Stratigraphy of the Messinian Sequences in the Deep Basin Setting of the Eastern and Western Mediterranean Basin*

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Abstract

Through several examples taken from both Eastern and western Mediterranean Sea, we show that the clastic input caused by sea level drop and marginal erosion, is not distributed evenly in space and time but is mainly localized in the lower section of the Messinian Salinity Crisis depositional megasequence. Significant similarities around the basin allow us to propose a global Messinian megacycle depositional scheme with system tracts deposited in three stages(1) a falling stage with marginal erosion, an important shift of depocenters towards the basin and a basinal early lowstand characterized by huge clastics deposition localized in front of major Messinian rivers (Rhone,Nile, Antalia gulf rivers) or smaller tributaries (offshore south Lebanon). These clastics are deposited in an oversaturated (salt) basin as shown by the interfingering evaporites and clastics facies. (3) An Upper "transgressive" or late lowstand system tract constituted by halite, dolomitic marls, gypsum and sands in the distal part of the margins and the deep basin. This Messinian megasequence is a logical consequence of a tectonic-eustatic isolation and reflooding of the Mediterranean basin. These results provide a new basis for discussion not only for the development of the Messinian Salinity Crisis but also for the reconstruction of the subsidence history of Mediterranean deep Basins. moreover, deposits related to the MSC in the deep offshore act as a major component of the petroleum system with thick extensive sandstones or mass transport complexes with evaporites, sealed by messinian evaporites and sourced by messinian or older source rocks.

This presentation is from a paper accepted for publication, "New imaging of the salinity crisis: Dual Messinian lowstand megasequences recorded in the deep basin of both the eastern and western Mediterranean, christian Gorini, Lucien Montadert and Marina Rabineau, in "Messinian events and hydrocarbon exploration in the Mediterranean", Marine and petroleum geology, special edition Editors Suc J.P., Bache F., Cagatay N., Csato I."

References Cited

Bertoni, C., and J.A. Cartwright, 2007, Messinian (late Miocene) intra-evaporitic fans in the eastern Mediterranean: evidence from 3D seismic data: in B.C. Schreiber, S. Lugli, and M. Babel, (eds), Evaporites through Space and Time: Geological Society of London, Special Publication 285, p. 37–52.

Dümmong, S., and C. Hübscher, 2011, Levant Basin – Central Basin: in Atlas of the Messinian seismic markers in the Mediterranean and Black Seas, J. Lofi, J. Déverchère, V. Gaullier, H. Gillet, C. Gorini, P. Guennoc, L. Loncke, A. Maillard, F. Sage et I. Thinon (eds), Mém. Soc. Géol. Fr., 179, and World Geological Map Commission, 72 p.

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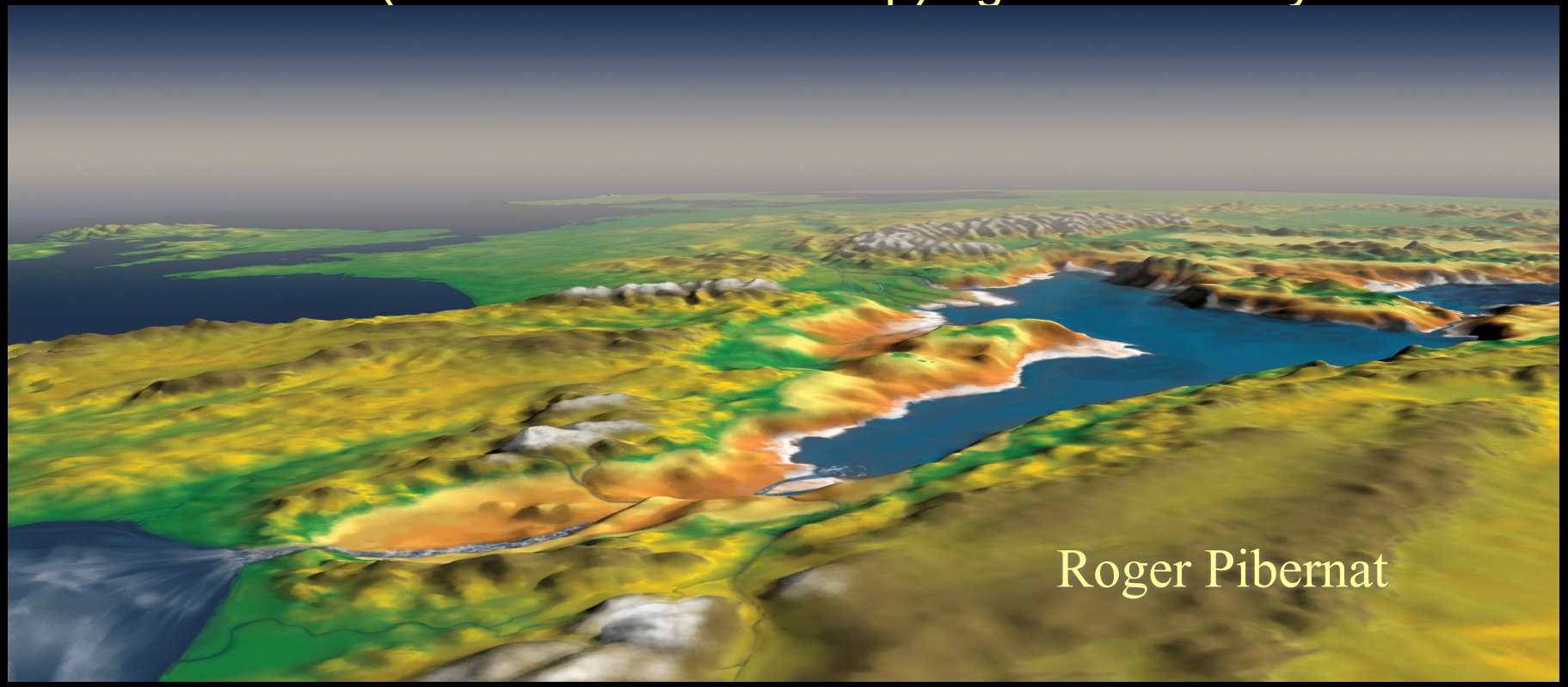
The Mediterranean Messinian salinity crisis (5.96/5.33) :
Extreme event (1500 m sea level drop) / giant salt body



By several examples in the Messinian deep basins showing that the clastic input due to the sea level drop and the subsequent erosion of the margins, is not distributed evenly through time but localized in the lower part of the interval (Eastern basin and Northwestern basin).

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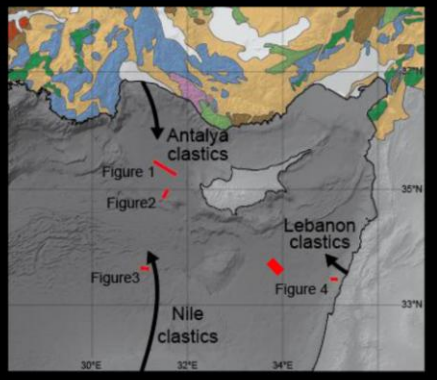
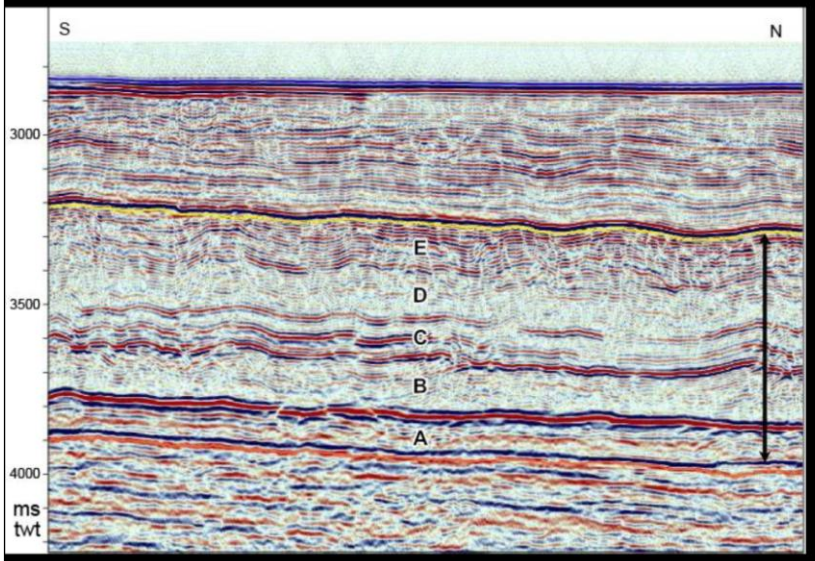
Levantine Basin

Relatively far from the sources of major Messinian clastic materials.

