

## **Brittle and ductile deformation in extensional tectonic settings within the Central Asian Orogenic Belt (evidence from Geotransect «East Siberian Plate - Siberian Craton –Central Asian Belt»)**

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The geotransect “East Siberian Plate – Siberian Craton – Central Asian Belt” within the Central Asian Orogenic Belt crosses the Ergun massif, Mongol-Okhotsk (Khangay-Daur) fold belt and Sayan-Baikal fold belt (Fig. 1). The geological interpretation of geophysical (multichannel seismic reflections, deep seismic soundings, magnetotelluric and gravity) data is based on rheological models of the Earth’s crust. These models suggest the presence of three main rheological crustal layers, which differ in deformation mechanisms and styles. The brittle-ductile transition zone is the middle layer and plays an important role for recognition of deformation and deep geological structures. Brittle processes dominate in the brittle layer above this zone, crystalloplastic or ductile processes dominate below the transition zone in the ductile layer.

Multichannel seismic reflection data provide us with the structural framework and the characteristics of the crust from seismic wave energy and are used for localization of the transition zone. The transition zone as identified from seismic data can be confirmed in other geophysical sections. Within the southern fragment of the Geotransect, the transition zone is localized at a depth of 15-20 km and is about 2-5 km thick, which corresponds to the theoretical rheological model.

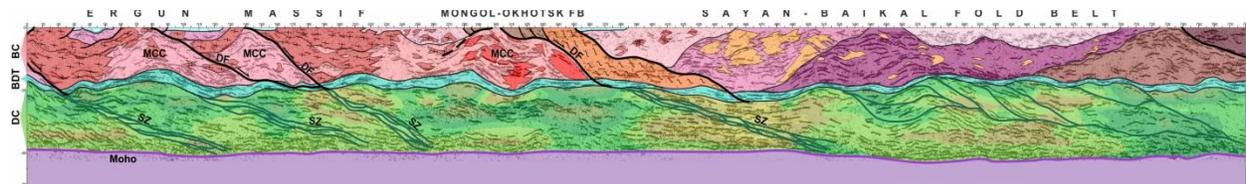
In extensional tectonic settings, detachment faults dominate within the upper brittle crust and pinch out along the locally-distributed transitional boundary (Cooper et al., 2017). Recognition of the detachment faults is crucial for understanding upper crustal deformation and structures.

Crustal deformation includes the formation of dome-shaped metamorphic cores, which are widespread within the studied part of the Geotransect. The role of the transition zone is demonstrated using the multi-stage evolution model of a detachment fault (Platt et al., 2015). The model suggests that deformation began from normal fault initiation and resulted in the formation of a gneiss dome. The first stage is the initiation of a normal lystric fault along a steep trajectory through the brittle crust. A detachment fault undergoes rapid reduction in dip due to horizontal stretching of the upper layer in the second stage. Upper and lower rolling hinges constrain the inclined part of the fault plane. The footwall structure has a dome-shaped geometry due to isostatic readjustment. Continued motion on the fault rotates the footwall around the upper rolling hinge into a subhorizontal orientation following the rolling-hinge model. Part of the detachment transforms into an inactive fault. The dome-shaped metamorphic core is exposed on the surface in the last stage. Gneiss domes and associated inactive and active parts of detachments are recognized in geophysical sections.

Below the transition zone, rheological models assume the transition from localized to penetrative deformation. Within the ductile crust, this suggests a dominance of anastomosing gneissic shear zones (Fossen and Cavalcante, 2017) that could be found within the profile in multichannel CMP reflection sections. Other geophysical data and especially local zones of conductivity demonstrate a strong correlation with the seismic data interpretation. Within the Mongol-Okhotsk fold belt and the Ergun stable block segments, there is a long-distance shear zone with very low angle dip below the transition zone. In many cases, these shear zones are deep continuations of the detachment faults and separate different blocks of the consolidated crust.

Results of the geological interpretation of the geophysical data confirm the importance of rheological

models for understanding consolidated crustal deformation and dynamics. This approach could also be proposed for other tectonic settings and geological structures crossed by adjacent deep seismic profiles (NE Sinoprobe).



**Figure 1.** Interpretation of geophysical data showing detachment faults (DF), metamorphic core complexes (MCC) within dome-shape structures in the brittle crust (BC), the brittle-ductile transition zone (BDT) and shear zones in the ductile crust (DC). The section is 780 km in length and down to 50 km depth.

### References

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- Platt, J. P., Behr, W. M., and Cooper, F. J., 2015, Metamorphic core complexes: Windows into the mechanics and rheology of the crust, *Journal of the Geological Society*, 172, 9-27.