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Tectonic stratification and seismicity of the accretionary prism of the Azerbaijani part of the Greater Caucasus

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OUTLINE

-The allocation of the accretionary prism within the Greater Caucasus;

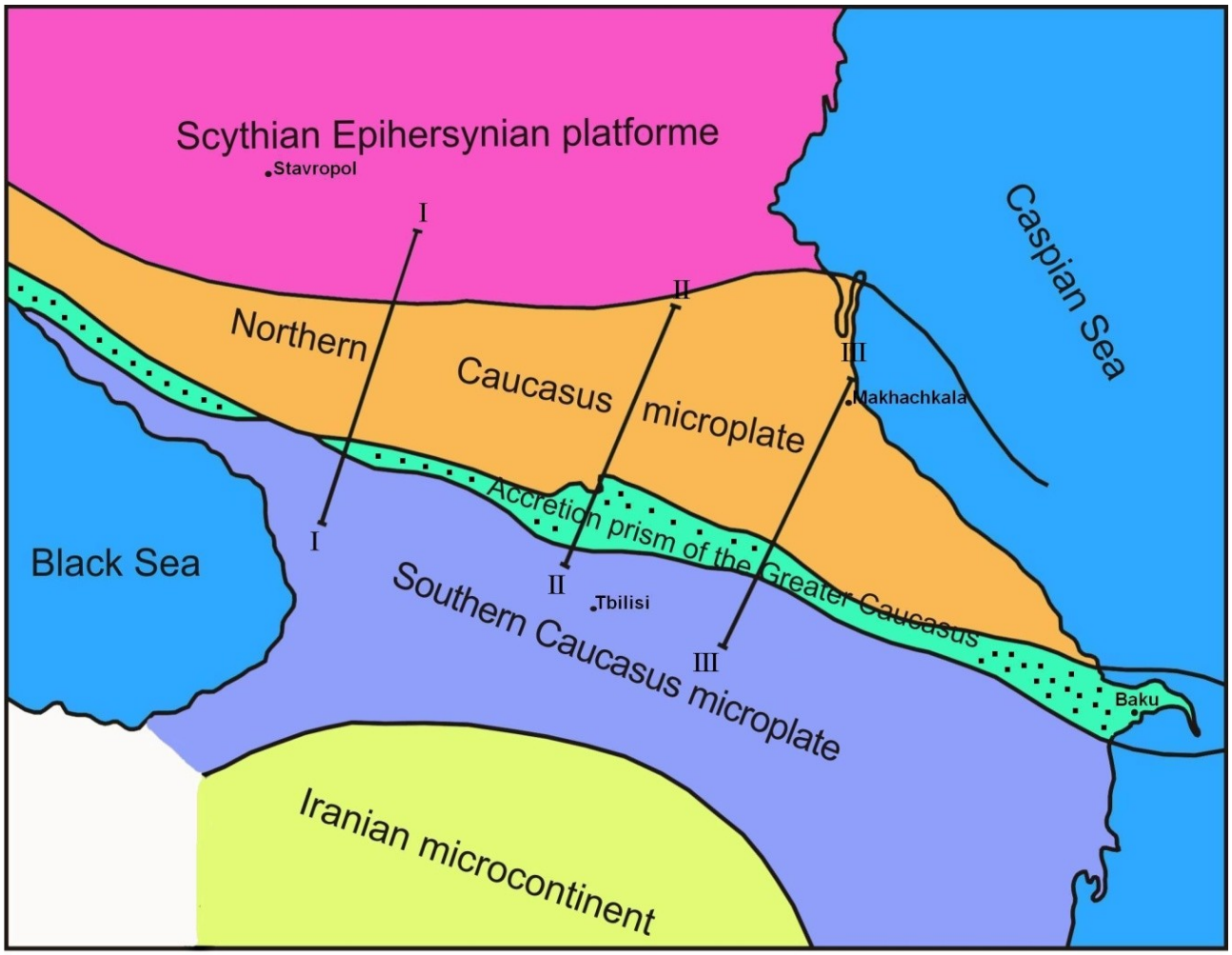
- Inner structure of the accretionary prism;

-The allocation of the accretionary prism within a structure of the Caspian depression;

- The process of formation of the accretionary prism;

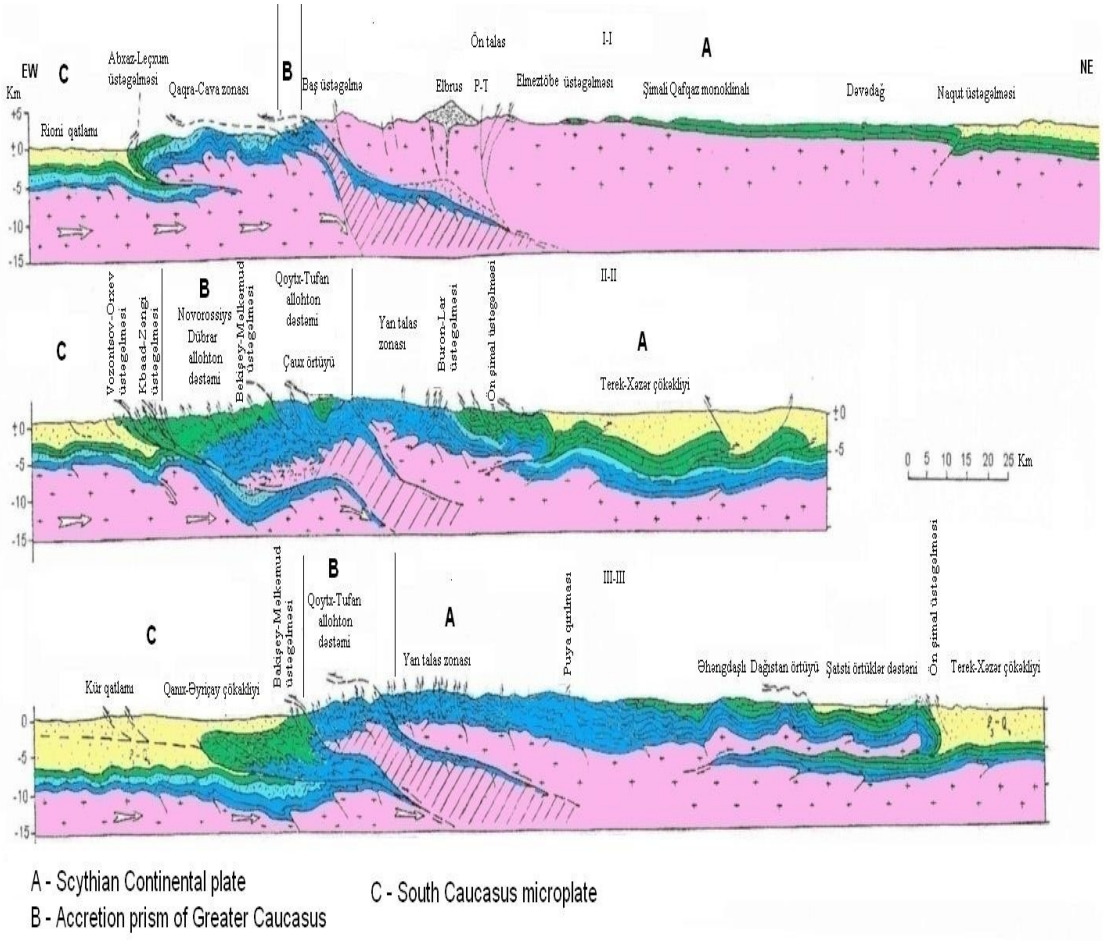
- Recent movements and its infruence on the accretionary prism.

Fig.1. Allocation of accretion prism within structure of the Caucasus isthmus.



The Greater Caucasus has formed during last stage of the tectogenesis in a geodynamic condition of the lateral compression, peculiar to the zone pseudo-subduction interaction zone between Northern and Southern Caucasian continental microplates.

Fig. 2. Geology sections from the Greater Caucasus (by S.I Dotduev).



