Salt tectonics on a passive margin: the influence of base salt relief in the Kwanza Basin, Offshore Angola

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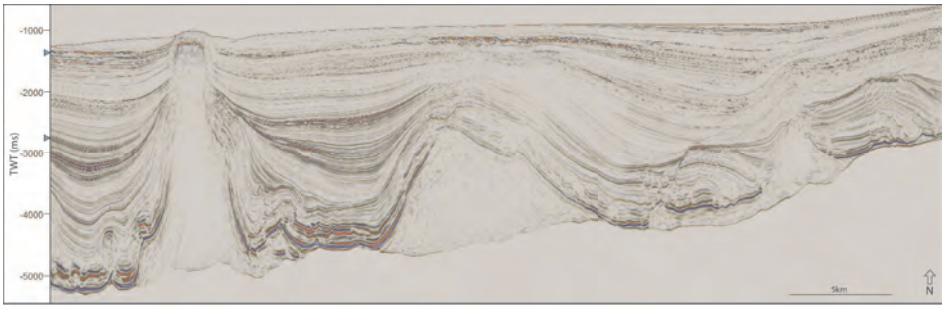
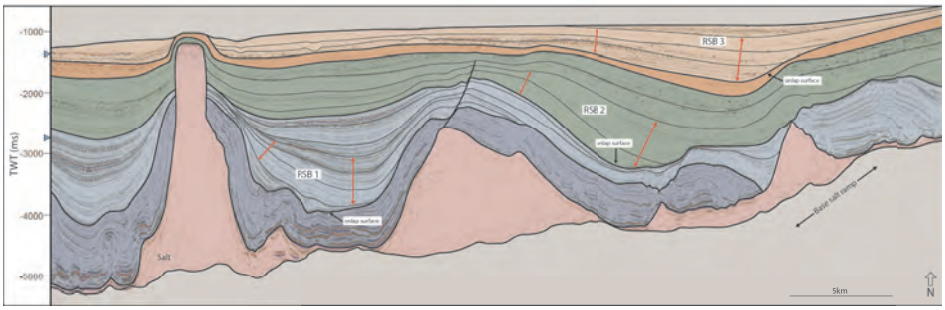
Salt-influenced passive margins are widespread and may contain large volumes of hydrocarbons. However, they can be structurally complex, with their kinematic development being poorly understood. Classic models of salt tectonics divide such margins into updip extensional, mid-slope translational, and downdip contractional kinematic domains. Furthermore, the faults, folds, and salt walls associated with each kinematic domain are typically assumed to form perpendicular to the maximum principal stress, which in gravitationally driven systems means broadly perpendicular to base salt dip. In this study we use high-resolution 3D seismic reflection data from the Outer Kwanza Basin, offshore Angola to show these models cannot explain the diversity of salt structures developing on passive margins, especially those defined by considerable relief on the base-of-salt surface.

We show rollers and walls in the mid-slope transitional domain of the Outer Kwanza Basin show three dominant trends, each characterised by different structural styles: i) salt walls perpendicular to the overall base salt dip, ii) salt walls parallel to the base salt dip, and iii) salt walls oblique to the base salt dip. Overburden seismic-stratigraphic patterns record the origin and evolution of the salt structures, allowing us to reconstruct deformation patterns through time and space. We show that each set of walls has a unique history, with synchronous phases of extension and compression occurring in adjacent structures despite their close spatial relationship. Our analysis suggests that, in the Outer Kwanza Basin, the structural evolution of the salt and overburden is predominantly controlled by base salt relief.

Changes in the downdip volumetric flux and velocity of the salt as it thickens and thins over topographic features cause local compression or extension, in addition to local changes in the base salt dip that can alter the direction of salt flow. This interaction with base salt relief creates locally variable stress fields which deform the salt and its overburden, overprinting the broader, margin-scale salt tectonics typically associated with gravity gliding and spreading.





As a result, salt walls in the Outer Kwanza Basin form at a range of orientations and demonstrate a complex structural evolution, independent of their overall position on the margin. We suggest that the base salt relief exerts a dominant control on salt-related deformation in the Outer Kwanza Basin as the salt is relatively thin compared to the magnitude of the relief. The overburden is therefore less 'cushioned' from the effects of base salt relief as it is translated downdip than in areas with thick salt and low relief. A better understanding of salt and overburden deformation on passive margins has wide implications for exploration in other salt-influenced regions such as offshore Brazil or Gulf of Mexico.

