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Geology

Event Deposits in Chaotically Built Formations

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ABSTRACT. **Proceeding from the analysis of the composition, structure and the forming mechanism of the Upper Eocene chaotically built formations of a part of the Alpine fold area (the Swiss and French Alps, the Dinarides, the Southern Slope of the Greater Caucasus), event deposits have been established; they are observed in the form of olistostromes and wild flysch. It is ascertained that the major factors of their formation were oft-recurring catastrophic events related to the thrusting accompanying the Pyrenean phase of folding, at the terminal of Late Eocene.**

With due regard for the degree of force and scope of display of these catastrophic events, it can be inferred that the olistostromes and wild flysch are event deposits of a higher order than analogous ones of rhythmically built formations (tempestites, turbidites). *© 2008 Bull. Georg. Natl. Acad. Sci.*

Key words: *event deposits, olistostromes, wild flysch, catastrophic events.*

In sedimentary basins, a uniform process of sedimentation during which, as is known, deposition of normally-sedimentary formations takes place rather seldom but with considerable consequences, disturbs different geological events further reflected in the lithological character of these rocks.

As a result, among the variety of sedimentary deposits there is a definite group of rocks which by their textural, structural and genetic features sharply differ from norm-sedimentary formations which led to their identification as an independent unit in the form of “event deposits”. It has been found out that one of the main determining factors of their formation are consedimentary catastrophic phenomena occurring impulsively and covering short time spans. As shown by investigations, such deposits can exist in genetically different formations.

As is known, geological catastrophic events (unlike cosmic and technological ones) in the nature are manifested in the form of earthquakes, volcanic eruptions, mudflows and turbidity currents, floods, landslide processes, etc. The sediments formed as a result of these processes are event deposits characterized by specific structural-textural and lithological features.

For the first time presence of event deposits was noted in cyclic (rhythmic) formations, treated in a number of interesting researches [1]. In chaotic formations the existence of event deposits was noted in the past in the Upper Eocene formations of the Southern Slope of the Greater Caucasus [2].

The purpose of the present study is, with account of classification of chaotic formations, to identify event deposits among them and to show their significance in the restoration of processes of the geological past, including catastrophic events.

Before passing to the task, I shall discuss in brief those criteria according to which event deposits were identifified in cyclically built rocks. As a rule, the latter are built of layered rhythms that are identical or fairly close by composition; they repeat regularly in a section. In terms of structural and textural features cyclically built formations have been united under the name of “cyclites” or "elementary cyclites". They included turbidites, storm deposits, calcareous-marly rhythms, flood deposits, etc. When their classification was endowed with a genetic notion, they were subdivided into three groups: periodites, tempestites and turbidites. Periodites are attributed to normally-sedimentary formations, while tempestites and turbidites - to "event deposits" [1]. The last ones (coquina beds, condensed layers, storm sandstones, flat-pebble conglomerates, turbidites, etc.) are geological bodies of sedimentary origin [3], formed as a result of rapid, single catastrophic events.

Cyclites belong to periodites; they are deposited in deep-water parts of the basin (below the wave base level) and are characterized by a certain periodicity of sedimentation caused by facial changes. They represent non-turbiditic pelagic and hemipelagic calcareous-marly rhythms [4]. Their sedimentation in time can last some tens and hundred thousand years.

Tempestites settle between the storm and normal baselines of waves, and turbidites - mainly on continental slopes. Unlike periodites, sedimentation of tempestites and turbidites occurs instantly, as a result of catastrophic events, the latter being one of the main factors of their formation.

The given examples show well the extent of diversity of sedimentation of structurally similar, but genetically different cyclically built deposits.

However, in nature there is also another group of rocks, which analogously to cyclic deposits, has an identical structure, but the involved rocks appreciably differ from each other genetically. This refers to chaotically built formations to which belong sedimentary conglomerates and breccias, olistostromes (block breccias), wild flysch, horizons with inclusions, volcanic breccias, tectonic breccias (mélange), glacial and mud breccias, etc.