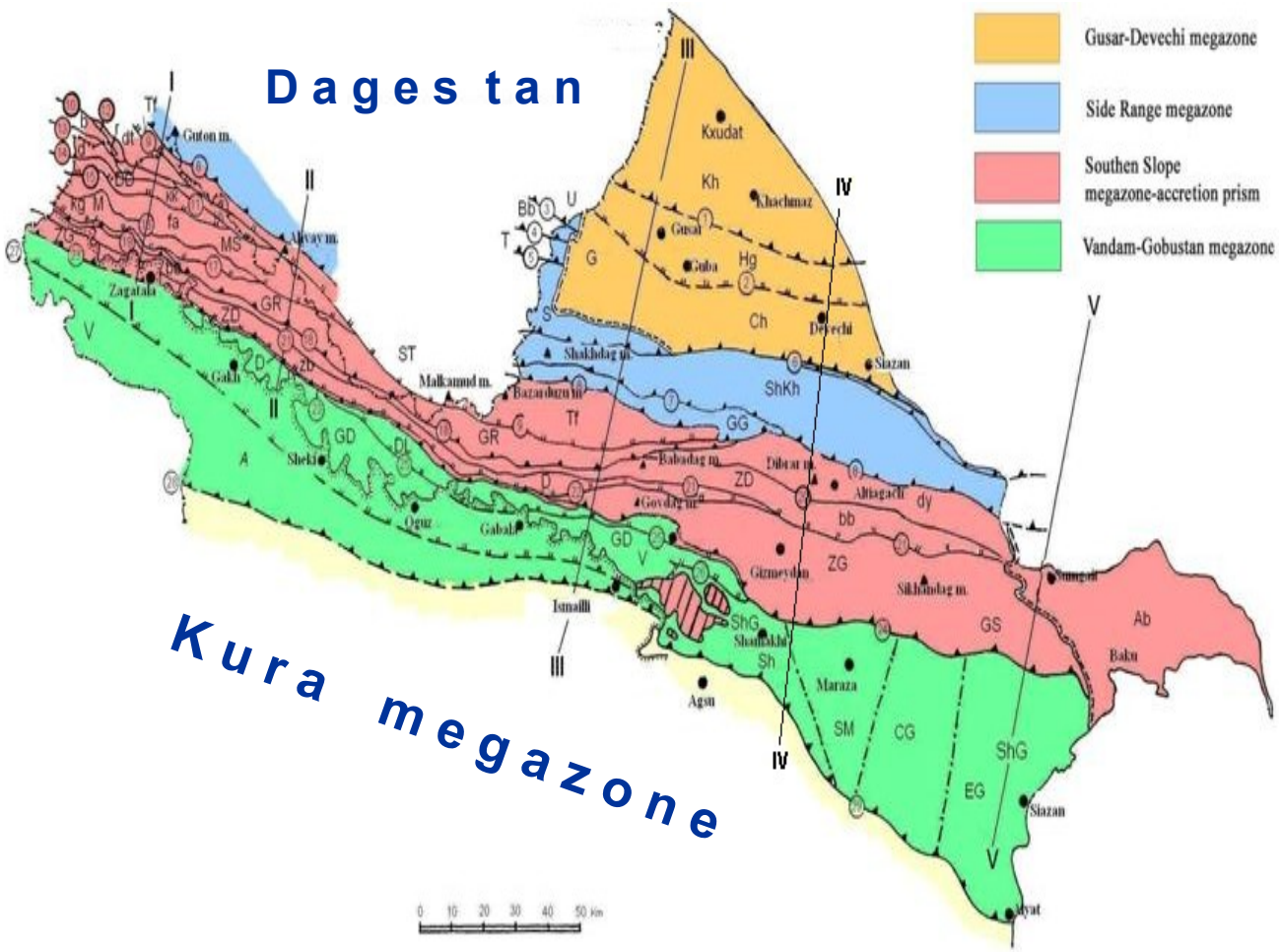
I – I ‘

II – II ‘

III – III ‘

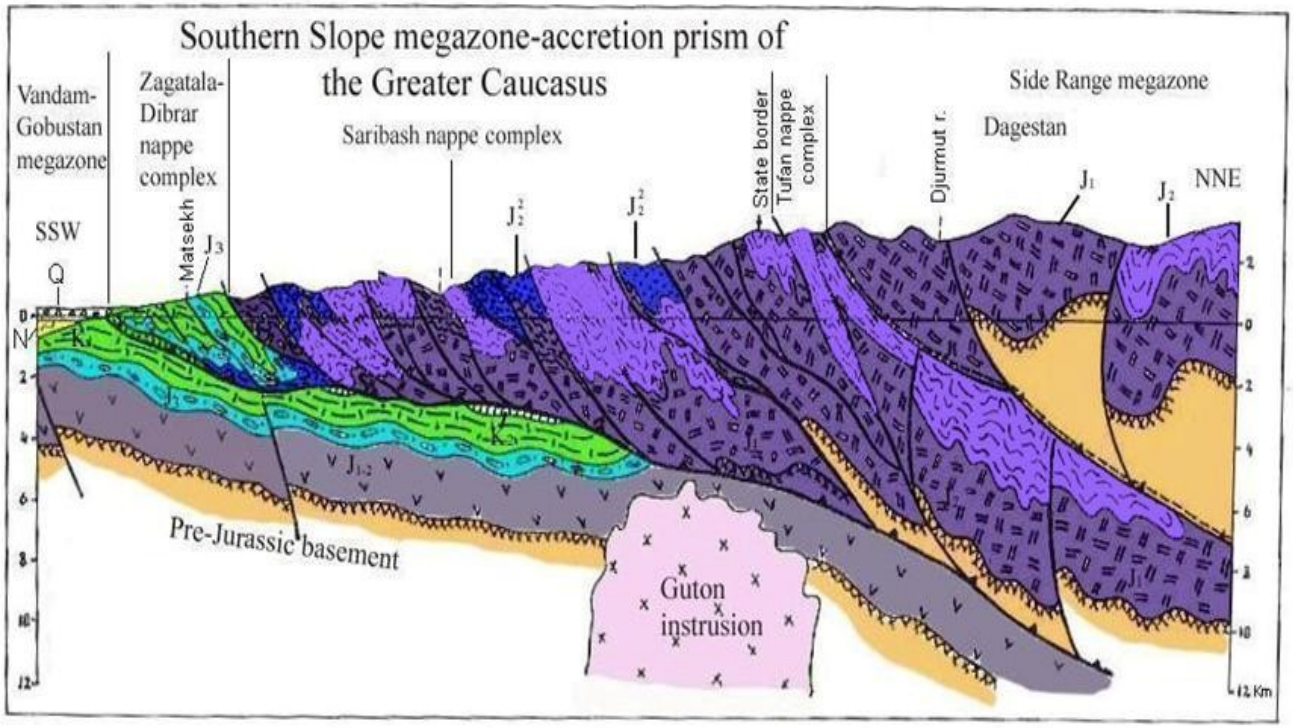
Its present day structure formed as a result of horizontal movements of the different phases and sub-phases of Alpine tectogenesis (from late Cimmerian to Valakhian), and is generally regarded as zone where, along Zangi deformation, the insular arc formations of the Nortern edge of South Caucasian microplate thrust under the Meso-Cenozoic substantial complex contained in the facials of marginal sea of Greater Caucasus. The last, in its turn, has been pushed beneath the North-Caucasus continental margin) of the Scythian plate (epihersynian platform) along Main Caucasus Thrust fault.

Fig. 3. Tectonic scheme of the Azerbaijan part of the Greater Caucasus



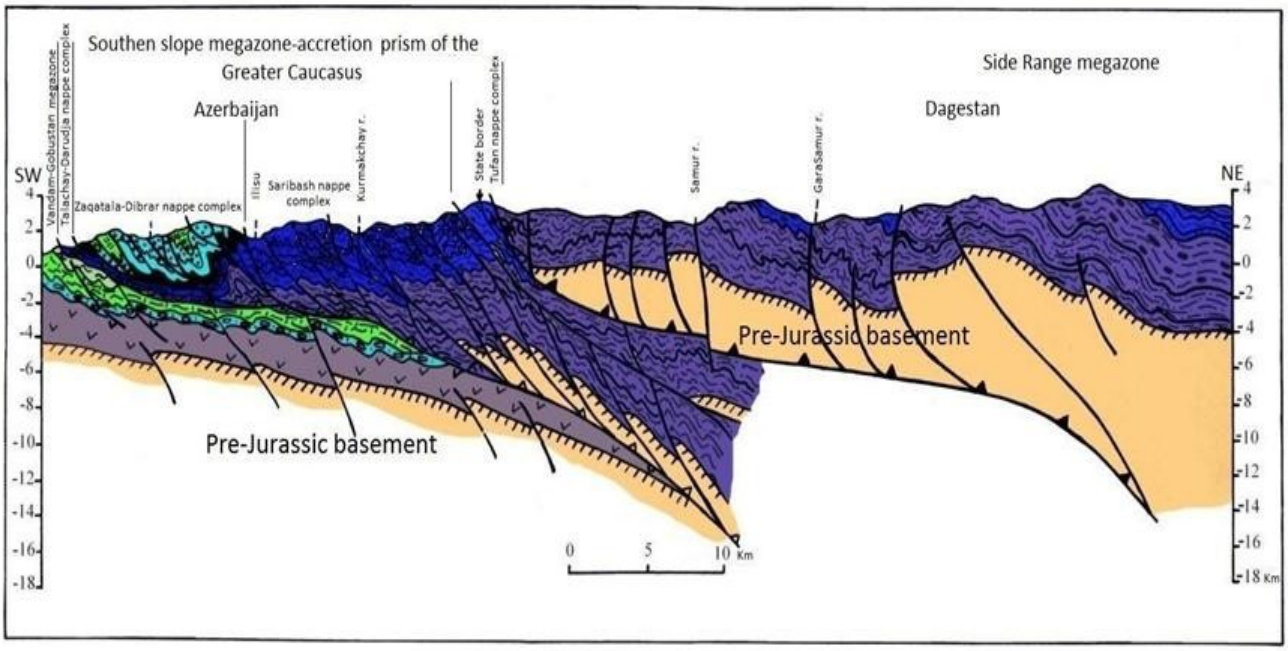
Within the Azerbaijanian territory techtonically stratified alpine substantial complex of the marginal sea of Greater Caucasus is distinguished as a structural Southern Slope zone (megazone). Compressed between Major Caucasus (from the north) and Kbaad-Zangi (from the south) thrusts, the megazone is classified as allochthonous accretionary prism in the front of first deformation with its' roots buried under southern brow of the Scythian plate (Side Range megazone)

Fig.4. Synthesized geology-geophysical section I-I' drawn along Masekh-Jurmut river's traverse passing through the nappe complexes of North-Western Azerbaijan.



Allocated beneath accretionary prism of the Southern Slope, the autochthonous bedding is presented by Meso-Cenosoic complex of the northern Vandam-Gobustan margin (megazone) the South-Caucasian miroplate, which is in its' turn crushed and lensed into southward shifted tectonic microplates gently overlapping the northern flank of Kura flexure along Ganykh-Ayrichay-Alyat thrust.

