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BALANCED STRUCTURES of Mz-Cz SEDIMENTARY COVER of HINTERLAND PART of GREATER CAUCASUS BASED on RESULTS of MEASURMENT of FOLD RELATED STRAIN

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Greater Caucasus (GC) is linear structure at the north part of Alpine mobile belt [1, 2]. GC possesses specific properties of structure which much differ from typical Alpine systems like Alps and Carpathians. There are: mainly folded thick flysch-like sedimentary cover (about 10 - 18 km thickness) from Lias up to Eocene, 2D deformations of "similar" morphology folds, a few nappes, also as absence of Alpine magmatic intrusions and of serious metamorphism. Systems of folds of different scales (from centimeters up to first kilometers) were studied earlier by compilation of detailed structural sections in three regions mainly [2]: North-Western Caucasus (NWC, [2, 3], 11 sections), Chiaur tectonic zone ([4], ChZ) on south part of Central Caucasus to the north of Transcaucasian Massif (South Ossetia, 3 sections), Tfan (TfZ) and Shakhdag (ShZ) tectonic zones of South-Eastern Caucasus (SEC, Dagestan, Azerbaijan, 8 + 2 sections [5, 4, 6]). Initial scale of main part of sections was 1:10000. To the north from Main Caucasian Thrust (including ShZ and to north) after first event of folding formation before Malm, the carbonate semi-platform was formed with only 2-4 km thickness of deposits instead of large (8-15 km) carbonate flysch sequences from Malm up to Eocene to the south from MCT (TfZ and ChZ on Eastern GC).

In methodical aspects several hierarchic levels of folded structures were discriminated based on its size and volume of layering: individual folds (layers), folded domains (package of layers), structural cells (whole sedimentary cover), tectonic zones (total crust?), and whole folded system such as Greater Caucasus (crust and upper mantle) [7, 4, 3]. The strain properties of folded domain (isometric volume of set of homogenous folds) are described by 2D strain ellipsoid (ellipse). Parameters of natural domain, such as a dip of folds axial plain and shortening value (fold interlimb angle) have relation to this idea. Dip of fold envelope plain, dip and length of domains part of section line also as two previous parameters (5 totally) are measuring in all natural domains for next calculations. Fault plains are boundaries between domains and its dips are measured also. Initial (pre-folded) position of section line inside domain is restored by three kinematic transformations – rotation, horizontal simple shearing and elongation (pure shearing) so, that actual strain ellipse became circle inside a flat horizontal layering [7, 3]. Sequential junction of pre-folded states of domains produces whole pre-folded (restored) cross-section. For each tectonic zone a stratigraphic model was offered for whole sedimentary cover. Structural cells were selected in pre-folded cross-sections as isometric volumes (width of cell should be similar to whole cover thickness). Total pre-folded and actual lengths of set of domains inside this volume give tectonic shortening value for such structural cells. It allows to calculate actual (post-folded) theoretical thickness of sedimentary column. Positions of domain inside stratigraphic model (stratigraphic depth of layer on section line) also as hypsometric height allow to calculate actual depth of bottom of sedimentary cover (top of basement), thickness of eroded part of the column and vertical positions of each boundary of stratigraphic units. All together it allows to construct the quasi-3D models of sedimentary cover structure for set of sections for pre-folded and actual stages of development of GC [7, 6].

The NWC was characterized by 347 km of actual length of 11 sections which were divided on 243 domains and 42 cells [7]. Prefolded length was 535 km as total and shortening value varied in cells in range 0 - 67% (average 35%). Prefolded width of structure was more 72-82 km (40-55 km actual, 12-52%) on the western part of NWC (for Lias-Eocene flysch basin) and 55-60 km (35 km actual, 32-40%) for Malm - Eocene flysch basin in its eastern part. Thickness of sedimentary cover deviates for cells in range 7.3 – 17.3 km (13.4 km average), actual depths of basement top were calculated as -2.2 up to -31.7 km (-13.3 km average). Set of these depths of formed reasonable structure [7]. Eroded parts of cover for cells vary as 0 – 22.2 km (8.9 km average).

Eastern Caucasus was characterized from south to north by three tectonic zones: by 3 sections in ChZ, 8 sections in TfZ and 2 sections in ShZ, 164 km of total actual length and 370 km of prefolded one. These sections were divided on 201 domains and on 36 structural cells. Shortening value for cells varied in range 36 – 67% and average values for tectonic zones were 57%, 55%, 52%. Observed structure has 119 km of cumulative prefolded width and 56 km of actual one (65/25, 23.5/11.1, 32.3/19.7). Initial thickness of Lias - Eocene cover varied as 15.3, 11.9 – 16.7, 9.8 km (13.6 as average). Calculated depths of basement top varied from south to north from -13.6 / -24.8 (-20.5 average) for ChZ, to -4.4 / -19.4 (-12.0 average) and -7.6 / -13.7 km (-10.2 average) for TfZ and ShZ. Similar to NWC, these data formed reasonable structure of basement top [6]. Eroded parts of cover for cells are 16.1, 19.2 and 9.6 km as average and varied in range 7.2 – 22.9 km.

Data of strain and positions of basement top for tectonic zones of Eastern Caucasus (ChZ + SEC) allow to calculate the evolution of vertical positions of former Moho, based on standard crust thickness of 40 km on beginning of Lias. Actual calculated depths of this marker vary from 100 to 75 km from south to north [6]. It means that about 60% of rocks of crust type (in density) for ChZ changed their nature to mantle type during of sedimentation, folding and of mountains growth.

Consideration of some genetic aspects may use these new data concerning of the structure. It was found that south boundary of GC (-20 km bottom of ChZ sedimentary cover) is about 10 km normal fault on level of basement top [3, 6]; it means that shortening of basement and of sedimentary cover is the same. Together with antinomies of some other key properties of natural structure with models ones, it forbids the use of conventional model of "accretionary prism" for explanation of GC hinterland structure. Significant correlations for 78 structural cells parameters, such as shortening value, initial thickness of sediments, eroded par of sedimentary column and others (r= 0.81, 0.39, 0.44) show that initial thickness of sedimentary cover has leading role in structure development. Almost constant position of average depths of basement top for prefolded and for actual stages (-13.4 and -13.3 for NWC; -13.6 and -14.8 for East Caucasus) in spite of different shortening (35% and 8.9 km of erosion; 56% and 16.7 km of erosion) show that isostasy has strong importance in set of processes of GC development.

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