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Quartz Grain Microtextures in the Paleogene Sosnov Formation: Implications for Sediment Provenance in the Eastern Russian Platform

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Abstract

The purpose of the research. The chief task of the research is to examine the microtextures of quartz grains in the Paleogene Sosnov Formation, which is a sedimentary unit located in the Ulyanovsk-Syzran Volga Region of the Russian Platform. By examining the microtextures, which include mechanical, chemical and mechanical/chemical features, it becomes possible to find out the mechanisms by which grains were transported and subsequently modified.
The relevance of the research. The relevance of this research lies in the fact that the analysis of quartz grain microtextures provides valuable insights into sediment provenance of sedimentary deposits is crucial for reconstructing past geological environments and unraveling depositional histories.
Research methodology. Twenty quartz grains were collected from sands of the Paleogene Sosnovka Formation, exposed by the Eastern-Tashlinsky and the Kuchurovsky quarries to a depth of 5 and 7.5 m, respectively. The research methodology involved scanning electron microscopy (SEM) to investigate the microtextures of quartz grains.
Results and conclusions. The study reveals 19 microtextures types, which were categorized into mechanical, chemical, and combined mechanical/chemical microtextures. An analysis of SEM indicated that chemical microtextures are present in the Paleogene Sosnov Formation, which made it possible to suggest that the sands passed through a low-energy phase during their transition. The data obtained enables us to reconstruct the diverse depositional paleoenvironments, including eolian, subaqueous, mixed subaqueous-eolian, and pedological settings.

***Keywords*:** Microtextures, Scanning electron microscopy, Quartz, Sosnov Formation, Paleogene, Russian Platform.

Introduction

Understanding the provenance of sedimentary deposits is crucial for reconstructing past geological environments and unraveling depositional histories. In this regard, microtextural analysis of quartz grains using SEM provides a powerful tool for understanding the transport processes and source regions of sediments [1, 2]. By examining the microtextures, which include mechanical and chemical features, it becomes possible to find out the mechanisms by which grains were transported and subsequently modified. This study focuses on the microtextures of quartz grains in the Paleogene Sosnov Formation, aiming to interpret the sediment provenance and transport dynamics in the Ulyanovsk–Syzran Volga Region (USVR) of the Eastern Russian Platform.

This study is an extension of the previous research by Zorina and coauthors [3], that examined the surface microtextures of quartz grains and origin of the Paleogene sands in the USVR. The authors used optical and electron microscopy to analyze the microtextures of the quartz grains to identify the paleoconditions of their formation. They found that the quartz grains from the Paleogene sands had different degrees of rounding and polishing, indicating different transport and depositional processes. The authors concluded that the Paleogene sands provide evidence of diverse depositional paleoconditions, including eolian, subaquatic (beach zone), subaquatic-eolian (coastal dunes), injective, and continental pedological settings. Which were derived

