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Thermal Subsidence Modelling in Sequential Restorations of Passive Margins

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Abstract

Correcting for the effect of thermal subsidence after a rifting event is a key step in sequential restorations of passive margins. Sequential restorations have corrected for elevation and geometry changes caused by subsidence by adjusting palaeo-elevation using palaeo-water depths from facies analysis. Thermal subsidence modelling, coupled with decompaction and isostasy modelling, allows for the reproduction of paleo-seafloor depths and surfaces more easily comparable to those created from facies maps. During periods of extension, the lithosphere is stretched and thinning is compensated by upward influx of mantle. An initial phase of rapid subsidence occurs caused by faulting. Thermal subsidence will occur as the lithosphere begins to cool and return to an equilibrium state. Thermal subsidence will exponentially decline as the lithosphere eventually cools to equilibrium over hundreds of millions of years. The Total Subsidence of a basin accounts for both the subsidence caused by the initial rifting event and the subsidence because of heat changes (McKenzie, 1978a). The amount of thermal subsidence expected for a basin is estimated based on the stretching factor (known as Beta). Beta can be estimated from different sources but essentially is a measure of the amount of horizontal extension. Heterogeneity of rift systems warrants that extension will not be constant along any single regional cross section. Variable beta factor values can be applied along an interpreted section to correct for differing amounts of extension. This will result in a more accurate reconstruction of the physical geology of the palaeo-seafloor surface compared with using a constant beta factor and assuming a uniform elevation change across the basin. This presentation outlines the workflow and results of separate sequential restorations of a hyperextended passive margin, comparing the effects of decompaction, flexural isostasy and thermal subsidence using the Move(tm) software suite. Uncertainties in the input parameters for thermal subsidence modelling are common and a number of sensitivity tests have been carried out to ascertain the impact of these uncertainties on a real world example. The impact of the timing of the rift event, variations of the beta value, as well as the separate effects of decompaction and flexural isostasy are tested.