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Palaeogeography

Palaeogeography of the Sarmatian of Eastern Georgia

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ABSTRACT. The limits of the Kura bay and of the adjoining tectonic high zones and depressions were inherited from the Middle Miocene and continued to exist. They had an important role in controlling the distribution of the sedimentary facies. The poorness in marine faunas of the Early Sarmatian deposits, together with the character of thickness and facies, suggest that these sediments formed in a big brackish basin. Towards the north and south from this basin, great mountain ranges of sublatitudinal direction existed. At the beginning of the Middle Sarmatian there were no important changes in the palaeogeographical and geotectonical situation. The basin expanded slightly towards the north, which is reflected by transgressive deposits of the Middle Sarmatian age on the northern Kakheti range (Chailuri, Manavi, Burdiani). The relatively homogeneous facies allows to suppose that the palaeogeographical and sedimentary conditions did not change for a long time. The orogenic movements, which began at the end of the Middle Sarmatian, reached their maximum in the Late Sarmatian (the Attic orogenic phase) and on the whole territory of Eastern Georgia a continental regime was established. Extension and depth of water bodies were significantly reduced: in the late Sarmatian the sea on the territory of Eastern Georgia was divided into isolated or semi-isolated comparatively small basins – lakes, lagoons. *© 2012 Bull. Georg. Natl. Acad. Sci.*

Key words: *Eastern Paratethyan, Caucasus, Upper Miocene, foraminifera.*

Beginning with the Late Eocene, to the Early Pliocene, the geological development of the Caucasus was closely connected with the history of the Paratethys Sea (Fig. 1). In that period, the whole Paratethys underwent complicated paleogeographical changes [1, 2], including the territory of Georgia.

During the whole Early Miocene the territory of Georgia was involved in orogenic processes of the Alpine cycle, although in separate areas subsidence also occurred. These sites accumulated thick argillaceous sandstones. On the territory of Eastern Georgia, the Sarmatian stage (covering the Late Middle

Fig. 1. Outline of the Paratethys-Mediterranean region during Late Miocene (according to Müller et al, 1999).

Miocene and the Early Late Miocene) is divided into three substages: Early (Volhynian), Middle (Bessarabian), and Late (Khersonian).

Early Sarmatian (Fig. 2). For the Early Sarmatian, the tendency of subsidence of the Transcaucasus, inherited from Konkian time, is characteristic. This was followed by a widening of the basin that on the northern border and on the periphery of the Dzirulian massifs is confirmed by transgressive beds of the Sarmatian [3, 4]. In Early Sarmatian time, a large part of the Dzirulian massifs was dry land. To the west it was bordered by the Okribian land area. These two land masses were separated by a shallow sea or were connected with the Rioni bay on the western part and the Kura bay to the east.