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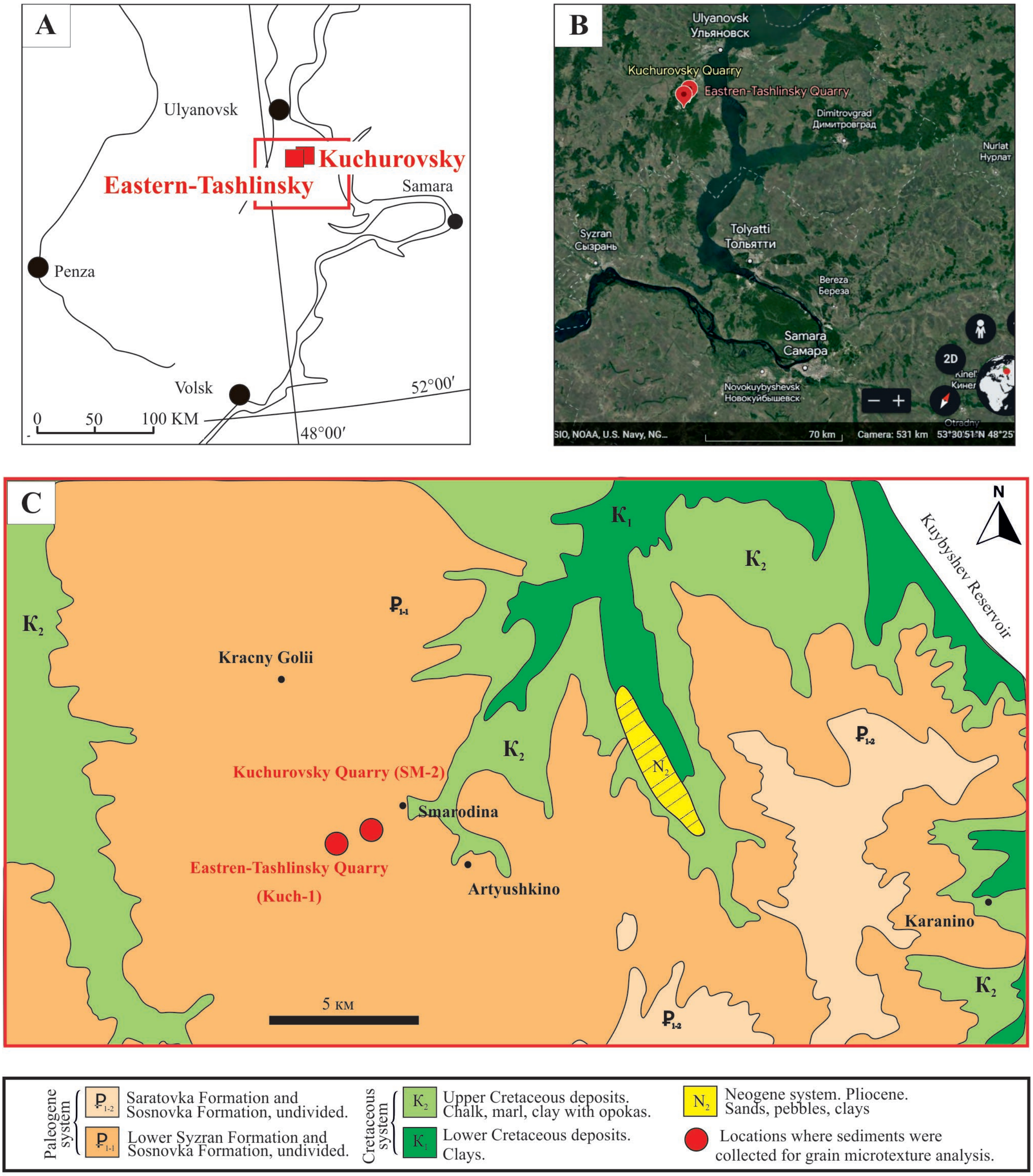

Figure 1. Location of the Eastern Tashlinsky and Kuchurovsky Quarries on a geographical map *A*, Google map *B*, geological map of the southeast the Ulyanovsk region (according to Lichman, 1989 with changes and additions) *C*

Рисунок 1. Расположение Восточно-Ташлинского и Кучуровского карьеров на географической карте *A*, карте Google *B*, геологической карте юго-востока Ульяновской области (по Личману, 1989 г. с изменениями и дополнениями) *C*

from diverse depositional environments, including eolian, subaqueous, mixed subaqueous-eolian, and pedological settings.

This study supports the previous results also and delves into a more meticulous investigation, based on the surface microtextural analysis of a larger number of quartz grains through the utilization of scanning electron microscopy (SEM). This technique, renowned for its capacity to scrutinize and elucidate the intricate minutiae and attributes of quartz grain surfaces with unparalleled precision, furnishes a formidable tool for characterization and examination.

Geological setting

The present investigation focuses on quartz sands from the Sosnov Formation of the Paleogene, which are exposed in

Table 1. Distribution of quartz grains occurring with specific microtextures in samples SM-2 and Kuch-1 of the Paleogene Sosnov Formation of the USVR (• – present)

Таблица 1. Распределение зерен кварца, встречающихся со специфической микротекстурой в образцах СМ-2 и Куч-1 палеогеновой сосновской свиты УСВР (• – настоящее время)

Types of microtextures			Locations of the studied quartz grain	
			Kuchurovsky sand quarry	Tashlinsky sand quarry
			Samples	
			SM-2	Kuch-1
Mechanical	Outline	1. Subrounded	•	
		2. Rounded	•	•
		3. Well-Rounded		•
	4. Conchoidal fractures		•	•
	5. Arcuate steps			•
	6. Straight steps			•
	7. Meandering ridges			•
	8. V-shaped percussion cracks		•	
	9. Crescentic percussion marks		•	•
	10. Bulbous edges		•	•
Chemical	11. Oriented etch pits		•	•
	12. Solution pits		•	
	13. Solution crevasses			•
	14. Silica globule and flowers		•	•
Mechanical and chemical	15. Low relief		•	•
	16. Medium relief		•	•
	17. Elongated depressions		•	•
	18. Chattermarks		•	
	19. Cracks			•

the Kuchurovsky and Eastren-Tashlinsky Quarries located in the USVR of the Russian Platform (Fig. 1, *A*, *B*, *C*).