5 major sequences visible in the Messinian evaporitic section about 1500 m thick.





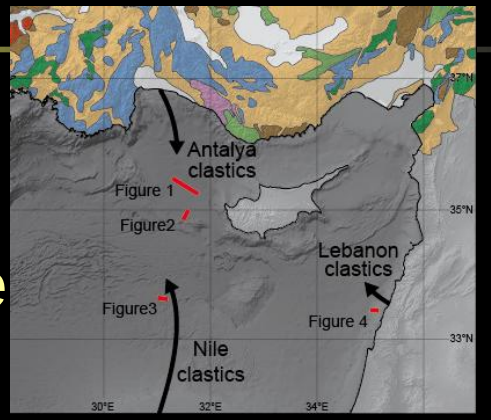
Evaporitic section is heterogeneous.

Necessity to have continuously inputs of sea water to have thick evaporitic deposits.

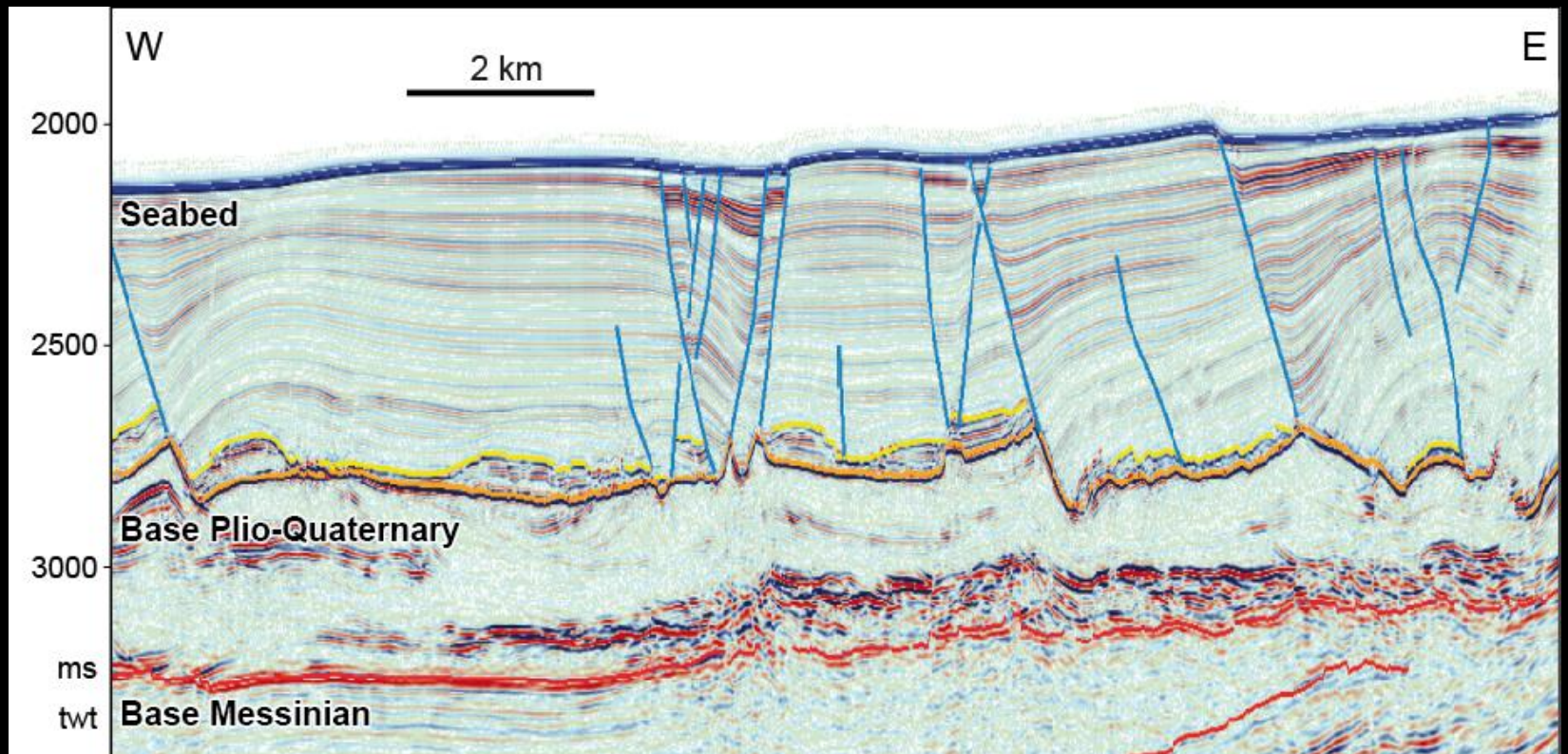
Large extend of this sequential organization as shown by regional studies of the Levant Basin. Bertoni and Cartwright (2007); Dummong and hübscher (2011)