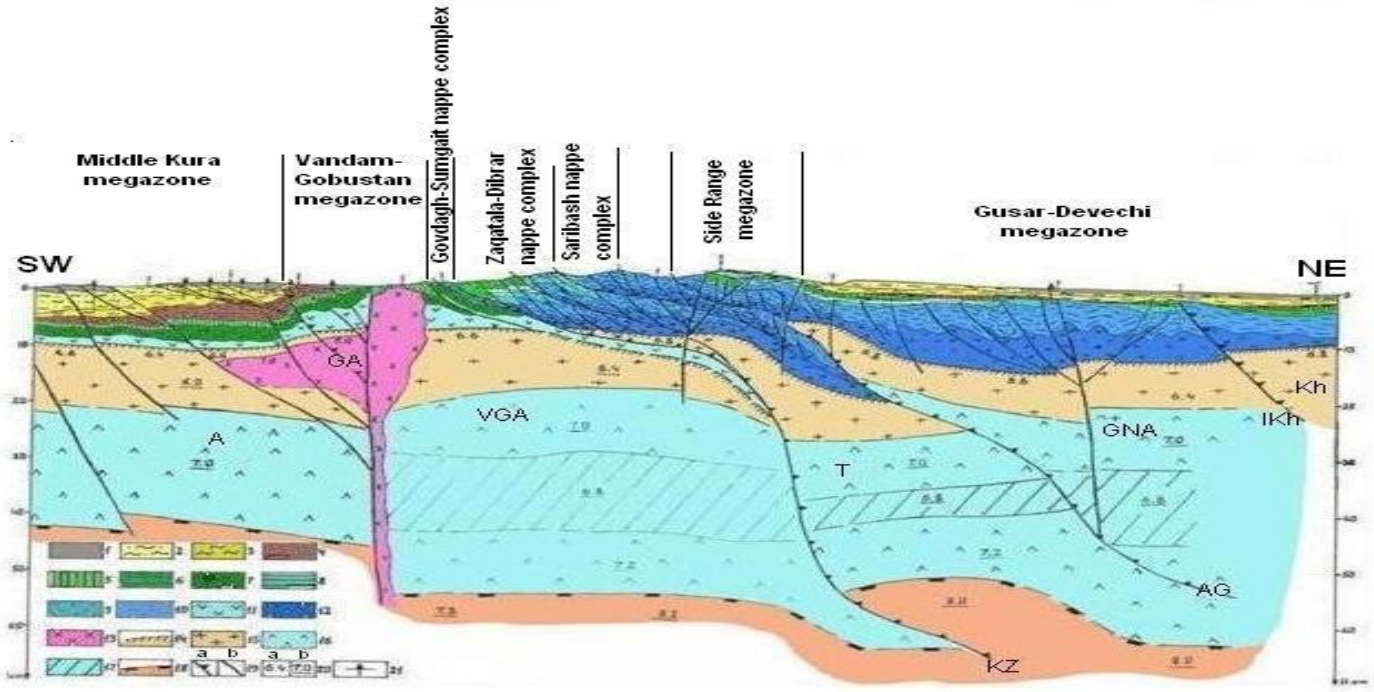
Fig.5. Synthesized geology-geophysical section II-II' drawn along Ilisu-Gara Samur river's traverse passing through the cover complexes of North-Western Azerbaijan and Mountainous Dagestan.



Tectonic stratification of the accretion prism very good revealed in a structure of Azerbaijan part of the Grater Caucasus, where in different years the different scale and aged nappe complexes have been determined. Such as Tfan, Saribash, Talachay-Durudja, Zagatala-Dibrar and Govdag-Sumgait.

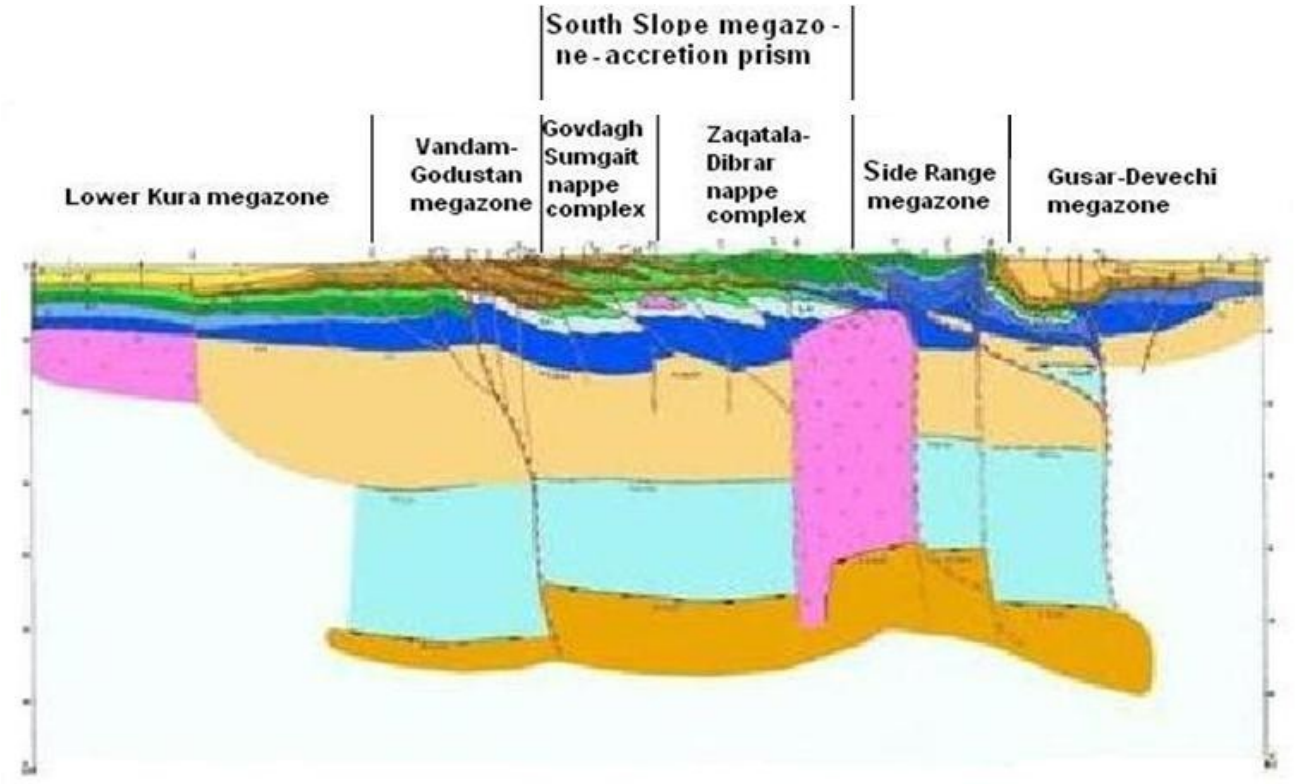
These complexes control eastern fragments of the transregional tectonic plates, western portions of those have been mapped in a territory of Georgia and Northern Caucasus.

Fig.6. Synthesized geology-geophisical section III-III' drawn along earth crust's Kurdmashi-Shirvanovka traverse.



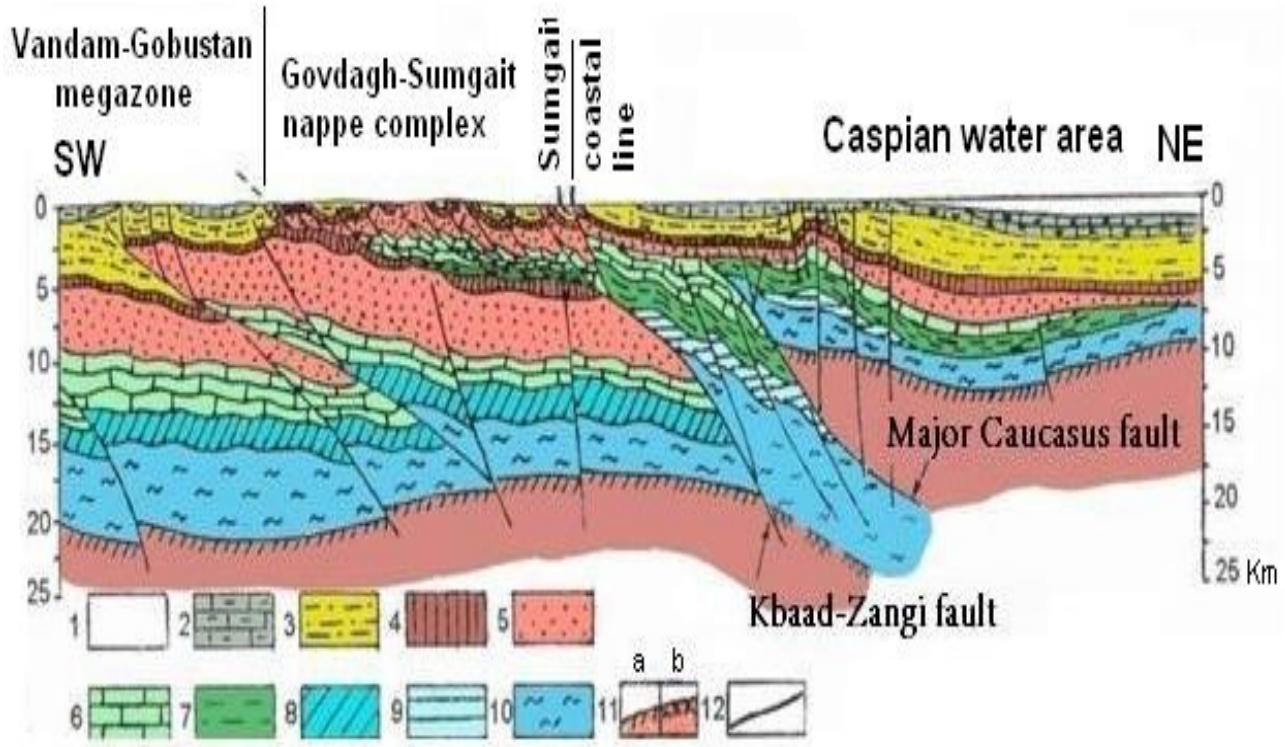
The representative material reveals the allochtone nature of the regions structure, with a predomination of the displacement of mountain masses in South direction.

Fig.7. Synthesized geology-geophisical section IV-IV' drawn along earth crust's Geylardag-Chaygaragashli traverse.



The accretionary prism of Greater Caucasus naturally extends into the territory of Absheron Peninsula and the Caspian Sea and manifests itself buried in the structure of Absheron threshold and possible Prebalkhanian zone of uplifts in the Transcaspian region.

Fig.8. Synthesized geology-geophisical section V-V' drawn along Shahgaya-Sumgait



The Absheron peninsula and adjacent waters of the Caspian Sea correspond to the area of periclinal immersion of allochthonous and parautochthonous structures that form complex Govdag-Sumgait overthrust sheet inside Zagatala-Govdag zone. The overthrust sheet is in a buried state, extending eastwards across the territory of Absheron peninsula and adjoining northern and southern parts of the Caspian Sea.