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Detecting foraminiferal photosymbiosis in the fossil record: a combined micropalaeontological and geochemical approach

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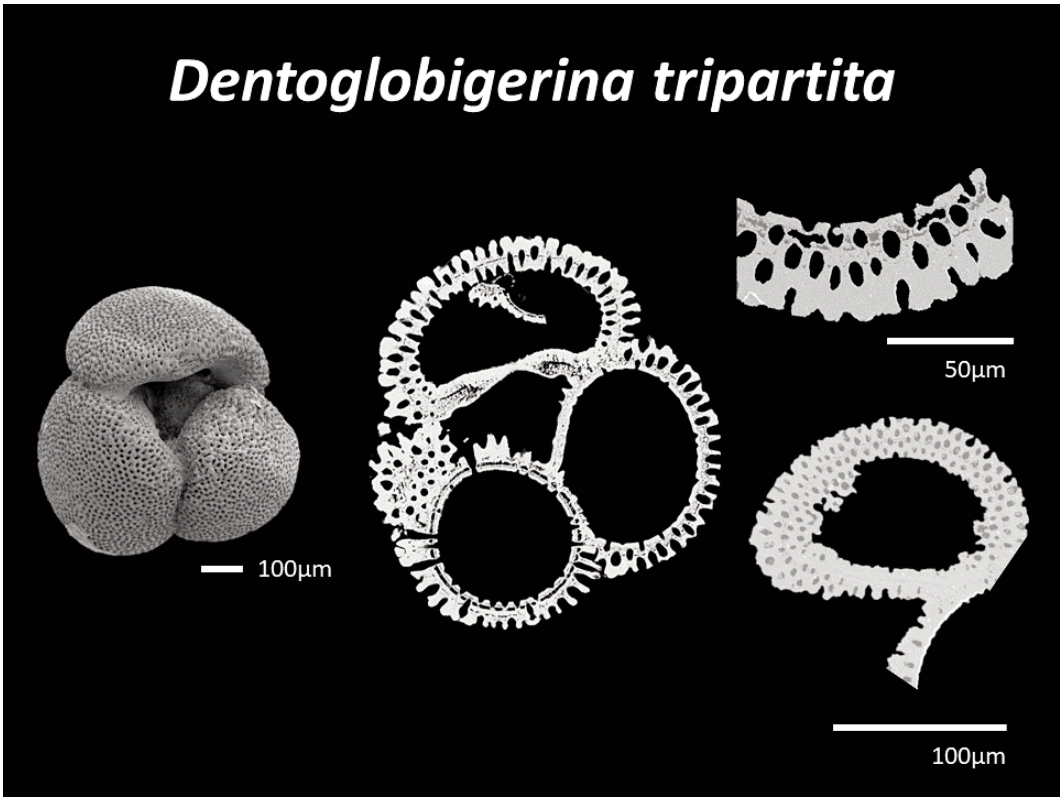
Modern symbiotic planktonic foraminifera exhibit cyclic Mg/Ca banding in their shell walls. Here we present electron microprobe data of well-preserved Eocene and Miocene planktonic foraminifera to investigate this feature in extinct taxa. In conjunction with δ13C and δ18O data, we further disentangle foraminiferal palaeoecology.

Surface dwelling species Globigerinoides subquadratus and Acarinina praetopilensis and thermocline dwelling species Dentoglobigerina tripartita and Parasubbotina hagni were analysed. Geochemical results indicate distinct ecological preferences between species. All surface dwelling species exhibit thick, prominent Mg bands, whilst in thermocline dwelling species Mg bands were thinner and less prominent. The spatial distributions of the δ13C and δ18O data on a carbon-oxygen cross-plot also correlate with the occurrences of Mg banding observed in the microprobe maps. Surface dwellers were δ13C enriched, whilst thermocline dwellers were δ18O enriched.

Having established these relationships, the evolution of photosymbiosis in middle and late Eocene hantkeninids was studied. Preliminary microprobe and δ13C data suggest an asymbiotic ecology in the middle Eocene and a photosymbiotic ecology in the late Eocene. The evolution of a photosymbiotic partnership in hantkeninids correlates with a depth habitat migration from deep to surface dwelling. Our data indicates that Mg banding is preserved in fossil planktonic foraminifera, and by combining micropalaeontological and geochemical data, more can be understood about extinct planktonic foraminiferal palaeoecologies



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