al., 2009) of the