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Devonian–Cretaceous repeated subsidence and uplift along the Teisseyre–Tornquist zone in SE Poland — Insight from seismic data interpretation

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ABSTRACT

The Teisseyre–Tornquist Zone that separates the East European Craton from the Palaeozoic Platform forms one of the most fundamental lithospheric boundaries in Europe. Devonian to Cretaceous–Paleogene evolution of the SE segment of this zone was analyzed using high-quality seismic reflection data that provided detailed information regarding entire Palaeozoic and Mesozoic sedimentary cover, with particular focus on problems of Late Carboniferous and Late Cretaceous–Paleogene basin inversion and uplift. Two previously proposed models of development and inversion of the Devonian–Carboniferous Lublin Basin seem to only partly explain configuration of this sedimentary basin. A new model includes Late Devonian–Early Carboniferous reverse faulting within the cratonic area NE from the Kock fault zone, possibly first far-field effect of the Variscan orogeny. This was followed by Late Carboniferous inversion of the Lublin Basin. Inversion tectonics was associated with strike-slip movements along the Ursynów–Kazimierz fault zone, and thrusting along the Kock fault zone possibly triggered by deeper strike-slip movements. Late Carboniferous inversion-related deformations along the NE boundary of the Lublin Basin were associated with some degree of ductile (quasi-diapiric) deformation facilitated by thick series of Silurian shales. During Mesozoic extension and development of the Mid-Polish Trough major fault zones within the Lublin Basin remained mostly inactive, and subsidence centre moved to the SW, towards the Nowe Miasto–Zawichost fault zone and further to the SW into the present-day Holy Cross Mts. area. Late Cretaceous–Paleogene inversion of the Mid-Polish Trough and formation of the Mid-Polish Swell was associated with reactivation of inherited deeper fault zones, and included also some strike-slip faulting. The study area provides well-documented example of the foreland plate within which repeated basin inversion related to compressive/transpressive deformations was triggered by active orogenic processes at the plate margin (i.e. Variscan or Carpathian orogeny) and involved important strike-slip reactivation of crustal scale inherited fault zones belonging to the Teisseyre–Tornquist Zone.

1. Introduction

Processes active within the continental plates forming forelands of active orogenic zones have been subject of the intense studies for many decades (cf. Ziegler et al., 2002). Intracontinental deformations form a very wide array of different structures, both regarding their structural style as well as their size (cf. Park and Jaroszewski, 1994). Numerous parameters decide upon exact structural style of intracontinental deformation zones. They could be subdivided into two main groups: (1) parameters defining foreland plate, and (2) parameters defining processes within the collision zones that could be regarded as a boundary processes triggering intracontinental deformations.

In most simple, and rather theoretical situation, foreland plate could be regarded as a uniform plate characterized by constant parameters like effective elastic thickness. In such a case, foreland deformations induced by stresses generated within the collision zones would be regular and would include lithospheric buckling and development of flexural bulges. Wavelengths of such deformations depend on quantitative characteristics of compressional stresses and their trajectories, as well as on mechanical properties of the foreland plate (elastic effective thickness etc.). Apart from continuous deformations (folding–buckling), also faulting could occur within such homogenous foreland plate being deformed due to on-going collision at their boundaries. Location and amount of such faulting would also be rather regular.

In reality however, continental plates, due to their complex geological history, are built of numerous crustal blocks of various composition and age of consolidation, which implies laterally and vertically variable mechanical properties of the foreland plate, directly translating to variable response of particular blocks to the far-field tectonic stresses. Vertically, every crustal block could contain different rock types, including relatively weak rock layers (e.g. shales, evaporites) that are prone to intra-layer deformation and formation of *decollemant* zones. Crustal blocks that compose continental plate are divided by various scale fault zones, that are characterized by a complex history of their activity, often taken on a multiphase reactivation during changing stress field. Fault zones form more or less

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coherent boundaries of sedimentary basins, that during their history go through periods of extension-related subsidence and compression-related inversion and uplift. All these inhomogeneities have decisive influence on the style and scale of the intracontinental tectonic deformations triggered by continental collision, that could be of thin- or thick-skinned type.

Collision zones that generate compressional stresses within the pro-wedge forelands evolve in time, and each of the stages of their development could be characterized by various degree of mechanical coupling between the orogenic wedge and the foreland plate (Ziegler et al., 2002). In general, consecutive increase of compressional stresses transmitted into the foreland plate is observed during transition from initiation of subduction of the oceanic lithosphere through periods of on-going subduction punctuated by arrival of more buoyant crust to collision zone of an orogenic wedge with passive margin and late-/post-orogenic uplift of an orogenic wedge (Ziegler et al., 2002).

