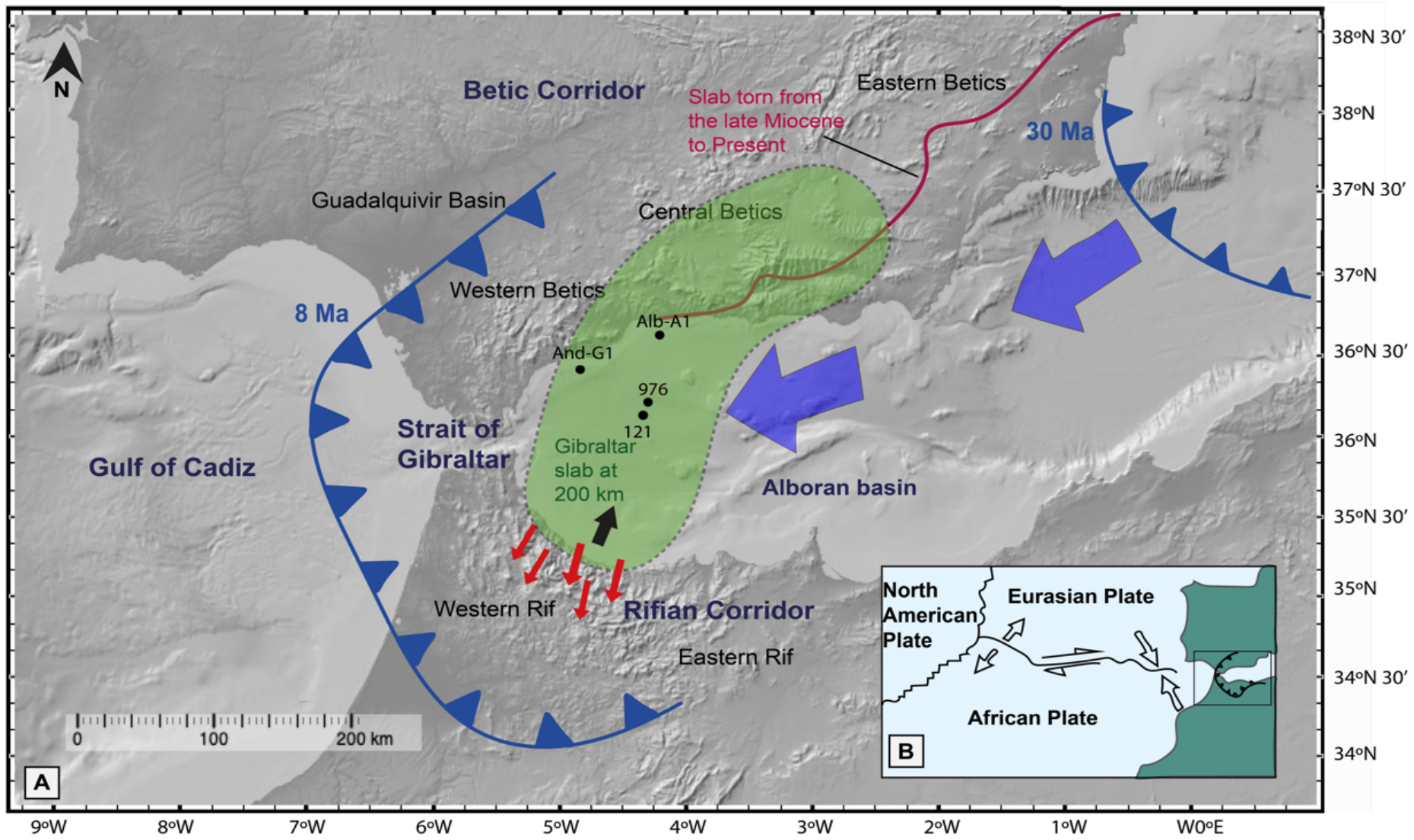
Revision of the Alboran Sea Tortonian-Pliocene record: possible new insights on Mediterranean-Atlantic connectivity during the Messinian Salinity Crises

Francesca Bulian and Francisco J. Sierro

University of Salamanca

Study location



Studied sites are indicated in the map as well as the main tectonic features of the **Alborán basin**.

