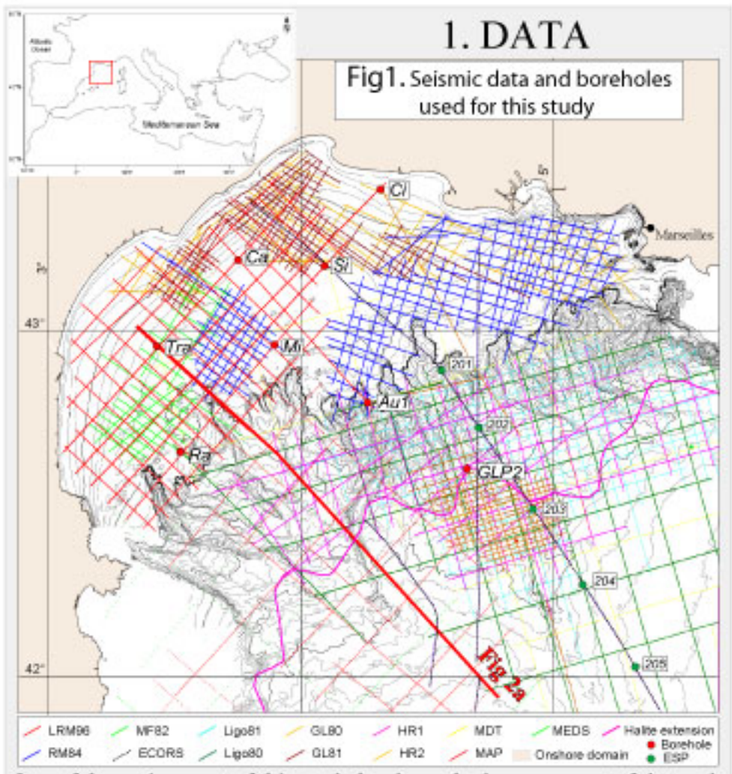
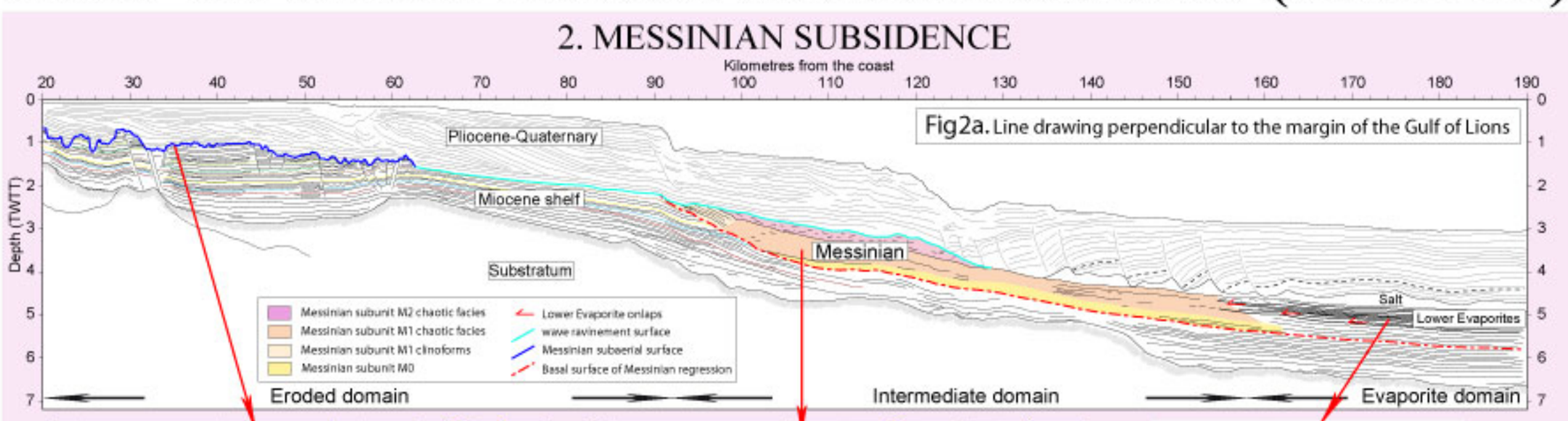
SUBSIDENCE OF THE GULF OF LIONS CONTINENTAL MARGIN (FRANCE)

