the overburden was eroded. For comparison, one of models did not contain the ductile layer.

During progressive extension of the sand-box a set of normal listric faults with conjugate antithetic counter listric faults bounding grabens developed in the sand layers. The number, geometry and location of these faults and grabens depended on: (i) thickness of the ductile layer, (ii) rate and amount of extension, and (iii) rate and amount of sedimentation. At small extension, the faults developed above the basement fault area; at higher extension, an additional set of faults developed on the ootwall. The latter did not originate when ductile layer was missing.

Reverse movement on the basement fault reactivated only few of the normal faults in the footwall. The rest of the normal faults were left dormant during the entire inversion. In one of the models, inversion also resulted in formation of thrust faults in the footwall far way from the basement fault. Evolution of these tectonic structures during progressive shortening was controlled by amounts of shortening and erosion. Performed models illustrate that the ductile layer decouples the basement from the cover units. In contrast, in the model which lacked a ductile layer, deformation in the cover was coupled with that of the basement.

Dynamic Topography: A Key to Understanding how the Earth's Mantle works?

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The dynamic surface topography is defined as a topographic signal maintained by the viscous flow in a sublithospheric mantle. The dynamic topography should not be confused with the observed topography, which is mostly related to isostatic compensation of crustal thickness variations and tothermal cooling of the lithosphere (for a detailed discussion of the concept see Le Stunff and Ricard, 1995). The analysis of geological data suggests that the amplitudes of the long-wavelength dynamic topography are significantly smaller than the observed amplitudes. This fact has been a puzzling problem for many years since a small dynamic topography can hardly be explained by numerical simulations of the whole-mantle convection and it seems to be in contradiction with the long-wavelength gravitational signature of the Earth as well. The interpretation of the dynamic topography thus represents a challenging problem the solution of which can provide important information about the style of mantle convection.

The last decade has seen many attempts to constrain the amplitudes of thedynamic topography from geological data and/or geophysical modeling. The first-order estimates of the dynamic topography based on whole-mantle flow models with a free-slip upper boundary usually show large topographic depressions close to subduction zones and topographic elevations in the neighborhood of ridges and the regions of hotspot activity. This paradigm is intuitively acceptable since it apparently agrees with the observation: We indeed find topographic heights close to spreading centers while the convergent plate boundaries are accompanied by pronounced depressions. A careful analysis of the bathymetric data taking into account thermal models of the oceanic lithosphere (Colin and Fleitout, 1990; Panasyuk and Hager, 2000) indicates, however, that the above concept may be misleading: The topography of the Pacific ocean corrected for the cooling effects shows an increase of amplitudes from slightly negative values (shallow depression) in the neighborhood of the East-Pacific Rise to positive values in the West Pacific (pronounced elevation). This result, which cannot be explained on the basis of whole-mantle flow models with a free-slip upper boundary, suggests that the dynamic topography may be strongly influenced by a complex flow situation at the boundary between the upper and lower mantles and by the existence of stiff lithospheric plates. If the plates are mainly driven by mass heterogeneities near the boundaries (slab pull), then the lithosphere drags the underlying mantle, giving rise to a large-scale flow. This flow generates and a negative topography close to the spreading centers and a positive large-scale topography above the convergent plate boundaries. At a short distance from the trench, the positive large-scale topography is overprinted by a small-scale depression.

We test this hypothesis using a model of mantle flow with imposed plate velocities, partial layering at 660 km and strong lateral viscosity variations in the tectosphere (Čadek and Fleitout, 1999, 2003). The parameters of the model are tuned up to satisfy the observed long-wavelength gravitational signal as well as thebasic seismic and tectonic information (buoyancy forces proportional to seismic velocity anomalies, existence of subducted slabs in the upper mantle, changeable thickness of the oceanic lithosphere, existence of continental roots, etc.).For such a model we predict a dynamic surface topography and we compare it with the oceanic topography corrected for the cooling effects (=presumable dynamic topography). Our model shows reasonably small topographic amplitudes (200–600 m) provided that the mass flux across the 660-km interface is significantly (by a factor of 3) reduced in comparison with the whole-mantle flow. The partial layering together with the plate motion imposed on the top leads to a flow pattern which strongly differs from the usual whole-mantle flow models and which produces a strikingly different pattern of the dynamic topography. The predicted dynamic topography basically fits the main trends of the bathymetric data corrected for the effects of lithospheric cooling: It shows a large-scale elevation in the West Pacific and South-East Asia, depressions close to the mid-ocean ridges and a weak elevation in the East Pacific.

Our model confirms the large-scale pattern of the dynamic surface topography proposed on the basis of bathymetric data and lithospheric cooling models. The amplitudes of the predicted dynamic topography are reasonably small and the distribution of the main topographic extremes is basically opposite to the observation. This suggests that the circulation in the mantle is partially layered and the whole-mantle flowmodels should be rejected. The lithospheric plates are an important ingredient to include in the mantle flow modeling. They can produce a significant large-scale flow influencing both the dynamic topography and the stress distribution in the lithosphere.

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EMTESZ – First Electromagnetic Probing of the Trans-European Suture Zone

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The Trans-European Suture Zone (TESZ) divides the European continent into the Phanerozoic part in the west and Proterozoic part in the east. The EMTESZ project is directed towards a magnetotelluric study of this zone along several profiles preferentially coinciding with recently studied refraction seismic lines in Poland. The study aims at inferring the main features of the resistivity structure of the lithosphere–asthenosphere system by using modern broad-band magnetotelluric array measurements. We present results of pilot measurements carried out in 2001 and 2002 in the northwestern part of the TESZ in Pomerania. We focus on the quality of earth response functions with respect to man-made noise which may create considerable problems to MT soundings in Poland. Several long-period magnetotelluric measurements together with magnetovariational responses from the Belsk observatory give us a possibility to estimate the regional geoelectrical structure of the upper part of the mantle. These measurements show that, at the depth of about 8–25 km, a layer with an apparent anisotropy can be formally interpreted with the resistivity of about 6 Ohm-m along the TESZ and about 300 Ohm-m in the orthogonal direction, which correlates with the seismic zone of relatively low velocities. A preliminary model of the geoelectric structure of the crust across the TESZ is presented.

Detrital Cr-spinels in Culm Sediments and their Tectonic Significance

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Detrital Cr-spinel is an important component of heavy mineral assemblages. The chemical composition of spinel grains provides specific information about the source rocks types in different tectonic settings. Cr-spinel (Mg, Fe^{2+})(Cr, Al, Fe^{3+})O_4 is a ubiquitous accessory mineral in basalts and peridotites. Spinel composition reflects magma chemistry, the degree of partial melting and fractional crystallization (Cr and Mg partitioning into the solid, Al partitioning into the melt), temperature, fO_2 (ratio of Fe^{2+} to Fe^{3+}) (Yong, 1999). The Mg# in volcanic spinels reflects the cooling rate.

Detrital Cr-spinels were found in the heavy mineral assemblages of greywackes from the Drahany Culm. Spinel grains show significant variations in most important compositional parameters such as Mg# (Mg/Mg + Fe^{2+}), Cr# (Cr/Cr + Al), TiO_2 and Fe^{2+}/Fe^{3+}. These variations suggest multiple sources for spinel grains.