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Structural and stratigraphic evolution of the Iberia-Newfoundland margin: A quantitative modeling approach

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Passive margins develop by extension and rupture of continental lithosphere. In general, the structure of a passive margin depends on a number of fundamental parameters, including the inherited rheology, rheological evolution during extension, magmatism, relative plate motions and the thermal properties of the continental crust and mantle before, during, and after rifting. These parameters determine the style, distribution and rate of extension, as well as the amount of syn- and post-rift accommodation and magmatism. In this presentation, we will investigate the paleo-water depths developed during hyper-extension of the Iberian-Newfoundland margin lithosphere by applying a process-oriented integration procedure that simulates the preserved margin stratigraphy using a model for deformation of the lithosphere and flexural isostasy. Seismic reflection and refraction data, gravity, and ODP drilling of the Iberian-Newfoundland margin are used as constraints. Manatschal et al., (2007) structurally reconstructed the Iberia margin to a 6-8 km pre-rift crustal thickness capped by shallow water Tithonian carbonates, suggesting an initial relief near sea-level. For reasonable crustal and mantle densities, this is difficult to achieve isostatically. Re-examining the evidence for shallow water sediments from Well 1069A (Leg 173 1069A16R3 127-130) suggests an environment of deposition consistent with a slope setting. The large organic content within the 1069A samples is dominated by woody and coaly particles, suggesting that this depositional package is part of a debris flow rapidly deposited in water depths of 500-1000 m from the laterally adjacent, shallow Galicia Bank to the north.

We have applied the Quantitative Basin Analysis (QBA) to integrate seismic stratigraphic interpretations of two representative sections across the northern and southern Iberian margin and Newfoundland margin (Sutra & Manatschal, in press) to model the thinning of the lithosphere and the respective environments of deposition (EODs) as functions of space and time. One transect corresponds to seismic lines SCREECH1 – ISE1 and the second south of the Galicia Bank corresponds to seismic lines SCREECH2 – TGS/LG12. ODP leg 103 was drilled on the northern transect while ODP legs 149 and 173 were drilled on the southern transect. From this analysis, we conclude that extension focuses oceanward during time, and propagates from south to north. Oxfordian – early Tithonian extension generated water depths of 500-1000 m across the southern transect while the northern transect had yet to be extended significantly at this time, consistent with shallow water Tithonian carbonates that are now part of the rotated footwall blocks of the Galicia bank. Carbonate-rich debris flows characterizing the depositional packages south of the Galicia Bank were deposited in a syn-rift environment. Thus, if the evidence for shallow water Tithonian sediments is incorrect, then the isostatic dilemma of thin crust and shallow water EODs is resolved.