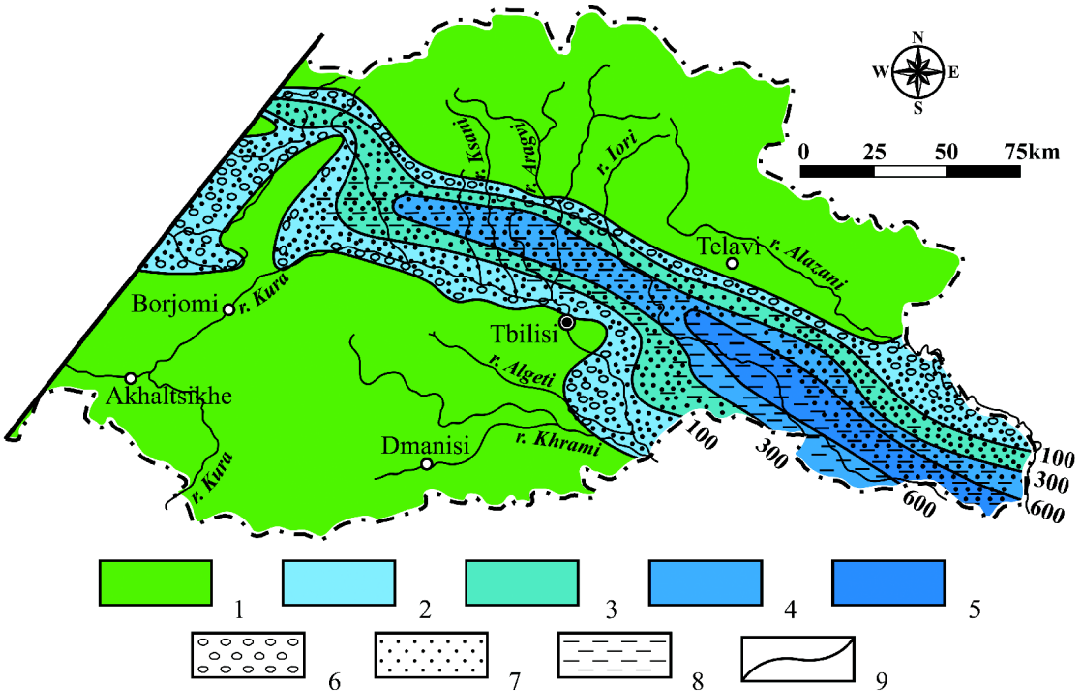
The outlines of the Kura bay practically coincided with the borders of the Eastern zone of sinking of Transcaucasian intermountain area. To the south, the Kura bay bordered the Trialetian range. Passing on from the eastern side of the Trialetian range, the Kura bay formed the Yalgudgi bay. Towards the southeast, the Kura bay extended to the right bank of the river Kura. To the west it reached the eastern periphery of the Dzirulian massif and farther in the north joined with the Rioni bay, through the Djava-Tedeletian strait. The northern border of the Kura bay extended towards the Cretaceous flysch deposits of the Greater Caucasus range.

The limits of the Kura bay and of the adjoining tectonic high zones and depressions were inherited from the Middle Miocene and continued to exist. They had an important role in controlling the distribution of the sedimentary facies.

The poorness in marine faunas of the Early Sarmatian deposits, together with the character of thickness and facies, suggest that these sediments formed in a big brackish basin. Towards the north and south from this basin, great mountain ranges of sublatitudinal direction existed.

In the eastern part of the Dzirulian massif, the Early Sarmatian transgressively overlies Palaeozoic, Mesozoic, and Cenozoic deposits. At the base it is represented by conglomerates, which pass into quartz-sandstones with intercalations of clay [3]. The thickness of these deposits is 50-90 m. On the northern border of the Kartlian depression, the Early Sarmatian lies concordantly on the Konkian regiostage and consists of sandstone – clay marine deposits. Towards the east of the Dzirulian massif the quantity of clay material increases. There, the maximum thickness of the Early Sarmatian is 250-300m.

In the southern part of the Kartlian depression, the Early Sarmatian is represented by coastal deposits: microconglomerates, sandstones, and clays. Towards the east the clay content increases. The thickness is variable (60-170 m). Between the rivers Kura and Iori, the Early Sarmatian is built by deposits of deeper water (clays and intercalations of sandstones),



1. land; 2. shoreface facies; 3. shallow-water facies; 4. transition facies; 5. deep-water facies; 6. conglomerate; 7. sandstone; 8. clay; 9. borders the same thickness.

