

Geology

New Tectonic Map of Georgia (Explanatory Note)

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ABSTRACT. The map has complex character and contains wide spectrum of data on structure and development of the Earth's crust of the Georgian territory, composition, attitude and geodynamic nature of its constituent rocks. Namely tectonic deformation of rocks and history of their formation, different tectonic structures (faults and folds) and their kinematic nature, deep structure of the Earth's crust, shown by means of the structure contours of different geological horizons, geodynamic conditions of the Caucasus in Mesozoic and Early Cenozoic time, character (direction and velocity) of horizontal movements and stress conditions of the Earth's crust on the territory of Georgia at the neotectonic stage are pictured on the map. © 2015 Bull. Georg. Natl. Acad. Sci.

Key words: tectonic map, history of tectonic deformation, tectonic structures, geodynamic complexes.

Introduction

New tectonic map of Georgia [1] appeared due to long-term investigations. Therefore, in the introductory part of the paper we shall state whose theoretical bases and specific geological investigations stipulated the composition of the map under consideration.

The fact is that starting with the 1960-s, mainly on the basis of the versatile geological and geophysical investigations of the oceans, a system of notions, gradually grown into modern geological theory – plate tectonics was developed. This revolution in geology with no doubt can be compared with signifi-

cance of quantum mechanics for physics, molecular genetics for biology and cybernetics for technics.

Plate tectonics provoked absolutely new interpretation of structure and development of lithosphere: problems of relief origin, change of climate, magmatism, sedimentation, tectonic deformations and seismicity of the Earth, problems of living organisms' settling and migration and at last spatial-temporal distribution of minerals, naturally connected with the history of plate displacement. Therefore plate tectonics became a stable theoretical basis of geosciences. As a result, the territory of Georgia and the whole Caucasus turned into unique natural labo-

ratory for investigation of endogenous and exogenous geological processes on the basis of plate tectonics theory. That type of investigations have been conducted by Georgian geologists over a long period of time. One of the authors of this paper (I. Gamkrelidze) in special book [2] analyzed the trustworthiness of the plate tectonics within the Mediterranean orogenic belt. It was shown that according to geological and geophysical data the theory was proved for the whole region. This statement was corroborated in a number of the later publications [3-14]. The establishment of horizontal tectonic layering of the Earth's crust and lithosphere particularly promoted the universalization of the plate tectonics theory. Similar tectonic layering has recently been reported from many regions of the world. It has also been traced throughout the whole central segment of the Mediterranean belt [20]. One of the authors of the paper (I. Gamkrelidze) had for a long time (1976-1990) been in a position to investigate the nappe structures of the Mediterranean belt and proved the existence of deep-seated nappes in the Alps, Western and Central East Carpathians, northern Apusenides, Bohemian massif, Rhodopian crystallinum, Pannonian basin, Transcaucasian massif and crystalline core of the Greater Caucasus [15-23]. Universal character of underthrusting (continental subduction) mechanism of nappe formation was established [15, 16, 19].

It turned out that synthesis of plate tectonics theory and conception of layering of the lithosphere and the Earth's crust is very fruitful for study of endogenous geological processes (magmatism and metamorphism) [21, 22, 24-27]. As a result of these researches the opinions about the age of the crystalline basement of the Caucasus cardinally changed. Besides, the inner structure of it was specified and main stages of the development and character of endogenous processes were established.

Besides, the development of terrane conception had certain significance for improvement of plate tectonics theory, starting since the 1980s from the North American Cordilleras. Terrane analysis gives an opportunity to carry out perfect interregional correla-

tions and make models of geodynamic evolution and paleotectonic reconstructions. On the basis of such analysis tectonic subdivision of the Caucasus and adjacent areas were fulfilled [14, 25, 27, 28].

It should be noted that, in spite of the existence of universal plate tectonics theory, it is necessary to continue the study of tectonic structures of all orders, beginning from the microscopic ones up to the regional structures, that means the study of Late Alpine and present deformation of the Earth's crust and investigation of the formation mechanisms of different tectonic structures. Such researches on the territory of Georgia have been carried out over a long period of time [2, 19, 29-34].

A problem of the newest deformation of the Earth's crust is directly connected with revealing of its seismicity. With that end of view the direction and velocity of horizontal movements and stress conditions of the Earth's crust on the territory of Georgia at the neotectonic stage were studied [33]. Active deep and regional faults have been investigated [32, 33]. The existence of deep faults, which in many cases were overlain by sedimentary cover of different thickness, was established on the basis of different geological (structural, sedimentary, magmatic etc.) and geophysical (gravimetric, magnetic, seismic and other) signs. For the first time for Georgia the Catalogue of active faults depicting their numerical expression of trustworthiness and degree of importance for seismic hazard assessment was compiled. The Catalogue naturally became the basis for seismic zoning of the territory of Georgia.

All above stated investigations underlay new tectonic map of Georgia (see Figure). Below we consider contents of the latter in detail.

