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Distribution of shortening values within the Great Caucasus structure based on the data of analysis of the geometry of different-scale folded structures

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Introduction. The most part of Alpine structures have widespread numerous napes that overlap the foreland sedimentary basin and consist of large-scale folds. The shortening values can be obtained for this structure by standard balancing cross-section procedures. Inner parts of Alpine structures consist of other type napes and of autochthonous folded rocks. The Great Caucasus structure mainly consists of the Alpine flysh sedimentary cover, which was deformed and formed numerous small-scale folds. The napes of different types are not wide spreaded in the Great Caucasus. Thus, the usual restoration based on standard balancing cross-section, is not possible for the Great Caucasus structures. The information about the types and values of deformations can be obtained from small fold and fracture geometry, and this information may be used. The best way is to begin with small and clear for understanding structures and to use these results for more and more large structures up to tectonic zones.

Shortening values obtained from studying of separated folds. The most reliable method for shortening value calculation uses the geometry of single viscous folds (SVF), which is related to clear mechanical model of fold formation (a combination of buckling and flattening). The model was realized in finite element numerous calculations (Hudleston et. al., 1973). Some geometrical parameters were measured in fold models and two diagrams were plotted. These diagrams show the relationship between the geometry and two parameters; the shortening value and the viscous contrast between a layer and a medium. 70 structures of SVF-type were studied in the Chiaur tectonic zone, which is the most southern zone at the Great Caucasus (Yakovlev, 1978). The shortening values for separated folds lay within the limits of 25% to 82% [Sh=(L0-L1)/L0]. The cinematic model for interchanged competent and incompetent

layers was also created (multilayer folds - MLF). This model used the same type of combination of buckling and flattening mechanisms of fold formation. Two parameters were used, such as the ratio of the competent layer thickness in flank of fold to its thickness in the hinge and the angle of dip of the flank. The relationship of these parameters can be shown in a diagram. The shortening values for MLF in the Chiaur tectonic zone lay within limits of the 27% to 83% (for 36 structures). The last version of the model gives the prognosis of the strain value and the ellipsoid orientation in the hinge and the flank of the fold for the competent and incompetent layers (Yakovlev, 2002). The comparison between data of strain analysis of the natural folds and its modeled predicted strain values shows a good coincidence (Yakovlev et. al., 2003). Both types of structures (MLF and SVF) were found in eight local structures of the Chiaur tectonic zone and shortening values were obtained. A good correlation coefficient about 0,95 for these 8 pairs of the values shows the reliability of MLF method.

Method for measuring shortening value method for large structures. The estimation of shortening values for large structures based on sets of shortening values of smaller folds is a methodical problem. Knowledge of a hierarchy of different scale folded structures was used for estimation of these shortening values. There are seven hierarchical levels - from intralayer deformed objects (grains, 1-st level) to meganticlinoria (6-th level) and the whole fold-thrust belt (7-th level). Separate folds (MLF and SVF types, 2-nd level), which have uniform parameters of the geometry and lay together along a part of a cross-section, may be combined in a domain (3-d level). The geometry of the domain has three main characteristics - shortening value in the direction perpendicular to the axial plane (MLF and SVF types shortening value), dip angle of the axial plane and dip angle of the envelope plane. Three kinematic operations are used for the restoration procedures. There are: rotation (dip of envelope plane is used; the horizontal position of layering will be the result), simple shear (along horizontal layering, the vertical position of the axial surface will be the result), and pure shear as an extension (from the new shortening value after simple searing on second step to zero, the folds disappear). Several prefolded states of domains may be jointed together, and the prefolded state of the cross-section appears. The faults are considered as the boundary planes of domains, and the prefolded angle dip of this plane may be calculated using the same operations. Two contacted layers in two neighbour blocks have the difference in their positions in the stratigraphic columns. Thus, the vertical amplitude and the horizontal amplitude of the displacement may be calculated. The combination of the prefolded domains and the prefolded fault boundaries gives the whole prefolded cross-section and its total length. The value of shortening may be easily calculated for a tectonic zone (5-th level) and a local anticlinoria as parts of the tectonic zone (4-th level) using recent length of the cross-section and its prefolded length. This method may be considered as a kind of cross-section balancing method

for central parts of fold-thrust belts, consisting of numerous small folds.

Regional results. There are three main tectonic zones within the structure of the Great Caucasus in its central and eastern parts, from the south to the north, such as Chiaurskaya, Tfanskaya, Shakhdagskaya zones. There is a wide Limestone Dagestan zone in the northern part of the eastern Caucasus. The next values of shortening were calculated for these parts of the Great Caucasus structure. Chiaurskaya zone in the whole (5-th level) has the shortening value of 0,452=(28,2 km/62,3km). Four parts of this zone (4-th level) have the shortening values from the south to the north of 0,56; 0,42; 0,40; and 0,41. Tfanskaya zone in the whole (5-th level) has the shortening value of 0,55=(14,5 km/26,2 km). Four parts of Tfanskaya zone (4-th level) have the shortening values from the south to the north of 0,70; 0,47; 0,49; and 0,66. Shakhdagskaya zone was characterized by a cross-section in its southern part. This cross-section in the whole (5-th level) has the shortening value of 0,51=(17,4 km/34,3 km), and the shortenings of its 4-th level parts are 0,58; 0,36; 0,70. Another part (Schist Dagestan) consists of large folds that have lower shortening. Limestone Dagestan zone has a recent width near 60 km and consists of simple large folds. The measurement of the length of the layer and of its horizontal projection gives the shortening value of 0,75. These values of the shortening may have some differences from place to place, of course. But these values for the Great Caucasus have the tendency to increase from the north to the south from about 0,75 to 0,45.

References:

Hudleston P.J., Stephansson O. Layer shortening and foldshape development in the buckling of single layers // Tectonophysics. 1973. Vol. 17, ź 4. pp. 299-321.

Yakovlev F.L. An estimate of deformations in a folded region on the basis of disharmonic folds. Bull.MOIP, Geol. Depart.,1978, 53(5), pp. 43-52. (in Russ.)

Yakovlev F.L. Investigation of the processes and mechanisms of the plicative deformations development in the Earth's crust (review of the existing approaches). // Tectonophysics today. Moscow.: UIPE RAS, 2002. pp. 311-332. (in Russ.)

Yakovlev F.L., Voitenko V.N., Khudoley A.K., Marinin A.V. Regarding ratio of shortening deformations values into folded domain and into competent layer. // Tectonic and geodynamic of continental lithosphere. Materials of XXXVI Tectonic meeting. GEOS, 2003, T.2, pp. 325-329 (in Russ.)