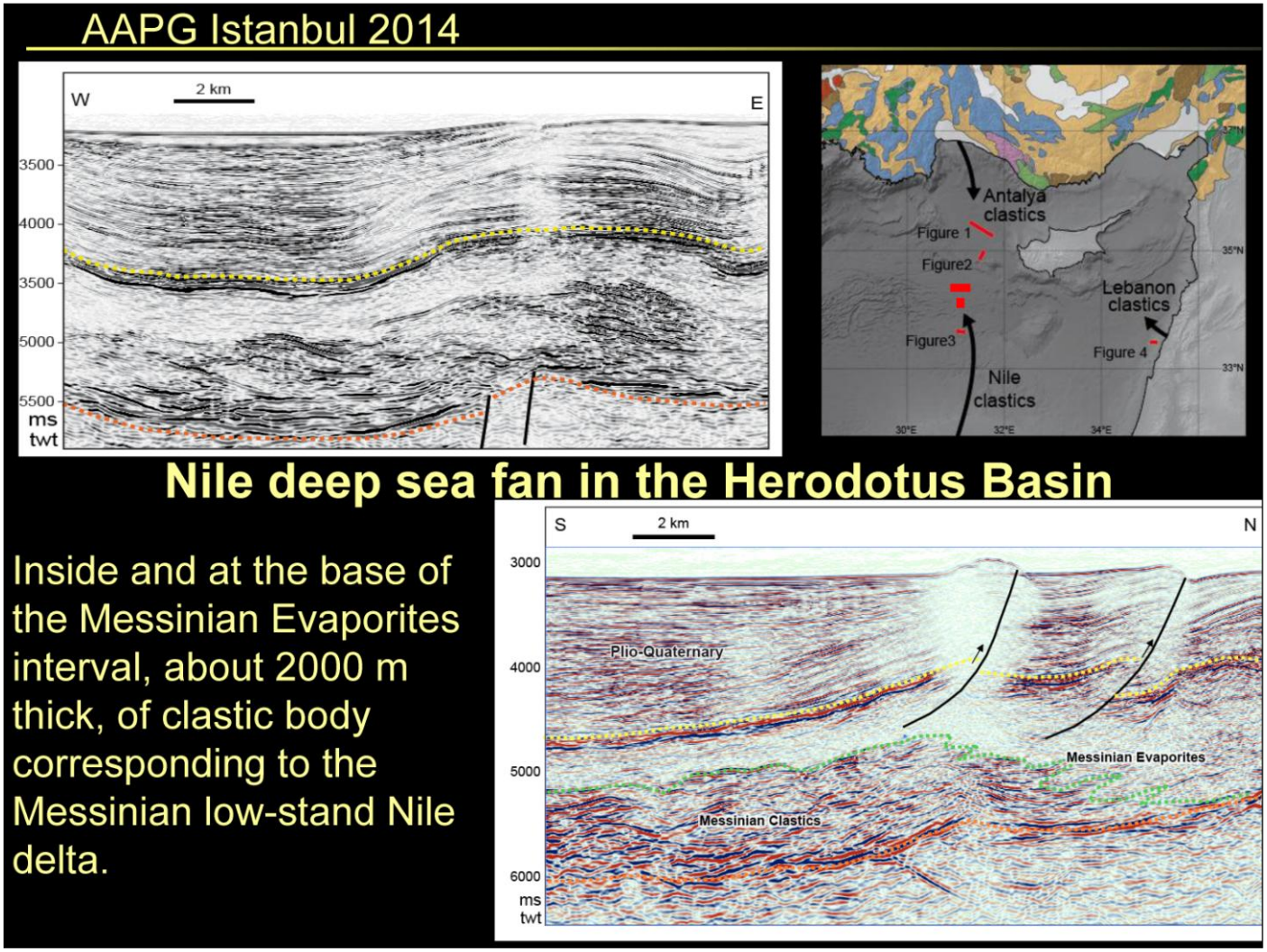
Presenter's notes: Seismic Stratigraphy of the Messinian Evaporites is in general difficult to apprehend because they have been frequently subject to internal deformations due to their ductility. Therefore, to be able to get information on the stratigraphy of the Evaporites, it is necessary to have seismic profiles in areas where the Evaporites stood relatively undeformed. The Levant Basin in the Eastern Mediterranean is a very favorable location for such observations.

Lebanon margin



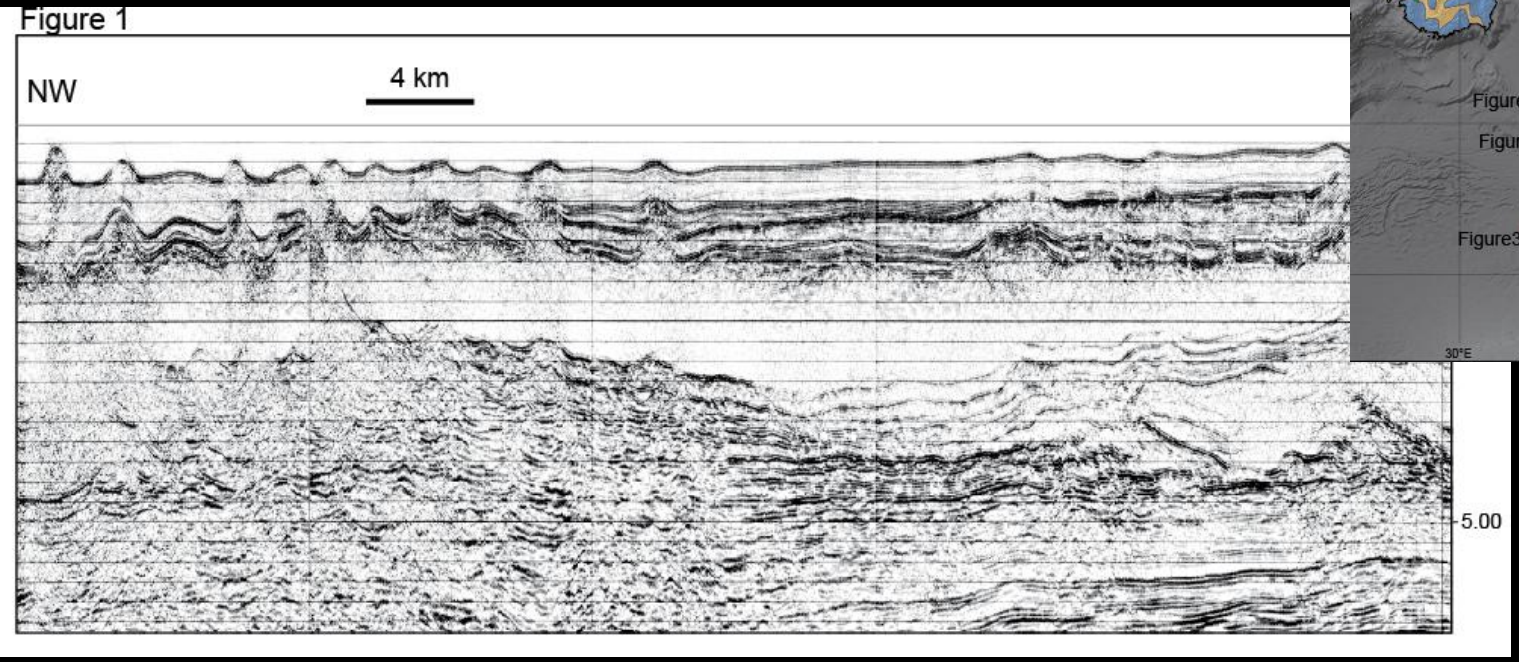
The area is characterized onshore by short river systems due to coastal important reliefs which are mostly made of carbonates. The clastic input is therefore limited. Clastics are localized in the lower half of the Evaporites interval (and on the upper margin).

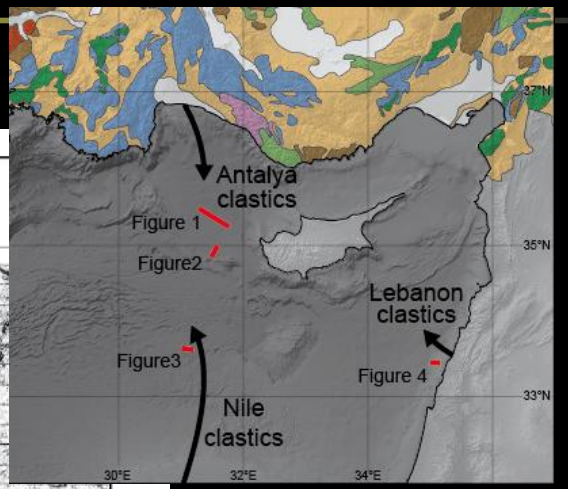




Presenter's notes: It is the opposite case compared to Lebanon. Since the Oligocene, there has been a considerable influx of sediments deposited along the Egyptian Margin. The Messinian sea level drop increased the role of the Nile as a conduit for sediments and subaerial erosion affected large areas of the former Miocene Nile Cone. The seismic lines show that most of the sediments during this period and during the Plio-Pleistocene were diverted westward by the prominent Eratosthenes Continental Block. E-W profiles.

