Sedimentary Geology 329 (2015) 28–39

Contents lists available at ScienceDirect

Sedimentary Geology

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

Levant jet system—effect of post LGM seafloor currents on Nile sediment transport in the eastern Mediterranean

U. Schattner [a,*], M. Gurevich [a], M. Kanari [b], M. Lazar [a]

[a] Dr. Mosses Straus Department of Marine Geosciences, Leon H. Charney School of Marine Sciences, University of Haifa, Mount Carmel 31905, Israel
[b] Israel Oceanographic and Limnological Research, Haifa 31080, Israel

ARTICLE INFO

Article history:
Received 4 July 2015
Received in revised form 16 September 2015
Accepted 18 September 2015
Available online 28 September 2015

Editor: Dr. B. Jones

Keywords:
Continental shelf
Seafloor currents
Shelf break jet
Contourite currents
Nile
Eastern Mediterranean

ABSTRACT

Sedimentary development of a continental margin is directly related to seafloor current dynamics. Yet the linkage between the processes remains vague due to the different time scales they represent. To narrow this gap we focus on the thoroughly studied distribution system of Nile derived sediments across the Levant continental margin (eastern Mediterranean). These sediments dominate the Late Quaternary stratigraphy of the entire margin. Their mobilization has been explained exclusively by longshore transport, while oceanographic evidence from the basin and margin are not incorporated in the known mechanism. New data indicates that longshore mechanism is part of a much larger system. Based on integrated interpretation of multibeam bathymetry, high-resolution single-channel seismic reflection and oceanographic (temperature, salinity and chlorophyll) data we suggest a jet current system mobilizes the Levant Surface Water (LSW), Levant Intermediate Water (LIW) and Atlantic Water (AW) northwards along the margin, between 0 and 400 m water depths. On the seafloor, contourite currents form elongated along-strike morphologies. Below 400 m along-dip gravity flows dominate sediment transport to down the slope, below the Eastern Mediterranean Deep Water (EMDW). Initiation of this mechanism during the Pleistocene–Holocene transition and not at the end of the Last Glacial Maximum (LGM) indicates a gradual recovery of the thermo-haline circulation. Current intensification in the early Holocene may have also increased water stratification. This comprehensive mechanism explains sediment transport along the entire depth range of the continental margin, while integrating seafloor currents, morphology, as well as their relation to sea level rise and stratigraphy of water masses in the Levant basin since the LGM. Given the consistency of seafloor currents throughout the Holocene we propose to address them as the Levant Jet System.

1. Introduction

Sedimentary development of a continental margin is directly related to seafloor current dynamics. Formation of sedimentary patterns and the degree of their preservation are driven by physical (e.g., direction, velocity) and temporal (e.g., seasonal, annual) variations of the currents (e.g., Trincardi et al., 2007). However, while sediments record the geological past oceanographic measurements represent present-day conditions. Given the oceanographic variability, deduction on its influence on past accumulation/erosion budget is not straightforward. It requires knowledge of key variables such as sediment source, mode of supply over geologic times, its consistency, stratigraphic patterns, their age constraints and correlation to sea level stages. Deduction also requires key oceanographic variables—present-day water masses, their mobilizing currents, and their velocities. The aim of this study is to provide a comprehensive understanding of the interaction between sediment transport and deposition and bottom oceanographic currents. Due to large amount of variables in such a correlation the eastern Mediterranean was chosen as a case study because many of these are well constrained.

1.1. Geological settings

Nile derived sediments dominate the Late Quaternary stratigraphy of the Levant continental margin, eastern Mediterranean (Figs. 1, 2). Their ubiquitous distribution extends from the shallowest continental shelf to the base of the continental slope down to a water depth of ~1 km. Their continuing supply is distributed northwards across the margins by anti-cyclonic circulation (Buchbinder et al., 1993; Ben-Gai et al., 2005). These homogeneous allochthonous terrigenous siliciclastic sediments settle along the northern Sinai and southern Levant margins (Coleman et al., 1981; Inman and Jenkins, 1984; Stanley, 1989; Frihy et al., 1991; Frihy and Lotfy, 1997; Almagor, 2000; Zviely et al., 2007; Hyams-Kaphzan et al., 2008), and coasts (Goldsmith and Golik, 1980; Rohrlich and Goldsmith, 1984; Carmel et al., 1985; Perlin and Kit, 1999).