Fig.9. Location of the Seismic cross-section through Absheron Ridge (Fig. 10-12)

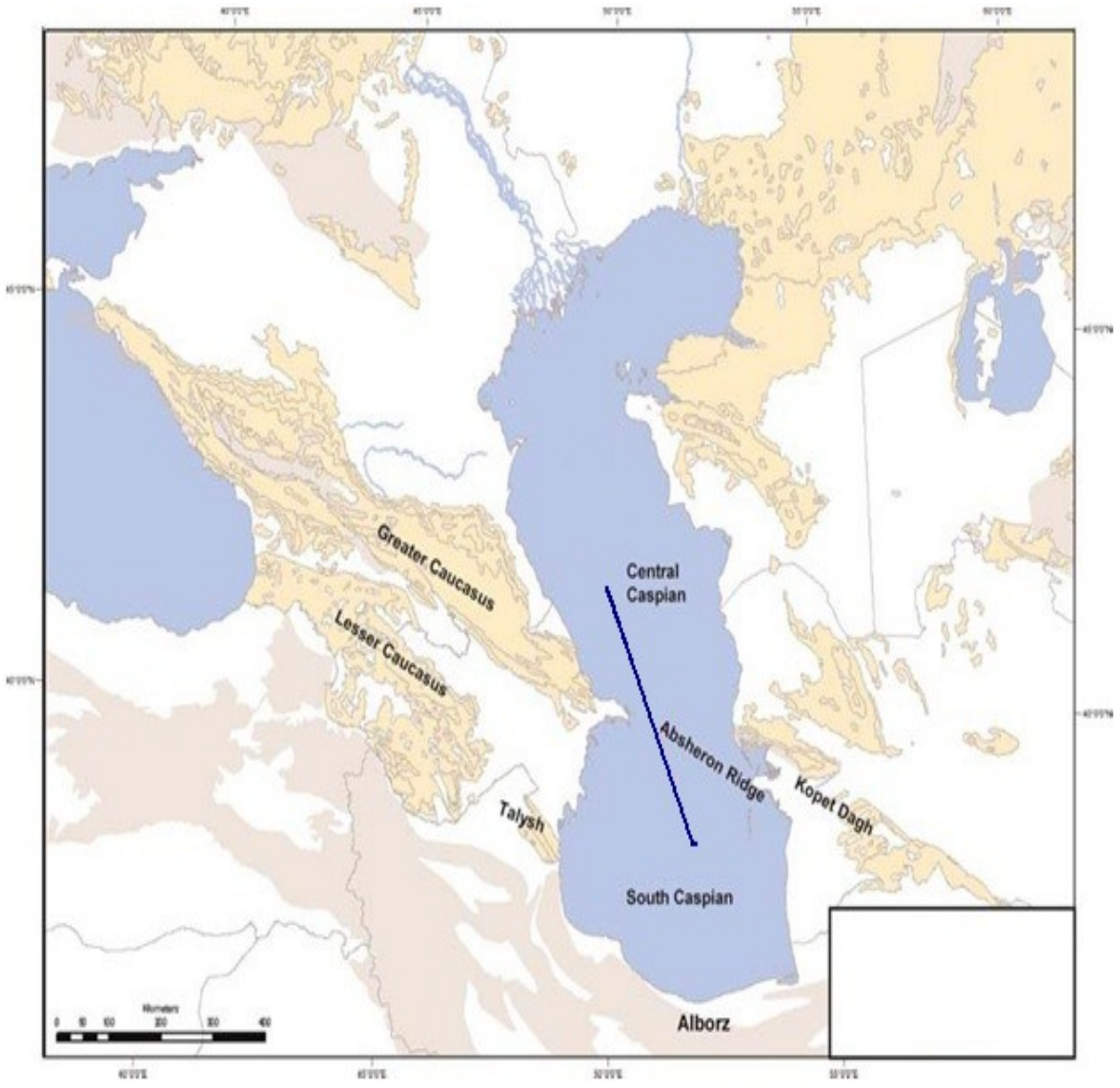
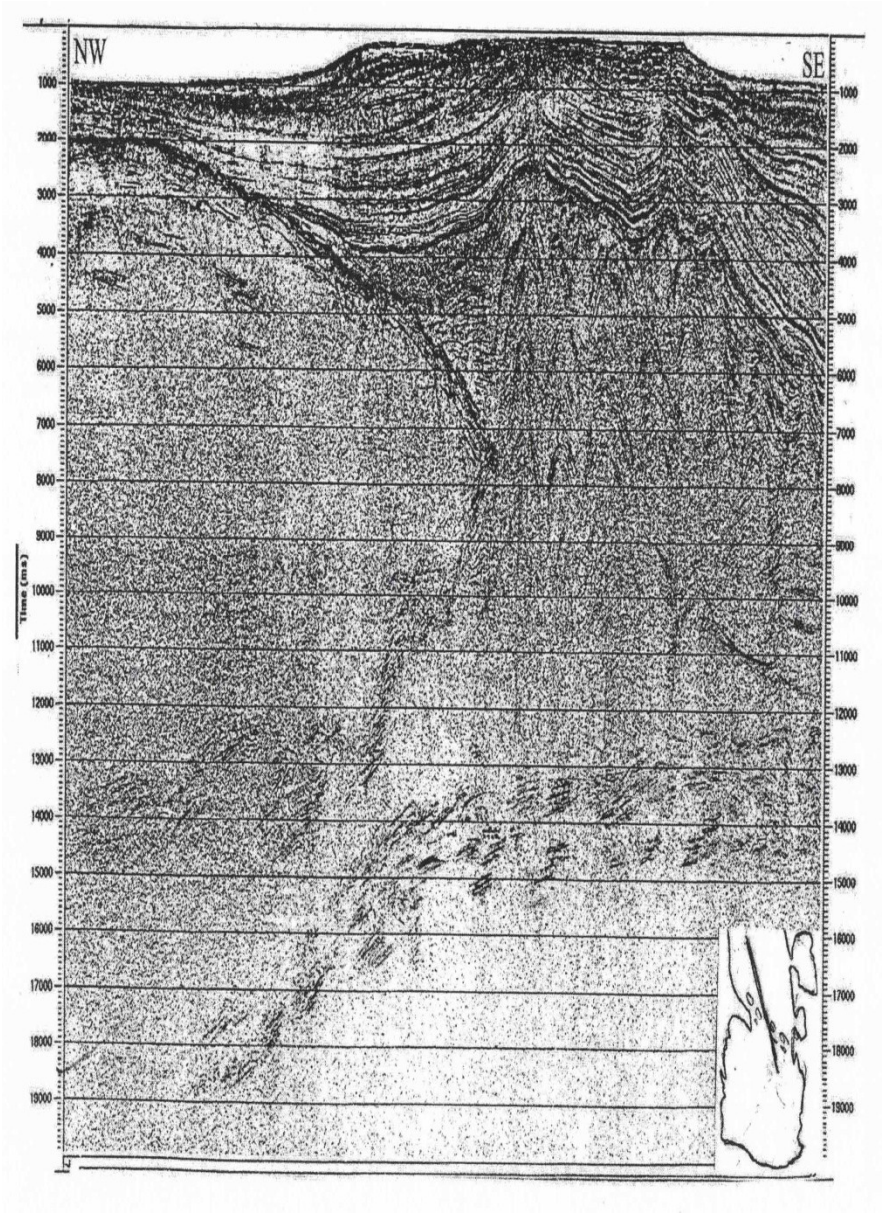


Fig.10. Seismic cross-section through Absheron Ridge



The results of latest seismic studies provided within the Azerbaijani sector of the Caspian Sea, geological interpretation of which does clearly reflect the process of intercontinental accretion accompanied by underthrusting (pseudo-subduction) of the South Caucasus microplate (Southern Caspian megazone as its' offshore extension) under Scythian epihersynian platform.

Situated on the boundary of these zones, the heterogeneous Absheron-Pribalkhan uplift zone is represented by buried structures of the Side Range (northern flank) and accretionary prism of the Southern Slope (southern flank) megazone's offshore extension. Thereafter the uplift zone is complicated by Absheron-Pribalkhanian fracture situated on the border of these megazones, and confined to the offshore extension of Major Caucasus thrust. From the south the zone is bordered by Kbaad – Zangi deep fault which separates Middle-Caspian block with relatively high pre-Jurassic basement from deeply submerged (amplitude of 9-10 km) and far northward underthrusted South-Caspian block. Just the narrow area constrained between Absheron-Pribalkhanian and Kbaad – Zangi fractures responds to a suture along which the intercontinental accretion occurs accompanied by underthrusting (pseudo-subduction) of the South-Caucasus microplate (represented by South-Caspian megazone in the offshore area) under Scythian epihercynian platform. Marine seismic reconnaissance data prove that the Southern Slope megazone's substratum is completely compressed and absorbed in a pseudo-subduction zone, while the alpine cover, being displaced from its' basement and overthrusted southwards, in its' southern flank serves as a parautochthonous bedding for sediments of the southern edge of Epihercynian platform, thrusted along Absheron-Pribalahan fracture.