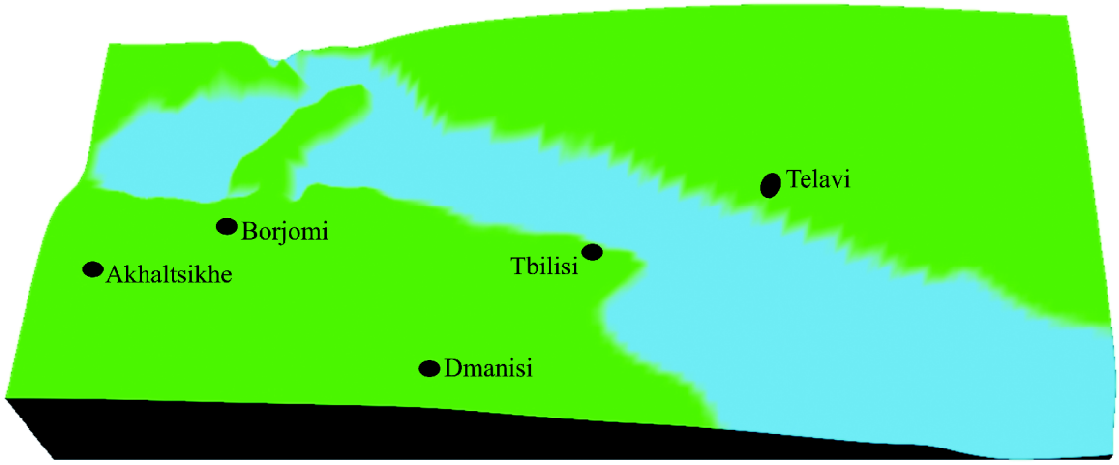
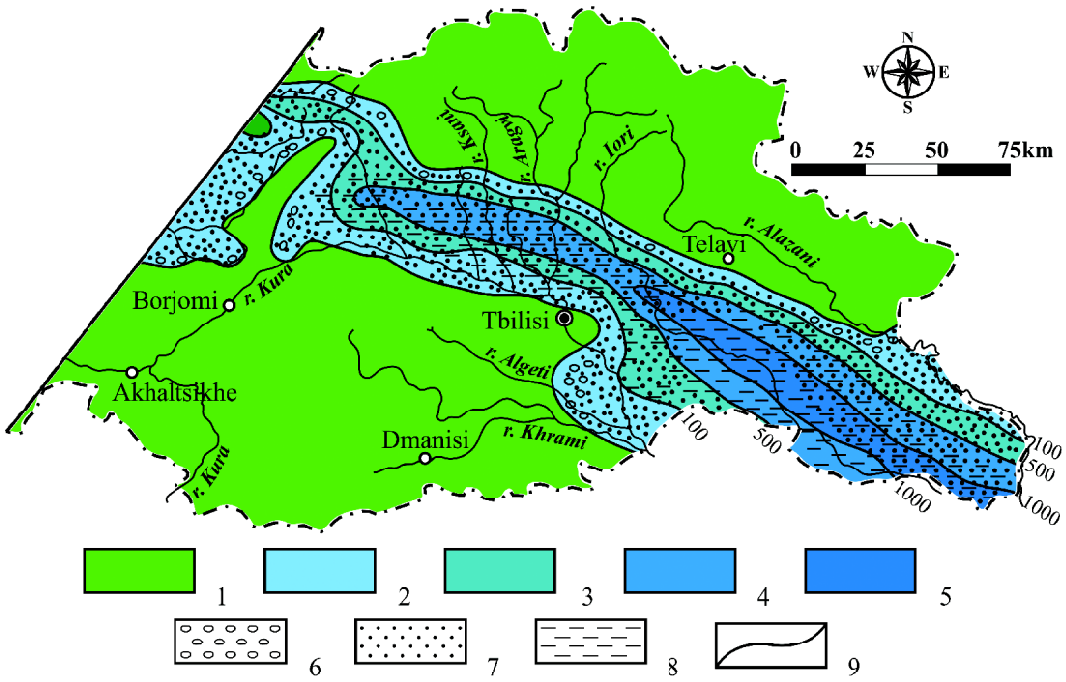


Fig. 2. Early Sarmatian lithofacies, thickness and paleogeographical map of Eastern Georgia.

and the thickness there reaches 250-350 m. To the south-east the Early Sarmatian is represented by sandstones with intercalations of microconglomerates and clays (40-70 m).

