The balanced model of east part of Mz-Cz sedimentary cover of the Greater Caucasus based on measurements of folded structures strain values

Fedor Yakovlev

The Schmidt Institute of Physics of the Earth, Moscow, Russia, yak@ifz.ru

Structural material of the Greater Caucasus which was used for the study

The Greater Caucasus is part of Alpine fold and thrust belt (Adamia et al., 2011). Detailed data of structures of a Mz-Cz sedimentary cover of on three tectonic zones having close or tight folds and faults are analyzed. Chiaur zone in the Central sector (42.5°N, 44°E) of the Greater Caucasus is the most southern, it borders on the Transcaucasian Massif across a large regional fault. Flysch carbonate and terrigenous thin-layered sequences of age from Upper Jurassic to the Upper Cretaceous are exposed here. The large fault separates it from more northern structure which is stretched to the east. The structure of this tectonic zone is presented better in the Southern-East Caucasus (41.2°N, 48°E) where it named Tfan zone. There are flysch-like not carbonate terrigenous deposits of Middle Jurassic (Rogozhin, Yakovlev, 1983). The Shakhdag zone following to the North separates from Tfan zone by large fault – Main Caucasian Thrust. Here there are breeds crumpled in folds Lower and Middle Jurassic too. Structures of the Scythian plate without folds (44°E), or gentle box-shaped folds located to the north from Shakhdag zone (46°E) or its analog. Thus, the specified three zones form complete cross-section of the Greater Caucasus sedimentary cover. 11 profiles of scale 1:10 000 (8 for Tfan zone) and 1:25 000 (Chiaur zone) in total length of 125 km were studied. The purpose of the analysis is restoration of a structure of a sedimentary cover in its full volume on the basis of the description of strain values at different scale levels.

Methods of structure restoration

Fold deformation description bases on strain ellipsoid conception which uses several parameters (fig. 1). There are inclinations of axial surfaces of folds (*sign 1*), an inclination of an envelope plain of folds (*sign 2*), interlimb angle of folds (*sign 3*) for shortening value estimation which were measured in the folded domains allocated in cross-sections (1-2 km width). Lengths and inclinations of the section line (*sign 4*) for each domain were measured also. Three kinematic operations are a basis of reconstruction method of pre-folded state of each domain. There are rotation to the horizontal position of folds envelope plain, simple horizontal shearing to the vertical position of the axial planes, horizontal stretching (pure shearing) up to disappearance of folds at which the strain ellipse becomes a circle (fig. 1). Aggregation of all domains pre-folded states allows to compile complete initial section and to define shortening value for any its parts (Yakovlev, 2009). Data about thicknesses of the main stratigraphic units in each tectonic zone were collected and «stratigraphic models» were compiled for each section for whole sedimentary cover for all three zones (thickness from 9 to 17 km, average mean is 13 km). For calculation of tectonic related homogeneous shortening, the structural cells were allocated in sections (5-7 km width) which were comparable on width to total thickness of a cover and uniting several domains each.

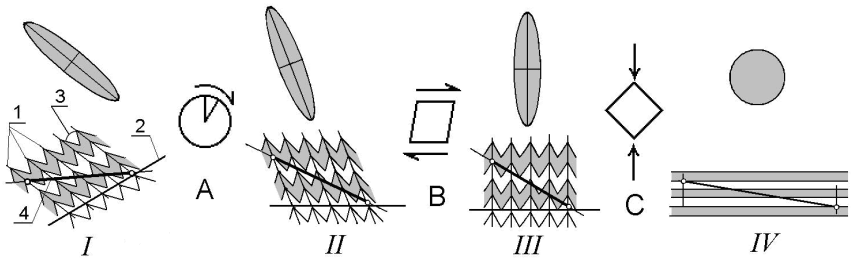

Figure 1: Operations for restoration of domain pre-folded state (IV) from recent state (I) A – rotation (from I to II), B – simple horizontal shearing (II – III), C –elongation (III – IV).