Fig.11. Seismo-geological cross-section through Absheron Ridge

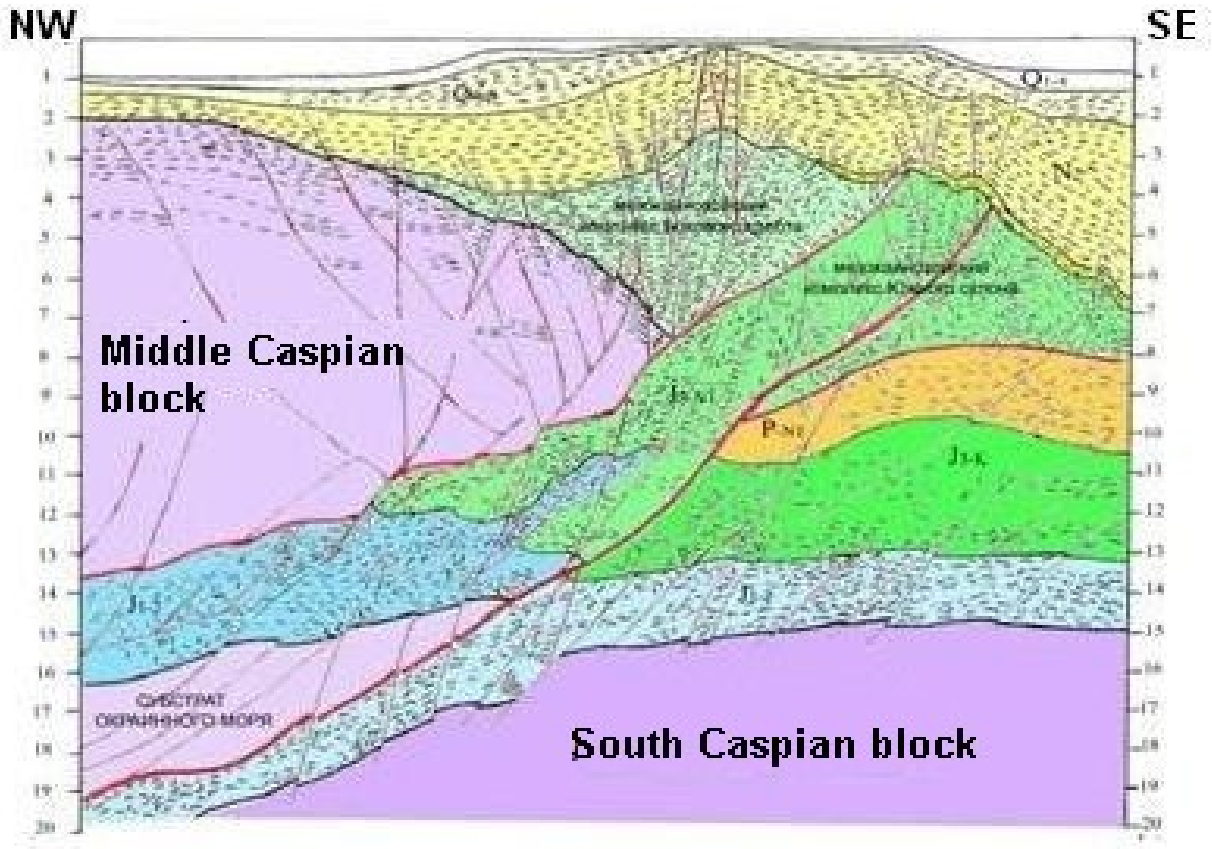


Fig.12. Tectonic balanced cross-section (a) and restoration (b) through Absheron Ridge (by Green, T., Abdullayev, N., Hossack, J., etc).

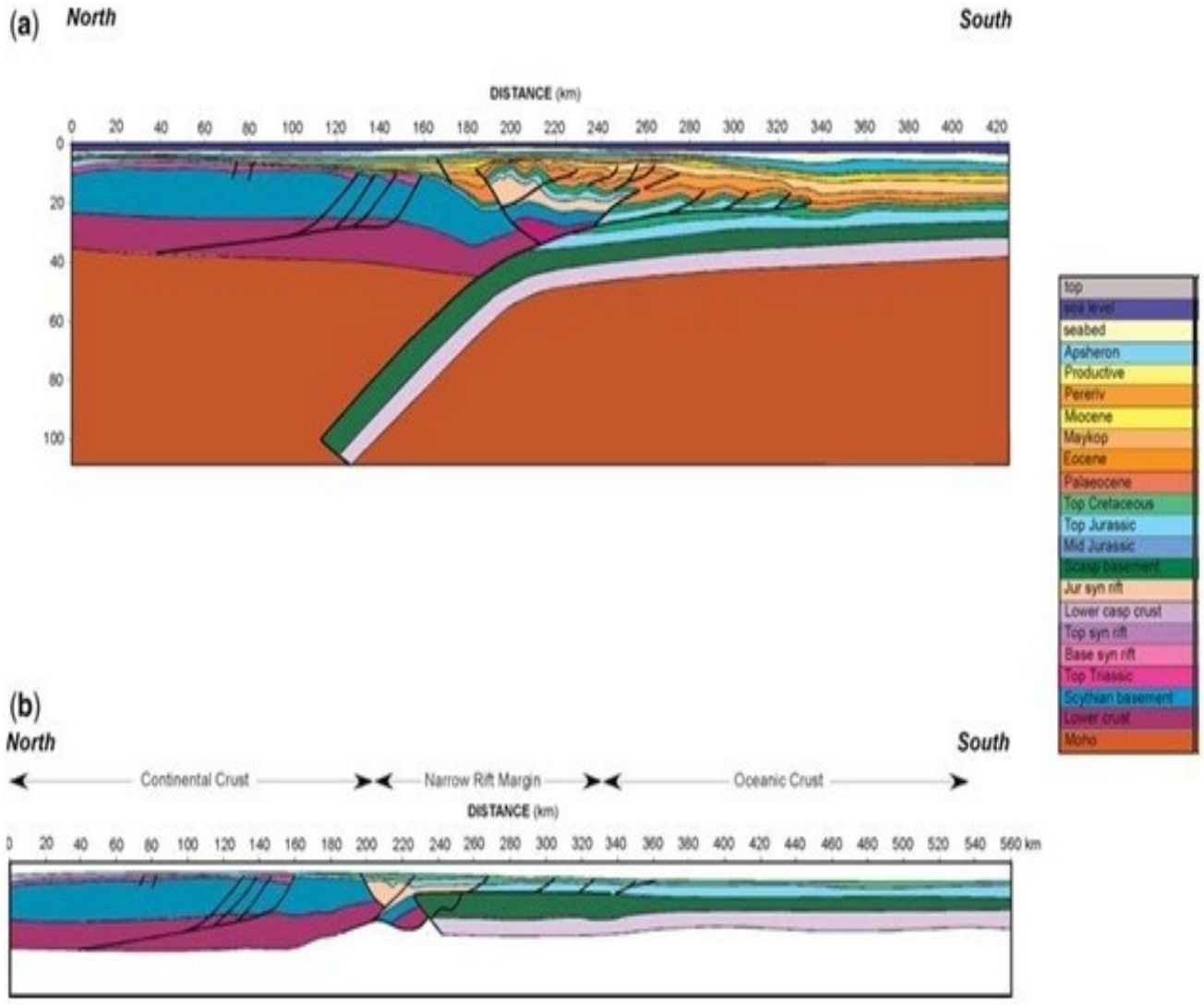
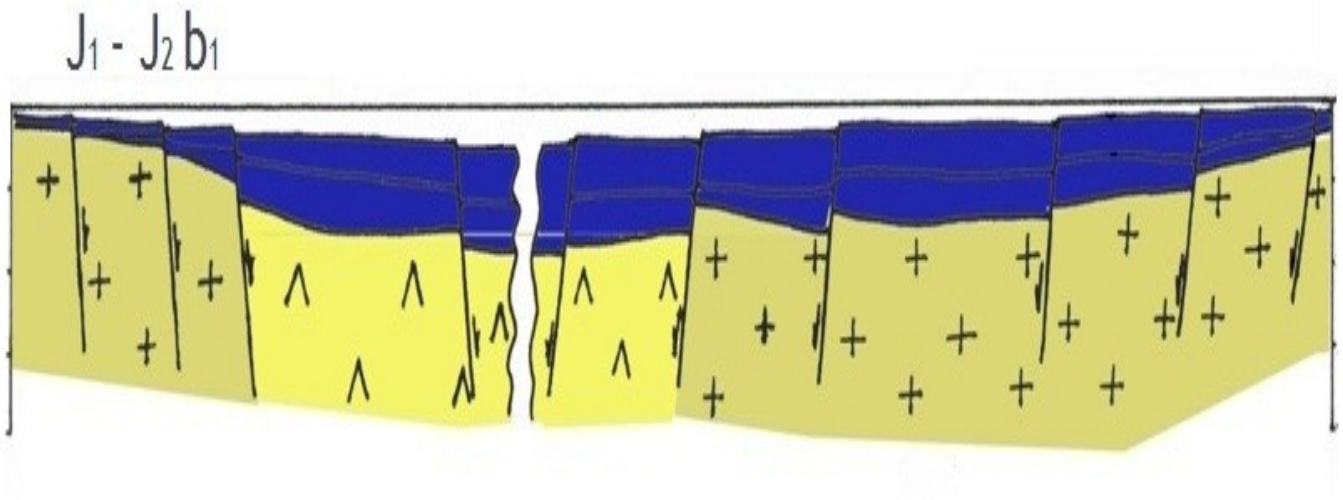


Fig.13. Reconstruction of tectono-sedimentary evolution by stages and phases

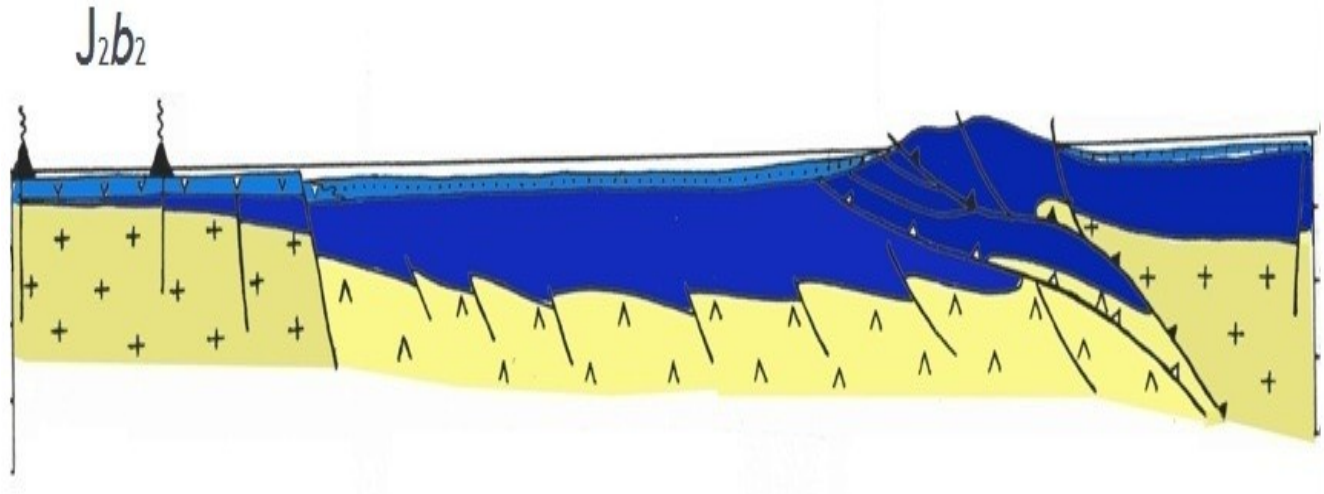
The process of formation of the folding-nappe structure of the accretion prism of the Greater Caucasus is studied in a view of geodynamic models, having in a base of underthrust and overthrust mechanism during formation of the modern orogens.