Antalya Basin

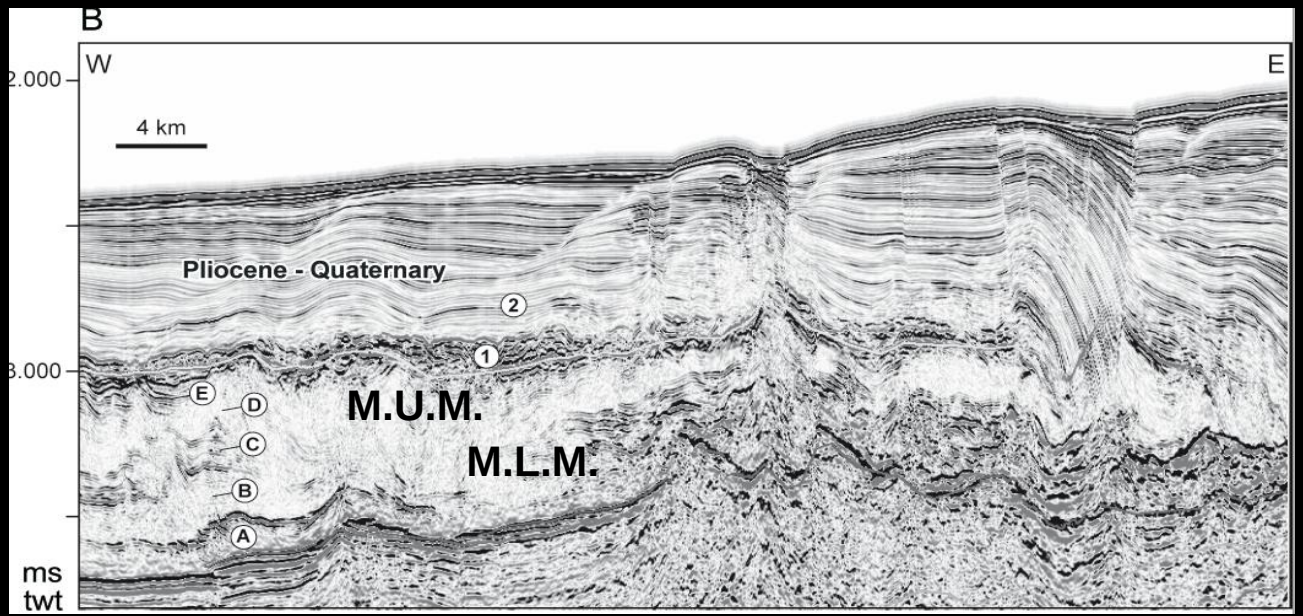




Why clastic input stopped?
"Transgression" of the upper part of the Evaporites on the margins? Climatic change ? Instantaneous (geological scale) precipitation of the upper salt?

From these examples: picking the base of the transparent layer (halite) as base of the Messinian episode would lead to a false interpretation in front of the big deltas.

Observations converge : The input of clastics linked to the Messinian sea level drop concerns a Lower Messinian Megasequence (**LMM**) corresponding to sequences A,B and C of the evaporites (type section of NW Levant Basin). Consequently the Messinian Upper Megasequence (**MUM**) of the Evaporites, corresponds to sequences D and E of the Levant type section, and can already be considered as a apparent transgressive system on the margins, stopping progressively the arrival of the clastic material.



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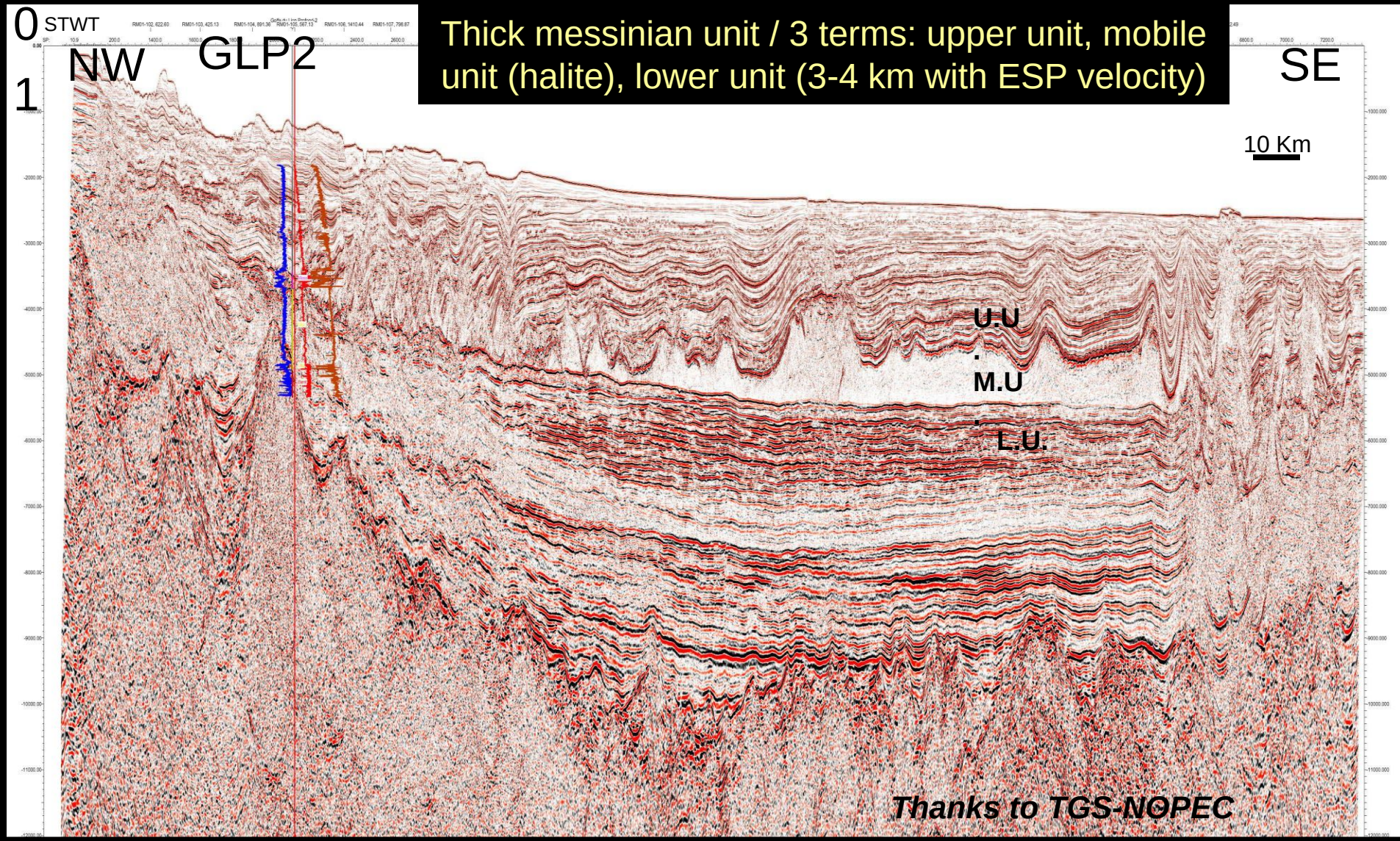
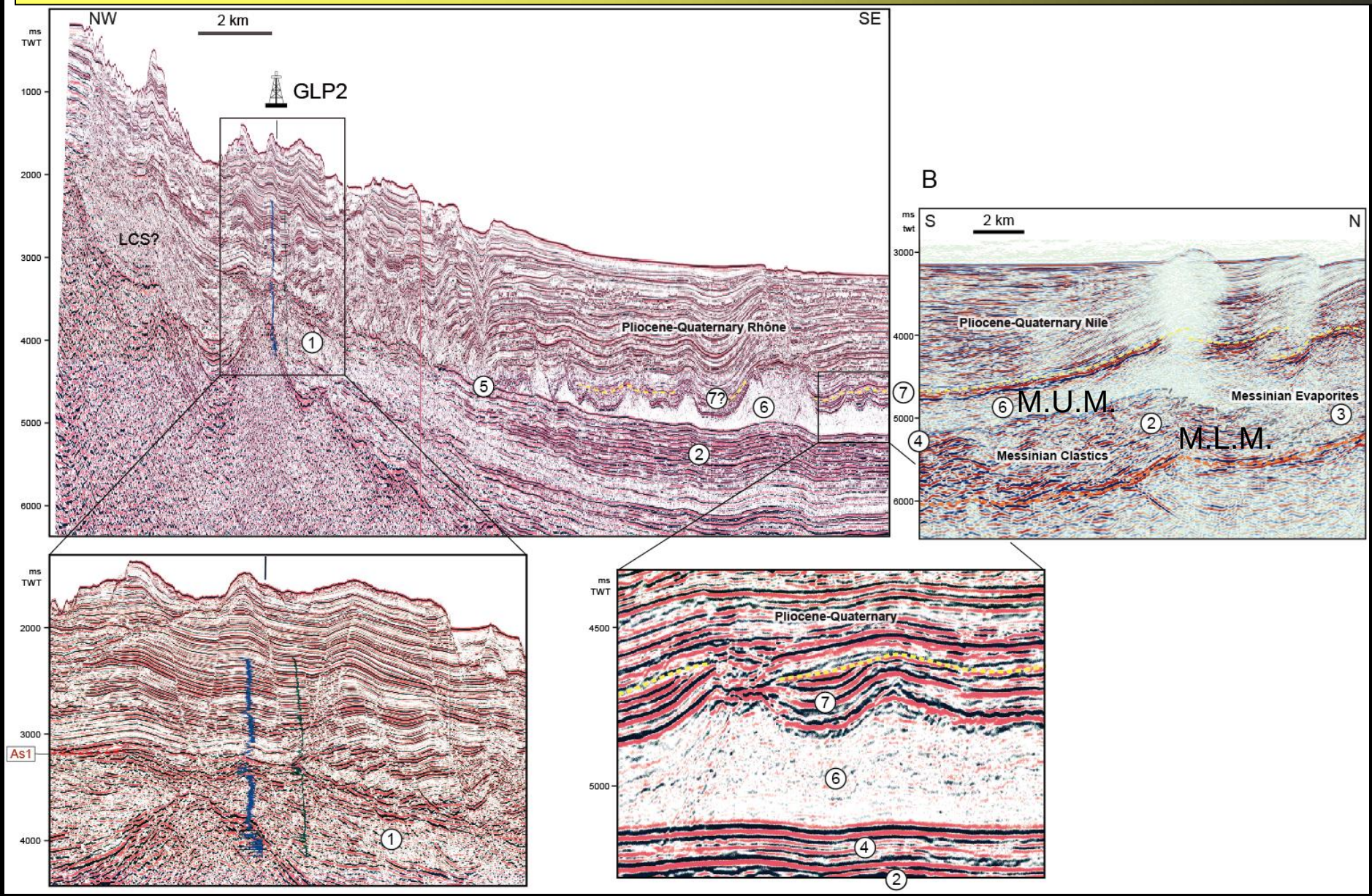
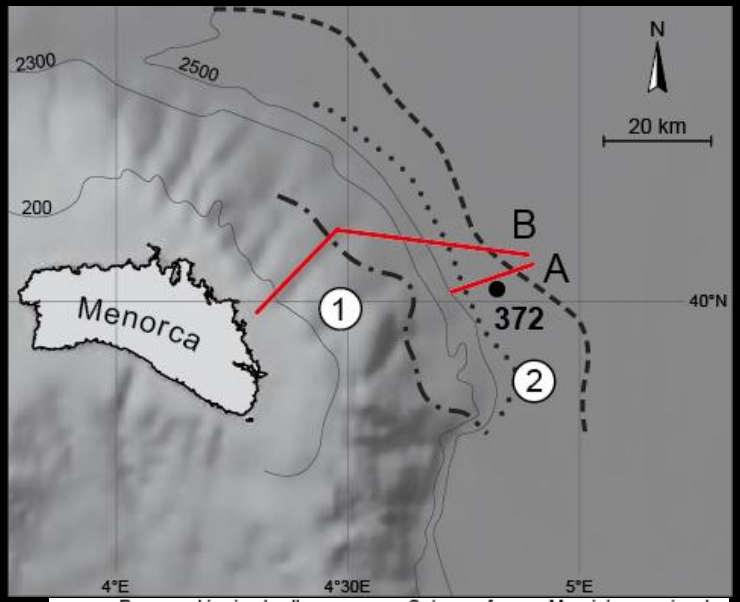