The fauna is mainly represented by euryhaline and eurythermal molluscs and benthic foraminifera that point to a shallow, fresh-water influenced basin. Two different assemblages of foraminifera are distinguished, indicating the existence of both shallow and deeper sites in the basin. The shallow-water fauna consists of representatives of the genera *Elphidium, Porosononion*, and *Nonion* which are characterized by coarsely sculptured tests. The fauna of the deeper basin is represented by forms with thin, nearly transparent tests of the so-called "miliolidian" complex [5, 6].



1. land; 2. shoreface facies; 3. shallow-water facies; 4. transition facies; 5. deep-water facies; 6. conglomerate; 7. sandstone; 8. clay; 9. borders the same thickness.

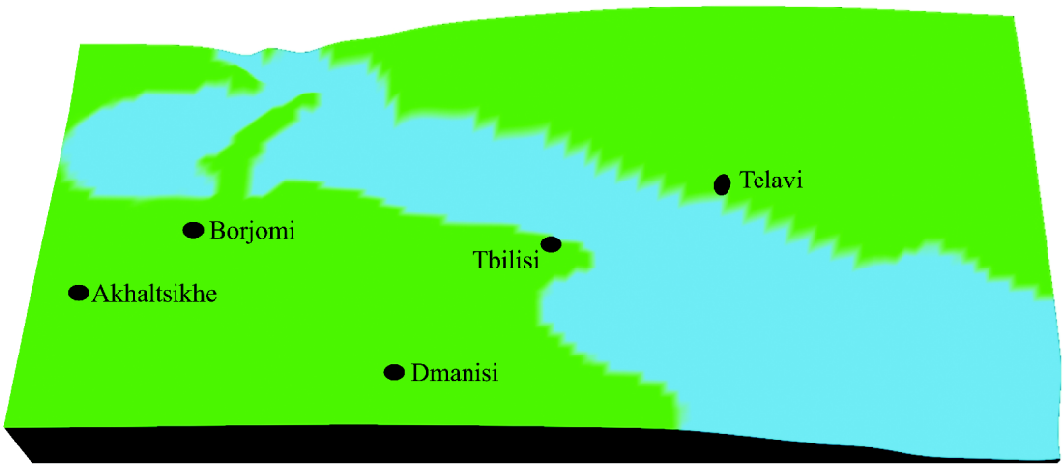


Fig. 3. Middle Sarmatian lithofacies, thickness and paleogeographical map of Eastern Georgia.

Middle Sarmatian (Fig.3)**.** At the beginning of the Middle Sarmatian there were no important changes in the palaeogeographical and geotectonical situation. The basin expanded slightly towards the north, which is reflected by transgressive deposits of the Middle Sarmatian age on the northern Kakheti range (Chailuri, Manavi, Burdiani) [3].

In the area between Koda and Tsnelisi, the Middle Sarmatian transgresses over the Bajocian porphyritic series and the granitoids of the Dzirulian massif, and in the territory of Tsablovani-Nabakhtevi it is deposited on the Middle Miocene sandstones. The Middle Sarmatian there is represented by quartz-feldspathic sandstones with intercalations of clays and conglomerates. The thickness is 160-180 m.

On the northern border of the Karthlian depression, the Middle Sarmatian concordantly overlies the Early Sarmatian. The lower part of the Middle

Sarmatian there is represented by sandstones and clays with so-called "cryptomactrian" layers, which can be seen in many sections [4]. The upper part of the Middle Sarmatian is represented by sandstones, clays and conglomerates [5]. The thickness ranges from 350 to 1000 m.

On the southern border of the depression, the Middle Sarmatian consists of sandstone-clay deposits with intercalations of limestones, lumachelles and conglomerates [7]. The thickness there is 100-350 m.

In southern Kakheti, the Middle Sarmatian is represented by two lithofacies. The first is composed of thick, comparatively deep basin clays and sandstones, but the second one is represented by deposits of shallow-water sandstones and clays with intercalation of oolitic limestones, conglomerates, and coloured clays [8].

