The Meso-Cenozoic Alentejo basin (SW Portugal) – lithological correlation from outcrop and well data

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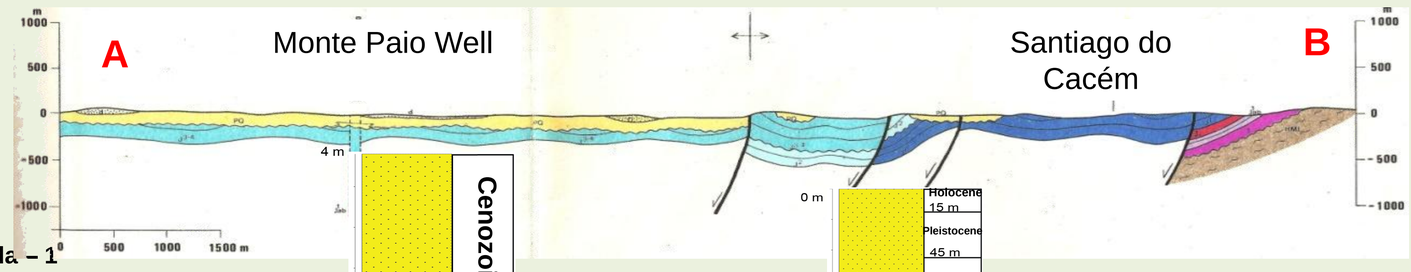


Figure 3 – Geological section from Santiago do Cacém towards W, with projection of the MP well (left side) (in Oliveira, 1984); for location, see red line in Fig. 1

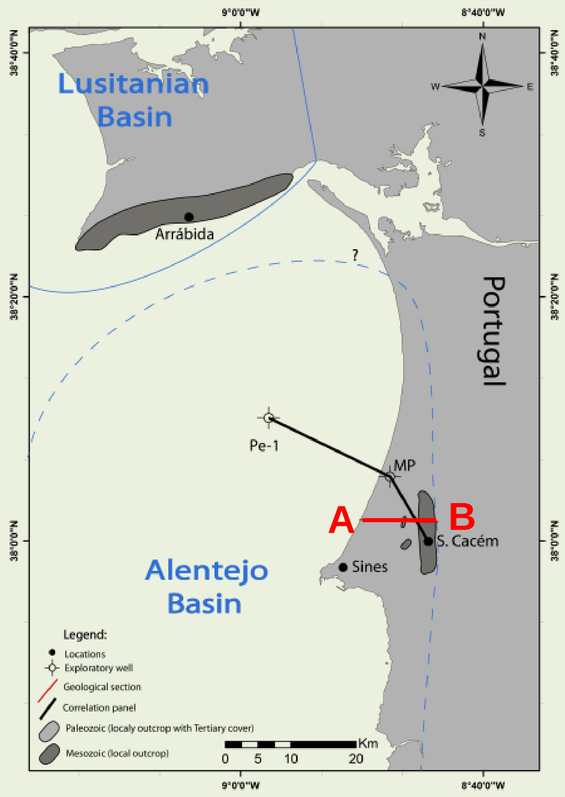


Figure 1 – Location of the three studied sites in SW Portugal: Pe – 1 well, Monte Paio (MP) well and Santiago do Cacém outcrops.

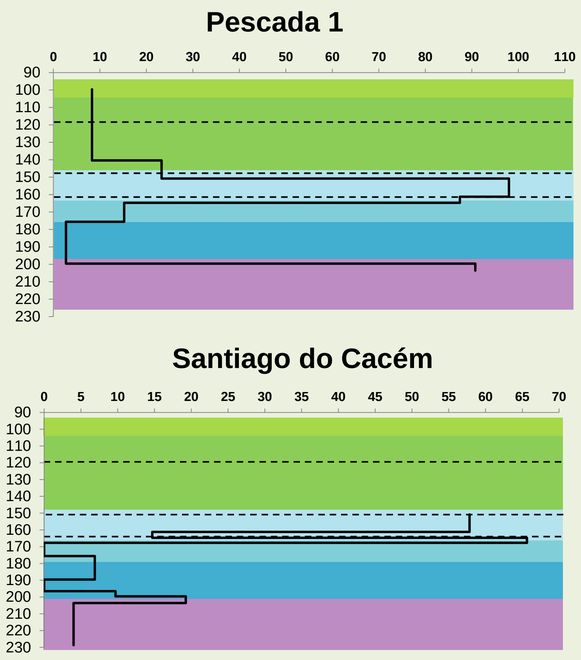


Figure 2 – Subsidence ratio of Pe-1 (Up) and SC (down). Adapted from Liborio *et al* 2011

Geological Framework

The Alentejo basin is one of the west Iberian Mesozoic basins, developed in relation with the North-Atlantic opening. First sediments are dated from Upper Triassic and the sedimentary infill includes Jurassic mostly carbonate and Cretaceous mostly siliciclastic sediments. A Cenozoic cover is also present, including Paleogene to Quaternary mostly siliciclastic sediments.