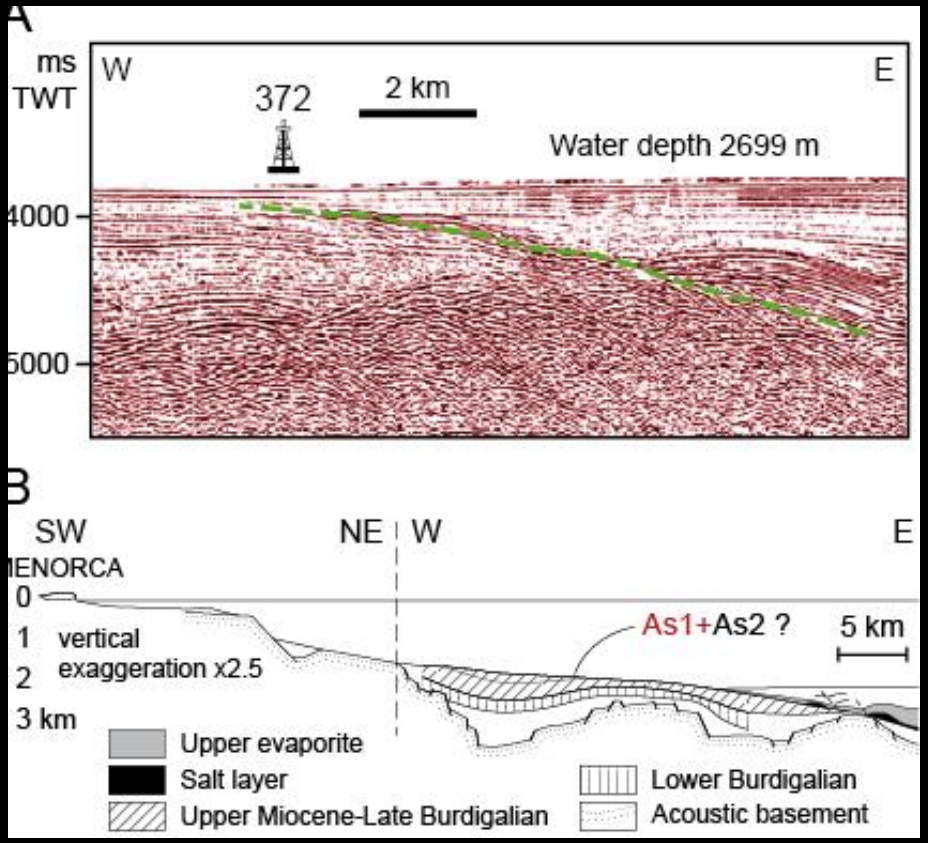
Same large increase of the sedimentary input in all deep basin in front of the big rivers in a hypersaline environment. (Rhône/Nil/Ebro?).