Contents of the Map

Folded complexes of different ages, by means of different colors and special indices, are shown on the map. Each of them envelopes different sedimentation cycle of a certain age, which is accompanied by relatively long extension and subsidence of the Earth's crust and mainly effusive magmatism of the

basic composition. Each sedimentation cycle ends with the relatively short-term folding phase (orogeny) characterizing by compression of the Earth's crust, intrusive magmatism of acid composition and, in the pre-Alpine time, by manifestation of regional metamorphism as well. The following folded complexes were distinguished: Grenville – Baikalian (Neoproterozoic), Late Baikalian (Neoproterozoic – Lower Paleozoic) and Variscan (Paleozoic – Triassic) folded complexes. In the Alpine time those were: Bathonian (Lower-Middle Jurassic), Andean (Upper Jurassic), Austrian (Lower Cretaceous), Subhercynian (Aptian – Campanian), Laramian (Upper Cretaceous), Laramian (Upper Jurassic), Laramian (Upper Jurassic – Cretaceous), Laramian (Lower-Upper Cretaceous), Laramian (Jurassic – Cretaceous) and Pyrenean (Paleocene – Eocene) pre-orogenic complexes; Styrian (Paleocene – Oligocene), Styrian (Oligocene – Lower Miocene) and Attic (Middle-Upper Miocene) early orogenic complexes; Rhodanian (Meotian – Pontian), Wallachian (Upper Pliocene) and Late orogenic-collision (Quaternary) folded complexes.

Geodynamic complexes of sedimentary rocks with different lithological composition are shown with the help of specks, on the map as well. Within them marginal sea complexes (mainly pelagic deposits) island arc rift (mainly carbonaceous and terrigenous deposits) and molassic complexes were distinguished.

Within the effusive rocks the following geodynamic types are represented: subduction (calc-alkalic, subalkalic), intraplate (alkalic, subalkalic), collision (calc-alkalic, subalkalic) and oceanic (tholeiitic) geodynamic complexes.

Using different colors and indices of geodynamic complexes of intrusive rocks, having different age (starting with Proterozoic and including Neogene rocks) and composition, are shown. By means of special colored specks the facies of suprasubduction progressive regional metamorphism are shown. These are: amphibolite and subgranulite, epidote-amphibolite and amphibolite, greenschist, epidote-amphibolite, amphibolite, greenschist and anchimetamorphic facies.

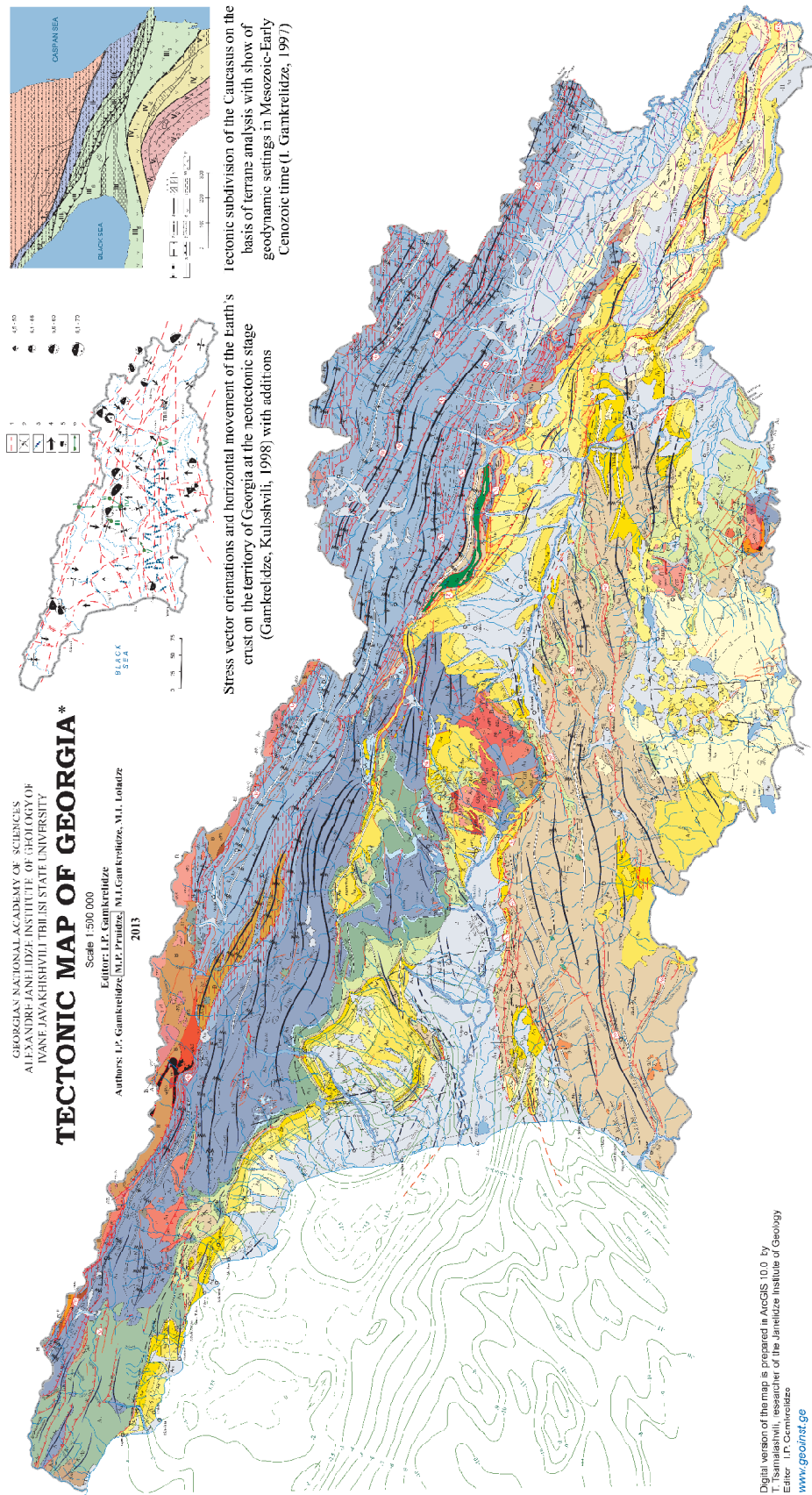
Tectonic structures of different types are plotted on the map with the help of special signs. These are: major folds (with indication of the birth and main formation time), different faults: nappes (with indication of the birth time), thrusts and reversed faults (with indication of birth time of regional faults), unspecified and normal faults, blind and strike-slip faults. Protrusion contacts are also shown.

