Quantifying effects of parameter variations on results of flexural modelling of continental collision 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 cf 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".