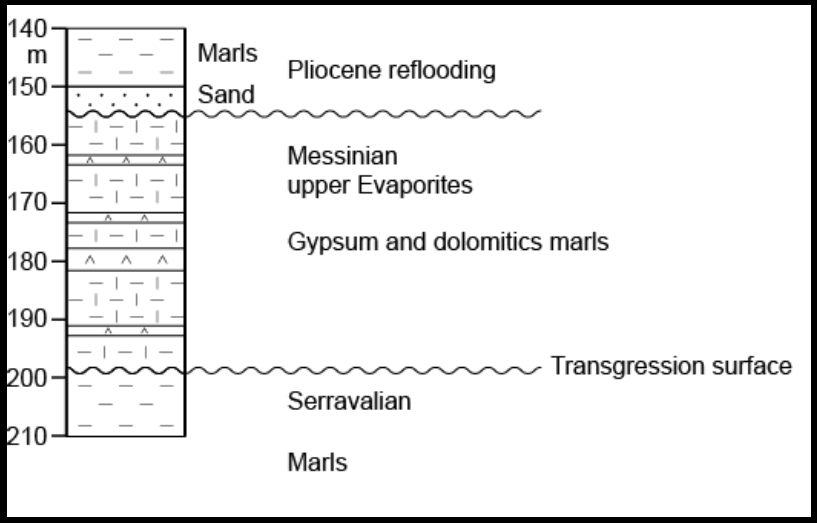


Rhone/Nil same scale: Lower Unit sensu largo,MLM, large increase of sediment input, hypersaline environment. MUM, Salt and gypsum

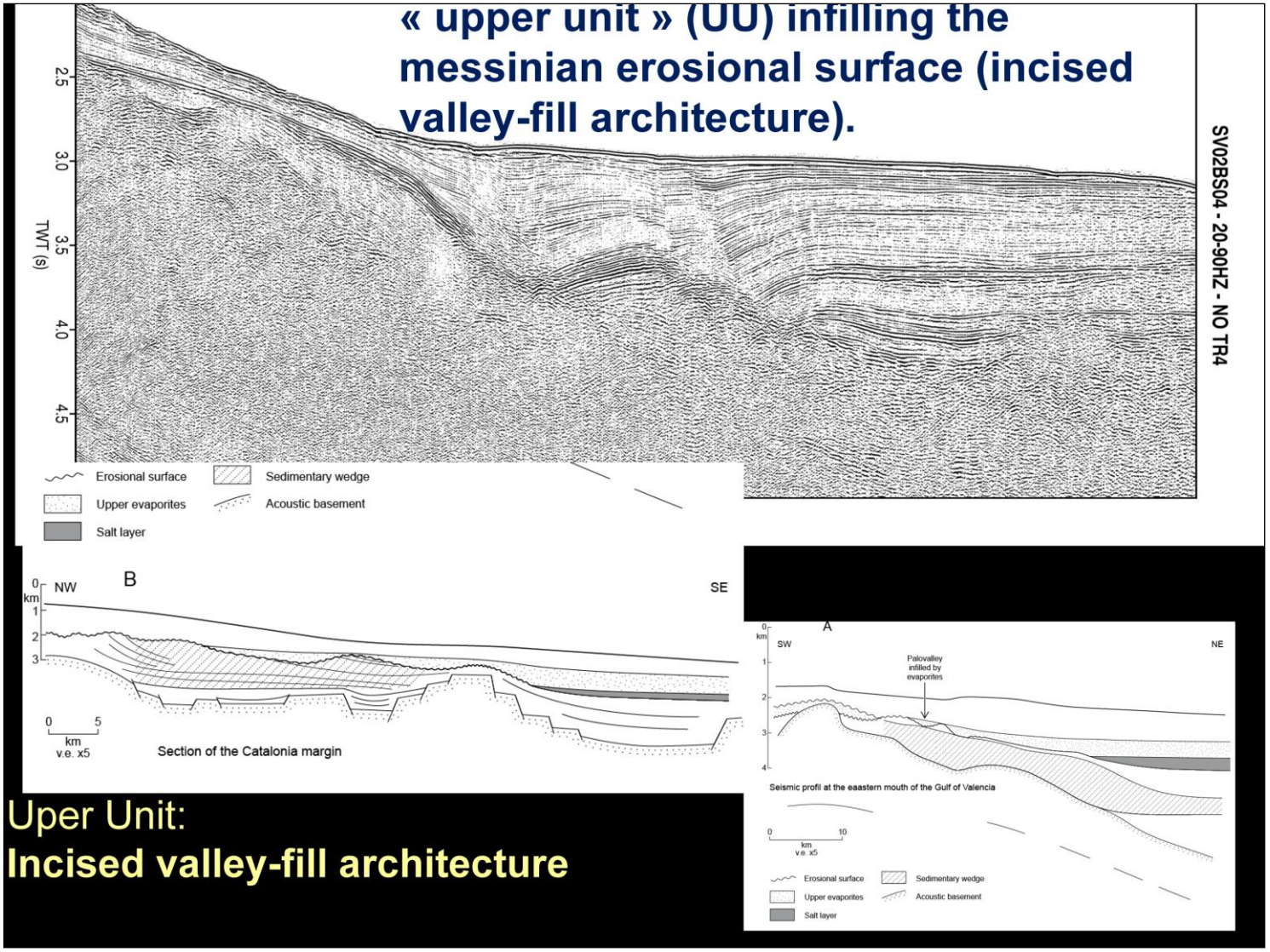
What do we learn from the deep sea drillings on the margins and/or isolated highs in the deep Basins?



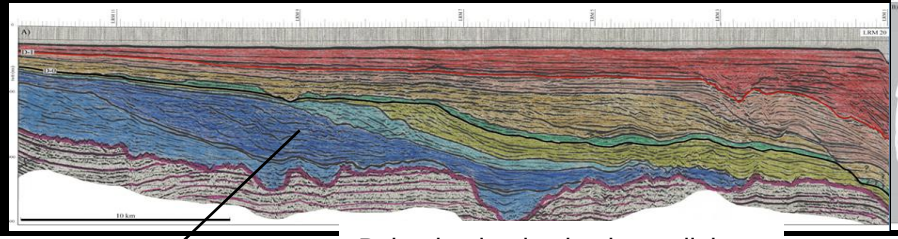


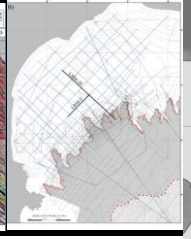


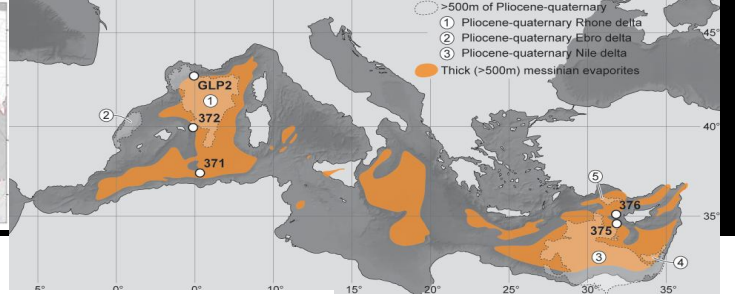
Site 372 on the eastern Menorca Rise (2699 m water depth) is sampling the Upper Unit (MUM top), made of alternations of gypsum beds and dolomitic marls, transgressive on the smooth Messinian maximum regressive erosional surface with a hiatus of the Tortonian. Coring indicates sand layer on top Messinian Evaporites;.



Presenter's notes: Section off the Catalan margin showing prograding regressive Miocene deposits and upper evaporites (UU) infilling the Intra-Messinian erosional surface (IVF).







Balearic-algerian basin-sardinian upper unit in sicilian basin

Valancia trough, Western Tyrrhenian, GOL Platform

Deep western basin, Eastern Mediterranean

1km

100 km

MES

AS

Sea floor

Peripherical Basin (Sorbas Basin)

Alboran Basins

PB

TES

MES

AS

Deep Basins (Eastern and Western)

Giant reflooding

sea level (m)

Ma

Globorotalia margaritae

Giant reflooding

+40m

5.33

5.42

?