Result: strain distribution and the Mz-Cz sedimentary cover common structure

These 11 balanced cross-sections in total length in 270 km of pre-folded state were compiled. Folded domains (amount of 220) were aggregated in 28 structural cells for which the shortening values were defined from 36 to 67 %, 54 % on the average, also as depth (or height) of boundaries of main stratigraphic units. According to these data, a relief of top of the basement in natural structures was described (depths from 4 to 24 km, 13 km on average). Subsidence of basement top in the Chiaur zone with amplitude of 10-15 km on southern regional fault relatively Transcaucasian Massif is reliably established. Probable existence of the 10 km of shift up on basement top of the northern block in a northern half of the Chiaur zone, and also the 10 km sinking of the southern half of structure of the Tfan zone in its east part were estimated also. The height of eroded part of recent sedimentary column above a relief was calculated as from 7 to 24 km at average value in 16 km. Some restored structures are shown on fig. 2. Results have good prognostic properties for balanced model within Shakhdag zone, allowing to assume a building of relief at the same time with folds formation at least locally.

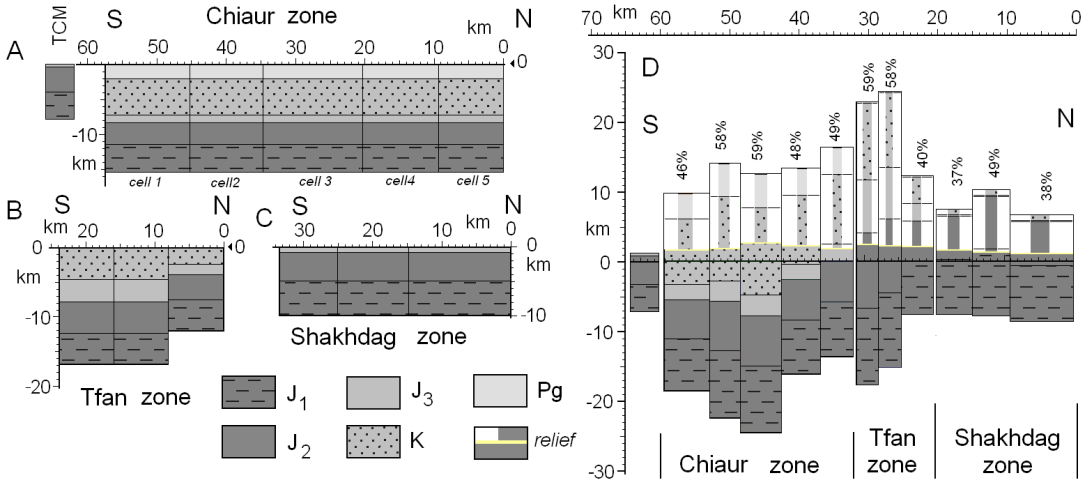

Figure 2: Results of sedimentary cover reconstruction. Pre-folded states of cover in structural cells for Chiaur zone (A), also Transcaucasian Massif (TCM), for Tfan zone (B) and Shakhdag zone (C). Recent state of sedimentary cover of zones (D), shortening values and eroded parts are shown.

Possible structure of Greater Caucasus in scale of Earth' crust

The general fold related shortening of cross-section of the studied part of the Greater Caucasus was double (from 113 km to 57 km) and was accompanied by considerable subsidence of Earth' crust rocks blocks located below the sedimentary cover. Data on distribution of shortening values, on a relief of basement top, on types and on amplitudes of displacements on faults in a folded sedimentary cover don't confirm existence of structures of thin-skin tectonics type in the Greater Caucasus. The Greater Caucasus Mz-Cz sedimentary cover should be attributed to structures of thick-skinned tectonics with prevalence of plastic deformation of the basement.

The data of balanced structure of sedimentary cover also as common structure of Grater Caucasus in scale of Earth' crust may be used as material for geodynamic modeling.

References

Adamia S., Sadradze N., Tsereteli N., Chabukiani A., Gventsadze A., Zakariadze G., Chkhotua T. Geology of the Caucasus: a review // Turkish Journal of Earth Sciences. 2011. t. 20. 5. pp. 489-544.

Rogozhin, Ye.A., Yakovlev, F.L., 1983. A quantitative estimate of the morphology of folding in the Tfan zone of the Greater Caucasus // Geotectonics. 17(3) 242-251 (in English).

Yakovlev F.L. Reconstruction of Linear Fold Structures with the Use of Volume Balancing // Izvestiya, Physics of the Solid Earth, 2009, Vol. 45, No. 11, pp. 1025–1036 (in English).