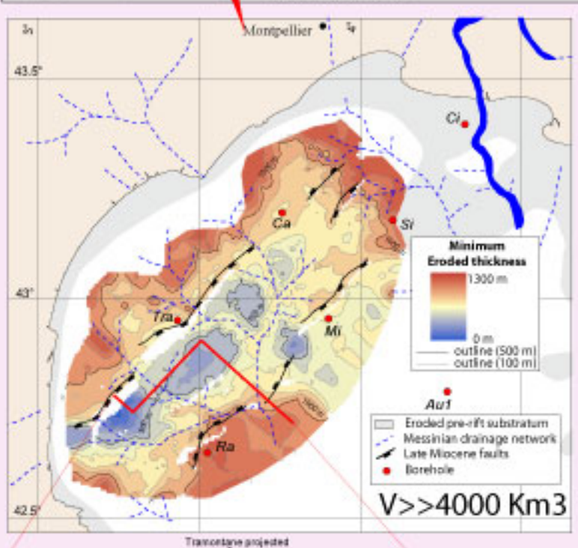
1. DATA



One of the major asset of this study has been the large amount of data collected in the area for both industrial and academic purposes. A partnership with Total gave us access to an exceptional set of conventional and high-resolution seismic reflection data from the coast to the deep domain. Seismic interpretation has been performed using the principles of seismic stratigraphy (Vail et al., 1977). We identified seismic units based on terminations and configurations of seismic reflections generated by sedimentary strata. The large coverage of seismic data enabled us to map these units in 3D in the entire Gulf of Lion. Further data were obtained from the logs of nine industrial boreholes that sampled the sedimentary cover down to the substratum. A detailed micropaleontological study (Cravatte et al., 1974) provided informations on the stratigraphy and depositional environments of the Miocene, Pliocene and Quaternary successions in four wells (Mistral1, Sirocco1, Autan1 and Tramontane1). The Ecors programme (De Voogd et al., 1991) provided three general seismic sections across the entire margin, completed by a series of ESP (Expanding Spread Profiles) (Pascal et al., 1993). ESP data were used to obtain propagation velocities from which it was possible to evaluate the thickness of the series from the seismic data (time-depth conversion), thus giving access to volumes of particular units.

2. MESSINIAN SUBSIDENCE





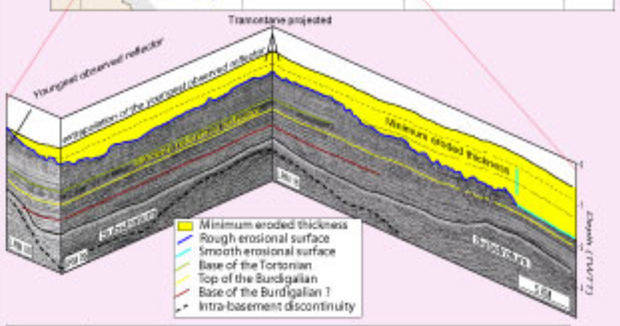


Fig 2b. Estimated thickness of the Miocene sediments eroded during the Messinian Event

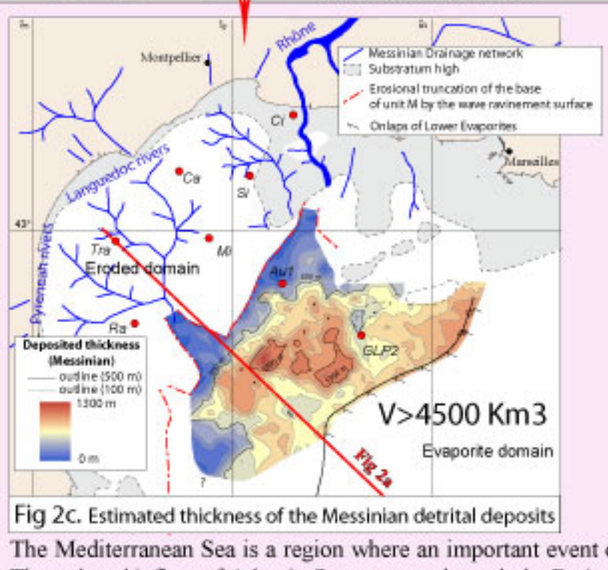


Fig 2c. Estimated thickness of the Messinian detrital deposits

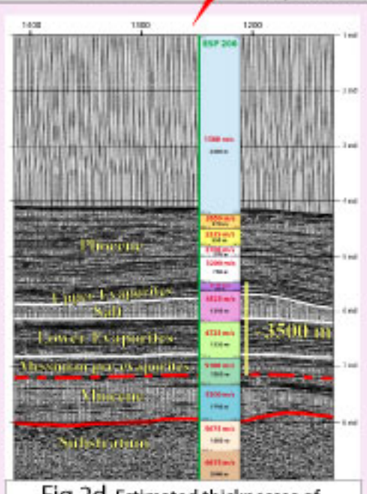


Fig 2d. Estimated thicknesses of the Messinian units in the deep basin

The Mediterranean Sea is a region where an important event of desiccation occurred at the end of the Miocene. The reduced inflow of Atlantic Ocean water through the Betic and Rifain corridors, together with a high evaporation rate, led to a significant lowering of the Mediterranean Sea's base level and gave rise to one of the most outstanding episodes of the sea's history, known as the "Messinian Salinity Crisis".