Turning point

5.55

-1500m

5.60

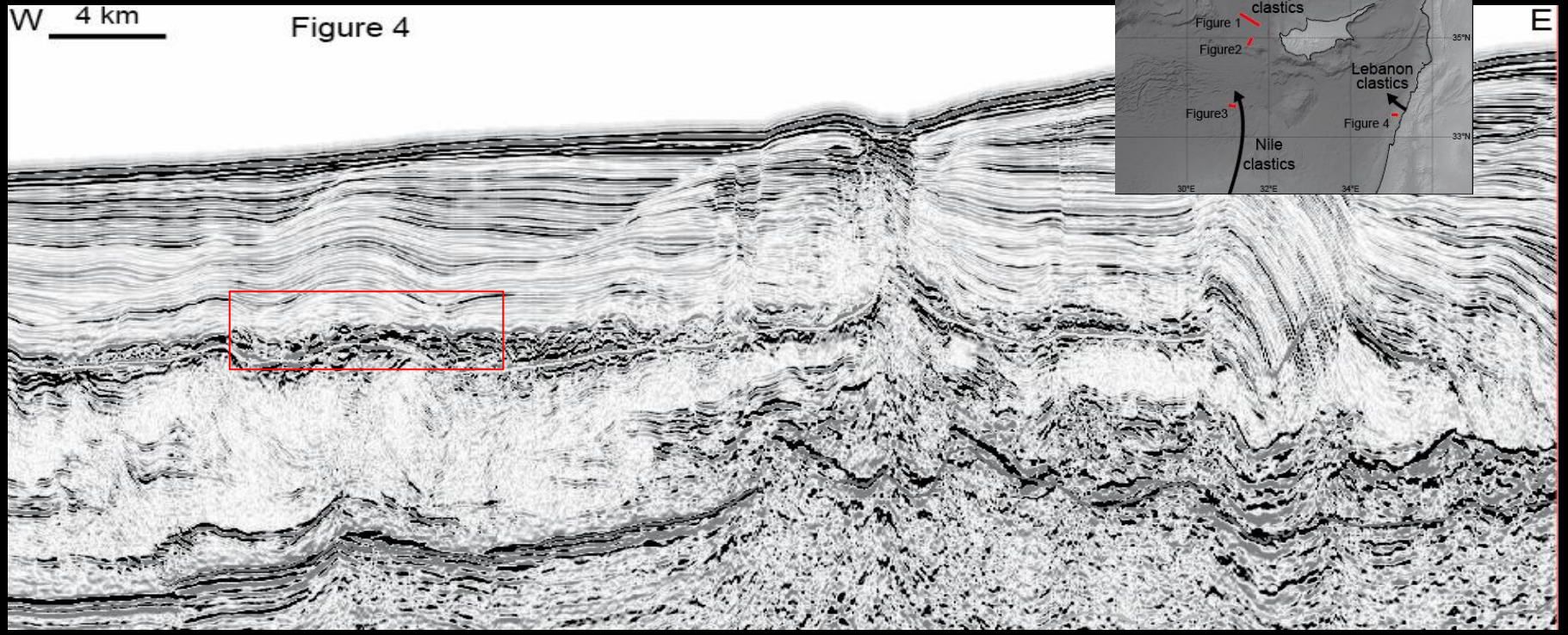
5.96

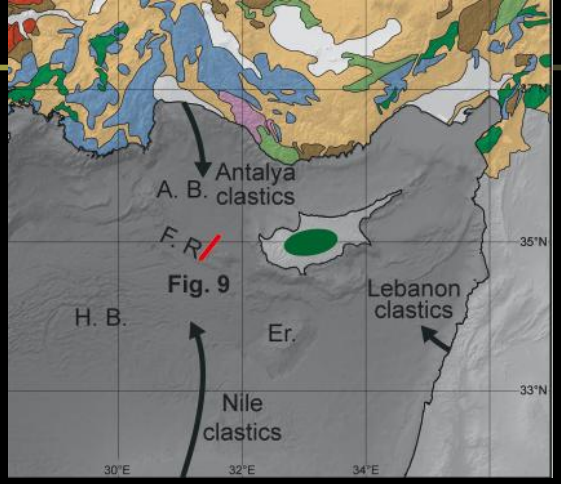
In a first conclusion messinian event is recorded in a megasequence divided in:

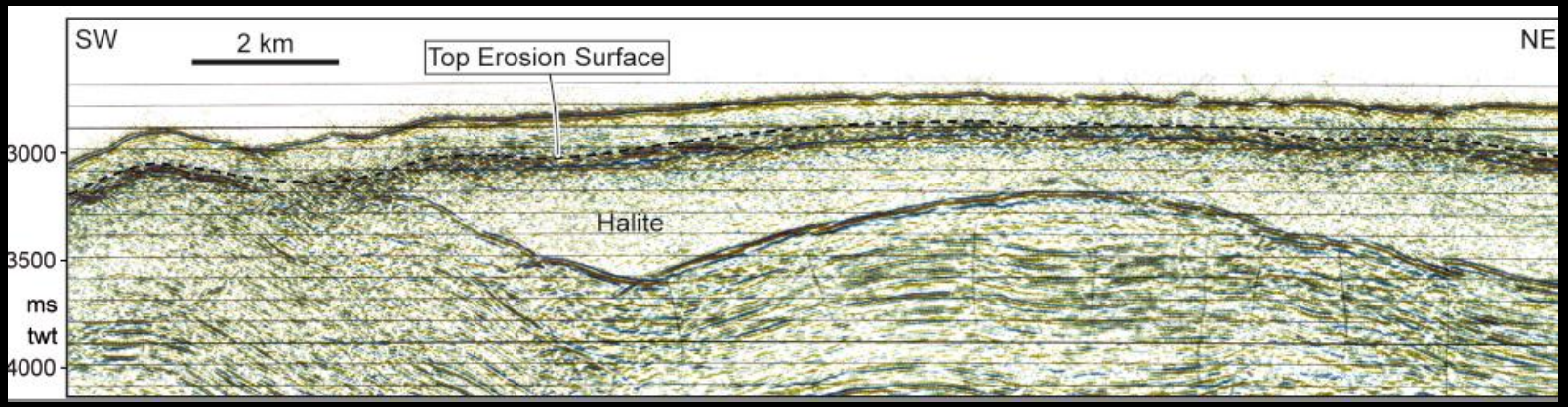
Messinian Lower Megasequence (MLM): Lower falling stage system tracts only preserved in the deepest Eastern, Northwestern Basins and Ionian Basin. Deep water clastics are located in this stage.

Messinian Upper Megasequence (MUM): Upper "transgressive" but still lowstand system tracts preserved over all the margins and in the basins in intermediate position (Algerian Basin, Tyrrhenian Sea, Adriatic Sea,Sicily?). It is constituted by mobile salt , marine marls, gypsum and sands in the deeper position, and fluvial conglomerates in proximal settings.