The relatively homogeneous facies allows to suppose that the palaeogeographical and sedimentary conditions did not change for a long time: as in the Early Sarmatian, accumulation of mainly conglomerates took place in the coastal zone, and of argillaceous sandstones in the deeper areas of the basin. The thickness there ranges from 600 m to 1000 m. The intensity of sedimentation was compensated by subsidence [3]. The absence of gypsum, anhydrite, and salt coupled with the occurrence of hydromica and carbonate as well as the poorness in marine fauna indicate the existence of a warm, low-salinity basin. The warm and humid climate of the Sarmatian is indicated by data of plant macrofossils [9] and palynological assemblages [10]: evergreen thermophilic plants dominated at this time.

The Middle Sarmatian assemblage of foraminifera is distinguished by abundant species and by numerous forms. Of great interest are typical Middle Sarmatian forms such as *Dogielina*, *Meandroloculina*, and *Sarmatiella*. Also large sizes, nearly 1 mm, of some representatives of *Elphidium* are to be mentioned [5,6].

The flourishing of the Middle Sarmatian fauna indicates favorable biotic and abiotic conditions - good aeration, sufficient quantity of food, and adequate temperature conditions in the basin.

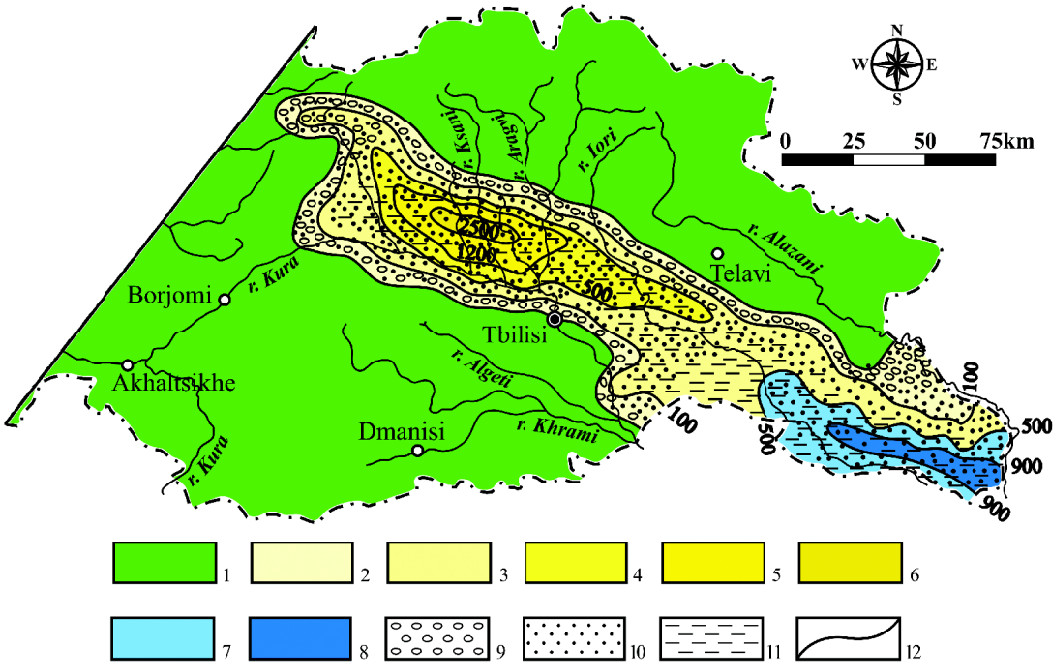
The abundance of foraminifera, their diversity, and the thickness of sediments allow us to suppose that the main structural elements established in the Early Sarmatian continued to develop.

Beginning with the second half of the Middle Sarmatian, tectonical movements were active and produced some changes in palaeogeography, erosion processes, and differentiation of facies. In depressions these processes were especially well developed: shallowing of the water, increasing of grain sizes, and changes in clay facies. The coarse-grained material (conglomerates) on the northern side of the Kartli depression in the Djava-Tedeletian strait and on the Tsivgomborian range became more abundant.