http://www.geomapapp.org/

Aim of the study

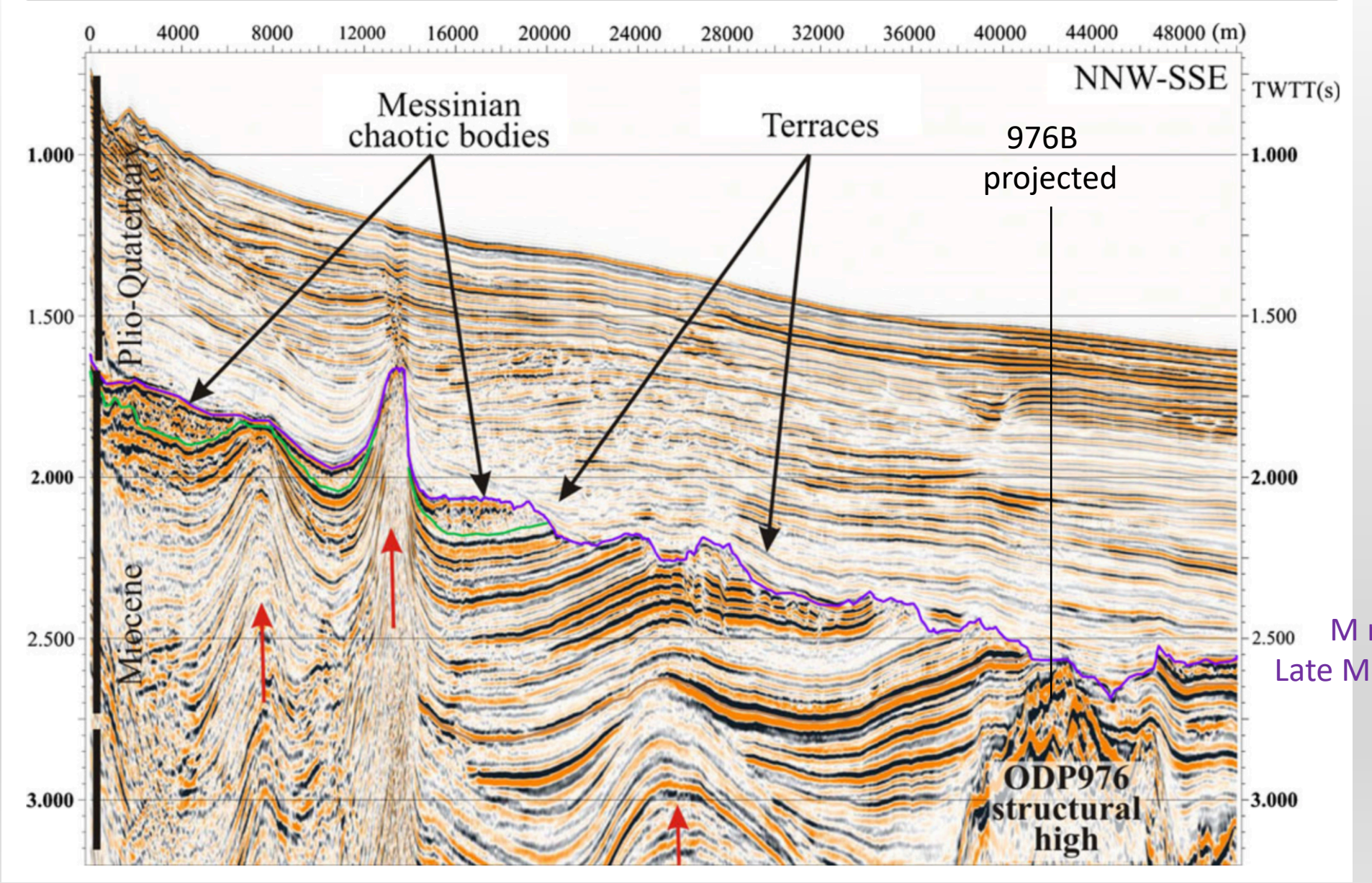
Construct a **firm chronology** of the West Alboran Sea (WAB) record mainly based on the ODP site **976B** (Leg 161) and completed with the aid of DSDP site 121 (Leg 13) and available industrial wells And-G1 and Alb-A1.

How visible is the Messinian-Atlantic gateway restriction imprint on the Alboran Sea record?

What drives the cyclicity in 976B sedimentary record?

What is the nature and magnitude of the late Messinian hiatus?

