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*Geology*

# Flysch Character of the Upper Jurassic-Cretaceous Formation of the Caucasus Marginal Sea Eastern Basin and Some Issues of its Origin

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(Presented by Academy Member David Shengelia)

**ABSTRACT. Study of origin of flysch sediments globally spread in the Earth's mobile belt is an actual issue of geological science. As a result of lithological study of the Upper Jurassic-Cretaceous flysch formation of the Caucasus marginal sea eastern basin two main grain-size groups of rocks characteristic of these sediments are established – phaneromere (psephitolites, psammitolites, aleurolites) and background – rhythmic alternation of cryptomere pelitolites, argillo-carbonaceous and carbonate silt expressed in recurrence of rocks with less changeable composition and different thickness (from one thousandth of centimeter to 10-12m). The rhythm begins with comparatively coarse-grained sedimentary deposits that are replaced by fine-grained formations in ascending order and are terminated by the background ones – pelitic. Sedimentation of the studied Upper Jurassic-Cretaceous flysch formation of the Caucasus marginal sea eastern basin took place mainly due to turbidite-forming suspension flows that formed spasmodically by gravitation, earthquakes and fluctuations of the World Ocean level and was also affected by climatic processes, sea currents, seismic events, dynamics of the basin, etc.The studied flysch formation evolved in the definite zone of sedimentary basin characterized by less stable hydrodynamic and unstable, peculiar hydrochemical conditions. At the same time in the basin normal marine sediments were developed. Thus, Upper Jurassic-Cretaceous flysch formation of the Caucasus marginal sea "Eastern Basin" (within the limits of Georgia) occurred due to tectonic and eustatic factors in controlled trough conditions.** *© 2017 Bull. Georg. Natl. Acad. Sci.*

**Key words:** marginal sea of the Caucasus, flysch sediments

Detailed study of flysch sediments spread in the mobile belt of the Earth is an actual issue of geological science. Problem of flysch is considered with due regard to its lithological characteristics and origin. Flysch textures are significant in reconstruction of physical-geographical conditions of past geological epochs, in particular in defining the nature of eustatic movements, direction and rate of sea currents, in ascertaining location of cordilleras and gulfs, floor and slopes in sedimentary basins, determining mode of rock occurrence, etc. [1].

Flysch complexes characterized by rhythmic al-

**Fig. 1.** Rhythmic alternation of sandstones and argillites in the Gheske river-gorge.

ternation of turbidites with graded texture (sandstones, aleurolites, clastic limestones or gravellites, conglomerates, breccias and tephroids more rarely) and pelitic, so-called background sediments (clays, argillites, marls, pelitomorphic limestones) differ from each other in numerous features that is expressed in different types of flysch.

As a result of detailed lithological study of flysch formation within the limits of the region under study two main grain-size groups of rocks characterizing these sediments are established – re-sedimentary phaneromere - psephitolites, psammitolites, aleurolites and background – cryptomere pelitolites, argillo-carbonaceous and carbonate silt. As it was already mentioned, these sediments are characterized also by rhythmic structure (Fig.1) expressed in recurrence of rocks with less changeable composition and different thickness (from one thousandth of centimeter to 10-12m). The rhythm begins with comparatively coarse-grained sedimentary deposits that are replaced by fine-grained formations in ascending order and are terminated by background ones – pelitic (conditioning sharp boundary between the rhythms).

According to textural interval complete and incomplete rhythms are distinguished in them. Texture of the rocks forming the studied flysch complex is mainly psammitic, aleuritic and pelitic; psephitic and micro-grained varieties are rare. Their texture varies – horizontal and cross-bedded; distinctly dominates horizontal bedding.

In separate turbiditic layers characteristic of flysch, as a rule, consistent succession of Bouma's gradational interval [2] is recorded (Fig.2): Turbidity currents form different forms of washout on a silt surface, then a coarser fraction is deposited; gradational interval-**a** with massive structure is accumulated; it is followed by a lower lamination interval – **b**, micro cross-bedded convolution packet – **c**, upper lamination interval-**d** and then turbidite is covered by a pelitic interval-**e**. Usually in this part of sediment bioturbation traces, worm (detritophage) trails, etc. are observed.

Different signs and hieroglyphs cover a subjacent plane of re-sedimented rocks in the rhythm (Fig.3).