One of the most striking results of intra-plate compression is inversion of sedimentary basins located within the far foreland of evolving orogenic wedges. The kinematics of basin inversion, as well as the relationship between the development of underlying compressional intraplate stresses and plate boundary processes (orogenic belts and sea-floor spreading axes), have been addressed by numerous papers (e.g. Ziegler, 1988; Cooper and Williams, 1989; Ziegler, 1990; Letouzey, 1990; Coward, 1994; Buchanan and Buchanan, 1995; Brun and Nalpas, 1996; Ziegler et al., 1995, 1998, 2002; Dézes et al., 2004). Inversion of extensional/transtensional sedimentary basins involves compressional/transpressional reactivation of major fault systems as reverse fault zones (Brun and Nalpas, 1996), uplift of the basin floor

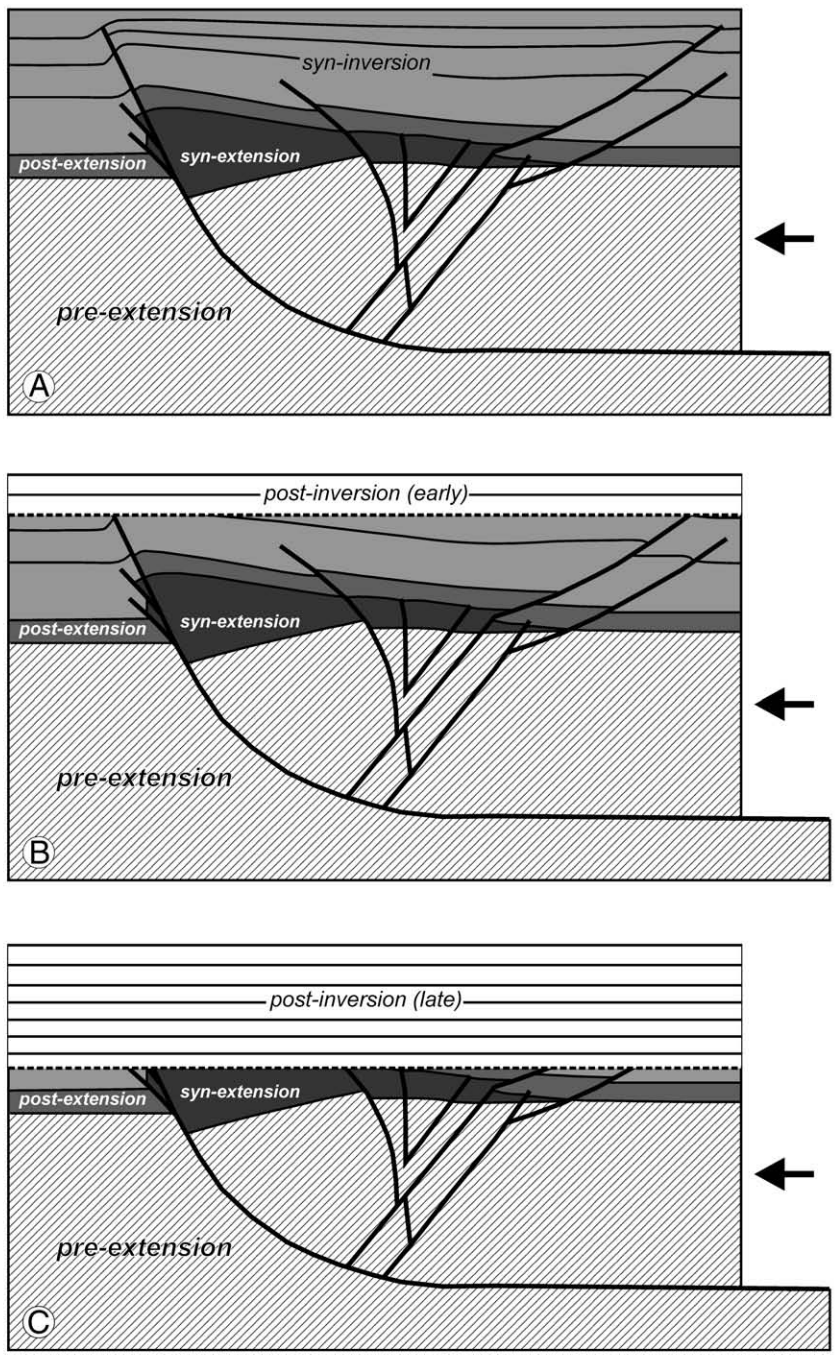

Fig. 1. Model of inverted listric fault. A: without post-inversion erosion, with syn-inversion strata full preserved, B: after partial post-inversion erosion, with syn-inversion strata partly preserved, C: after deep post-inversion erosion, with syn-inversion strata almost entirely eroded (based on McClay, 1995, modified and supplemented).