The results that we have obtained fall within the logic of the hypothesis of a deep desiccated evaporite basin (Hsü, 1972; Hsü et al., 1973): thick detrital deposits at the outlet of the Messinian Rhône and Messinian Languedoc and Pyrenean rivers are present at the foot of the continental slope. We are able to underline the following points:

*the evidence of a pre-evaporite phase corresponding to a "Messinian Erosional Crisis" in the deep basin

*the probable presence of Lower Evaporites, with a thickness up to 1500 m, located below the halite bed.

With this hypothesis, the total thickness of Messinian deposits in the basin should be about 3500 m. This thickness implies that the depth of the basin was already significant at the time of their deposition. The basin was thus initially drained and then gradually filled during the Messinian Salinity Crisis. This filling inevitably had a significant effect on the vertical movements of the basin.

3. INITIAL SUBSIDENCE

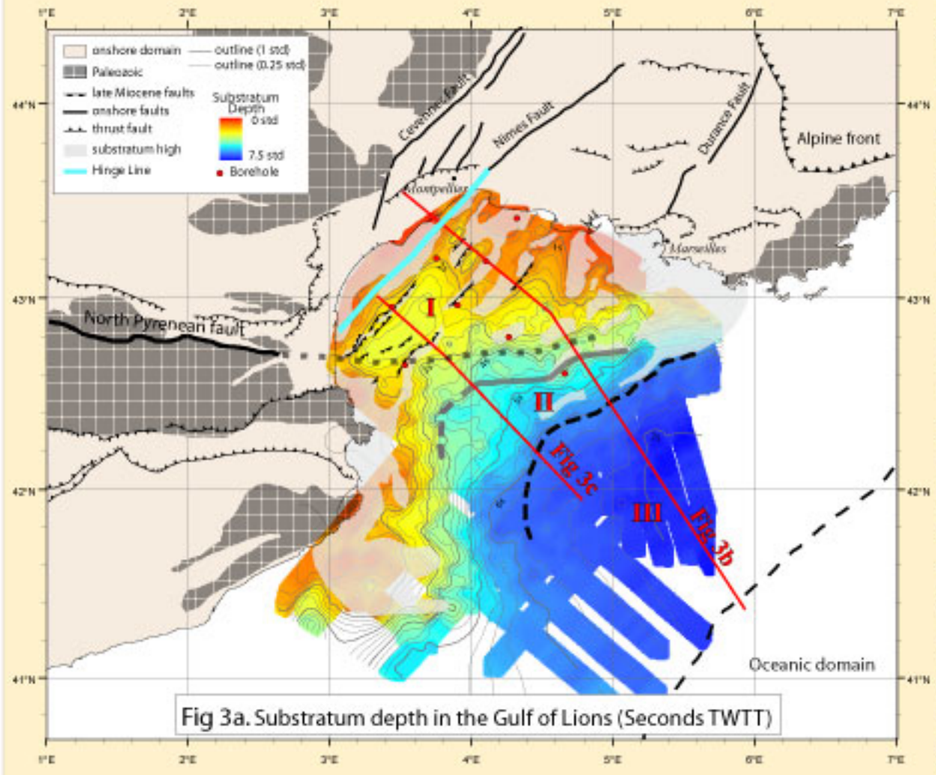


Fig 3a. Substratum depth in the Gulf of Lions (Seconds TWTT)

The study of crustal structures and early sedimentation in the Gulf of Lions margin showed a surface of early erosion at the top of synrifts products (generally with minor thickness) or directly on the substratum (zones I and II). This erosional surface suggests that the whole shelf stayed in a high position during the rifting period. Numerous superimposed shelves progradation from lower to middle Miocene (Fig 3c - zone I) reveals that margin morphology and subsidence pattern changed after the rifting. In fact, the major part of subsidence occurred after the rifting.