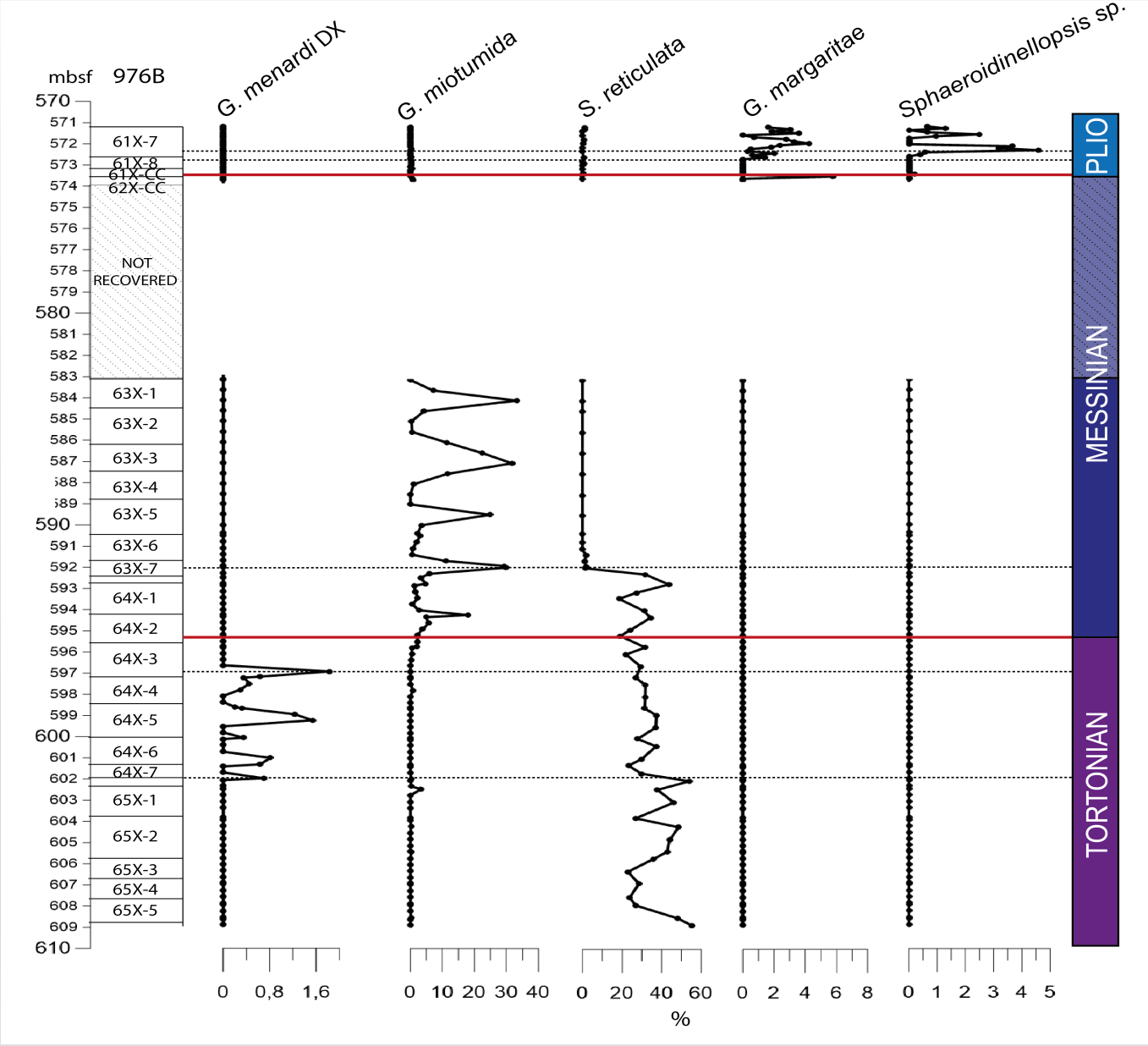
ODP 976B site



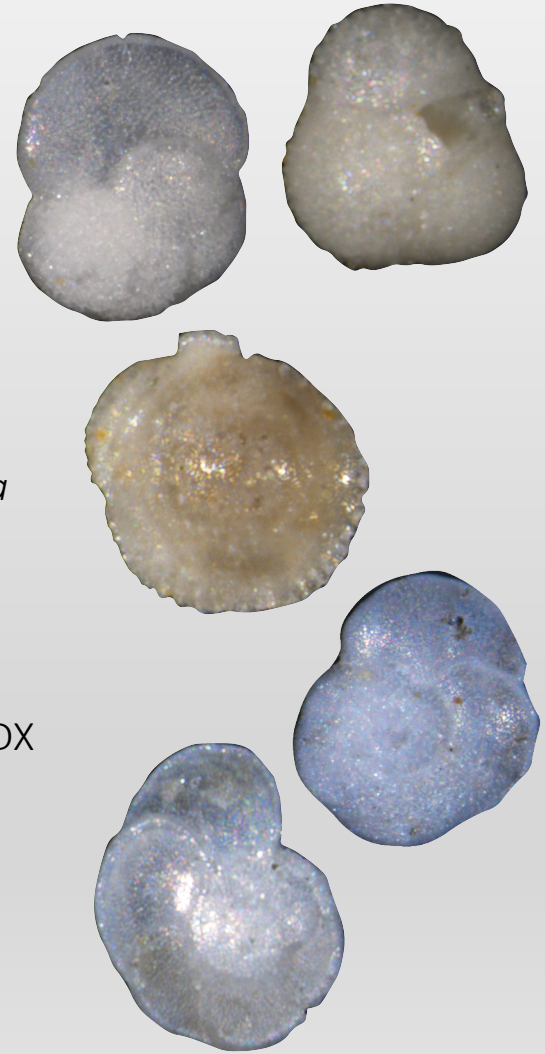
M reflector
Late Messinian hiatus

Estrada et al., 2011

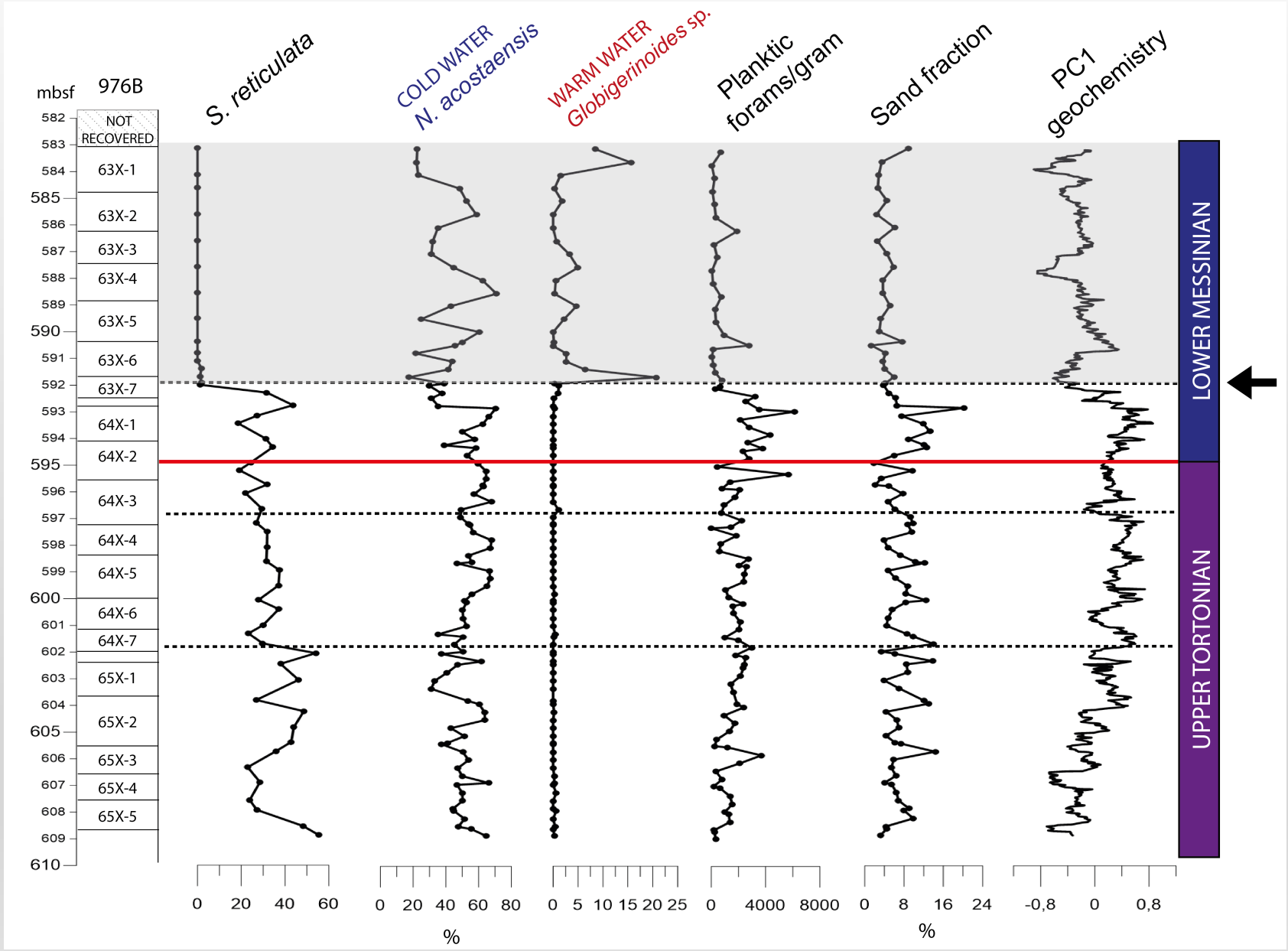
976B chronology

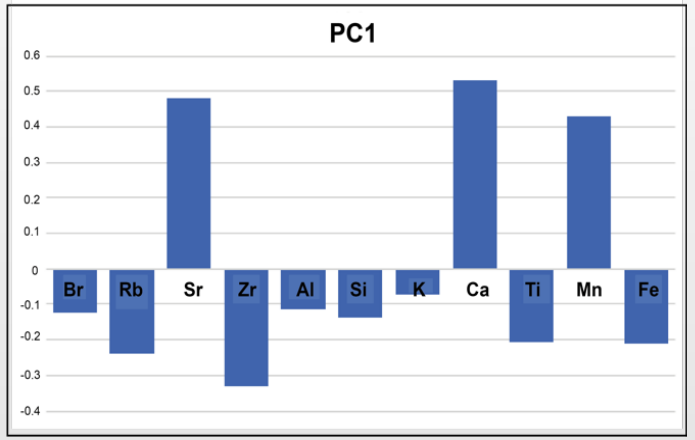


- *G. margaritae* and *Sphaeroidinellopsis* spp. Suggest Early Pliocene age
- Disappearance *S. reticulata*
- 7.24 FCO *G. miotumida*
- LO *G. menardii DX*
- 7.36 Ma FCO *G. menardii* DX