In sections of the Kura bay coloured clays including fresh-water and land fauna occur. This indicates the existence of dry-land conditions on the periphery of the basin during the second part of the Middle Sarmatian. The retreat of the sea was so quick that the Djava-Tedeletian strait ceased to exist and full isolation of the Kura and Rioni bays took place.

Later the sea retreated towards the south-east, and at the beginning of the Late Sarmatian Kartli depression, Southern slopes of Tsiv-Gombori range and a significant part of Gare-Kakheti was the region of accumulation of fresh-water, continental sediments. Marine facies are preserved only near the Iori river.

Late Sarmatian (Fig. 4). The orogenic movements, which began at the end of the Middle Sarmatian, reached their maximum in the Late Sarmatian (the Attic orogenic phase) and on the whole territory of Eastern Georgia a continental regime was established. Extension and depth of water bodies were significantly reduced: in the late Sarmatian the sea on the territory of Eastern Georgia was divided into isolated or semi-isolated comparatively small basins – lakes, lagoons. The increasing orogenic processes promoted the widening of the hydrographical network, and a large amount of eroded sediment was transported by rivers. The river mouths formed deltas in the lakes, composed of conglomerates, clays and sandstones.



1. land; 2-6. continental facies; 7-8. marine facies;
9. conglomerate; 10. sandstone; 11. clay; 12. borders the same thickness.

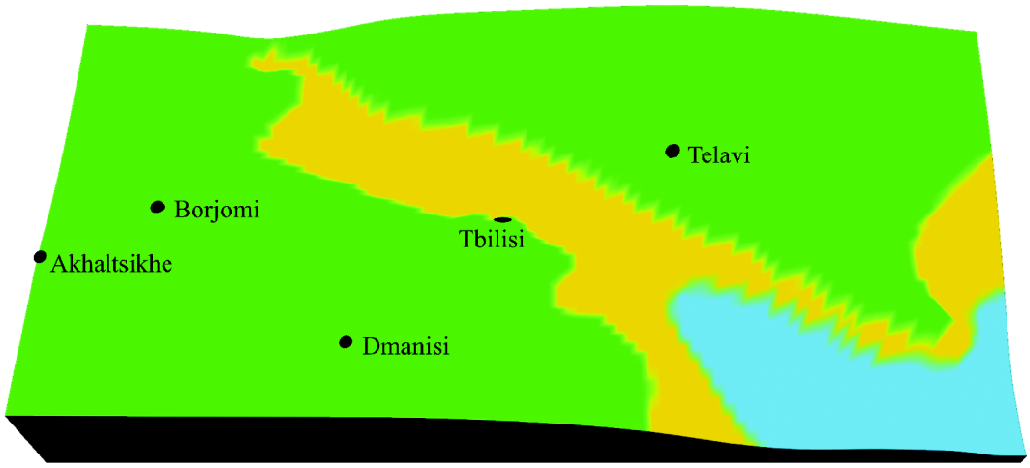


Fig. 4. Late Sarmatian lithofacies, thickness and paleogeographical map of Eastern Georgia.

In the Late Sarmatian, the Kartlian depression and part of Kakheti turned into an important depocenter. In the Karthlian depression, the Late Sarmatian is represented by fresh-water deposits and continental clays and sandstones with intercalation of micro-conglomerates and conglomerates. The sediment thickness ranges between 1000-2500 m.

The boundary between Middle and Late Sarmatian is drawn where the Middle Sarmatian layers containing fauna disappear and are replaced by thick, so-called "dumb" continental deposits, the Natskhorian suite [3, 11].

In the Late Sarmatian, the southern wing of the Tsivgomborian range began to subside and like the Kartlian depression the argillaceous sandstones of the Natskhorian suite began to accumulate here. The main source of the terrigenous material was the southern slope of the Caucasus

Range, but towards the southern edge of the Transcaucasian depression the amount of the terrigenous material decreased and the depression was finally filled with material from the Adjaro-Trialetian range [12].