Formation of the described nappe complexes is directly confined to Late Aalenian – Quaternary time interval corresponding to transitional (Late Aalen – Middle Miocene) and continental (Late Miocene - Quaternary) stages of the alpine phase of the geological development of Caucasus (Late Cimmerian and next phases of the tectonic activity).

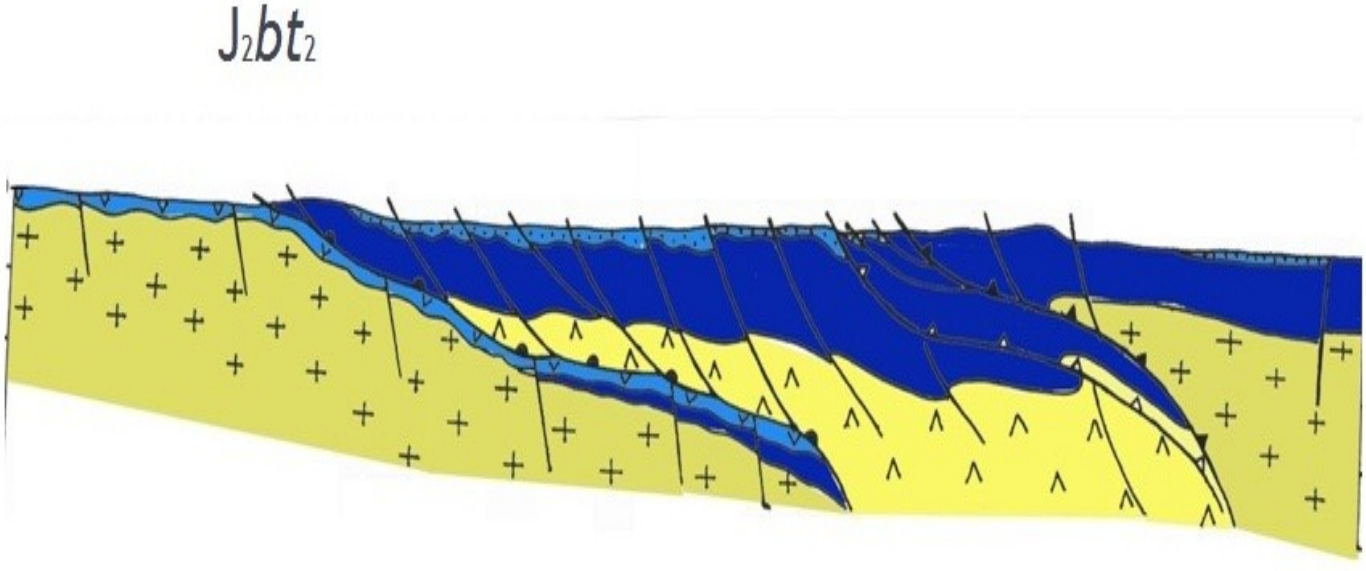
A. Oceanic stage



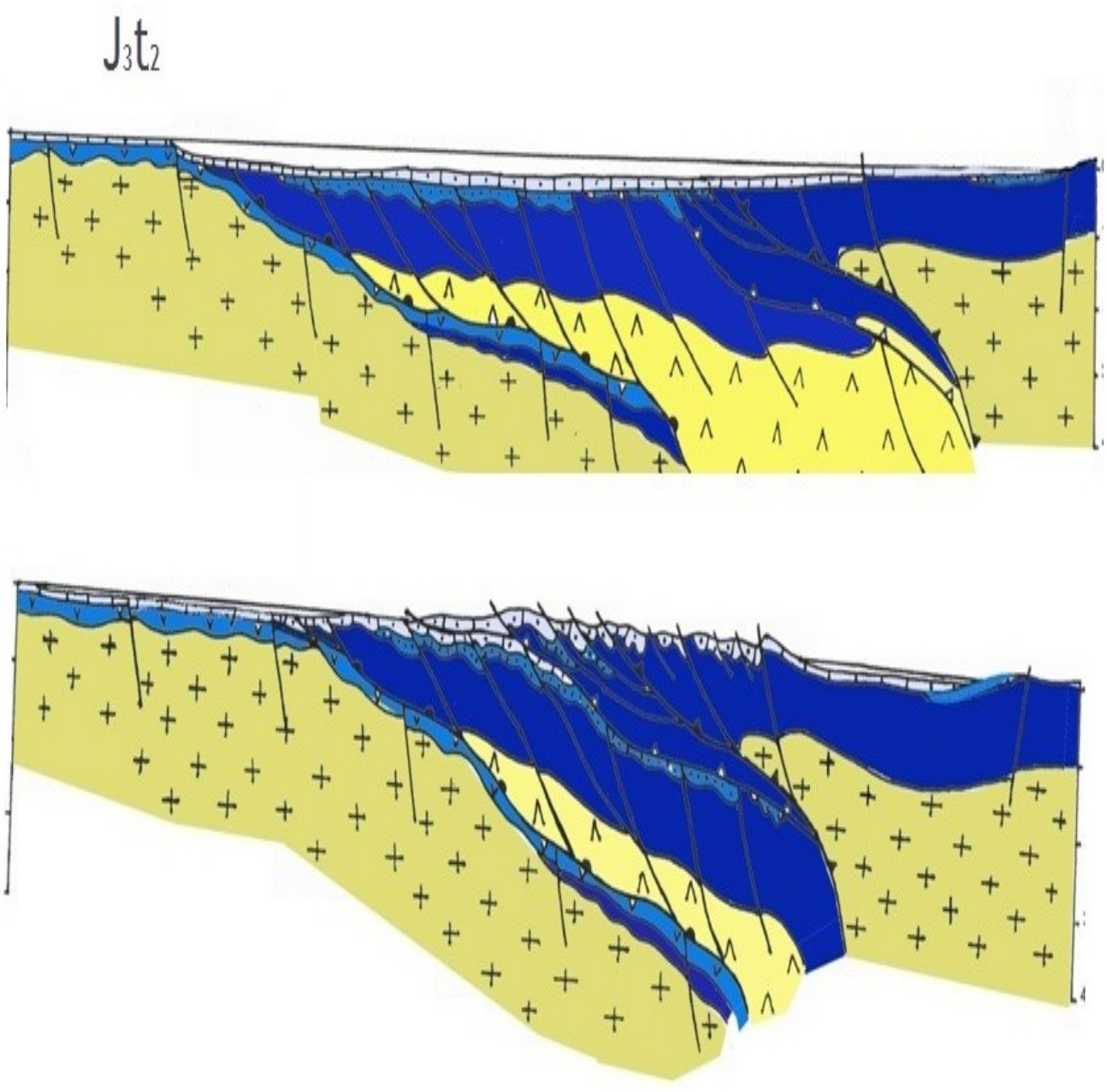
B. Transition stage
Adigey phase (from Later Bajocian)- napping of Tufan complex.



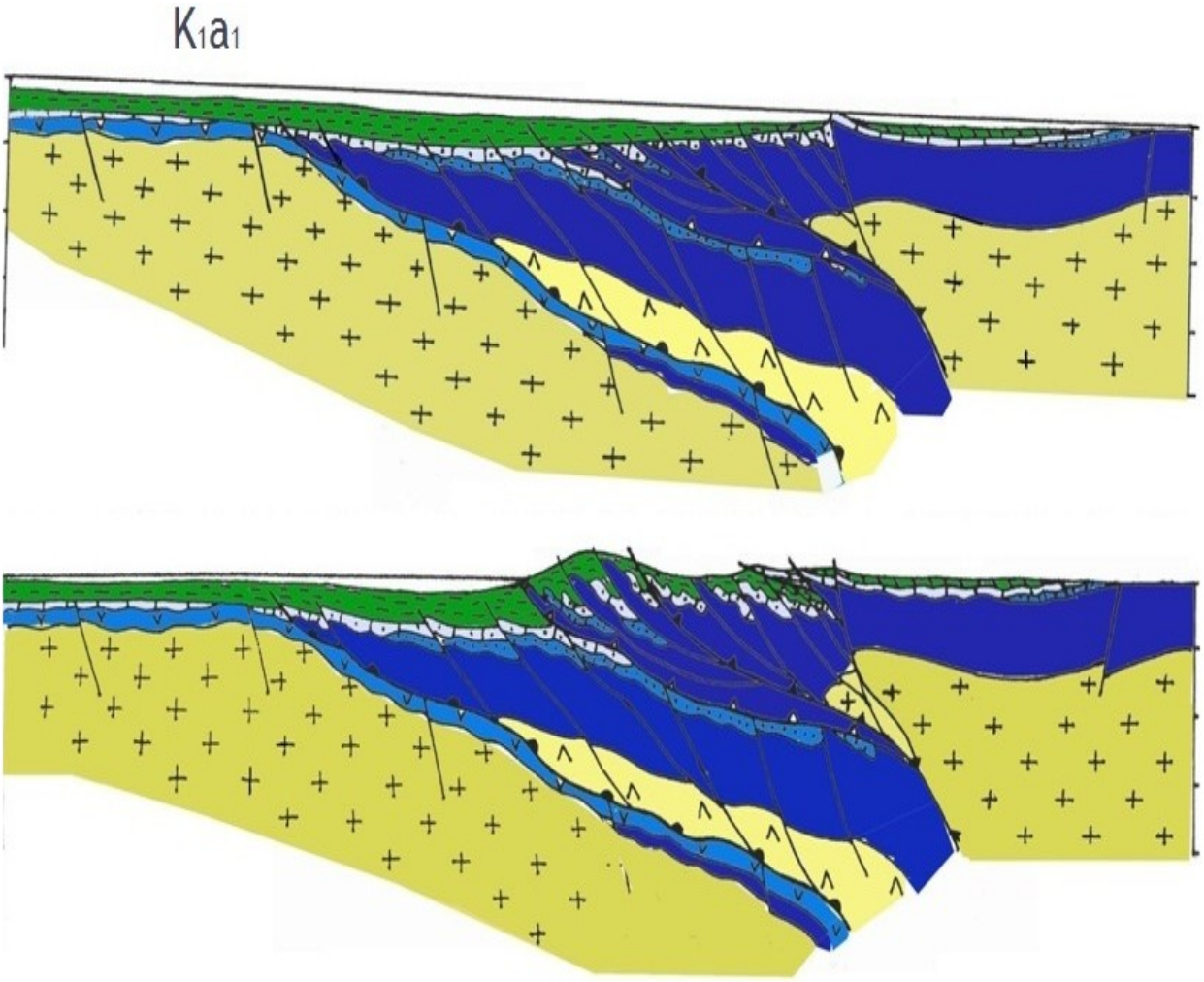
Chegen phase (from Callovian)- napping of Saribash and Talachay-Durudja complexes.