These results led us to propose a model for the formation of the Gulf of Lions in three steps. First, a deep thermic event keeps the shelf subaerially exposed during the early phase of rifting. In a second step, rupture occurs (during Late Aquitanian, around 20 Ma) and the first «unusual oceanic crust» (transitional zone) is built. The third step corresponds to the formation of typical oceanic crust in the centre of the basin.

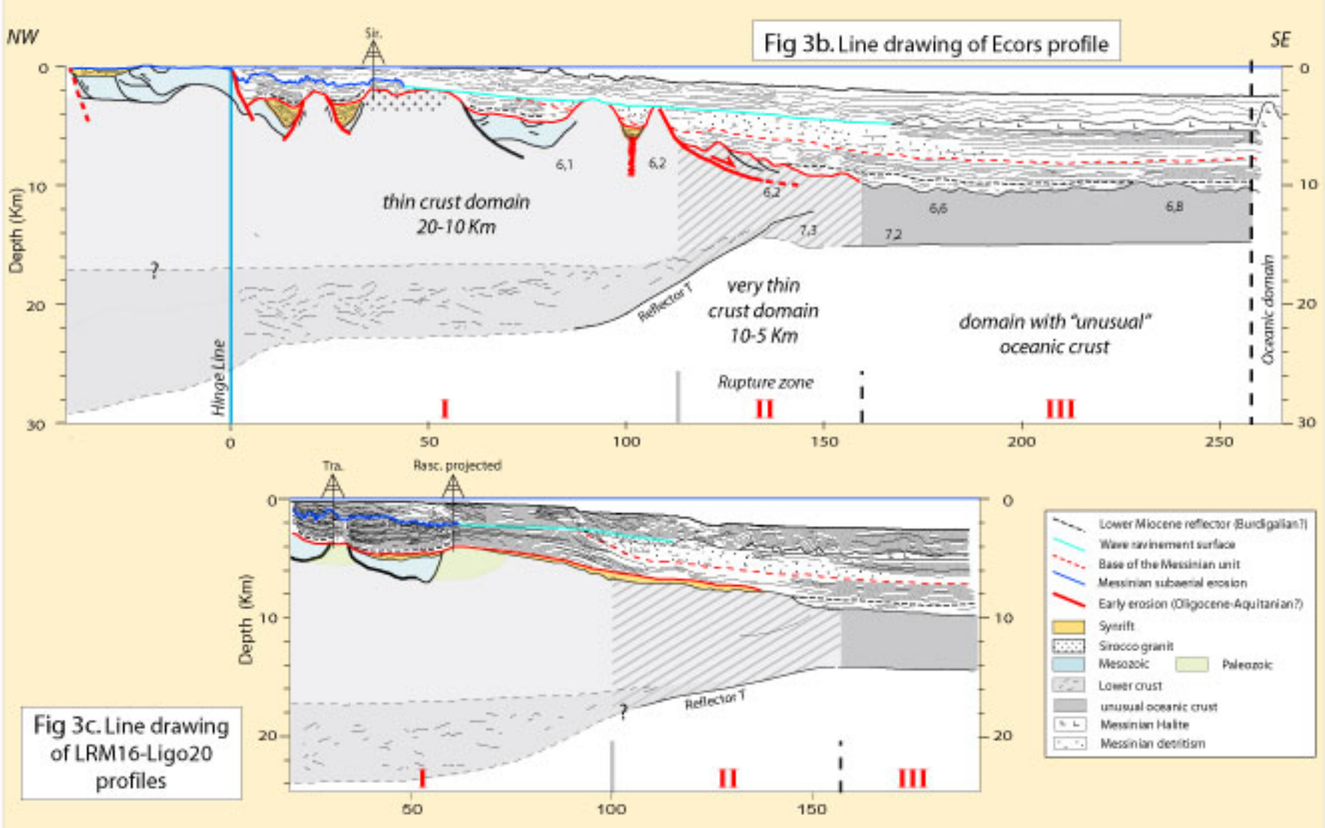


Fig 3c. Line drawing of LRM16-Ligo20 profiles

4. CONCLUSION

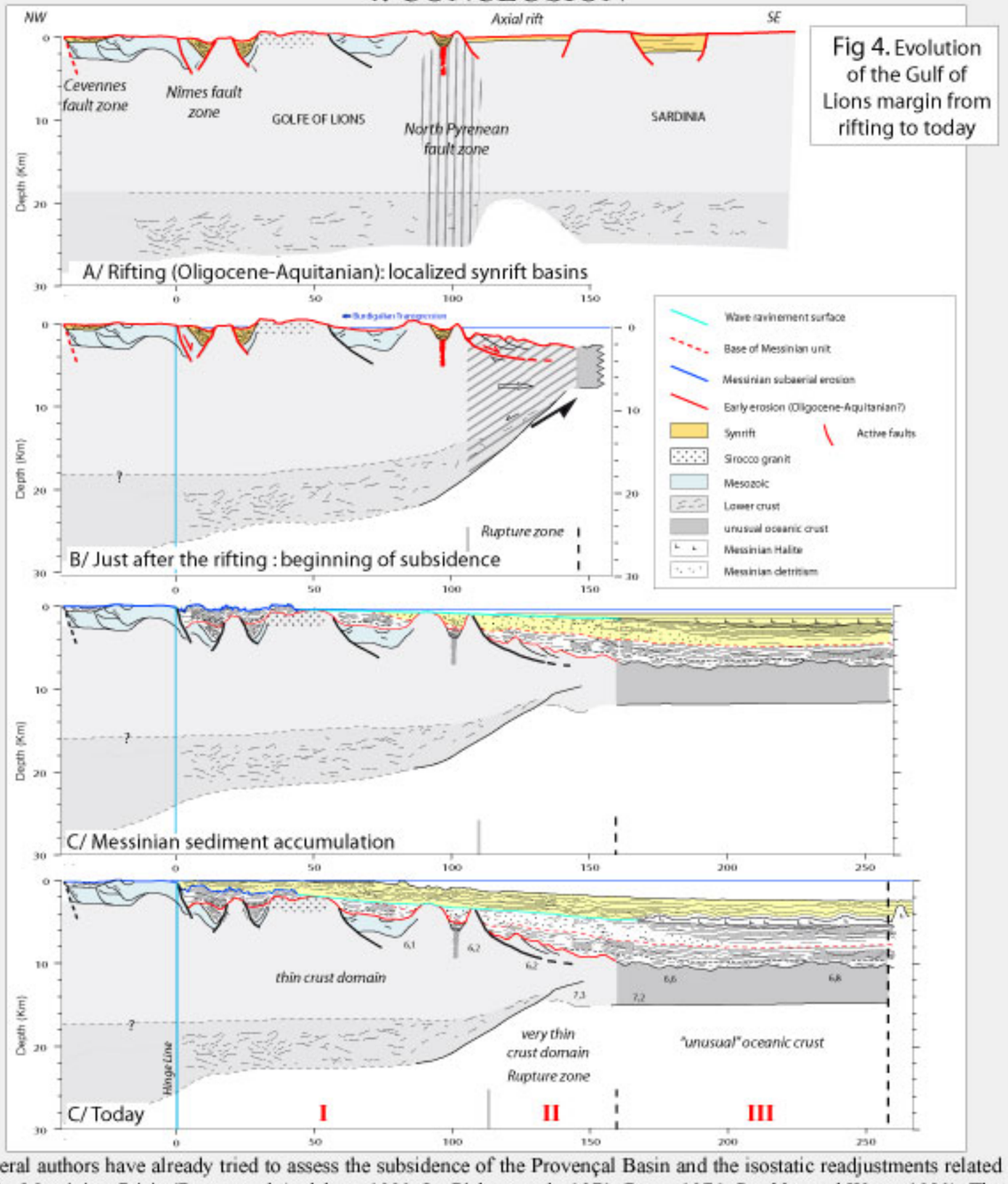


Fig 4. Evolution of the Gulf of Lions margin from rifting to today

Several authors have already tried to assess the subsidence of the Provençal Basin and the isostatic readjustments related to the Messinian Crisis (Burrus and Audebert, 1990; Le Pichon et al., 1971; Ryan, 1976; Steckler and Watts, 1980). The new elements that we provide give a new starting point for estimating the subsidence of the Provencal Basin and better understand its evolution:

*we identified about 3500 m of sediments deposited during the messinian crisis (s. l.) (from the first erosional event to the re-flooding of the basin). The shelf registered a loss of up to 1000 m thick of sediments. This implies a great amount of sediment transfer from the shelf to the deep sea (Fig 4C). A full study of isostatic readjustments related to the messinian event remains to be done; this would bring a better understanding of the response of the crust to varying loadings.

*A major erosional surface suggests that the whole shelf stayed in a high position during the rifting period (Fig 4B): the major part of subsidence occurs after the rifting (Fig 4C and D). Comparable observations have been described on other margins. For some authors, it shows the persistence of a deep thermal anomaly during the early history of the margin (Dupré et al., 2007; Steckler, 1985). It should be very advantageous to compare our well-constrained observations in the Gulf of Lions with other comparable areas for testing different hypothesis of formation.

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