Among these genetically different chaotic formations, the object of my attention are their exclusively sedimentary varieties, formed in marine basins. Such are breccias, conglomerates, olistostromes, wild flysch, horizons with inclusions, and reef breccias. All of them are made up of fragments and pebbles of rocks of different composition and age; their size varies from several centimeters (conglomerates, breccias) to several hundreds and thousand cubic meters (olistostromes, wild flysch).

As is known, reef breccias, owing to their specific conditions of formation, differ from other sedimentary breccias. In particular, they are formed as a result of the action of sea waves on the slopes of reef structures, and representing a product of destruction of coral islands. Usually, reef breccias closely merge with the reef body composed of massive or obscurely lamellar limestones. In case of surf processing of boulders, they pass into well-rounded pebbles, forming conglomerate seams. Their characteristic feature is that, as well as breccias, they contain limy pebbles and cement.

As for the horizons with inclusions, the laminated norm-sedimentary rocks in them are base components, and the clastic material has a subordinate role; by their lithological nature, they most likely belong to intermediate (transitive) deposits between norm-sedimentary and chaotic formations.

As to conglomerates and breccias, by origin they are identical, with the only difference that in conglomerates the degree of roundness of the fragments composing them is higher. Genetically olistostromes and wild flysch are alike as well. The basic distinction between them lies in the conditions of their formation. In particular, olistostromes settled in the basins with epicontinental mode of sedimentation, and wild flysch - in flysch basin.

As is known, in the formation of sedimentary deposits, along with many factors (climatic changes, activity of organisms, fluxes and refluxes, facies realm, etc.), tectonic movements play quite an important and often defining role. The sedimentary chaotically built formations under consideration are not an exception.

Transgressive and regressive deposits, mostly composed of conglomerates and breccias, are formed as a result of the lowering and rise of sedimentary basins. During these processes, the tectonic movements proceed rather evenly without any cataclysms; thus, as the normal process of sedimentation is uninterrupted, the conglomerates and breccias are norm-sedimentary formations. However, in cases when tectonic movements, occurred catastrophic events during which in appropriate paleogeographic and facies conditions took place deposition of olistostromes and wild flysch, representing event deposits.

Thus, proceeding from the genetic principles, the chaotic formations under consideration, can be subdivided into two groups: normally-sedimentary (conglomerates, breccias) and event (oilstostromes, wild flysch) deposits.

One of the vivid examples of chaotically built event deposits are the Upper Eocene olistostromes and wild flysch of the Alpine folded area, a subject of interest of many researchers [5-13]. They contain valuable information for paleogeographic reconstructions and about the tectonic movements at the Eocene-Oligocene boundary, being one of the important periods in the history of the given region.

In the greater part of the Alpine fold system olistostromes are part of flysch formations, allowing

F.Kaufman [14] to identify them as "wild flysch", though according to a number of researchers, by their nature and structure they differ from typical flysch [8] or are not at all flysch [15]. However, as correctly noted by M.G.Leonov [16] wild flysch is a component of flysch formations of the Alpine area, in a greater part of which flysch formation was complated in Late Eocene.

As to the term "olistostrome" (landslide bed), it was introduced much later by G.Flores [17] for any chaotically built sedimentary rocks and from the beginning it implied their formation as landslide-induced events only. However, as it often happens, the initial meaning of the term loses its sense and it begins to be applied to structurally and lithologically similar formations as well. The term olistostrome is no exception either. Subsequently, it turned out that in the formation of olistostromes, besides landslide events, an important role is played by tectonics and that is especially important, for their formation in time mostly corresponds to the peaks of Alpine tectogenesis [18].

Before passing to the issues concerning the paleogeography and nature of formation of the Upper Eocene olistostromes and wild flysch, let us familiarize ourselves with the geological position of these formations in some folded structures of the Alpine system. Considering the limited format of the paper, I shall consider only a few examples where, in my opinion, deposits of our interest are most well studied.