First changes in the Alboran basin





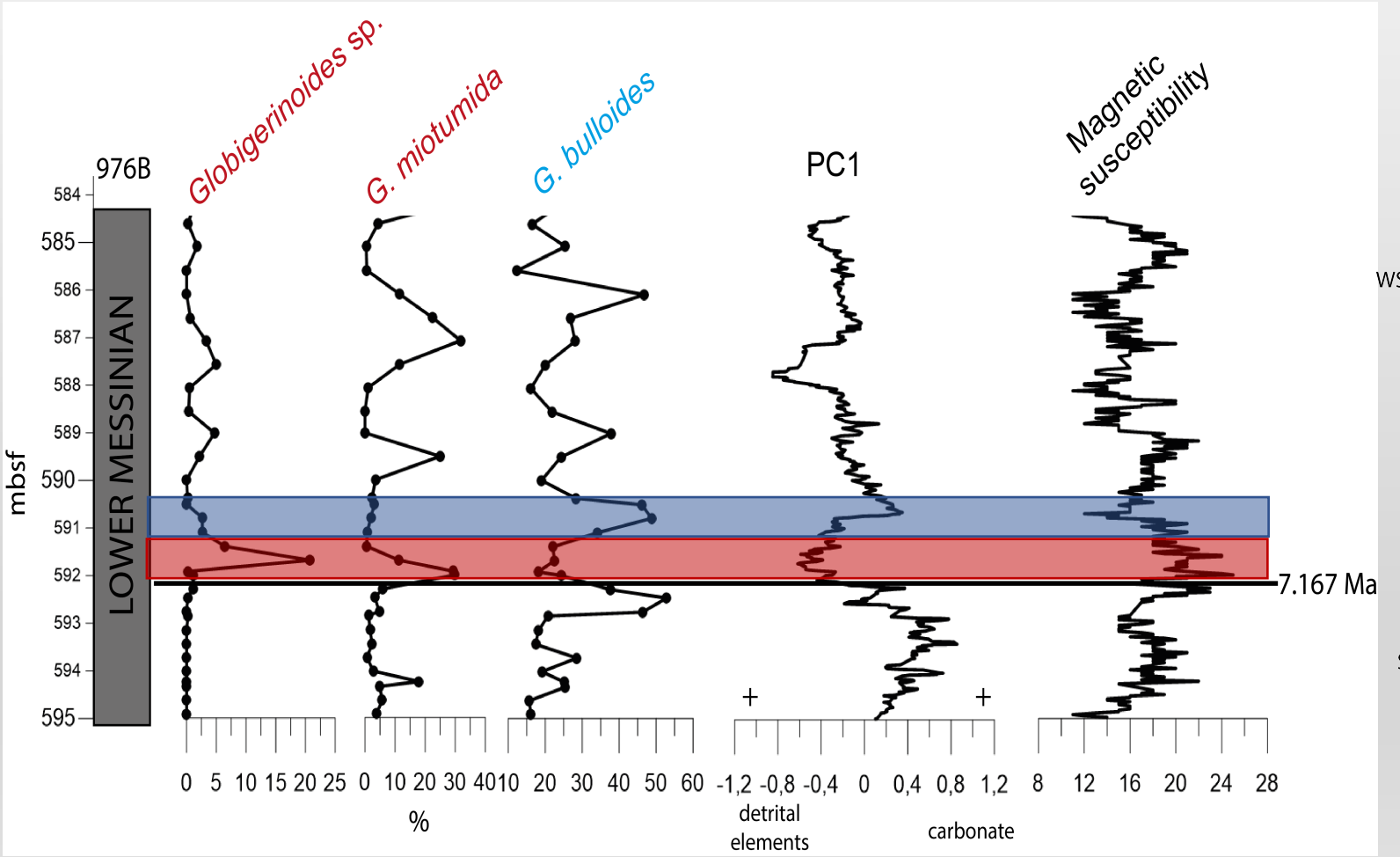
7.17 Ma

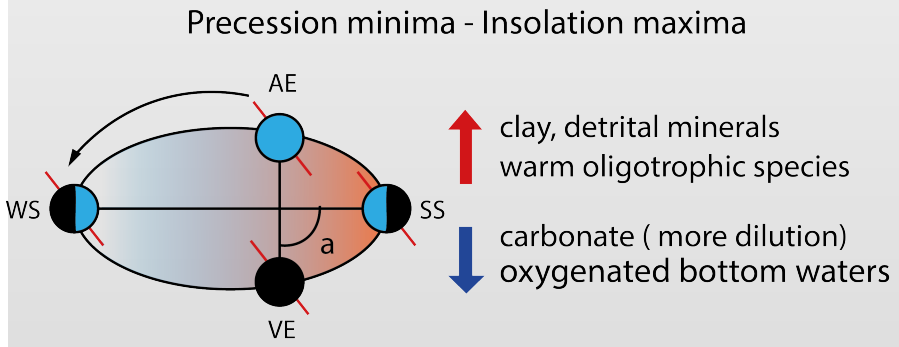
After 7.17 Ma:

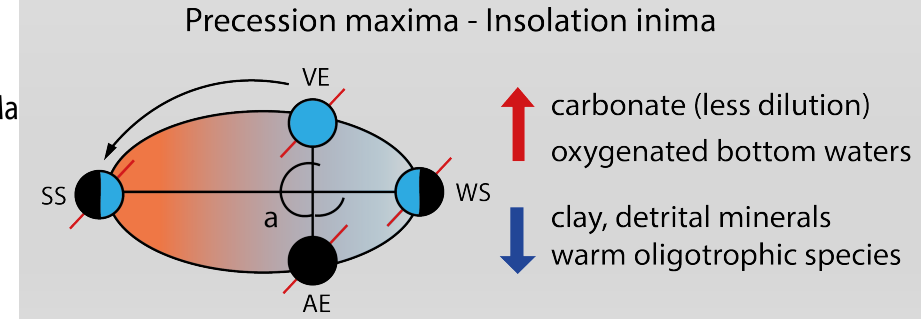
- Decrease in cold water species.
- Appearance of warm water species *Globigerinoides* spp..
- Decrease in planktonic foraminifera abundances and sand fraction.
- Increase in detrital elements (Rb, Zr, Al, Ti).

Accentuated cyclicity after 7.17 Ma

After 7.17 Ma cyclical behaviour of both micropaleontological and geochemical record becomes more obvious. It's a typical PRECESSIONAL cyclicity found all over the Mediterranean.