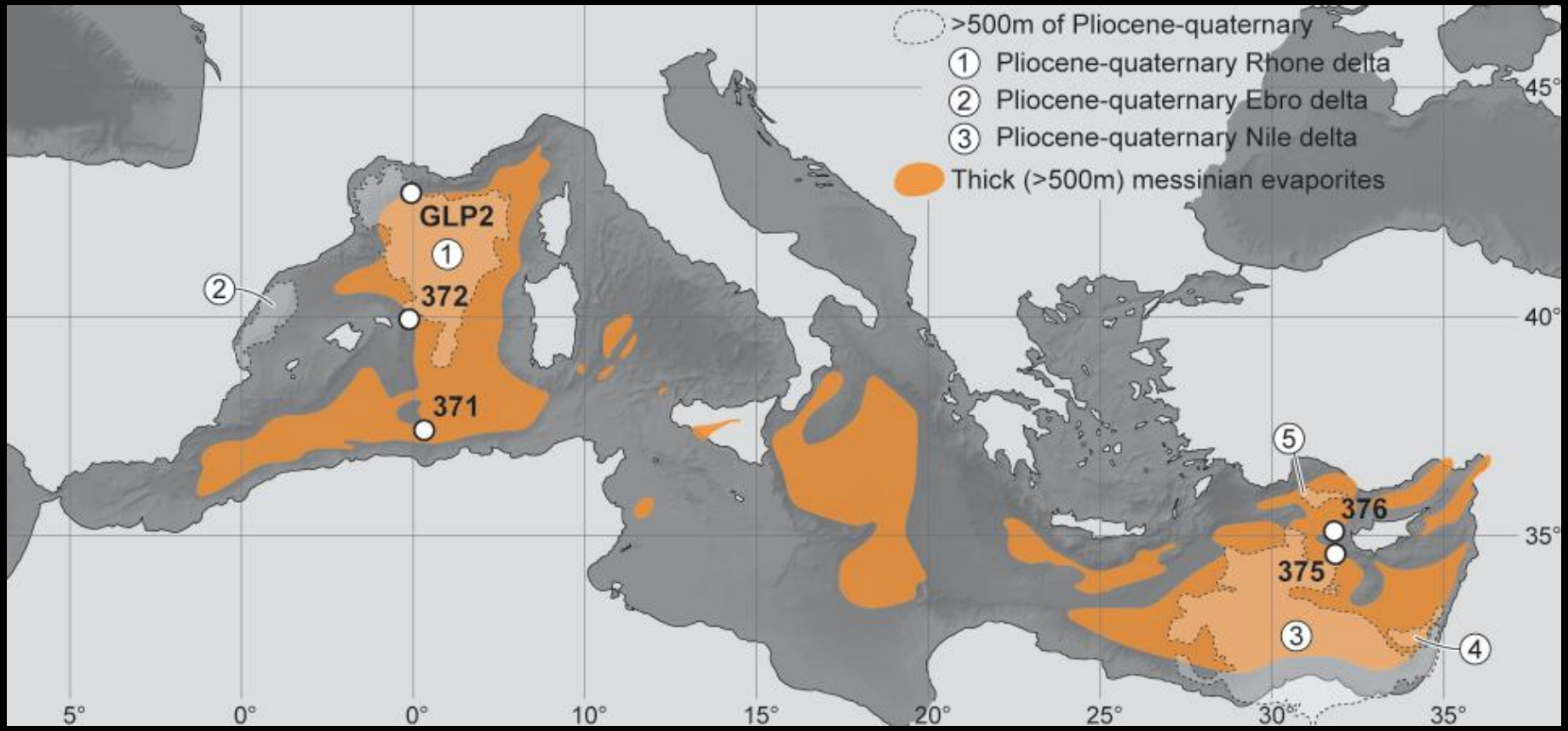
On the Lebanon Levant Margin, clastic material from the upper eroded margin, have been reworked by the Pliocene transgression, in a series of channels above the Messinian Evaporites. These sands exist also in the Israeli Margin as proven by drillings.

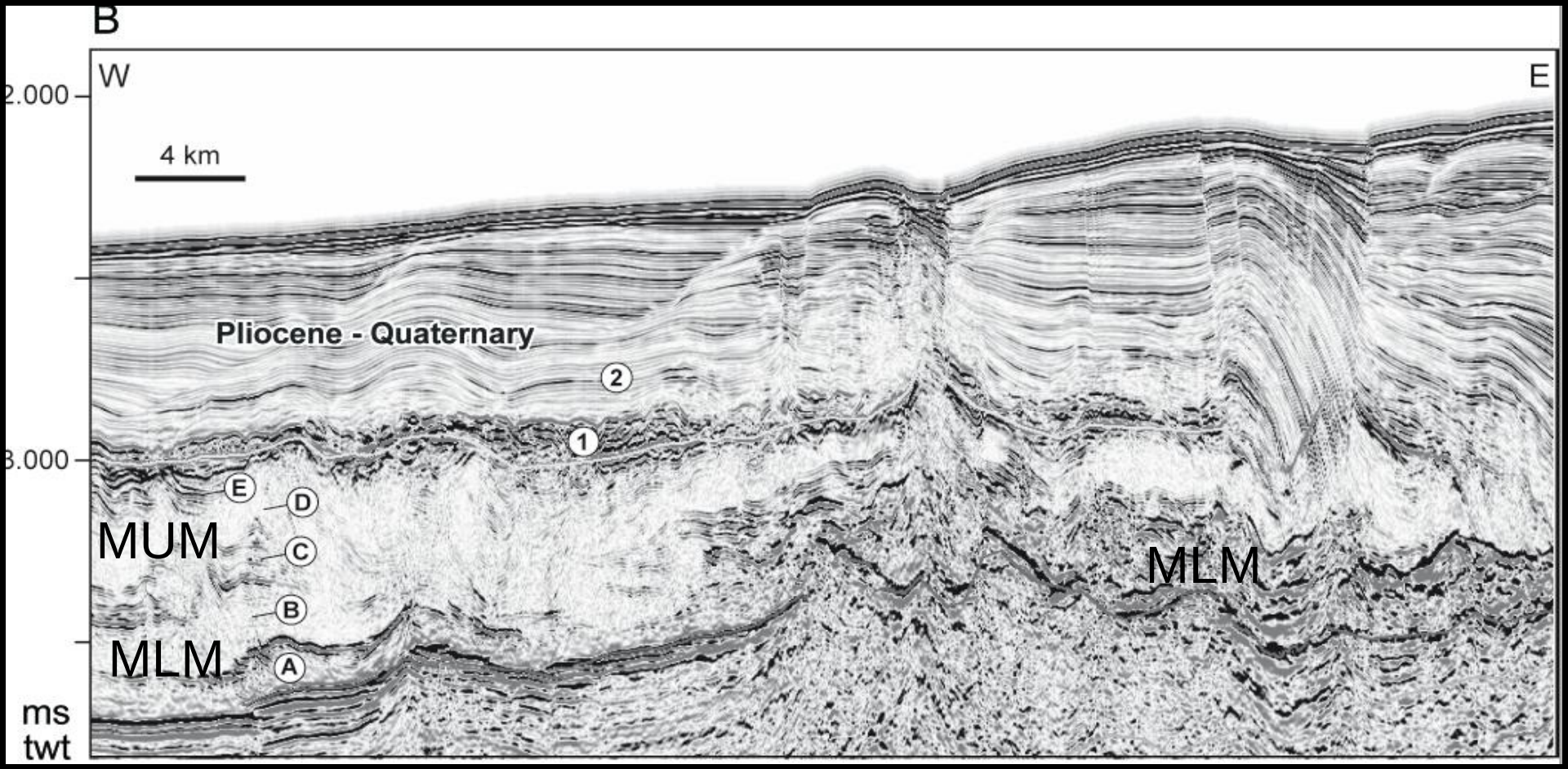






On the Florence Ridge west of the Cyprus Island, the thick Messinian Evaporites have been uplifted and eroded. The horizontal erosion surface is spectacular testifying of the erosive action of the sea at the onset of the Pliocene flooding


>500m of Pliocene-quaternary
1 Pliocene-quaternary Rhone delta
2 Pliocene-quaternary Ebro delta
3 Pliocene-quaternary Nile delta
Thick (>500m) messinian evaporites
GLP2
372
371
376
375
45°
40°
35°
5°
0°
0°
10°
15°
20°
25°
30°
35°


B
W
E
2.000
4 km
Pliocene - Quaternary
2
1
3.000
E
D
MUM
C
B
MLM
A
MLM
ms
twt