Their investigation provides definite data for reconstructing physical-geographical environment of the formation of studied sediments. Flysch

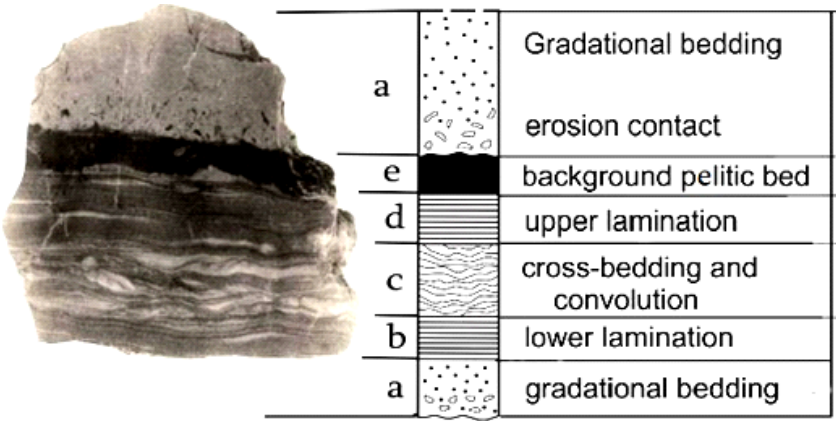


**Fig. 2.** Succession of Bouma's sedimentary textures in turbiditic layer of Early Cretaceous flysch (the Aragvi river); 3x reduced.

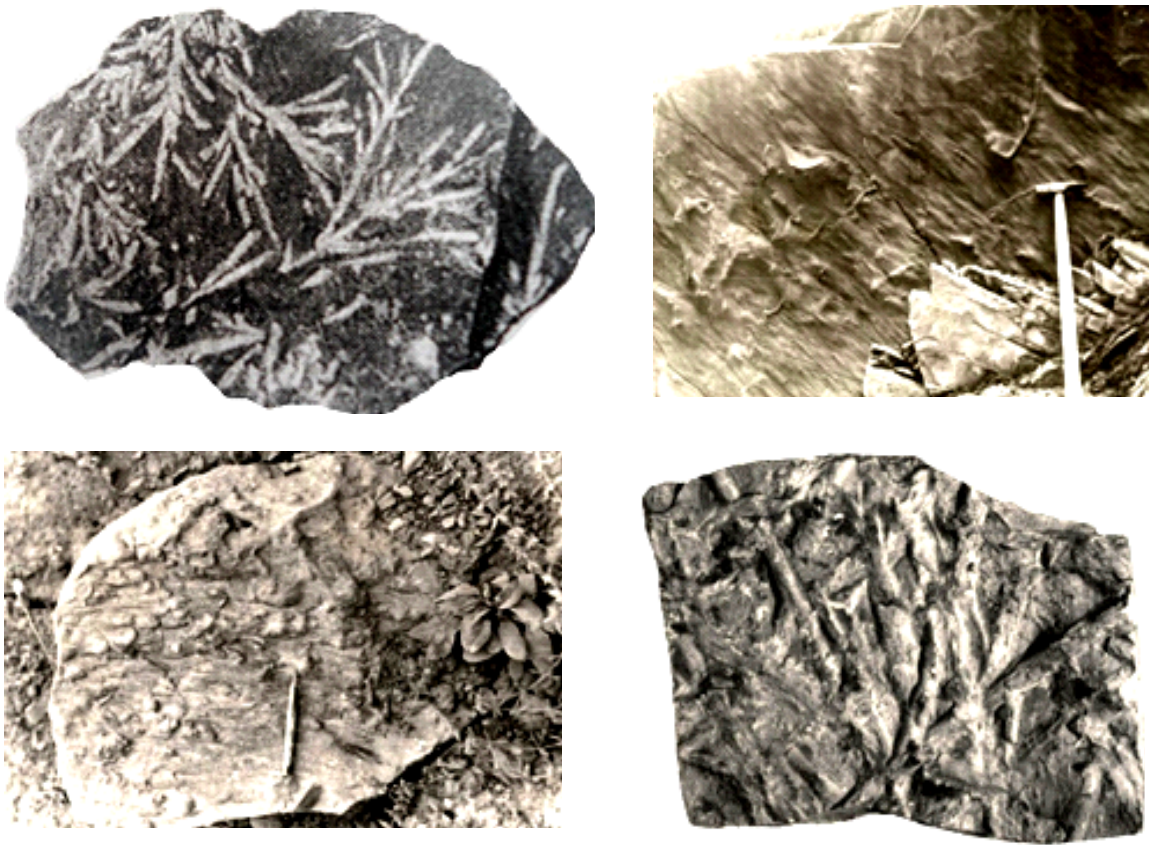

**Fig. 3.** Flysch figures - erosion hyerogliphs in geological sections of the Gheske, Didi Liakhvi, Aragvi and Ilto river gorges.