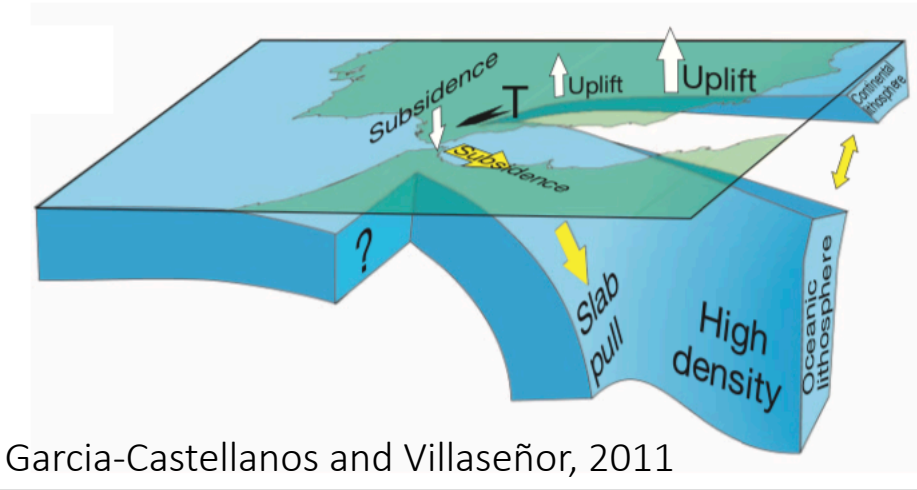






First signs of Mediterranean-Atlantic gateway restriction at 7.17 Ma

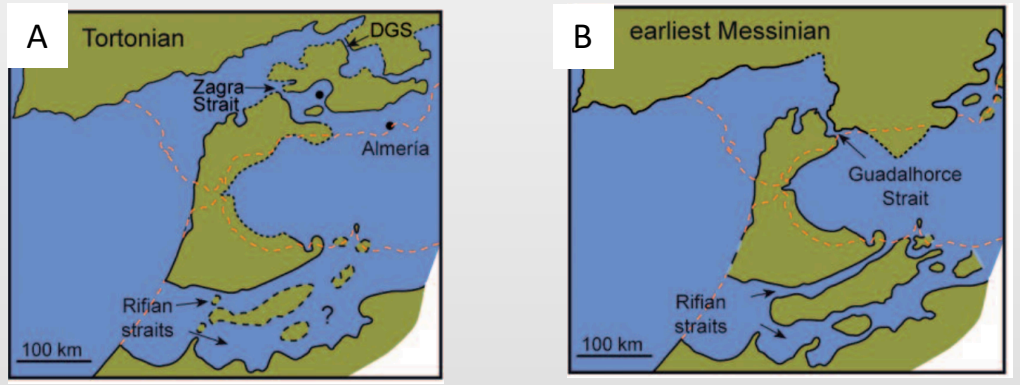
UPLIFT



Garcia-Castellanos and Villaseñor, 2011

Enhanced input of siliciclastic particles (Zr,Al,Rb) to the basin could be related to uplift along the margins of the WAB. Indeed, from this point onward the sedimentation rate increases dramatically as well, supporting an amplification of river erosion and sediment transport to the Alboran basin.

