Geophysical Research Abstracts
Vol. 13, EGU2011-2159, 2011
EGU General Assembly 2011

Plan configuration of denudation escarps as an indicator of neotectonic stresses for the platform plains

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It is well known how difficult it is to determine horizontal components of tectonic movements and stresses in platform settings with gently dipping strata. In that time, it became obvious that collisional tectonic stresses penetrate horizontally far into the lithospheric plates. Ways of optimization of methods of detection of this poorly studied horizontal component in the platforms by studying a plan geometry and dinamics of formation of denudation escarps of the Russian plate are shown. Configuration of the escarps was affected by erosion as well as by abrasion in case of penetration of Neogene seas into river valleys. Non-uniformity of river bank height and steepness is explained by different causes, including the Coriolis forces, unequal damping of differently facing slopes, neotectonic tilt of the river bottom in its transverse profile, so on. A view on long neotectonic faults as a possible cause is also widespread.

The author and his colleagues made mass measurements of the mesotectonic structures, i.e. slikensides, extension joints, and stylolites, in the most extended (up to many hundred kilometers) denudation escarps of the Russian plate, namely the submeridional Volga-Ergeni, sublatitudinal Middle Volga and L-curved Upper Don ones. The studies show that the escarp morphology was formed in accordance with regional neotectonic stresses. This was confirmed by macrostructural analysis, i.e. by correlation to orientation of major intraplate neotectonic structures of different kinematic signs, i.e. upthrusts, strike-slip, and normal faults. The escarp orientation and plan geometry often reflect local variatioms of the regional neotectonic stress field which have been also determined by independent meso- and macrotectonic methods. For example, a strike-slip setting can be determined from en echelon arrangement of the valley segments, with step-overs pointing to a strike-slip kinematic sign as well as from occurrence of valley widenings similar to pull apart basins at release bends of the escarp line. Areas of horizontal extension are characterized by festoons of enclosed arc-like excavations, with adjacent ones jointed by acute corners. Such amphitheatres remind the landslides back walls, however being distinguished by enormous size of some tens, up to few hundred kilometers long. Just the same are sizes of listric fault amphitheatres in the rift zones. Some valleys have in plan a zigzag-like geometry characteristic of break-away extension fractures. (Sure, we do not mean a real 2-3-km detachment of opposite river banks but the valley forms can duplicate deep-seated extension structures in plan). A whole of horizontal compression setting is not typical for platforms but it also can be supposed from locally increased height and steepness of the escarps as well as from disappearance or aligning of the arc-shaped excavations which are changed by convexity (“overhanging”) of the steep banks toward valleys. Because the geological and geophysical mapping of the denudation escarp zones have not discovered faults of similar length, it should be considered that above-mentioned features of the escarp plan geometry were resulted from synerosional preparation of walls of the tectonic release joints, which correspond in orientation and kinematic sign to the regional neotectonic stress field. This is consistent with the fact that the detailed drilling and seismic profiling in the escarps zones have revealed in some places strips of the joints and minor faults concentration.

The results obtained are important in several aspects: (i) methodical one as they provide an additional tool for prognosticating orientation and kinematic sign of the poorly studied horizontal component of the neotectonic stresses in platforms; (ii) theoretical one, because they draw our attention to the joints/minor fault zones as concentrators of the collisional stresses transmitted far to the north from the Eurasian plate southern boundary through the platform lithosphere; (iii) applied one as they explain a confinement of the epicenters of intracratonic earthquakes as well as the tectonic release joints, landslides, and karst to the 1-st order denudation escarps and, in general, they make us to consider the denudation escarps zones as areas of a higher geological emergence.