Quantifying effects of parameter variations on results of flexural zones: Polish Outer Carpathians

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Previously completed flexural modelling studies of the Polish Carpathian Miocene collision zone proved, that along the entire Polish segment of this orogenic belt, subsurface loads related to slab-pull mechanism were most important for its development. Also, it was concluded that there are significant variations of the effective elastic thickness (EET) of the foreland lithosphere along the Polish segment of the Carpathians. These modelling studies were based on several simplifying assumptions, like constant EET of the foreland lithospheric plate, lack of subsurface horizontal forces, etc. Such a model can serve as a first approximation of the continental collision zone.

In order to fully estimate influence of variations of all the parameters included in the model of thin elastic plate flexure, like: variations of flexural rigidity, horizontal subsurface forces, irregularly distributed topographic loads, two point boundary conditions etc., a new modelling code was developed. The code is based on the concept of using numerical integration for finding solutions of the full flexural equation. This equation belongs to a very difficult class of stiff equations. This type of equation could be solved by relaxation method. Two point boundary conditions are also handled effectively by this method. The numerical solution is consequently fitted to the data points by adjustments of coefficients in the equation. Best values of parameters are found by fitting with multidimensional down-hill simplex algorithm. With this procedure, it is possible to "free" or "fix" any parameter of the equation and select any desired set of parameters for fitting.

Our analysis of solutions produced by the above scheme shows that some parameters are more important then others. There is also (rather unfortunate) effect of "complementary" parameters which could change a shape of the solution in the very similar way. Thus, it is difficult to find a precise value of such quantities. They act rather as a pair, and one can be used in place of another. The horizontal force and Moho density contrast is an example of such a pair of parameters.

We have found that inhomogeneities of elastic properties of the plate could play a great role, and could greatly improve a solution with respect to "ideal" homogenous case. We have also found that distributed topographical loads could be of greater importance than highly localised loads, since the influence of a localised force acting on the elastic plate is generally limited to the length of "flexural wave".

Two-dimensional models of petrophysical parameter distribution in structural-facies units of Polish Outer Carpathians in the Łupków–Jarosław profile

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The tectonics of the Cretaceous and Palaeogene flysch formations in the Łupków–Jarosław profile is characterised by elevated asymmetric folds and thrust sheets that are cut by overthrusts. Their deep geological structure was interpreted to obtain the best coincidence of the surface cartographic
Pre-Miocene tectonic events in the foreland of the Polish Carpathians

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(1) A zone displaying distinctively great crustal thicknesses, which comprises the Lublin Graben and the Radom-Kraśnik Uplift in south-eastern Poland, and extends into the western Ukraine, can be interpreted as a result of Late Variscan (late Westphalian-early Rotliegendes) transpressional tectonics.

(2) The multistage evolution of the Polish Permo-Mesozoic Rift Basin dates back to the Permian (late Rotliegendes) in northern and central Poland, and to the Middle Jurassic south of the Holy Cross Mts Lineament. This evolution was terminated by the Laramide inversion of the proximal zone of this basin. The inversion gave rise to the Mid-Polish Anticlinorium, which extends from the Baltic Sea south-east across cratonic areas of Poland and the western Ukraine, plunging beneath the nappes of the Outer Carpathians.

Available evidence permits to interpret a vast area of cratonic Poland as belonging to the Polish Permo-Mesozoic Rift Basin, assuming a concept of asymmetrical rifting, with simple shear involved. According to such an interpretation, the Mid-Polish Anticlinorium corresponds but to the proximal zone of the Polish Rift, whereas regions situated further south-west (e.g., the Szczecin-Lódź–Miechów Depression, the Fore-Sudetic and Cracow-Silesian Monoclines, the Upper Silesian Coal Basin and the Opole Depression) represent more distal portions of the rift basin.

(3) The southernmost (peri-Carpathian) portion of the Polish Rift Basin roughly coincides with the Meta-Carpghan Arch, a zone of uplift or lesser subsidence that separated the Central European Basin from basins of the Carpathian Domains in Permian, Mesozoic and Cenozoic times. An exception to this rule is the strong subsidence that affected the arch in the Late Jurassic. Presumably, the development of the Meta-Carpghan Arch should be interpreted in terms of crustal or lithospheric folding.

(4) The formation of the Mid-Polish Anticlinorium, with some dextral strike-slip movements involved, was chiefly a Laramide event, culminating in the Paleocene. Still controversial is the evidence for an earlier commencement of the development of this anticlinorium in mid-Late Cretaceous time, but a discrete Subhercynian event (of extensional nature?), centered over the Coniacian, can be recognized in the Cracow region, beyond the Mid-Polish Anticlinorium.