GATEWAY RESTRICTION



Martin et al., 2014

Mediterranean-Atlantic connection becomes less efficient (Kouwenhoven et al., 2003; Seidenkrantz et al., 2000)

976B

Micropaleontological record changes:

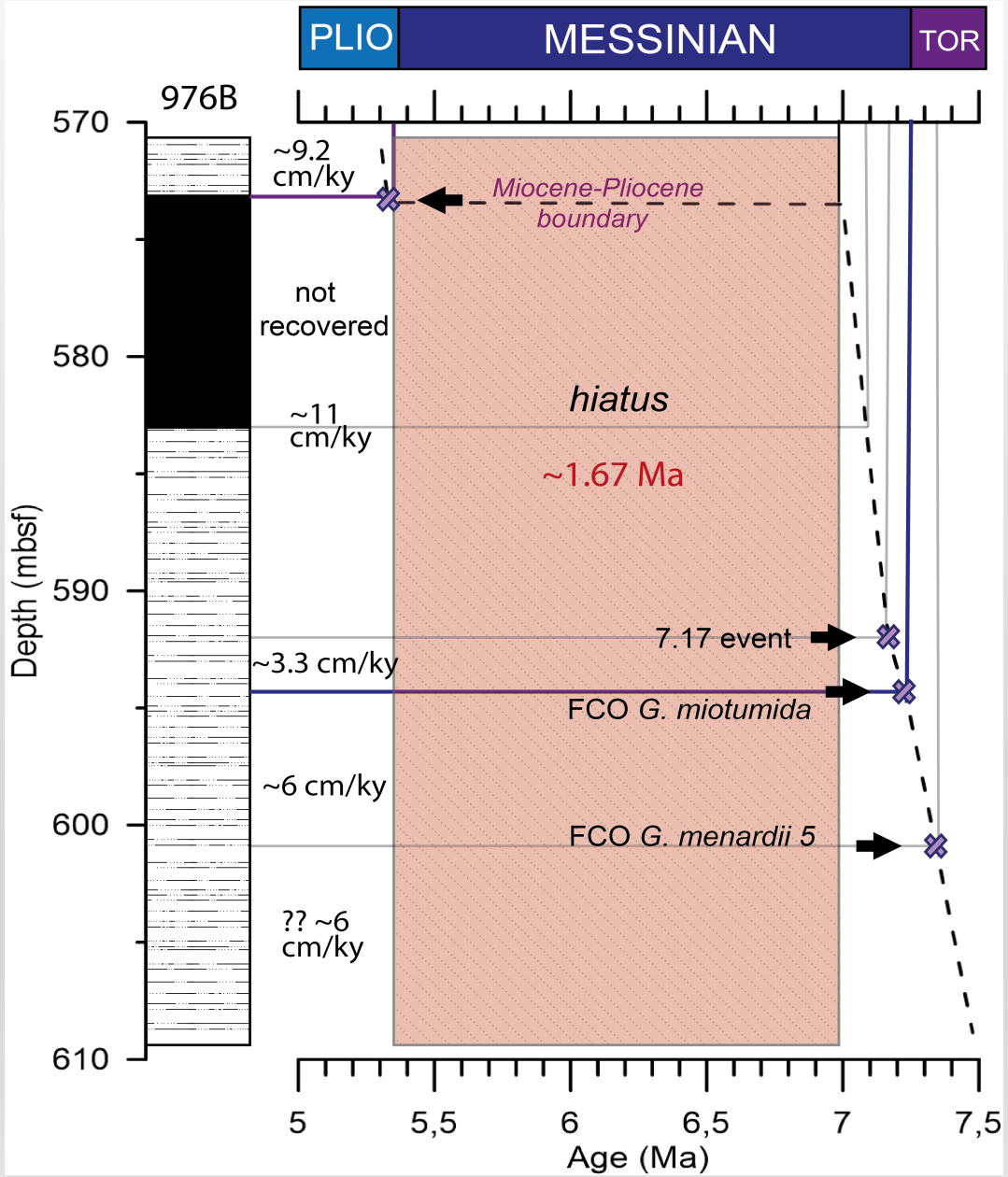
- warm water foraminifera *Globigerinoides* sp. firstly appears→ and more stratified waters (restriction)
- Accentuated cyclical behaviour → increased climate sensitivity