The Sosnov Formation, with a thickness of up to 180 meters, is widespread in the USVR and consists of white, brownish, and pinkish-white fine-grained quartz sands with sporadic nodular interbeds of sandstones on siliceous cement. The sand deposits are underlain and overlain by lower Cretaceous Maastrichtian chalk, but in some areas, they are predominantly underlain and overlain by Paleocene Lower Syzran opokas and diatomites [4, 5].

Research materials and methods

Two bulk samples (Sm-2, Kuch-1) were collected from sands of the Paleogene Sosnov Formation of the USVR. Sand sample Sm-2 was collected from the Kuchurovsky and Kuch-1 was taken from the Tashlinsky quarries. The whole number of quartz grains is 20, 10 grains of each sample. The samples were prepared with meticulous, ensuring the preservation of the original surface features. The quartz grains are carefully mounted onto SEM stubs, followed by polishing and carbon coating to minimize charging effects and enhance conductivity. This preparatory stage plays a crucial role in achieving high-resolution imaging and accurate chemical and mechanical analysis, providing a solid foundation for interpretations. Then, samples were examined under a Zeiss LSM 780 visible light confocal laser scanning microscope (Kazan Federal University). The acquired images were then processed using specialized software (CorelDRAW 2018) to measure the dimensions of specific microtextures of individual grains. Based on Vos [6], surface microtextures of quartz grains are interpreted and analyzed.

Results

Quartz grains microtextures of both samples (Sm-2) and (Kuch-1) are distinguished generally by rounded quartz grains with low relief, bulbous edges and elongated depressions. Other features such as meandering ridges, crescentic percussion marks, v-shaped percussion cracks and chattermarks are also frequently observed. Solution-related features including solution pits and crevasses are more pronounced in Kuch-1 grains (Table 1).

The microtextures mentioned above reveal 19 types of microtextures which can be subdevided into three categories based on their mode of origin: mechanical, chemical and mechanical/chemical.

1. Mechanical microtextures

The characterization of surface microtextures of quartz grains is crucial for comprehending their geological behavior. Mechanical microtextures, such as roundness, provide essential insights into the processes of grain transportation, abrasion, and weathering. *Roundness* is a measure of the degree of sphericity or angularity of a particle, reflecting its resistance to abrasion and transport. The SEM analysis revealed the roundness values for the examined quartz grains. Most quartz grains of both samples (Sm-2) and (Kuch-1) exhibited a near-perfect spherical shape (Plate 1, *A*, *E*, *F*; 3, *C*, 4, *A*), while others dis-