During the Mesozoic, the **subsidence was important (Fig.2)**, with thick Upper Jurassic carbonate sequences. However, the basin suffered the **first inversion event** during the Callovian, marked by a sub-aerial unconformity and intra-formational conglomerates. After this event, other stronger events occured during late Cretaceous and Cenozoic, related with the **Alpine orogeny** and Africa-Iberia plates collision.

Around **Santiago do Cacém** (**Fig.1**) are located the only **outcrops of Alentejo basin**, which show complete sections of the Upper Triassic to Lower Jurassic sequences, including Silves Fm (red beds), Dagorda Fm (red clays), CAMP related volcanic (**Fig. m**) and Fateota Fm (**Fig. l**); above a regional depositional hiatus, Middle Jurassic units are represented by Rodeado and Monte Branco Fm. (limestones) (**Fig. k**) and a second hiatus precedes a thick Upper Jurassic sequence including intra-formational conglomerates and limestones of the Deixa-o-Resto Fm (**Fig. j & h**) (Inverno *et al*., 1999; Pereira & Alves, 2012). This Mesozoic sequences are affected by lystric faults towards W, folded, eroded and unconformably covered by Tertiary sands (**Fig. 3**).

Monte Paio well

This well has been **drilled onshore in the 70's**, crossing Upper Triassic siliciclastics and evaporites, the whole Jurassic sequence with predominant carbonates and Cenozoic sandy cover. However, its detailed **lithostratigraphy is poorly known**, besides from a very synthetic report and some unpublished Upper Jurassic biostratigraphic studies.

This study addresses a **detailed and continuous lithological description** of Monte Paio well, important to understand better the basin area between the onshore (Santiago do Cacém) and the offshore (Pe-1 well), providing a better knowledge of the inner proximal margin of Alentejo Basin and the tectono-stratigraphic evolution of whole basin during the Mesozoic and Cenozoic.

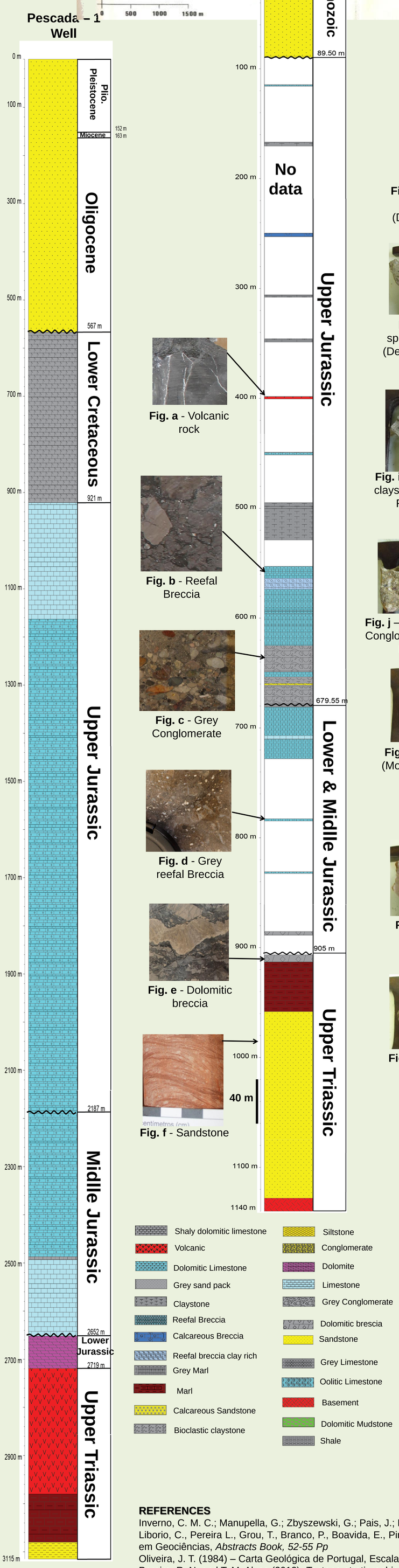
The **Upper Triassic** (around 230m thick) is mainly composed of fine sands (**Fig. f**) and clays, with restricted coarse facies (mainly at the base) and the total absence of rich salt units (only centimetric veins towards the top). At the top it grades into a 10 m tick dolomitic breccia (**Fig. e**), representing the first openings to marine very shallow marine influences. The CAMP-related Hettangian volcanics, well represented in Santiago do Cacém outcrops and Pe-1 offshore, are absent in this well, indicating irregular distribution of these flows.