The Swiss Alps. In the segment of the Alpine folded system under consideration wild flysch is developed in the Ultrahelvet nappe, which is situated above the Helvetide nappes. The Ultrahelvetian cover is built up of intensively deformed flysch deposits in which thin covers are developed. Wild flysch comprises the lowermost of them - the Plen-Mort nappe [19]. It is developed in the form of a narrow strip between the Alpine molasse

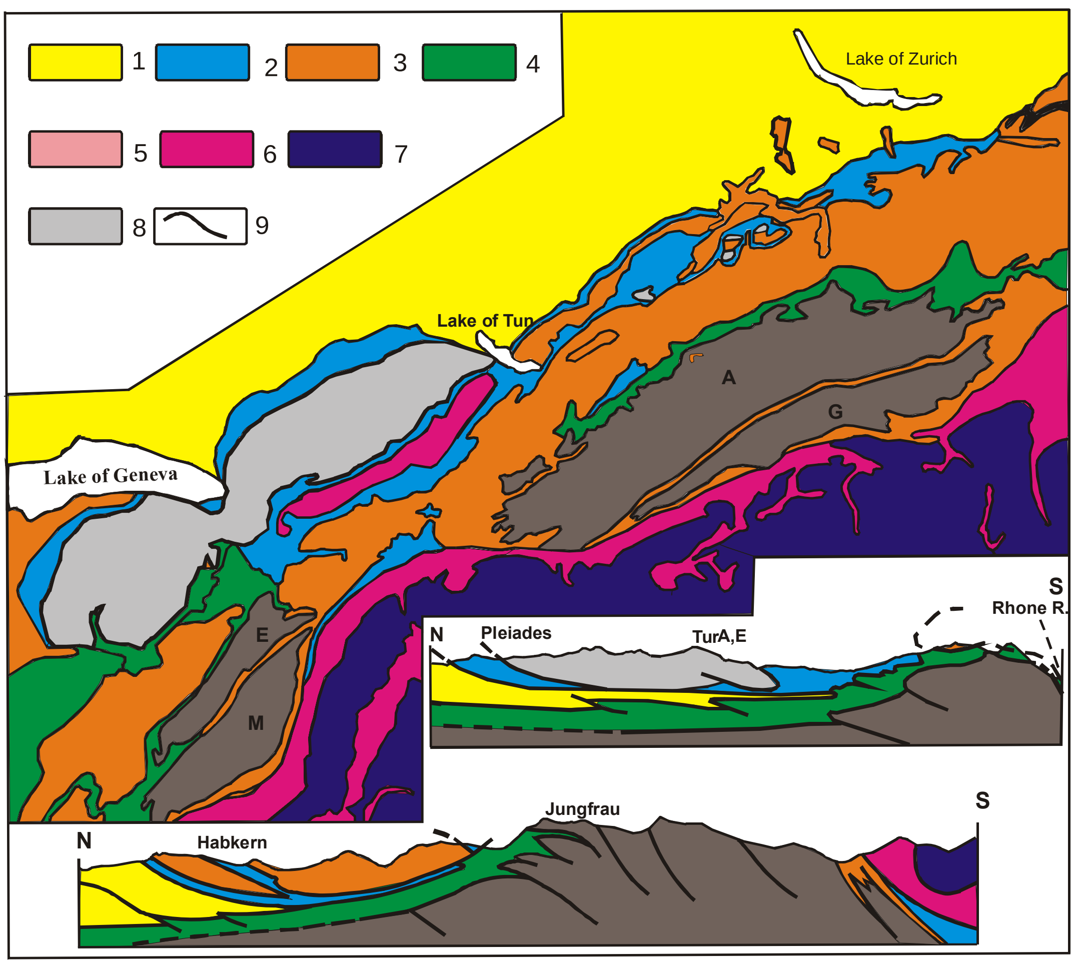

Fig. 1. Tectonic diagram of the northern part of Swiss Alps (based on Carte geologique de la Suisse, 1951)
1 – Molasse zone; 2 – Ultrahelvetian nappes (including a wild flysch); 3 – Hian nappes; 4 – autochthonous and parautochthonous mantle of the Hercynian Massifs; 5 – crystalline cores of the Hercynian Massifs (À – Aarian, G – Hottarian, E – Egui-Ruge, M – Mont Blanc); Pennine nappes: 6 – rocks of the mantle; 7 – rocks of the crystalline basement; 8 – Pre-Alpine nappes; 9 – nappe boundaries.