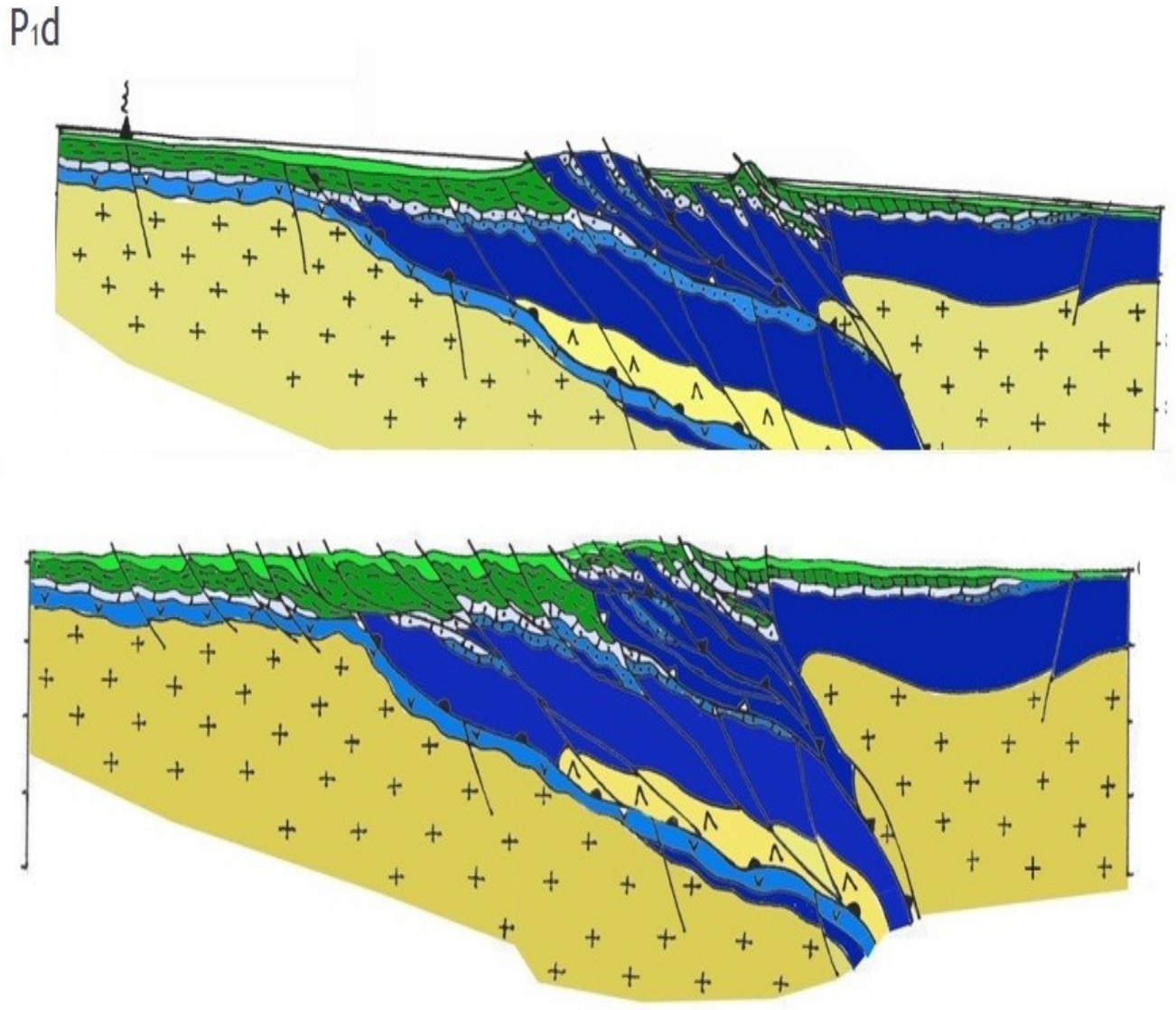
Andian phase (on the beginning of Lower Titonian)-duplication overlap of central part of the Saribash nappe complex.



Austrian phase (Middle Aptian)-napping of Shakhdag-Beshbarmag complex.



Laramian phase (Early-Lower Miocene boundary)-napping Zagatala-Dibrar complex.



B. Continental stage.
Styrian (Middle Sarmatian) and Attic(Lower Meotian) phases - napping of Govdagh-Sumgait complex.

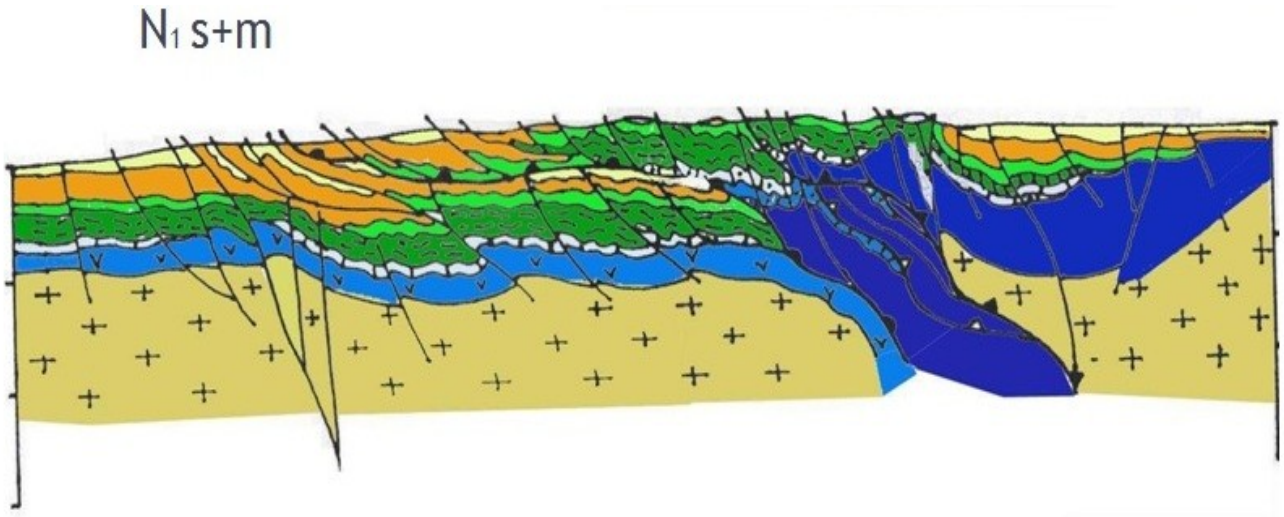


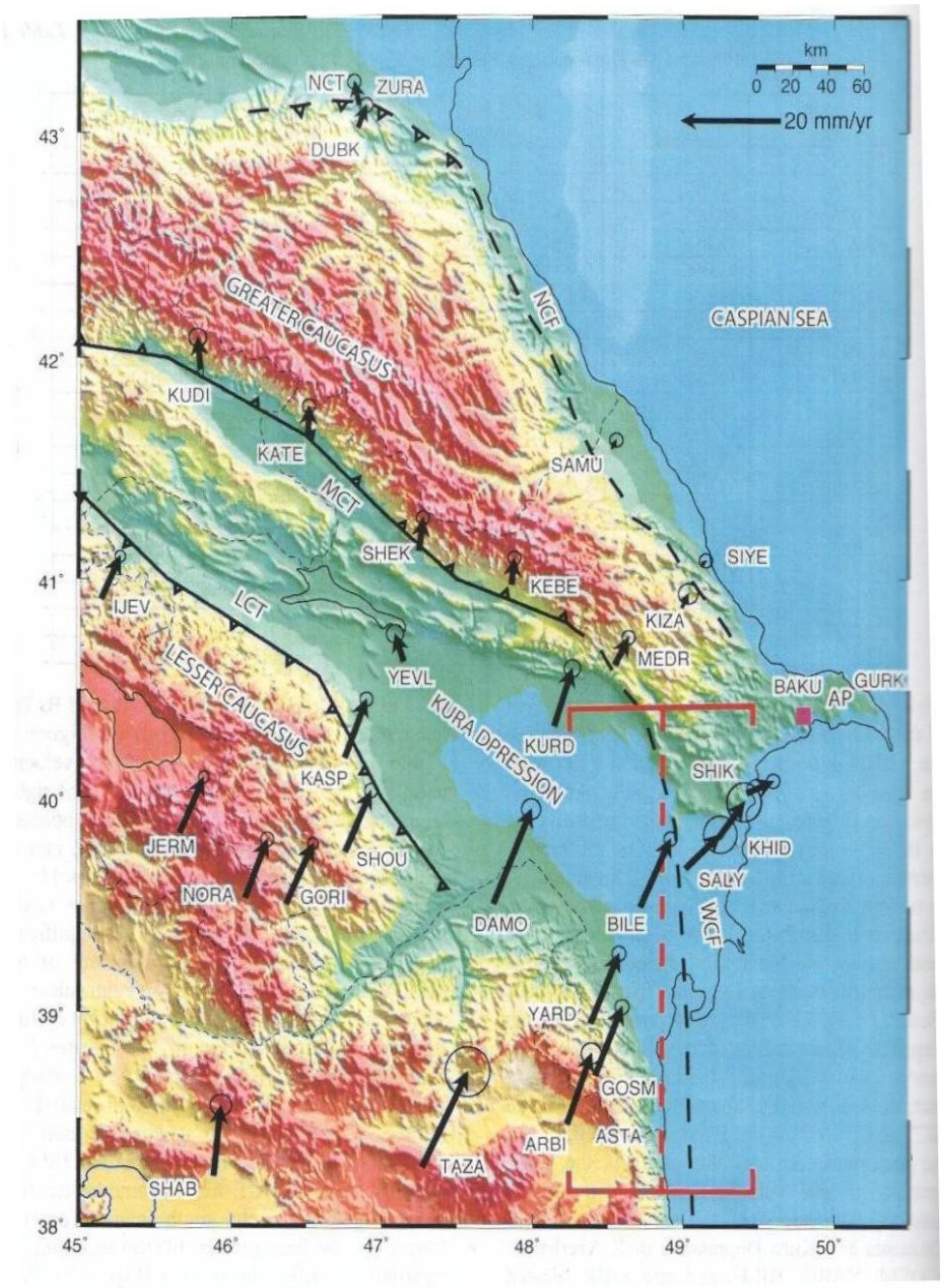
Fig.14. Recent geodynamics of the Caucasus region

Formation process of folded-cover structure of the Greater Caucasus accretionary prism is studied in direct connection with intracontinental S-subduction (pseudo-subduction) under pressure of the Arabian plate.