hieroglyphs (mechanoglyphs, bioglyphs, etc) by various sculpture, size and relief, naturally should be of different origin – mechanoglyphs are represented by prod cast figures left after dragging and rolling, sliding and striking of coarse material; erosion hieroglyphs –convex parts (bas-relief) of washout, crescent, elongated and irregular form are abundant, they seem to represent negative casts of furrows left after different types of material transport. Orientation of sharp terminations of turbidity current formations should be indicative of current direction.

Bioglyphs are numerous and diverse – bioturbation traces, worm trails, algal formations– fucoids, etc. Above-mentioned flysch textures occur in the first and second elements and they are related to the lower (basal) plane of sandstone, aleurolite and limestone beds.

As the studied Upper Jurassic-Cretaceous sediments of the region by composition and material source are characterized by all above mentioned features indicative of flysch, they represent an unbroken flysch formation, where clastic limestone-bearing and clastic-aluminosilicate flysch types are distinguished (Fig.4).

In clastic limestone flysch type according to matter content and thickness of rhythm element following varieties are distinguished: clastic-carbonaceous coarse flysch (Fig.4-a), limestone-marl bearing (Fig.4-b), limestone-bearing (Fig.4-c) and marl-bearing flysch (Fig.4-d); coarse flysch in clastic-aluminosilicate (gravelstone-bearing) type (Fig.4-e), marly-argillite bearing (Fig.4-f), norm i.e. sandstone-argillite bearing (Fig.4-g), sandstone-bearing (Fig.4-h) and agillite-bearing (Fig.4-i) flysch is distinguished.

The studied flysch types are rather stable along the strike and in vertical section they replace each other almost in conformity to pattern.

