



The effects of a lithospheric strength transition on foredeep evolution: Inferences for the East Carpathian foredeep

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Lateral variations in lithospheric strength have been used often in flexural modelling (both 2D and 3D) in order to better fit the observed basement deflections, typically supported by gravity data. This is essentially a “snap-shot” of the role of lithosphere strength in determining the present day geometry.

In contrast, we investigate and quantify the effects of a lateral change in lithospheric strength on the evolution of the foredeep of an advancing orogen. Transitions in lithospheric strength are common in the foreland of orogens and are quite variable as to the width of the transition zone and the magnitude of the strength difference. Former passive margins, for instance, will display strength changes distributed over widths of several tens to few hundreds of kilometers. Other transitions may originate from juxtaposition or accretion of pieces of lithosphere with different properties and may be characterized by a much larger gradient than former passive margins. An example is the Tornquist-Teyssere Zone at the western margin of the East European Craton.

We applied a constant, moving load to a 2D elastic plate with a lateral strength increase from 15 to 40 km (effective elastic thickness). The effects of this strength transition on the foredeep geometry include: (1) stepwise basin widening: the distal margin migrates at a rate of up to 4.5 times that of the mountain belt; (2) oscillation of the bulge: the flexural bulge elevation first rapidly decreases, then increases again before decreasing to its equilibrium elevation; (3) stepwise volume increase; (4) concentration and amplification of bending stresses around the strength transition. The larger the gradient of the transition, the more evident are its effects.

The increased rate of basin widening combined with lowering of the flexural bulge could have controlled the Sarmatian invasion of the East Carpathian Foreland. We tentatively propose that the effects of a transition in lithosphere strength are of a similar order of magnitude as those associated with previously studied parameters such as the rate of mass accretion by thrusting, the rates of erosion and sedimentation and sea level rise, and should hence be regarded as an equally important factor controlling foredeep stratigraphy.