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The structure of Greater Caucasus in scales of sedimentary cover and crust, based on restored structural sections, which were obtained from study of fold-related strain

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Geological setting. Greater Caucasus (GC) belongs to a linear branch of the Alpine belt (Crimea, Caucasus, Kopet-Dag) which is not arc-like as the Alps. The main stripe of the Alpine deformations in GC occupies space about 1000 x 50 km between the Scythian plate and the Transcaucasian massif. Folded structure prevails and it is accompanied by almost total absence of thrust in a hinterland and by limited thrusts in forelands. The Paleozoic basement outcrops only in a northern half of this linear structure, occupying about 1/8 part of GC. Alpine sedimentary cover (J1 – Pg2) has 10-15 km thickness of flysch-like sequences of sands, argillites, limestones. These sediments formed numerous folds of 0.1 - 1.0 km width. Because each fold has information about strain, the existence of so rich material allows to restore geometry of a sedimentary cover from soil to its top.
Method. Three regions were studied due based on 24 detailed structural sections of 510 km total actual length. Two kind of isometric objects of different scale were established: domains and structural cells. There were domains as associations of 2-5 folds; sections were split on 505 one. In these domains, three parameters of morphology were measured as elements of strain ellipsoid (ellipse): dip of axial plain, dip of envelope plain, value of shortening as interlimb angle [1, 2, 3]. It was possible to restore actual state of domain to its pre-folded state (from ellipse to circle) by sequence of three kinematic operations: by rotation to horizontal position of envelope plain, by horizontal simple shear to vertical axial plain and by vertical flattening (pure shear). Pre-folded state of whole section is forming by aggregation of pre-folded states of domains. “Structural cells” were formed by aggregation of 5-10 domains in each cell for correct measuring of shortening value in scale of whole sedimentary cover; there were 78 for three regions. “Stratigraphic models” from bottom to top of cover for each cell were found based on famous (outcropped) column and on some interpolations. It allow to find vertical positions (depth) of section lines inside models. Initial thickness of cover was reformed to new post-folded thickness and knowledge of section line depth allow to find a depth of cover bottom and virtual heigth position of cover top (uplift amplitude).
Results. North-Western Caucasus (NWC) was studied on 250x50 km stripe in 11 sections and 42 cells [1]. Initial thickness of sedimentary cover was 13 km (7.3÷17.3 km). Shortening value for structural cells deviated from small (-10%, 2%) at pericline part to 15-67% and it has 35% in average. Actual depth of basement top (soil of sedimentary cover) was -13 km (-2.2÷-31.7 km). Three sectors along strike of NWC were found: with central depression at pericline (-19, -23 km), with sinking of south part of structure (-27, -32 km) and with central depression again on East (-25 km). Amplitude of erosion has reasonable distribution on NWC: from small in average at pericline (3 km) to high value at center (15 km) with smaller values on edges of sections. Average value was 8.9 km (+0÷+22.2 km). Chiaur tectonic zone in South Ossetia (ChZ) and two zones in South-Eastern Caucasus – Tfan Zone (TZ) and Shakhdag zone (ShZ) have formed together the other part of Caucasus [3]. Initial and actual depths of sedimentary cover have had close values -15 (-21) km, -10 (-10) km, -13 (-12) km. Southern part of structure (ChZ) has had considerable actual subsidence of basement top (-13.6÷-26.3 km). The shortening values were found as 57% in average for ChZ (with deviations 46÷67%), 55% for TZ (36÷67%), 49% for ShZ (37÷62%). Amplitudes of erosion were calculated as 16 km for ChZ (10÷22), 19 km for TZ (12÷24), 10 km for ShZ (7÷12). On the southern border of GC, depths of basement top were found as -8 km for Trans-Caucasian massif (stable block) and -19 km for adjacent cell of ChZ (GC). It means that: 1) value of shortening of sedimentary cover of ChZ 57% is equal to shortening of basement, 2) regional detachment and thrusts in GC above basement cannot exist. Based on these data, calculation of vertical movements of former Moho (-40 km for beginning of J1) shows that actual position of these rocks may has depth about 110 km [3]. It means that considerable part of crust rocks should became “mantle” in density and this kind of rocks transformation is inescapable condition of folding formation for structure of GC.
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