South-east of the Kakhetian range, the Natskhorian suite is replaced by the Eldarian suite. In southern Kakheti, the Late Sarmatian starts with marine deposits that gradually change into continental sediments. Their lower part (thickness 150-350 m) is represented by clay-sandstone facies with poor microfauna, characteristic of the Late Sarmatian [3, 4]. The upper part is represented by colored clays of the Eldarian suite.

In the regions along the Iori River, marine sediments of so-called "marine thickness" appear. This is proven by the consistency of the material from the boreholes of Taribana and Eldari [8].

Towards the end of the Sarmatian, the sea had completely retired from the eastern part of the Transcaucasian intermountain region and the long-term regression of the Miocene sea was completed.

პალეოგეოგრაფია

აღმოსავლეთ საქართველოს სარმატული დროის პალეოგეოგრაფია

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(წარმოდგენილია აკადემიის წევრის ა. ვეკუას მიერ)

ადრესარმატულ დროში მტკვრის უბის ფარგლებში ნალექების ფორმირება ხდებოდა საკმაოდ ვრცელ მარჩხი ზღვის გამტკნარებულ აუზში, რომლის ჩრდილოეთით და სამხრეთით მდებარეობს სუბგანედური მიმართულების მაღალი ქედები. მარჩხი ზღვის გამტკნარებულ აუზზე მიგვანიშნებს ნალექებში განამარხებული ფაუნაც, რომელშიც უპირატესად ევრიჰალური და ევრითერმული მოლუსკები და ბენტოსური ფორამინიფერები გვხვდებიან.

შუა სარმატულის დასაწყისში რაიმე მნიშვნელოვანი ცვლილებები პალეოგეოგრაფიული და გეოტექტონიკური თვალსაზრისით არ მომხდარა. ამ პერიოდის ფორამინიფერები გამოირჩევიან სახეობათა მრავალფეროვნებით და სიმრავლით. ფაუნის გაფურჩქვნა მიუთითებს ხელსაყრელ ბიოტურ და აბიოტურ პირობებზე, პირველ რიგში საკვების საკმაო სიუხვეზე, აუზის კარგ აერაციაზე და თბილ ჰავაზე.

შუა სარმატულის მეორე ნახევრიდან გაიდევნება ტექტონიკური მოძრაობების გააქტიურება, რომლებმაც პალეოგეოგრაფიულ ვითარებაში ზოგიერთი გარდაქმნა გამოიწვია, რაც აისახა გადარეცხვის პროცესების გაძლიერებაში, ფაციესების დიფერენციაციასა და მათ მრავალ-ფეროვნებაში.

მტკვრის უბის სხვადასხვა მონაკვეთზე შუა სარმატულის მიწურულში ჩნდება ფერადი თიხები, რომლებიც შეიცავს მტკნარი წყლის და ხმელეთის ფაუნას, ეს კი იმაზე მიგვანიშნებს, რომ შუა სარმატულის მიწურულს აუზის პერიფერიულ ნაწილში კონტინენტური რეჟიმი ჩამოყალიბდა.

შუა სარმატულის ბოლოს დაწყებული ტექტონიკური მოძრაობის ინტენსივობა ზედა სარმატულში მაქსიმუმს აღწევს (დანაოჭების ატიკური ფაზა) და აღმოსავლეთ საქართველოს მთელ ტერიტორიაზე კონტინენტური რეჟიმი მყარდება. ამ დროისთვის მკვეთრად შემცირდა წყლის აუზის ფართობი და მისი სიღრმე. ფაქტობრივად შეიძლება ითქვას, რომ აღმოსავლეთ საქართველოში გვიან სარმატულში ზღვა დანაწევრდა მეტ-ნაკლებად დაკავშირებულ ან იზოლირებულ, შედარებით მცირე ზომის აუზებად – ტბებად, ლაგუნებად.

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