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The Subhercynian intraplate foreland basin: a consequence of intraplate inversion tectonics

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The Harz mountains are one of the most impressive examples of a widespread pulse of Late Cretaceous, intraplate shortening and basement uplift which is found across the Central Western European region and is nowadays considered to be causally linked to the early stages of Iberia-Europe convergence associated with the uplift of the Pyrenees. The geometry and kinematics of the Harz uplift can be relatively well constrained by simple structural balancing and suggest a 45 degree dipping basement ramp with 7 km of northeast directed shortening and uplift. The timing of this event is also well constrained thanks to the so-called "Subhercynian Basin" on the northern margin of the Harz, which is filled by their erosive product. Late Cretaceous (Santonian-Campanian) sediments overlie Mesozoic strata in a 20 km wide basin extending 90 km laterally along the entire length of the Harz mountains. At its depocentre it reaches 2500 m thickness. Some interaction between a regional basal detachment rooted in Zechstein evaporites, underlying the Subhercynian basin and the main Harz Boundary Fault (HBF) have led to folding of the infill and the development of a number of angular unconformities. However, the broad geometry of the basin is clearly wedge shaped, and thickest near the HBF. One major question regarding this basin, as well as numerous others along the wider Late Cretaceous deformation front, is how to generate such a short wavelength, high amplitude subsidence pattern in an intraplate setting. Subsidence in compressional settings has generally been associated with foreland basins which require a load to elastically flex and depress the lithosphere. Usually, these are considered to operate at the orogenic and plate tectonic scale with high magnitude loads from major fold thrust belts with 100's kms shortening, and large wavelength (>100 km) basins. The Subhercynian Basin does not fit within this paradigm, and it is easy to show that for a "normal" lithospheric flexure model, the Harz load is insufficient to generate the required subsidence. The same would apply across the rest of the Late Cretaceous inversion front. We propose a modification of the lithospheric flexure condition which we call a "broken plate" model, where we introduce a weakness due to a narrow zone of reduced elastic thickness in the middle of a flexed plate and apply a load across it. Under these conditions, it is easy to produce the short wavelength, high amplitude basins required to explain many Late Cretaceous depocentres in the intraplate setting of the Central Western European paltform. We suggest that weaknesses correspond to basement rooted thrust faults, which reduce the effective elastic thickness of the lithosphere across a narrow zone. Our model thus combines the effects of isostatic subsidence of quasi-distinct crustal blocks and their elastic flexureand is able to match the geometry of the Subhercynian basin very closely.