(in the north) and the deposits forming the Helvetian and Pre-Alpine nappe from Lake of Geneva in the south-west to the Austrian Alps in the north-east (Fig.1).

The most interesting exposures of wild flysch are observed in the Habkern zone, situated in the northern part of Central Switzerland, between the lakes of Tun and Firvaldshtet. Here the flysch formations forn a syncline trough and are represented by Habkern flysch, outliers of Klippe nappe and Schlieren flysch. The object of our interest is Habkern flysch which, by structural-lithological features, is subdivided into three parts, each representing an independent tectonic sheet [20]. The lowermost part is represented by a flysch of basal sheet followed by a flysch with the packages of Limern beds and wild flysch. The sediments, composing the latter two sheets are interesting in that they, to a different extent are a consequence of event sedimentation and were formed synchronously.

Marls among which there are sandstones, conglomerates and breccias, also lenses and partings with fragments of foraminifer shells form the tectonic slab of the basal sheet. By the fauna in the deposits of basal sheet, these rocks are dated as Late Eocene (Priabonian) [20]. The given sheet tectonically thrusts over the more ancient deposits of the Helvetian nappe and the Upper Eocene formations.

In its turn, the slab of basal sheet from south is also overthrusted by another sheet, containing flysch with packages of Limern beds and a wild flysch. Flysch formations composing the given sheet are lithologically similar to the rocks of the basal sheet and are represented by alternation of marls, aleurolites, sandstones and breccias. The only difference between them is that in the sheet under consideration, in the groundmass of flysch there are fragments of thick marls and limestone blocks of the Upper Cretaceous and Paleocene age; in some places, their size reaches several tens of meters. By faunistic data and that of the nummulites inclusive the groundmass of flysch, which contains these inclusions, , is dated as the Late Eocene (Priabonian) [20].

The next tectonic sheet represented actually by wild flysch was identified by Gigon [20] as an independent facies; it consists mainly of dark marls and marl slates with intercalations and lenses of sandstones, limestones, conglomerates and breccias. This groundmass contains inclusions of crystalline and sedimentary rocks with a stratigraphic range from the Triassic to Eocene inclusive. Among the crystalline rocks, the Habkern granites prevail in volume and quantity and Limern limestones among the sedimentary rocks. Overall, the dimensions of clastic material vary from several centimeters to several thousand cubic meters. In particular, separate blocks of Habkern granites reach 13000 ì^3, and the Limern limestones - 100m in length [20, 21]. In intercalations and lenses of conglomerates and breccias the same rocks, as the olistholites of wild flysch, are mainly represented by clastic material. Separate partings of breccias contain a considerable amount of fragments of oyster shells. Along with them condensed beds (tempestites) are also present, consisting of elements of re-deposited fauna of different age; along with wild flysch they represent event deposits of two generations.

The age of wild flysch is reliably defined by faunistic data as the Late Eocene (Priabonian) [21, 20]. If the assumption is accepted that wild flysch was formed as a result of overthrusting, and that it began at the end of Late Eocene [11] the age of wild flysch can be specified as the upper part of Upper Eocene.

Lithological similarity and synchronism of flysch formations forming separate tectonic sheets of the Habkern zone allow one to assume that they settled in a single flysch basin. In Late Eocene, in the process of flysch formation, as a result of the catastrophic events of different scale and force here, there took place sedimentation of event deposits of different categories. During powerful catastrophic processes a wild flysch was formed with packages of Limern and Habkern granites, and at their weaker manifestation tempestites (coquina breccias, the condensed layers) and turbidites were deposited.

The location of the parent rocks of those exotic blocks and fragments, whose bedrock outcrops are not exposed nowadays, today are debatable among the researchers. This primarily refers to Habkern granites, to crystalline schists and Limern beds. Inclusions of the last, as was already marked, are distinguished in large dimensions. The researchers connect the presence of exotic blocks in wild flysch, as well as the origin of the latter, with destruction of the frontal parts thrusting south Pennine and Austrian-Alpine nappes [23, 6, 20,]. In order to explain the presence of fragments of Habkern granites the existence of hypothetical granite boundary between the Ultrahelvetian and Pennine areas [6] has been assumed. An analogous assumption, as will be shown below, also has been made for exotic inclusions (Upper Jurassic reef limestones, Bajocian volcanogens, Pre-Jurassic crystalline rocks), contained in the Upper Eocene olistostromes of the Southern Slope of the Greater Caucasus.