The Carmel Structure extends across the central part of the margin, over 10 km (Fig. 2; Garfunkel and Almagor, 1985; Ben-Gai and Ben-Avraham, 1995; Schattner et al., 2006). This elevated bedrock structure (~25 m water depth) obstructs northward sediment transport

* Corresponding author.
E-mail address: schattner@sci.haifa.ac.il (U. Schattner).

http://dx.doi.org/10.1016/j.sedgeo.2015.09.007
0037-0738/

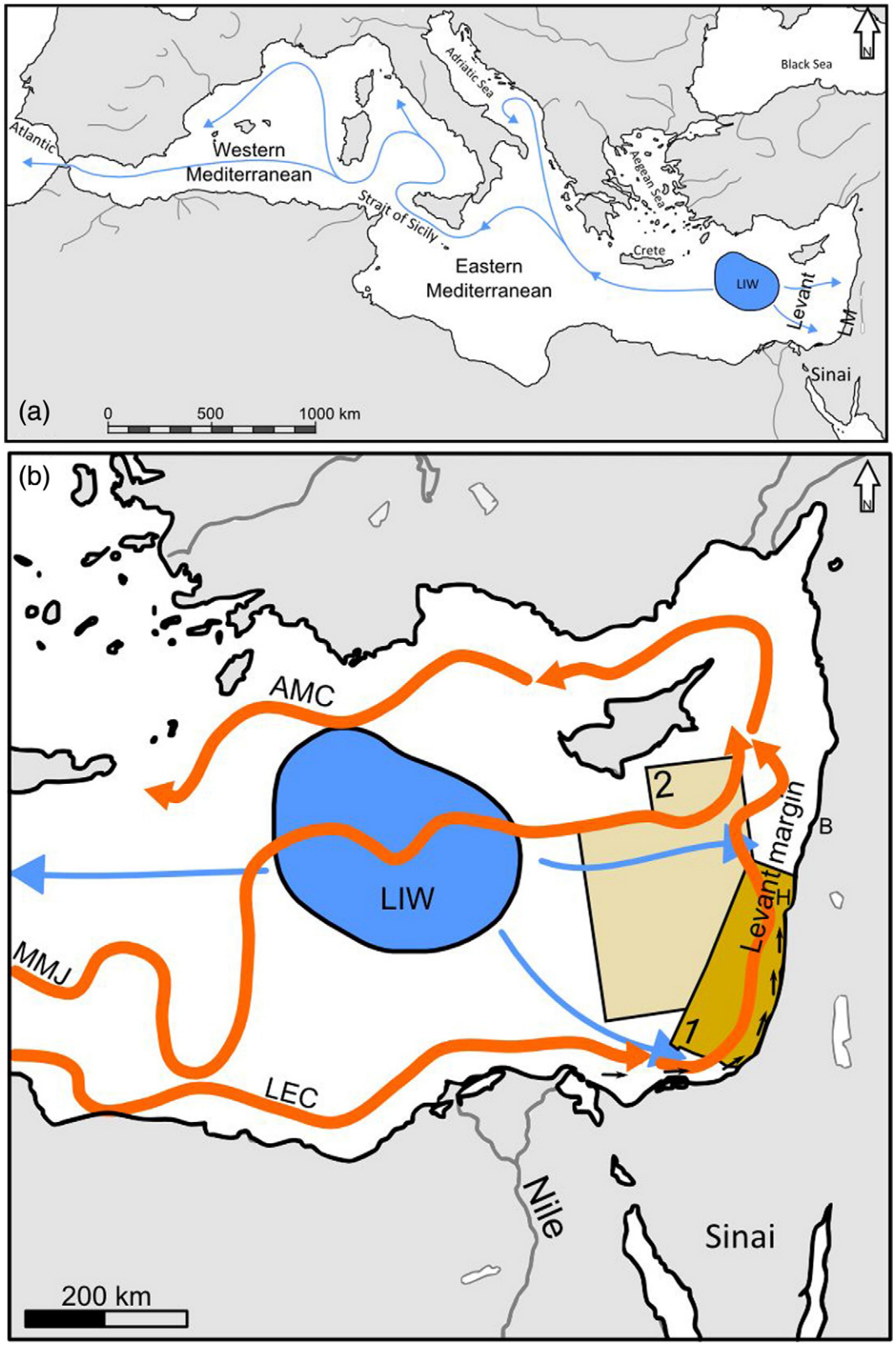

Fig. 1. (a) Origin and migration path of the Levantine Intermediate Water (LIW) across the Mediterranean and into the Atlantic. (b) Close-up of the eastern Mediterranean, showing the LIW. In orange, currents transferring the Atlantic Water mass (AW): Libyo-Egiptian Current—LEC, Mid-Mediterranean Jet—MMJ, Asian Minor Current—AMC (after Malanotte-Rizzoli et al., 2014): (1) marks the location of the current study, (2) extent of Hecht et al. (1988), H—Haifa Bay, B—Beirut.

(e.g., Goldsmith and Golik, 1980). Sediments that bypass this structure accumulate in Haifa Bay, the northernmost limit of the Nile Littoral Cell (Pomerancblum, 1966; Nir, 1980; Inman and Jenkins, 1984; Almagor, 2000; Zviely et al., 2006, 2007; Avnaim-Katav et al., 2012). Slope canyons that appear from the Carmel Structure northwards, channel surplus supplies to the deeper basin (Almagor, 2000). North of Haifa Bay, the shelf narrows from 3 km until disappearing off Beirut, while its slope steepens (Ben-Avraham et al., 2006; Carton et al., 2009).