This assumption is justified by a number of researches to cover Caspian-Caucasus-Black Sea region. Described process continues also at the present stage of alpine tectogenesis as demonstrated by real-time GPS survey. Monitoring of data on the distribution of horizontal shift velocity vectors, produced during 1998-2012 by GPS geodesic stations in Azerbaijan, indicates considerable (up to 17-18 mm/year) north-northwestward shifting velocity of the southwestern and central parts of South Caucasus microplate, including territories of the Southeastern part of Lesser Caucasus, Kur depression and Talysh. At the same time, within the microplate's northeastern flange confined to Vandam-Gobustan megazone of Greater Caucasus, velocity vectors reduce by 8-12 mm/year, while further to the north, on a hanging wall of Kbaad-Zangi deep underthrust, e.g. directly within the boundaries of accretionary prism the velocity becomes as low as 0-4 mm/year (2010-2012 data). In general, the belt's earth crust reduction is estimated as 4-10 mm/year.

This phenomenon reflects consecutive accumulation of elastic deformations within pseudo-subduction interaction zones between structures of the northern flank of South Caucasus microplate (Vandam-Gobustan megazone) and the accretionary prism of Greater Caucasus. Continued pseudo-subduction is indicated by unevenly distributed seismicity by depths (seismic levels of -2-6, -8-12, -17-22 and -25-45 km): distribution analysis of the earthquake cores evidences the existence of structural-dynamic interrelation between them and the subvertical and subhorizontal contacts in the earth crust. Horizontal and vertical seismic zonality is explained from the viewpoint of block divisibility and tectonic stratification of the earth crust, within the structure of which the earthquake cores are confined mainly to an intersection knots of the ruptures with various strike, or to the platitudes of deep tectonic failures and lateral shifts along unstable contacts of the substantial complexes with different competency.

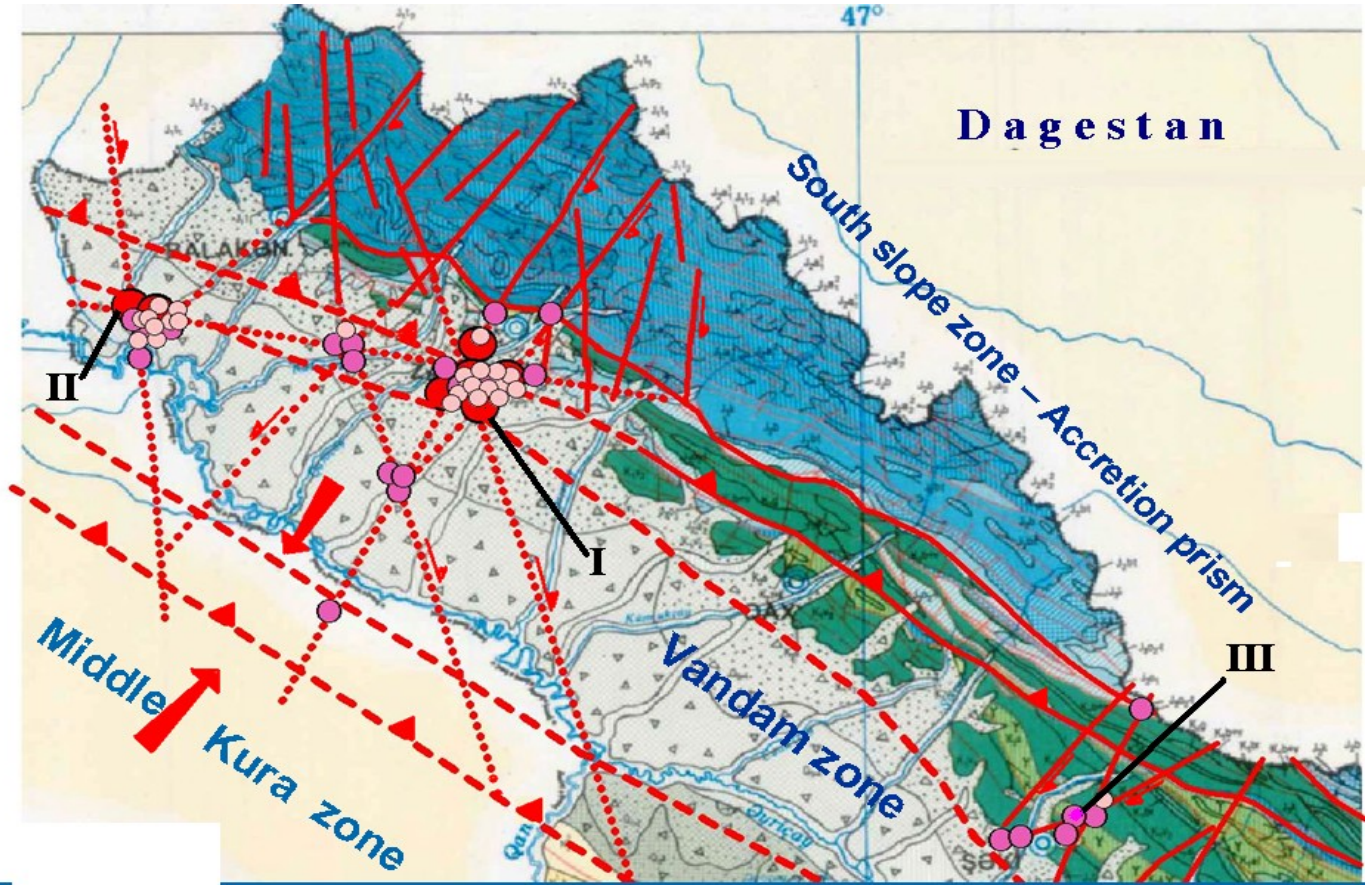
Fig.15. GPS-velocity field, and 95% confidence ellipses for Azerbaijan and surrounding areas of the Caucasus region. (by F. Kadirov, R. Reilinger etc.)



Types of focal mechanisms in general correspond to the understanding of geodynamics of the microplates' convergent borders, where the entire range of focal mechanisms, from normal-fault to upthrust, is observed. At the contemporary stage of tectogenesis the maximum seismic activity is indicated in structures of the northern flank of South Caucasus microplate controlled by Ganikh-Ayrichay-Alat deep overthrust of the "general Caucasus strike" in the west, and submeridional right-slip zone of the West-Caspian fault in the east of the Azerbaijani part of Greater Caucasus.

Under lateral compression the small-scale blocks that constitute the region's earth crust become reason for the creation of transpressive deformations, which combine shift movements along limiting transversal deformations with compression structures to include general Caucasus strike ruptures. Such regime leads to a creation of multiple concentration areas of the elastic deformations confined to mentioned dislocations and their articulation knots. It is just the exceeded ultimate strength of the rocks that causes energy discharge and brittle destructions (according to stick-slip mechanism) in such tectonically weakened regions of the southern slope of Azerbaijani part of Greater Caucasus.

Fig.16. Map of Earthquake foci zones of the North-West Azerbaijan (I – Zagatala, May, 2012, II – Balaken, October, 2012, III – Sheki, May, 2012



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This fact is particularly proved by earthquakes which have taken place between May and December, 2012 in Zagatala, Sheki and Balakan.

Focal zone of the earthquake is confined to a complex intersection knot of different strike faults, and is located in Pre-Jurassic basement. The very seismic event is mainly related with activity of Zagatala fault with northwestern strike which caused activation of connected dislocations.

Focal zone of the earthquake is confined to a complex intersection knot of the faults with various strike, and is located in the upper part of Pre-Jurassic basement. Seismic event is mainly related to activity of Khimrikh-Khalatala fault with submeridional strike, which in tern led to activization of connected northeastern Balakan and sublatitudinal Mazimgarishan-Katekh dislocations. Discharge of seismic energy occurred in most granulated zones confined to the intersection knots of these dislocations with faults of the general Caucasus strike.

Earthquake's focal zone is situated in the upper part of Pre-Jurassic basement. Seismic event is connected with activity of subvertical faults with northeastern strike. Discharge of seismic energy occurred in most granulated zones confined to the intersection knots of these dislocations with faults of the general Caucasus trace.

Results:

- Epicenters' spatial distribution demonstrates that mentioned events are confined to transversal (northwestern, northeastern and submeridional strike) disjunctive dislocations. However epicentral zones are in general of a general Caucasus strike, dislocated along and to the north of mentioned deep upthrust. Both transversal and longitudinal dislocations are mapped by a complex of seismic and electric reconnaissance methods. They are characterized as a natural southern extension of the fault-slip type disjunctive zones which outcrop in the mountainous area where structural-substantial complexes of a accretionary zone come to a surface;

- Focal mechanisms of impacts in the separate groups reveal different, mainly close-to-vertical, planes of fault and fault-slip type movements in the earthquake focuses. Only in four cases established were strictly upthrust and upthrust-overthrust type movements;

Results:

- Hypocenters of major seismic impacts (M = 4,5-5,7) and absolute majority of aftershocks are confined to a pre-Jurassic basement's surface or its' depths of up to 20 km;

- Most of the hypocenters were confined to a sloping stripe which subsides in the northern rumbas, identified with the zone of Ganikh-Ayrichay-Alat deep overthrust and its' flakes;

- In general the seismic activity of a mentioned period is explained by accumulation of lateral compression stresses and their later discharge in an underthrust articulation line of Middle Kur and Vandam tectonic zones along Ganikh-Ayrichay-Alat deep overthrust.

- Lateral compression firstly contributed to a creation of transpressional failures along the displacement planes of various-strike transversal dislocations, and the energy discharge in most granulated and weakened areas confined to the intersection knots of these dislocations between each other and with deep overthrust with its' northern rear flakes.

THANKS FOR YOUR ATTENTION!

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