The French Alps (Western Alps). Here chaotic event deposits are represented by olistostromes which have developed within the Tertiary basin of Valensol, a part of the subalpine chain and forming the external sedimentary cover of the Dauphiné zone. Olistostromes here are developed in two places, where they extend for tens of kilometers in the form of narrow strips. The first outcrop of olistostromes is confined to the Digne-Barle nappe; its northern part passes within the subalpine chains and the southern - between the deposits of subalpine chains and Provence. In the northern part the mentioned nappe has more or less meridional, and in the southern - an arcwise orientation.

Due to this thrust, the allochthonous deposits of the Mesozoic (Trias-Liassic) from the east to west thrust over the autochthonous molasse formations. The thrust zone suffered heavy tectonic impact and is built up of several tectonic sheets, consisting of rocks of diverse age.

One of such sheets contains olistostromes with red bed matrix. In them, unlike the western outcrops of olistostromes, besides Cretaceous rocks olistoliths of Upper Jurassic limestones are present as well, their size varying within 20-80m [24].

To the west of the Digne-Barle thrust the second outcrop of olistostromes is located. Here they take part in the structure of red molasses, occupying its bottom horizons. The red molasse itself is a lower part of the autochthonous molasse. In the ascending section, it is replaced by continental deposits. The latter, in their turn, are overlapped by Miocene marine molasse and the Mio-Pliocene Valensol conglomerates.

The red molasse olistostromes consist of separate horizons of chaotically built breccias and olistoliths of Cretaceous rocks that reach several hundred meters in diameter. The maximum thickness of olistostromes is up to 1 km [24].

Study of the structure, tectonic position and composition of the olistostromes of the Valensol basin, led the majority of researchers to the conclusion that olistostromes were formed in similar paleogeographic conditions and that the main factor of their formation was tectonics that caused the disintegration of rocks and formation of the tectonic cover made up of olistostromes [24, 25].

According to brachiopods and algae, also, by its stratigraphic position beneath the Miocene marine molasse, the age of the red molasse turned out to be the Lower Oligocene. The olistostromes that occupy the lower part of the red molasse are conventionally dated to the Upper Eocene.

Outerl Dinarides. In the particular fold system, wild flysch is developed in the Ionic zone, within Albania and in the north-west of Greece. Here these formations are located between the Oligocene and Upper Eocene flysch deposits. They are most widespread along the eastern margin of the Ionic zone, in the area from the Greek border to middle Albania (Gavrovo zone). It is remarkable that in the clastic parts of wild flysch, besides dense sandstones and limestone blocks, there is a considerable amount of fragments of Mesozoic ophiolites (serpentinites, periodites, gabbro, diabases, etc.) [26].

In this part of the Dinarides in flysch formations (as well as in molasses and other terrigenous deposits) there occur buried, rootless detached (exotic) blocks up to tens of millions of cubic meters in volume, mainly represented by limestones. They got into the sedimentary basin due to strong consedimentary tectonic movements that took place at the end of Late Eocene [26].

Formation of wild flysch occurred in a short time interval, as testified by the complex of foraminifers; they are observed in the layers underlying and overlying the wild flysch, represented by practically the same complex of microfauna [27], most likely dating these formations to the upper part of the Upper Eocene.

The Greater Caucasus. In the given folded area, the Upper Eocene event deposits in the form of olistostromes are developed on the Southern Slope of the Greater Caucasus. Their greatest part is located within Georgia and only their separate outcrops are observed in the Azerbaijan part of the Southern Slope of the Greater Caucasus (Dashbulag, Talistan outcrops, Talistan and Shabian “cliffs “).

