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2D numerical modeling of gravity-driven giant-scale deformation processes in the offshore Barreirinhas Basin (Brazil)

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Gravity-driven deformation processes at continental passive margins occur at different scales, from small-scale turbidity currents and sediment slides, to large-scale mass transport complexes (MTCs), to the giant-scale deep water fold and thrust belts (DW-FTBs), which affect most or the entire sedimentary sequence. This kind of giant structures, quite widespread in passive margins, may be active for tens of millions of years. In this context, the Brazilian Atlantic margin hosts several well-known DW-FTBs detached on both shale and salt décollement. Despite of their relevant scientific and economic importance, the mechanical processes driving the onset and evolution of these giant-scale structures are still poorly investigated. In this work, we focus on the shale décollement DW-FTB of the Barreirinhas Basin, where the continental slope has been affected by multi-phase gravitational processes since the Late Cretaceous. This DW-FTB consists of a linked fault system of listric normal faults updip and thrust faults downdip, detached over a common concave upward décollement surface. From the onshore extensional to the offshore compressional domain the DW-FTB is about 50 km wide and involve a sedimentary sequence up to 5 km thick. Shortening within the compressional domain is accommodated almost entirely from a single thrust ramp with a large related anticline fold. Previous studies have shown that the main activity phases of the gravitational processes are closely linked to significant increases in the sediment supply within the basin. Indeed, the highest deformation rate, accounting for about 80% of the net strain, occurred in the Upper Miocene following a drainage rearrangement which led to the birth of the modern Amazon River drainage system. The Barreirinhas Basin DW-FTB entails a rather simple geometrical structure, which can be well schematized, therefore is particularly suitable for numerical simulations aimed to study and understand the dynamics of DW-FTB at this particular place and also elsewhere. We set up a 2D fluid dynamic model by considering a Finite Element Method (FEM) environment, which allows us to well represent the geometries, densities and viscosities of the geological materials, as derived from geophysical investigations. Our study aims at understanding whether the long-term mechanical behavior of the Barreirinhas Basin DW-FTB can be reproduced by considering a simplified Newtonian fluid dynamics environment or it is controlled by a more complex rheology, which might include the effect of additional parameters such as internal friction, cohesive strength and pore-fluid pressure at the basal detachment.