By means of structure contours the positions of different geological horizons (of crystalline basement surface, of the Upper Cretaceous top and of the Upper Pliocene floor) are indicated.

The map has two insertions: "Tectonic subdivisions of the Caucasus on the basis of terrane analysis and geodynamic conditions in Mesozoic and Cenozoic times." On the scheme, by means of different colors and figures, accretionary terranes of the Caucasus are shown, which by trustworthy or supposed ophiolite sutures of different ages (relicts of small or large paleoceanic basins) are separated. Terranes of the first order, in their turn, consist of great number of subterrane delimited, as a rule, by deep faults or regional thrusts. Besides in many places of the Caucasus region there are ophiolite terranes, obducted from the above-mentioned ophiolite sutures.

Geodynamic settings in Mesozoic and Early Cenozoic time are shown on the scheme as well. Geodynamic types of the Earth's crust and chemical and petro-chemical nature of their constituent effusive rocks and character of sedimentary rocks are distinguished. These are: marginal sea (pelagic sediments, turbidites, submarine tholeiite-basaltic volcanites), island arc (shallow marine sediments and submarine volcanites of calc-alkaline composition), intraarc rift (pelagic sediments, tephro- and sandstone turbidites, tholeiitic and shoshonitic mainly basaltic submarine volcanites and microcontinental (of passive margin type in the Mesozoic with the shallow marine sediments, and of the Andean type active margin in the Early Cenozoic with calc-alkaline submarine volcanites) geodynamic types.

On the second insertion: "Stress vector



*Full version of the map see at science.org.ge/newsite, publications

orientations and horizontal movement of the Earth's crust on the territory of Georgia at the neotectonic stage" active (seismogenerating), mainly hidden, deep faults, orientations of the subhorizontal maximum compressive stress axis, revealed by means of detailed and regional struc-

tural analysis, presumable direction of the Earth's crust motion at the neotectonic stage, fault-plane solutions of the earthquakes with different magnitude and directions of the present motion of the Earth's crust obtained by means of GPS technology are plotted.

გეოლოგია

საქართველოს ტექტონიკური რუკა (განმარტებითი ბარათი)

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რუკა კომპლექსური ბუნებისაა და შეიცავს მონაცემების ფართო სპექტრს საქართველოს ტერიტორიის დედამიწის ქერქის აგებულებისა და განვითარების, მისი ამგები ქანების ზასიათის, განლაგებისა და გეოდინამიკური ბუნების შესახებ. რუკაზე ნაჩვენებია: ქანების ტექტონიკური დეფორმაციები და მათი ფორმირების ისტორია, სხვადასხვა ტექტონიკური სტრუქტურები (ნაოჭები, რღვევები) და მათი კინემატიკური ბუნება, დედამიწის ქერქის სიღრმეული აგებულება სხვადასხვა გეოლოგიური პერიოდების სტრატოიზოპიფსების საშუალებით. კავკასიის გეოდინამიკური პირობები მეზოზოურ და კაინოზოურ დროში, დედამიწის ქერქის პერიზონტალური მოძრაობების ზასიათი (მიმართულება და სიჩქარე) და დამაბულობის პირობები საქართველოს ტერიტორიაზე ნეოტექტონიკურ ეტაპზე.

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