Eastern Mediterranean

Micropaleontological record changes:

- Becomes rich in low oxygen foraminifera species
- Cyclical behaviour accentuated by sapropel deposition → poorly oxygenated bottom waters

Sedimentation rate and hiatus estimation



1 cycle (21.7 ky)= 2.4 m

age estimates

1.67 Ma hiatus

Sedimentation rate estimates

After 7.17 Ma increase in sedimentation rate

Conclusions

The restriction of the Mediterranean-Atlantic gateways that started with uplift of the Betic and Riffian corridors and the first changes in the sedimentological record all over the Mediterranean can be seen from 7.17 Ma. Nonetheless, our data shows that the impact on the marine environments were less pronounced in the West Mediterranean (WAB) in respect to the Eastern Mediterranean record.

976B cyclicity is precession-driven. High annual rainfall during Northern Hemisphere summer insolation maxima (precession minima) results in higher freshwater discharge to the Alboran Sea that generates water stratification in the water column, warmer sea surface waters and reduced vertical mixing. As a consequence, the relative proportion of warm water species increases. The enhanced river discharge results in higher inputs of clay and other siliciclastic particles to the Alboran Sea increasing its relative concentrations in the sediments at the expense of the pelagic biogenic carbonate particles which get diluted.

Because the sediments directly above the last Messinian ones are early Pliocene, we assume that the hiatus was caused by the Zanclean re-flooding. The Atlantic inflow managed to erode approximately 1.67 Ma worth deposits.

Bibliography

Estrada, F., Ercilla, G., Gorini, C., Alonso, B., Vázquez, J.T., García-Castellanos, D., Juan, C., Maldonado, A., Ammar, A. and Elabbassi, M., 2011. Impact of pulsed Atlantic water inflow into the Alboran Basin at the time of the Zanclean flooding. *Geo-Marine Letters*, *31*(5-6), pp.361-376.

Garcia-Castellanos, D. and Villaseñor, A., 2011. Messinian salinity crisis regulated by competing tectonics and erosion at the Gibraltar arc. *Nature*, *480*(7377), pp.359-363.

Kouwenhoven, T.J., Hilgen, F.J. and Van der Zwaan, G.J., 2003. Late Tortonian–early Messinian stepwise disruption of the Mediterranean–Atlantic connections: constraints from benthic foraminiferal and geochemical data. *Palaeogeography, Palaeoclimatology, Palaeoecology*, *198*(3-4), pp.303-319.

Martín, J.M., Puga-Bernabéu, A., Aguirre, J. and Braga, J.C., 2014. Miocene Atlantic-Mediterranean seaways in the Betic Cordillera (Southern Spain). *Revista de la sociedad geológica de España*, *27*(1), pp.175-186.

Seidenkrantz, M.S., Kouwenhoven, T.J., Jorissen, F.J., Shackleton, N.J. and Van der Zwaan, G.J., 2000. Benthic foraminifera as indicators of changing Mediterranean–Atlantic water exchange in the late Miocene. *Marine geology*, *163*(1-4), pp.387-407.