The olistostromes under consideration - despite their strong tectonic processing and displacement over great distances (20-50 km) - give valuable information about the paleogeography and tectonic events, including catastrophic ones, going on in the second half of Late Eocene.

Olistostromes formed to the south of the flysch basin, within the northern part of Gagra-Java zone with epicontinental mode of sedimentation, at present overlapped with overthrust nappes. They are distributed irregularly and observed in two localities (Fig.2).

Their minor part, developed in the western segment of the fold system (Adler depression) is part of the regressive Matsesta suite represented as a “horizon with inclusions” [28]. The completeness of the section of the Matsesta suite, contained the nummulitic fauna in it and distinct borders between the underlying and overlapping suites (Argveti and Khosta suites), allows to establish the beginning and duration of the New-Pyrenean phase of folding. This phase of folding has caused accumulation of the given suite as a whole, and in its maximum display - formation of the “horizon with inclusions”. By its nature, the latter constitute typical olistostromes of tectonic-gravitation origin [29, 30].

The main part of Upper Eocene olistostromes is developed in the eastern segment of the Southern Slope of the Greater Caucasus. Here, from the river Rioni they stretch as a narrow strip to the east, along the frontal line of the thrust of allochthonous flysch deposits of the Mestia-Tianeti zone (Fig. 2). Due to this thrust, the deposits under consideration partially, and at places, probably entirely, are tectonically overlapped by the Cretaceous-Paleogene flysch deposits. In their turn, from the north, the olistostromes thrust over the autochthonous normally-sedimentary rocks of the Gagra-Java zone, including the Upper Eocene ones.

Researchers disagreed on the issue of olistostrome age. They were attributed to different stratigraphic levels of the Eocene. According to nummulitic fauna, they have been dated to the Upper Eocene [31]. Initially it was believed that the olistostromes cover all the Upper Eocene or its base. Then, on the basis of new faunistic findings [16] and correlations with the coeval formations of the adjacent areas [29, 32] it proved feasible to specify the age of the olistostromes and to refer them to the uppermost Upper Eocene. My studies show that the olistostromes are synchronous formations of the “horizon with inclusions” of the Matsesta suite [29].

Olistostromes are built up mainly of olistoliths of the Mesozoic and, partially, Paleogene deposits of the Gagra-Java zone. Among them prevail the Upper Jurassic reef limestones and volcanites of the Bajocian age. Moreover, these olistoliths are characterized by huge size, especially limestones. In separate exposures these limestones correspond to olistoplacs; in volume they reach several hundreds and thousand cubic meters (mountains Orbodzala and Alevis-klde, the Georgian Military Road, etc.). Because of the huge sizes of these rocks, some of them had earlier been recognized as Upper Jurassic bedrocks.

When dealing with the formation mechanism of olistostromes of the Greater Caucasus Southern Slope, it should be noted that many researchers consider tectonics to have a key role in their formation. Some scientists attribute the process of their formation to the periods of folding and nappe formation [16, 29, 32-35]. V.P.Rengarten [36] was the first to specify the linkage of olistostrome formation (block breccias) with the destruction of frontal parts of tectonic nappes.

In olistostromes, there are frequent fine ruptures and gliding planes indicating that they had suffered appreciable tectonic processing. Their matrix is represented predominantly by carbonaceous pelitolites and aleurolites. The thickness of olistostromes is from ten to several hundred meters.

The presence in olistostromes of exotic inclusions of the Upper Jurassic limestones (the Georgian Military Road, Kakheti) and crystalline rocks of the basement (to the east of the Aragvi River) gave rise to the question of the location and structure of the land that supplied the Late Eocene basin with clastic material. Such a hypothetical land, was most likely the Racha-Vandam land; it was a chain of separate cordilleras, located in the northern peripheral part of the Gagra-Java zone, extending

