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Structural restoration of a hyper-extended rift basin (Porcupine Basin, Ireland)

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As part of the Irish Atlantic Margin, the Porcupine Basin is a large north-south sedimentary basin of Late Paleozoic to Cenozoic age. It opened as result of repeated extensional events, resulting in a hyper-extended margin. Here we present an evolution model using structural restoration through time of a W-E oriented section crossing its two conjugate margins. Interpretation is constrained by well, seismic and gravity data. Thermal subsidence and compaction effects have been taken into account during the restoration. Biostratigraphic ages and sedimentological model helped to calibrate paleo-depositional settings.

Results show that after an initial stage of crustal stretching, steep normal faults accommodate first Middle-Late Jurassic syn-rift sequences. As extension continues, two “necking” faults develop soling out in the Moho and lower crust is exhumed. Late Jurassic syn-rift sediments deposit at this time over the central part of the basin. During the Cretaceous, breakup of the north-Atlantic margin produce a major unconformity (Basal Cretaceous Unconfromity; BCU) and magmatic activity builds a volcanoclastic complex lying onto the BCU at the same time that the rift system is aborted. The BCU unconformity is faulted towards the western margin of the basin, implicating re-activation of the main necking fault during Early Cretaceous time. However, thermal subsidence becomes the main mechanism for accommodation space and up to 5000 meters of Cretaceous sediments are deposited. Lower Cretaceous shallow marine carbonates developed on the top of the volcanic ridge while clastic sediments passively fill the basin in apparent onlap. Late Cretaceous is characterized by global sea-level rise: the decrease in siliciclastic input to the basin led to chalk deposition. Finally, while thermal subsidence is still active, the Porcupine basin is passively filled by Cenozoic deposits after a sediment-starving period occurring at the end of the Eocene, in addition to a potential inversion phase, which caused some erosion and concluded with an important erosive unconformity well documented in the whole basin.