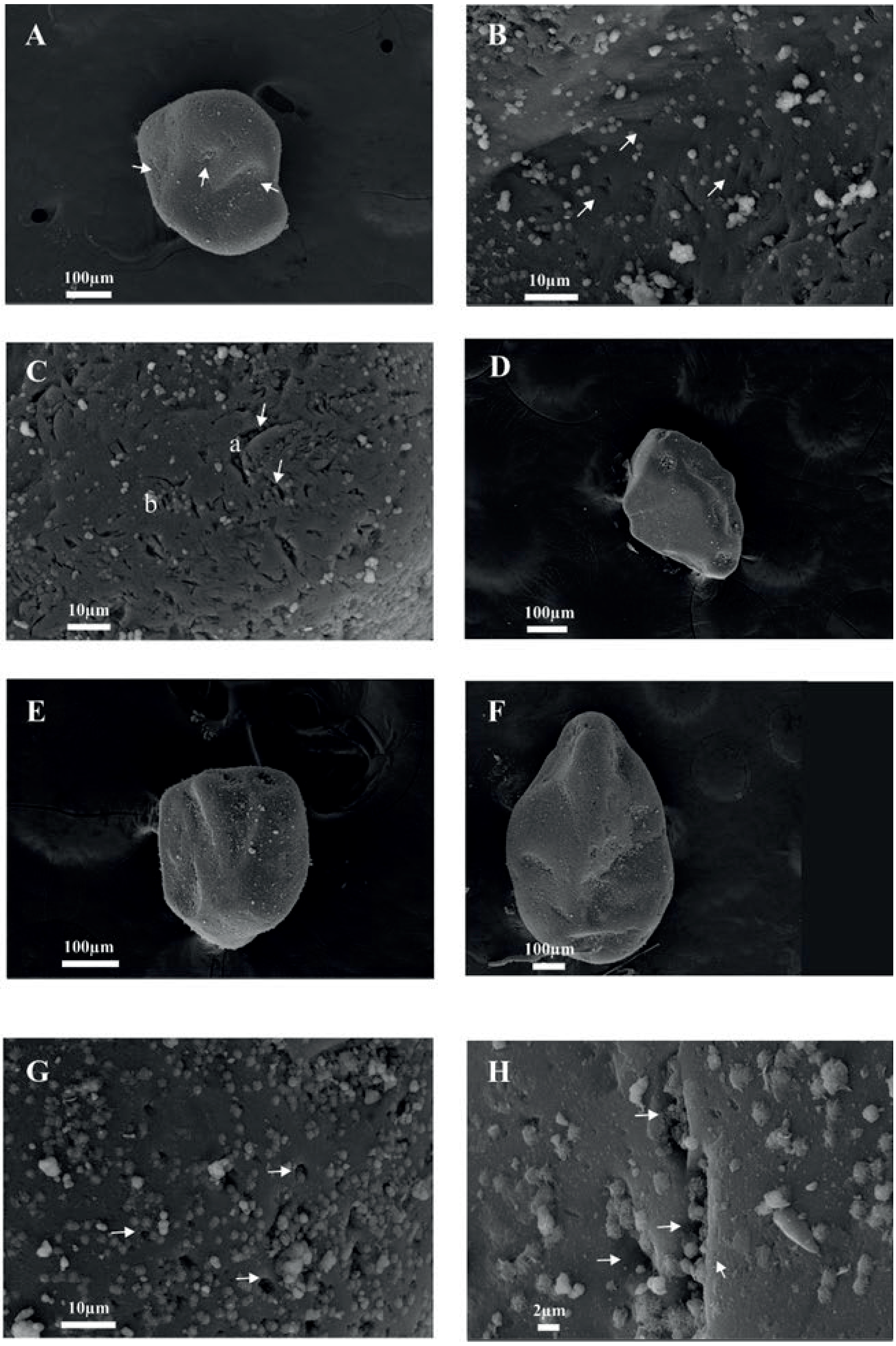

Plate 1. Micrograghs of quartz grains of SM-2: *A* – Rounded grain with low relief and bulbous edges. On the grain can be observed depressions with dimension 40–104 μm (arrows); *B* – Detail of oriented triangular etch pits (2 μm) on the old conchoidal fracture plane; *C* – Crescentic percussion marks (*a*) and chattermarks (*b*) widened by solution. Note their irregular orientation and variation in size (2–18 μm). Numerous scattering silica flowers (*B*, *C*) on the surface and within crescentic percussion marks (arrows in C); *D* – Subrounded grain with low to medium relief and smoothy edges. Note on the grain elongated (60–120 μm) and circular (50 μm in diameter) depressions; *E* – Rounded grain with low relief. On the grain, 3 elongated depressions (0.1 mm) can be observed; *F* – Rounded grain with low relief and bulbous edges. Note many depressions (80–210 μm) on the grain; *G* – Circular solution pits (1–3 μm in diameter) on a fracture plane. Some of pits are filled with silica flowers particles (arrows). Note silica flowers on the plane formed by merging silica globules due to continued precipitation; *H* – Elongated solution pits on a fracture plane (arrows)

