

Benguela Basin and the Prospectivity of Hyper-Extended Margins

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ABSTRACT

Passive margins are commonly divided into three zones. Adjacent to the unstretched continent is the “Proximal Margin,” a zone of minimally thinned crust that generally remains subaerial or shelfal. It is characterized by horst and graben. Top basement and Moho are roughly parallel to each other and more than 20km apart. The next zone outboard is the “Necking Zone,” corresponding roughly to the bathymetric “slope.” Structurally it is often underlain by one or two major faults and marked by a sharp tapering of crustal thickness toward the “Distal Margin,” the last zone before oceanic crust. By definition, it is less than 10km thick, with top basement and moho once again roughly parallel to each other. In composition it is highly variable and may consist of hyper-extended continental crust, volcanic transitional crust, exhumed mantle, or a mix. The Benguela basin lies on the rifted Atlantic margin of Angola, within the larger South Atlantic Salt Basin. Extension began at about 132Ma, marked by flood basalts, widespread faulting, and clastic deposition. Over the next 25-30 million years, active rifting progressively focused toward the line of break-up, with the first oceanic crust forming in the Albian. Over the same period, deposition changed from clastics to lacustrine carbonates as the basin deepened, then salt and finally marine carbonates as a connection with the open ocean was established. Structurally, the basin today is marked by a narrow proximal margin, a necking zone close to the shore and a broad expanse of hyper-extended continental crust. BP entered Benguela basin in 2011, along with much of industry, hoping to replicate the success of the Brazilian pre-salt play. At the time, reservoir deliverability was viewed as the key risk. Over the next 5 years, thousands of square kilometres of 3D seismic data were shot, and 5 wells were drilled, including one discovery. Other wells found salt directly on basement or reservoirs with remnant oil shows, and large volumes of CO₂. Subsequent analysis reveals a complex structural story and a post-rift heating event that cracked existing oil accumulations to gas and some flushed some traps with CO₂. Analysis of these data yield insights that may be applicable to other hyper-extended margins. They are not simply deeper water versions of the familiar proximal margins.