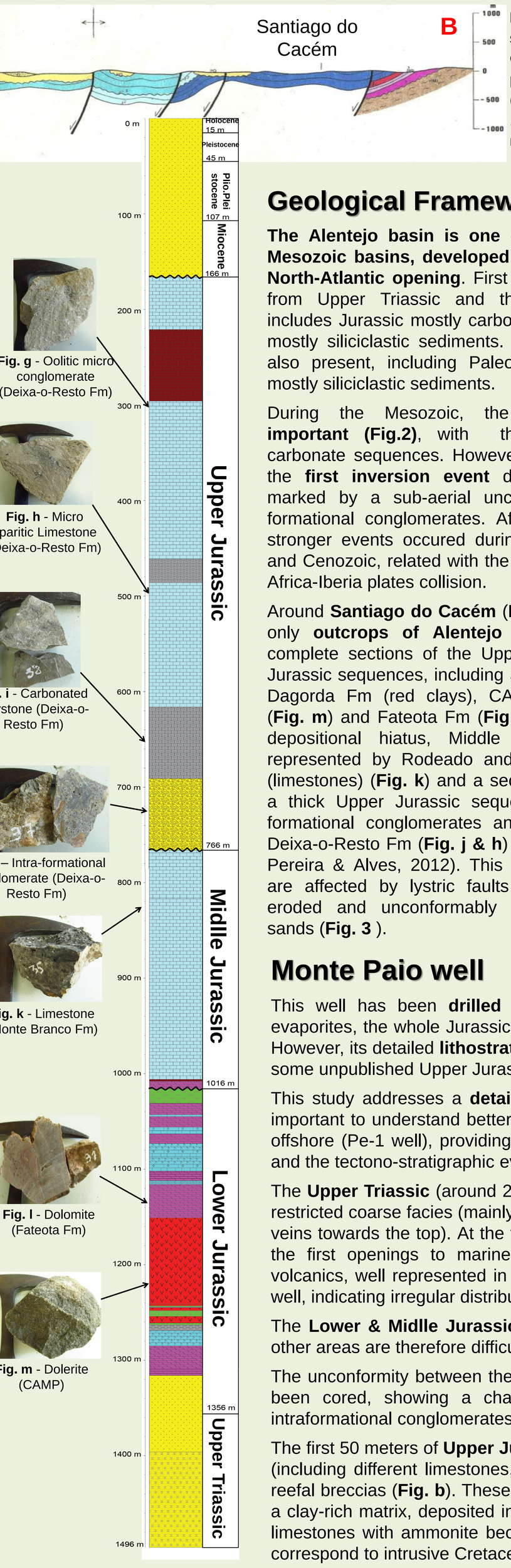
The **Lower & Midlle Jurassic** have been sparsely cored, and lithostratigraphic correlations with other areas are therefore difficult.

The unconformity between the top of the Middle Jurassic and the base of the Upper Jurassic has been cored, showing a change from reefal breccias (**Fig. d**) with carsification, to coarse intraformational conglomerates (**Fig. c**) deposited in continental environments.

The first 50 meters of **Upper Jurassic** deposits show mainly grey polymictic conglomerates (**Fig. c**) (including different limestones, black-pebbles and locally abundant coal) with a 10m tick layer of reefal breccias (**Fig. b**). These breccias become predominat in the next 50 meters, sometimes with a clay-rich matrix, deposited in continental to shallow marine environments. Towards the top, grey limestones with ammonite become predominant. The volcanic rocks (**Fig. a**) cored at 400m may correspond to intrusive Cretaceous dykes.

Cretaceous formations, present in the Monte Paio well, are absent, such as in Santiago do Cacém.





Conclusions

The study of the Monte Paio well brought **a better insight into regional facies distribution and stratigraphic evolution**. The **absence of Upper Triassic conglomerates** indicates a distal position, whereas the **absence of salt layers** indicates a strictly continental influence. Lower and Middle Jurassic evolution is hard to address from the sparse cores. The **Upper Jurassic unconformity** is quite similar to the one observed in other locations of this and other close-by basins (Algarve and Lusitanian).

The **Upper Jurassic** sediments point to an **important inversion and up-lift** of marginal areas of the basin, whereas the central and distal parts were subjected to intense subsidence and sediment accumulation. Erosion of Lower-Middle Jurassic carbonates delivered abundant clasts into coastal areas, where reefal deposits were being formed and destroyed, mixing with lagoonal clay-rich deposits.

These Upper Jurassic paleoenvironments and facies show very **good characteristics to develop a complete petroleum system**, such as in the Lusitanian basin (Pena dos Reis & Pimentel, 2011). This petroleum system may be **important in the off-shore of the Alentejo basin**, where exploration is being developped by Petrobras and GALP-Energia.

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