Фотопластинка 1. Микрофотографии зерен кварца СМ-2: *A* – округлое зерно с низким рельефом и выпуклыми краями. На зерне наблюдаются углубления размером 40–104 мкм (стрелки); *B* – чертеж ориентированных треугольных ямок травления (2 мкм) на старой плоскости раковистого излома; *C* – серповидные следы от перкуссии (*a*) и от трещин (*b*), расширенные раствором. Обратите внимание на их неправильную ориентацию и изменение размера (2–18 мкм). Многочисленные разбросанные цветки кремнезема (*B*, *C*) на поверхности и в серповидных следах от перкуссии (стрелки в C); *D* – полукруглое зерно с рельефом от низкого до среднего и гладкими краями. Обратите внимание на удлиненные (60–120 мкм) и круглые (диаметром 50 мкм) углубления в зернах; *E* – округлое зерно с низким рельефом. На зерне наблюдаются 3 удлиненных углубления (0,1 мм); *F* – округлое зерно с низким рельефом и выпуклыми краями. Обратите внимание на многочисленные углубления (80–210 мкм) на зерне; *G* – круглые ямки раствора (диаметром 1–3 мкм) на плоскости излома. Некоторые ямки заполнены частицами цветков кремнезема (стрелки). Обратите внимание на цветы кремнезема на плоскости, образовавшиеся в результате слияния глобул кремнезема в результате продолжающегося осаждения; *H* – удлиненные ямки раствора на плоскости излома (стрелки) played varying degrees of spherical (subrounded, plate 1, *D*; 2, *A*, *E*) and well rounded (Plate 3, *A*, *B*). The obtained results indicated that the roundness of quartz grains is influenced by factors such as transport distance, depositional environment, and post-depositional processes. The occurrence of rounded grains often indicates their involvement in eolian phases.

Among mechanical microtextures of the sands Paleogene Sosnovka Formation, another diagnostic indicator for eolian transportation is the occurrence of bulbous edges [6–8]. *Bulbous edges* have the shape of a parabolic curve and appear together with elongated depressions (Plate 1, *A, F;* 3, *C*). Eolian processes involve the transportation of sediment particles by wind, and during the eolian phase, grains repeatedly bounce and collide with each other and the substrate. These repeated impacts result in the abrasion and rounding of particle edges, leading to the characteristic roundness and bulbous edges observed in these grains.

Furthermore, the presence of conchoidal fractures is observed in both studied samples. *Conchoidal fractures* are characterized by smooth, curved surfaces resembling the interior of a seashell or a broken glass (Plate 1, *B*; 2, *A, B;* 3, *D;* 4, *B*). These fractures are common in quartz grains and primarily formed through a process called conchoidal fracturing. When subjected to stress, quartz grains exhibit a unique behavior known as brittle failure, where the grains break along planes of weakness rather than undergoing plastic deformation. It could happen with arcuate and straight steps (Plate 3, *B*). The high-energy impact or rapid release of stress during fracturing creates shockwaves that propagate through the grain, resulting in the formation of conchoidal fractures. These fractures can indicate the occurrence of high-energy events, such as rapid sediment transport, impact processes, or post-depositional tectonic activities.

The grains from both samples exhibit numerous oriented and not oriented crescentic percussion marks (Plate 1, *C*; 2, *D*; 3, *A, B*). *Crescentic percussion marks* are curved or arc-shaped features that form on the surface of quartz grains. They resemble crescent moons or horseshoes and vary in size (2–18 μm) in the studied grains. These marks can indicate past impact events, such as particle collisions or high-energy sedimentary processes involving grain-to-grain interactions and pointed of eolian transportation phase during the sedimentary history of the grain. Also, can note that some marks are widened by solution processes (Plate 1, *C*).

In sample Knch-1 exhibited meandering ridges (Plate 3, *F*; 4, *B*). *Meandering ridges* are elongated, sinuous features that traverse the surface of quartz grains. They appear as raised or elevated structures with a winding or serpentine pattern. These ridges are commonly observed on the surfaces of grains that have been subjected to transport processes, such as fluvial or aeolian transport.

V-shaped percussion cracks showed in sample Knch-1 (Plate 2, *C, F*). Those cracks are small, linear features that form at the impact points on the surface of quartz grains. They resemble V-shaped notches or fractures and are commonly observed on grains that have undergone mechanical impact or post-depositional alteration. These cracks can indicate past impact events, such as high-energy transport or sedimentary processes involving particle random collisions.