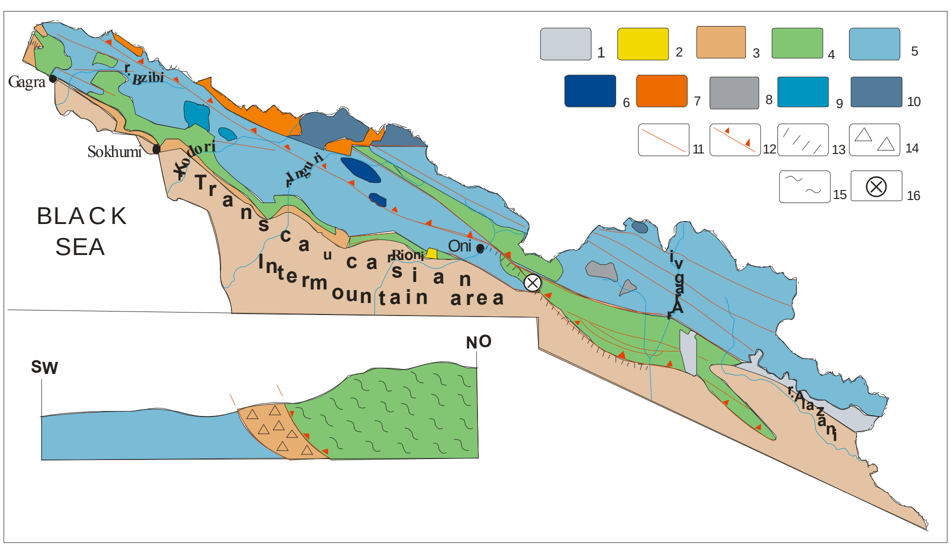

Fig. 2. Schematic geological map of the Georgian part of the Greater Caucasus
1 – Quaternary: 2 – Neogene: 3 – Paleogene: 4 – Cretaceous: 5 - Jurassic: 6 – Middle Paleozoic-Triassic: 7 – Neoproterozoic-Lower Paleozoic: 8 – Neogene- Quaternary subaerial volcanites: 9 – Jurassic granitoids: 10 – Neoproterozoic-Paleozoic granitoids: 11 – faults: 12 – frontal line of overthrust nappes: 13 – zone of olistostrome development: 14 – olistostromes: 15 – flysch: 16 – location of the section.

from the Utsera meridian in the west along the southern boundary of the flysch basin [35, 29].

The composition of the clastic material of olistostromes shows that this cordillera zone had been built up mainly of Mesozoic and partially of Lower Paleogene rocks of the Gagra-Java zone; beginning from the river Aragvi and more easterly, it consists of the rocks of the Pre-Jurassic crystalline basement. It was the main source of terrigene material not only in Paleogene but most likely in the Cretaceous period as well [32, 37]. In the second half of Late Eocene, during the Pyrenean phase of folding, along the thrust front of flysch formations, due to thrust formation [16, 33, 35, 29, 2] there took place an intensive destruction of the Racha-Vandam cordillera zone and dislocation of the disintegrated material in the southward direction, towards the epicontinental basin; here there began deposition of olistostromes around the cordilleras.

The cordillera zone - at present completely overlapped with flysch thrust – was apparently formed due to the Bathonian orophase, existing up to the Late Eocene inclusive [35].

As to the issues of the general paleogeography and genesis of both the olistostromes and the wild flysch of the Alpine fold system, it should be noted that, along with catastrophic events, their formation necessitated the presence of a dissected relief in the form of cliffs and cordilleras - the basic suppliers of clastic material. Movements of disintegrated material to the areas of sedimentation, as illustrated by the examples, mostly occurred due to the tectonic movements and the attendant downfall-landslide processes, being indicative of their tectonic-gravitational origin. These geological events occurred especially frequently in the zones of development of deep faults and in the process of nappe-formation as well.

Whereas olistostromes and wild flysch of tectonic-gravity origin are, as a rule, characterized by regional propagation, great thickness, polygenic content of rocks of different age and by the presence of exotic blocks, analogous formations of purely landslide genesis are spatially restricted and have a rather uniform composition of inclusions.

Gravity-induced olistostromes are indicators of intensification of vertical movements, mainly along high-angle faults, while tectonic-gravity olistostromes point to horizontal dislocations connected with the formation of tectonic nappes [33, 38].

