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Factors controlling depth of continental rift zones

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Subsidence of continental rift basins is caused by thinning of the crust and lithospheric mantle together with isostatic compensation for the extra load of sediments and thermal relaxation. It is generally believed that the final depth of rift basins is primarily controlled by the amount of stretching and that other processes, such as rheology and sedimentation, only have secondary influence. However, we show that the relative rheological strength of faults inside and outside rift zones exerts substantial control on the volume of the final rift basin (by more than a factor of 3) even for the same amount of extension (total or inside the rift zone). This surprising result is mainly caused by irreversible deepening of the rift graben during stretching due to lower crustal flow when the faults in the rift zone are weak, whereas the effect is negligible for strong faults. Relatively strong faults inside the rift zone lead to substantial stretching of adjacent crust, and we find that long term stretching outside the main rift zone may explain the formation of wide continental margins, which are now below sea level. We also demonstrate that fast syn-rift erosion/sedimentation rates can increase the final volume of rift basins by up to a factor of 1.7 for weak crustal faults, whereas this effect is insignificant for strong faults inside the rift zone. These findings have significant implications for estimation of stretching factors, tectonic forces, and geodynamic evolution of sedimentary basins around failed rift zones.