2. Chemical microtextures

Silica globules and flowers covered most of the older fracture planes of grains in the sample (SM-2) and less in the sample (Kuch-1). First, silica globules are formed when stationary grains find themselves embraced by silica-laden fluids that overflow with saturation [9]. Then, during continuing silica precipitation, silica globules mixed to form silica flowers (Plate 1, *G*; 2, *C*; 4, *F*). Thus, their genesis requires relatively low-energetic environments such as continental, pedological, and diagenetic settings [9].

The abnormal meandering surface topography of quartz grains in sample Kuch-1 related to solution processes, solution pits and crevasses, while those processes are a less influence on the quartz surface of SM-2 grains sample (Plate 3, *E*; 4, *A*). Elongated and semi-regular circular solution pits (1–3 μm in diameter) are reported in SM-2 grains sample on a fracture plane (Plate 1, *G, H*). The formation of solution pits is a result of the dissolution of specific crystallographic planes on the quartz surface, influenced by factors such as pH, temperature, and solution composition. Another feature caused by dissolution is the crevasses of the solution. A deep crack on the surface of Kuch-1 is observed, 1mm long and 3 μm wide. Their occurrence is associated with chemical dissolution activity (Plate 4, *C*).

Oriented etch pits occur on quartz grains of both samples as extremely regular, triangular depressions on an old fracture plane (Plate 1, *B*; 4, *D*). These etch pits, which are formed by selectively dissolving the quartz surface in a suitable etchant, provide valuable information about the crystallographic orientation and texture of quartz grains. Once in sample Kuch-1, oriented etch pits exhibit distinct morphological features that reflect the underlying crystal lattice orientation. We measured the apical and basal angle of one angle of triangular etch pits (74 to 81°, respectively), (Plate 4, *E*).

3. Mechanical/chemical microtextures

Nearly all grains (SM-2, Kuch-1) exhibit *low to medium reliefs*, resulting from either a lack or a modest presence of topographic irregularities (Plate 1, *A, D, E, F;* 2, *E;* 3, *A, B, C, E;* 4, *A*). The genesis of these reliefs emerges from encounters, marked by collisions, with adjoining grains or through transformative processes. The relief of the grains can be further diminished through the artistry of solution and precipitation processes. These mechanisms fill the depressions and dissolve the ridges, skillfully molding the grain's relief.

Elongated depressions more manifest in sample (SM-2) as vast, bowl-shaped concavities upon quartz grain's surface with dimension reaches a range of 40 to 210 μm (Plate 1, *A, D, E, F;* 2, *A;* 3, *C*). The dimension of elongated depressions is inversely proportional to the size of the quartz grains [10]. The genesis of these features is attributed to the active eolian transport, characterized by direct collisions amidst saltating or creeping grains [7].

Noted in sample (SM-2) scarcely scattered shallowly indented *chattermarks* occur with random orientations and some of those are widened by solution (Plate 1, *C*; 2, *F*). Chattermarks are not characteristic of a certain sedimentary environment.

Discussion

The SEM analysis of quartz grain microtextures in the Paleogene Sosnov Formation revealed a variety of features that