When considering the process of wild flysch formation from the point of view of catastrophic events, one should note the following sequence in its formation. During flysch formation when the background deposits settled in definite time intervals, due to relatively weak catastrophic events turbidites were deposited. However, when tectonic movements reached their peak, strong catastrophic processes took place, thus delivering into the basin fragments (blocks) of huge size causng the formation of individual olistostrome strata building a wild flysch.

Comparing event deposits of cyclically (tempestites, turbidites) and chaotically (olistostromes, wild flysch) built formations, it may be stated that they sharply differ from each other by structure and lithology, though they are similar by genesis, being products of catastrophic events of varying scale and force. While tempestites and turbidites are products of single and very short-term catastrophic manifestations, olistostromes and wild flysch were often formed due to recurring catastrophic events; thus, their formation in time lasted longer, though according to geological criteria it too is a short-term event. Even at great thicknesses, the stratigraphic range of their accumulation is excessively short [33].

The increased interest in studying the Upper Eocene olistostromes and wild flysch is accounted for by the fact that they are widespread in the entire Alpine fold belt; besides, they are peculiar marker formations, allowing to establish the time and duration of the manifestation of the Pyrenean phase of folding, thereby enabling correlation of the tectonic movements including catastrophic events, both in the Alpine fold system and beyond its limits.

The considered event deposits of the Alpine fold system, being synchronous formations, clearly pointing to their timing to the same geological event. In particular, as V.E.Khain [39] assumes, such could have been a collision leading to the formation of the fold-nappe structure of the Greater Caucasus. It began at the end of Late Eocene, reaching its maximum in Late Miocene when the Arabian plate became detached from the African plate and began movement to the north.

It should be noted in conclusion that, in my opinion, classification of event sediments, should be made with account of the extent of the force and scale of manifestation of those catastrophic events which form these sediments. From this point of view, event-induced chaotic sediments (olistostromes, wild flysch) are formations of higher order than analogous sediments of rhythmically built formations (tempestites, turbidites).

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გეოლოგია

მოვლენათა ნალექები ქაოსური აგებულების წარმონაქმნებში

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(წარმოდგენილია აკადემიკოს ე. გამყრელიძის მიერ)

ზღვიურ აუზებში, სადაც უპირატესად ნორმულ-დანალექი სედიმენტაცია მიმდინარეობს, კატასტროფული მოვლენების შედეგად გეოლოგიურ წარსულში ადგილი ჰქონდა სპეციფიური ბუნების ნალექების წარმოშობას, რომლებიც "მოვლენათა ნალექების" სახელითაა ცნობილი. პირველად, აღნიშნული ნალექები რიტმული აგებულების ქანებში გამოიყო ტემპესტიტების და ტურბიდიტების სახით.

წინამდებარე სტატიაში ანალოგიურ მოვლენათა ნალექების არსებობა ქაოსური აგებულების წარმონაქმნებში დადგინდა. კერძოდ, ალპური ნაოჭა სისტემის ნაწილში (შვეიცარიის და საფრანგეთის ალპები, დინარიდები, კავკასიონის სამხრეთი ფერდობი) განვითარებული ზედაეოცენური ქაოსური აგებულების წარმონაქმნებში (მათი შედგენილობის, სტრუქტურის და წარმოშობის მექანიზმის გათვალისწინებით), გამოიყო მოვლენათა ნალექები ოლისტოსტრომების და ველური ფლიშის სახით. გაირკვა, რომ მოვლენათა ნალექების წარმოშობის ძირითად ფაქტორს მრავალჯერადი კატასტროფული მოვლენები წარმოადგენდნენ. რომლებიც გამოწვეული იყო იმ ტექტონიკური მოძრაობებით, რაც თან ახლდა პირენეულ დანაოჭებას გვიანი ეოცენის ბოლოს.

აღნიშნული კატასტროფული მოვლენების ძალისა და გავრცელების მასშტაბების გათვალისწინებით შეიძლება დავასკვნათ, რომ ოლისტოსტრომები და ველური ფლიში წარმოადგენენ უფრო მაღალი რანგის მოვლენათა ნალექებს, ვიდრე რიტმული აგებულების ანალოგიური წარმონაქმნები.

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