Thus, evolution of Upper Jurassic-Cretaceous

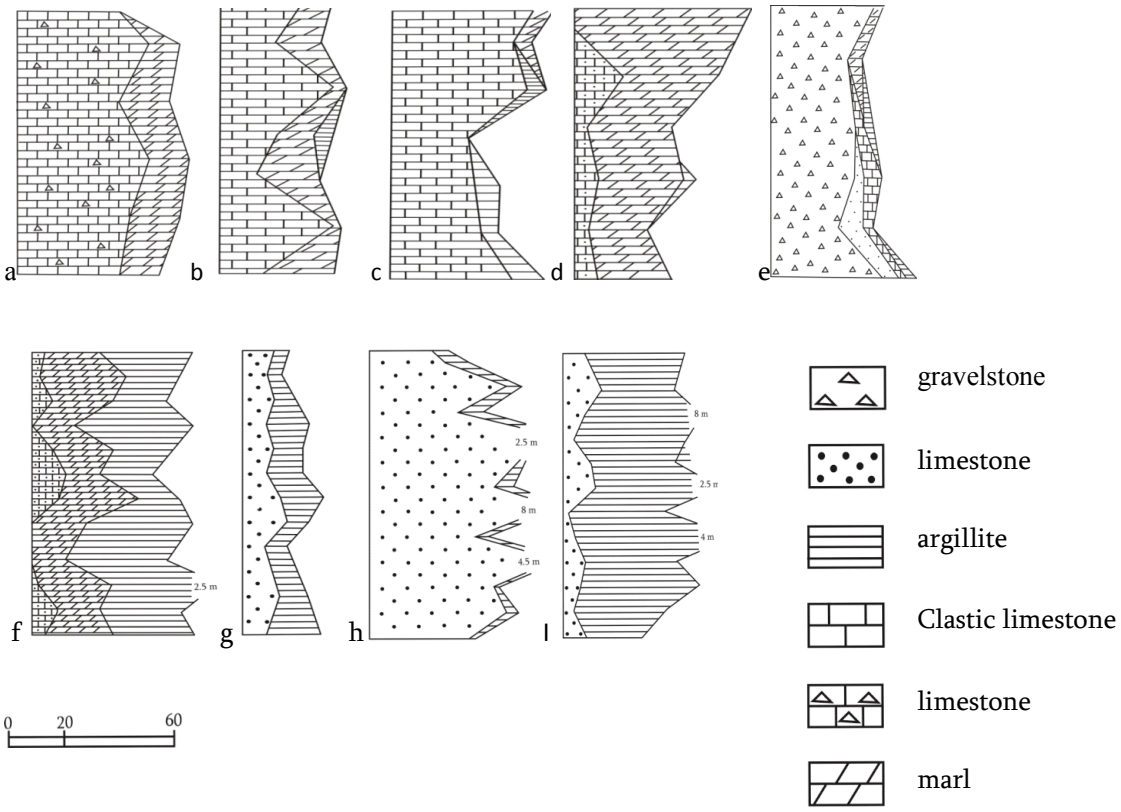


**Fig. 4.** Rhythmograms of Upper Jurassic-Cretaceous Flysch: a – clastic-carbonaceous coarse flysch; b – limestone-marl bearing, c – limestone-bearing, d – marl-bearing, e – coarse flysch in clastic-aluminosilicate type (gravelstone-bearing), f – marly-argillite bearing, g – norm i.e. sandstone-argillite bearing, h – sandstone-bearing, i – argillite-bearing.

flysch sedimentation in the mentioned basin is reproduced in regular alteration of flysch types studied in ascending section.

In geological section according to the character of material transport in sedimentary basin ascertaining of the position of sediments building the studied complex, study and the analysis of their petrographic composition and textural peculiarities give possibility to distinguish following genetic types of sediments: submarine slide, close-grained, liquefied flows and turbidity currents. These different types of sediments occur due to re-sedimentation. They formed as a result of remobilization and re-transportation of primary, comparatively shallow marine sediments with matter content of different density and grain-size and also transition of eastern part of the Greater Caucasian marginal sea sedimentary basin into comparatively deep marine conditions. In the studied sections, the above-mentioned re-sedimentary formations rhythmically alternate with background sediments, their feeding source is supposed to be erosion products of sedimentary formations occurring on internal uplifts of the basin and also of the Bathonian cordilleras situated to the south of the basin.

It should be noted that in spite of numerous studies, problem of flysch origin still remains unsolved. There are mainly two hypothesis concerning flysch genesis and its rhythmic structure. According to the hypothesis of fluctuation motions, the rhythmicity developed due to changes of the sea coast and depth of sedimentary basin – formation of the coarse-grained part of the rhythm corresponds to the shoaling of the basin, deposition of fine-grained material corresponds to the deepening.

The followers of episodic turbidity flow theory call

the flysch or flysch formation a suite or packet, which may not be characterized by all essential features indicative of flysch – flysch formation is considered as a paragenetic coexistence of sediments, among which turbidites sharply dominate. Turbidite-forming turbidity currents move down the steep slopes of cordilleras that bound the flysch basin, or the internal ones reach great depths. Afterwards these sediments may spread along the basin (contourites). It is likely that the episodic formation of turbidites was provoked by movements induced not only by general tectonic activity but mainly by shallow-focus earthquakes taking place between the orogenic phases due to subsidence and stretching. Formations similar to turbidites can occur as a result of severe storms (tempestites), floods (inundates) and other events as well. It is known that turbidites evolve in several days, while deposition-accumulation of pelagic background deposits takes tens and hundred thousand years. Study of recent sediments from the Black Sea and Atlantic Ocean revealed that the sediments similar to flysch formations, at present evolve on the continental slope, as well as on its termination.

Thus, Upper Jurassic-Cretaceous flysch formation of the studied region is represented by deep-marine and comparatively shallow-marine sediments. Upper Jurassic complex by structural-textural peculiarities belongs to shallow-marine basin formations with carbonate sedimentation. During these period turbidity currents – turbidites often were formed due to active tectonic regime, mainly gravitation on a steep slope of oceanic internal cordilleras and earthquakes related to subsiding and stretching processes taking place between the orophases. In the lower part of turbidites as a result of gravitational grading granular clastic limestones accumulated; during the calm background fine-grained silty limestones and marls were deposited.

In the Early Cretaceous, terregene flysch sedimentation took place from turbidity (suspension) flows, which turned out to be also formed spasmodically due to above-mentioned various reasons. Gradational bedding also is characteristic of limestones of that time. During the calm period thin-layered argillites and marls were deposited.

In the Upper Cretaceous in the region great variety of sedimentary formations (clastolites, carbonates, silicates, volcanogenes) and terregene rocks of different grain-size spectrum are observed. Upper Cretaceous flysch of the southern strip (Zhinvali-Gombori geotectonic subzone) of the studied region starts with coarse-grained clastolites that stratigraphically upwards pass into fine-grained carbonate rocks and in some places into siliceous ones. Here, Upper Cretaceous sediments are terminated by coarse-grained orbitoidal suite, while to the north in the Shovi-Pasanauri subzone thin-rhythmic flysch sedimentation continued in the Upper Cretaceous.

Thus, flysch sedimentation in Upper Jurassic-Cretaceous sedimentary basin of the studied region took place mainly due to turbidite-forming suspension flows that formed spasmodically by gravitation, earthquakes and fluctuations of the World Ocean level and was also affected by climatic processes, sea currents, seismic events, dynamics of the basin, etc. After defining morphology of sedimentary basin we suppose that the studied flysch formation evolved in the definite zone of sedimentary basin characterized by less stable hydrodynamic and unstable, peculiar hydrochemical conditions. At the same time, in the basin mormal marine sediments were developed.

From above-mentioned it follows that Upper Jurassic-Cretaceous flysch formation of the Caucasus marginal sea "Eastern Basin" (within the limits of Georgia) occurred in trough conditions controlled by tectonic and eustatic factors.

*გეოლოგია*

# კავკასიონის კიდურა ზღვის აღმოსავლეთ აუზის ზედაიურულ-ცარცული ფორმაციის ფლიშური ხასიათი და წარმოშობის ზოგიერთი საკითხი

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(წარმოდგენილია აკადემიის წევრის დ. შენგელიას მიერ)

გეოლოგიის მეცნიერებაში აქტუალურია დედამიწის მოძრავ სარტყელში გლობალურად გავრცელებული ფლიშური ნალექების წარმოშობის საკითხების შესწავლა. კავკასიონის კიდურა ზღვის აღმოსავლეთ აუზის ზედაიურულ-ცარცული ფლიშური ფორმაციის ლითოლოგიური კვლევების შედეგად დადგინდა ამ ნალექებისათვის დამახასიათებელი ქანების ორი ძირითადი გრანულომეტრული ჯგუფის - რესედიმენტაციული ფანერომერული (ფსეფითოლითები, ფსამიტოლითები, ალევროლითები) და ფონური - კრიპტომერული პელიტოლითების, თიხიან-კარბონატული და კარბონატული შლამის რითმული მორიგეობა, რომელიც გამოიხატება შედგენილობით ნაკლებად ცვალებადი და სხვადასხვა სიმძლავრის მქონე ქანების გამეორებაში. რითმა იწყება შედარებით მსხვილმარცვლოვანი სედიმენტაციური ნალექით, რომელიც ვერტიკალურად ზემოთ იცვლება წვრილმარცვლოვანი წარმონაქმნებით და თავდება ფონურით - პელიტურით. შესწავლილი ფლიშური ფორმაციის ნალექდაგროვება ხდებოდა ძირითადად ტურბიდიტების წარმომქმნელი სიმღვრივის (სუსპენზიური) ნაკადებიდან, რომლებიც წარმოიშობოდა სპაზმურად გრავიტაციის, მიწისძვრებისა და მსოფლიო ოკეანის დონის რყევის შედეგად, რასაც თან ერთვოდა კლიმატური პროცესების, ზღვიური დინებების, სეისმური მოვლენების, აუზის დინამიკისა და სხვათა გავლენა. შესწავლილი ფლიშური ფორმაციის წარმოშობა ხდებოდა სედიმენტაციური აუზის განსაზღვრულ ზონაში, რომელიც ხასიათდებოდა ნაკლებად სტაბილური ჰიდროდინამიკური და არასტაბილური, თავისებური ჰიდროქიმიური რეჟიმით და აუზში ლატერალურად ნორმული ზღვიური ნალექებიც ვითარდებოდა. ამგვარად, კავკასიონის კიდურა ზღვის „აღმოსავლეთ აუზის (საქართველოს ფარგლებში)“ ზედაიურულ-ცარცული ფლიშური ფორმაცია წარმოშობილია ტექტონიკური და ევსტატიკური ფაქტორებით კონტროლირებად ტროგულ გარემოში.

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