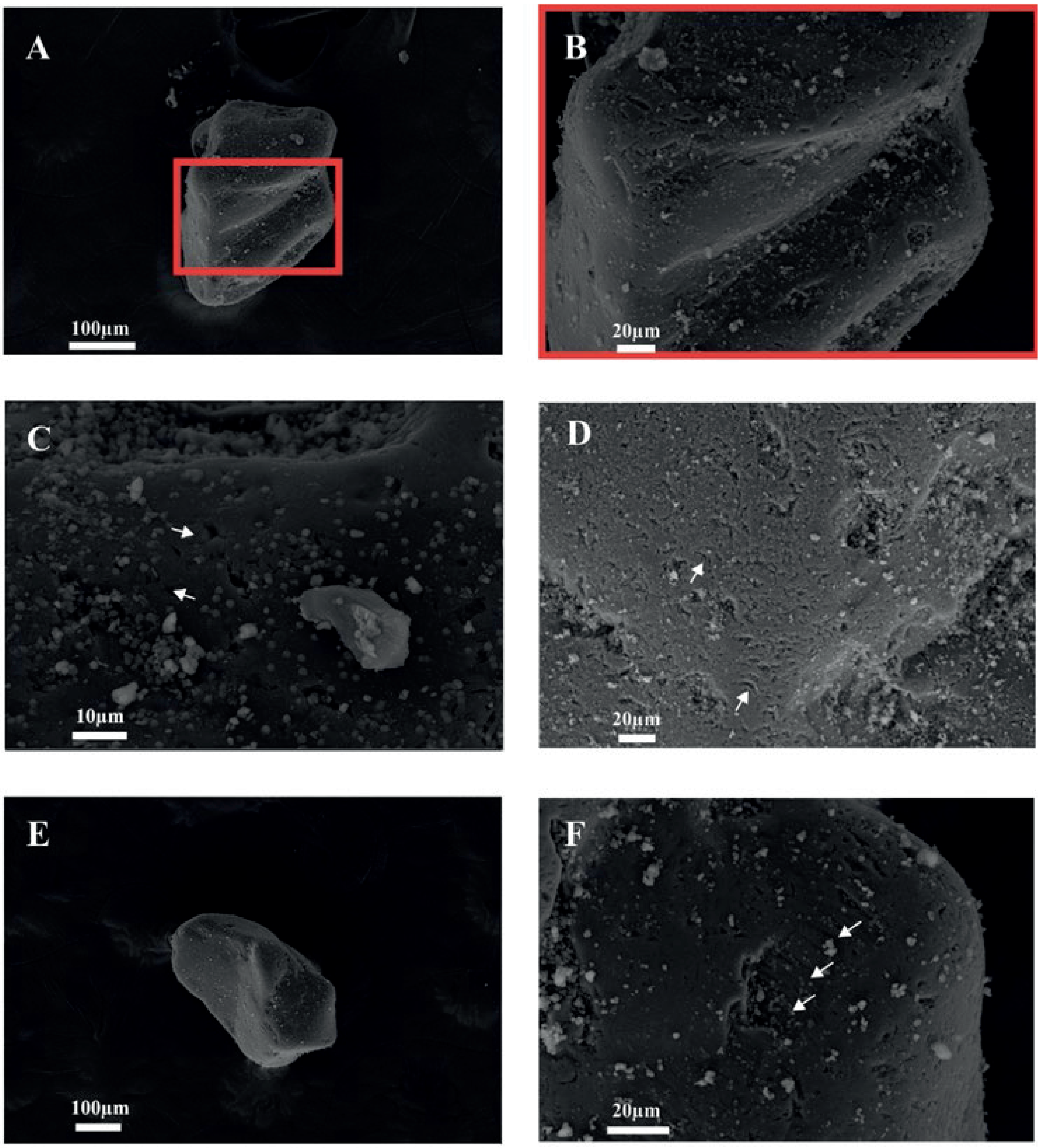

Plate 2. Micrograghs of quartz grains of SM-2: *A* – Subrounded quartz grain. Elongated depressions can be observed on an old conchoidal fracture; *B* – Closer view of image (*A*); *C* – Old fracture plane with V-shaped percussion cracks. The plane is covered with globules and flowers silica; *D* – Numerous crescentic percussion marks presence, pointing of eolian transportation phase during the sedimentary history of the grain; *E* – Subrounded quartz grain with low relief; *F* – Old fracture plane with V-shaped percussion cracks, triangular etching pattern and shallowly indented chattermarks (arrows)

Фотопластинка 2. Микрофотографии зерен кварца СМ-2: *А* – округленное зерно кварца. На старом раковистом изломе можно наблюдать удлиненные впадины; *B* – изображение поближе (*A*); *C* – старая плоскость излома с V-образными трещинами от перкуссии. Плоскость покрыта глобулами и цветками кремнезёма; *D* – наличие многочисленных серповидных следов от перкуссии, указывающих на эоловую фазу преобразования в осадочной истории зерна; *E* – полукруглое зерно кварца с невысоким рельефом; *F* – старая плоскость излома с V-образными трещинами от перкуссии, треугольным рисунком травления и неглубокими трещинами (стрелки)

can be used to infer the sediment provenance and transport processes in the USVR. The observed microtextures can be classified into three main types: mechanical, chemical and mechanical/chemical according to Gillott [7]. The mechanical microtextures include meandering ridges, bulbous edges and percussion cracks, which are formed by grain-to-grain collisions and friction during transport. The chemical microtextures include pits, silica globules and flowers, which are formed by dissolution and precipitation processes in pedogenic or diagenetic environments. The mechanical/chemical microtextures include relief and elongated depressions, which are formed by a combination of abrasion and silica precipitation [6].

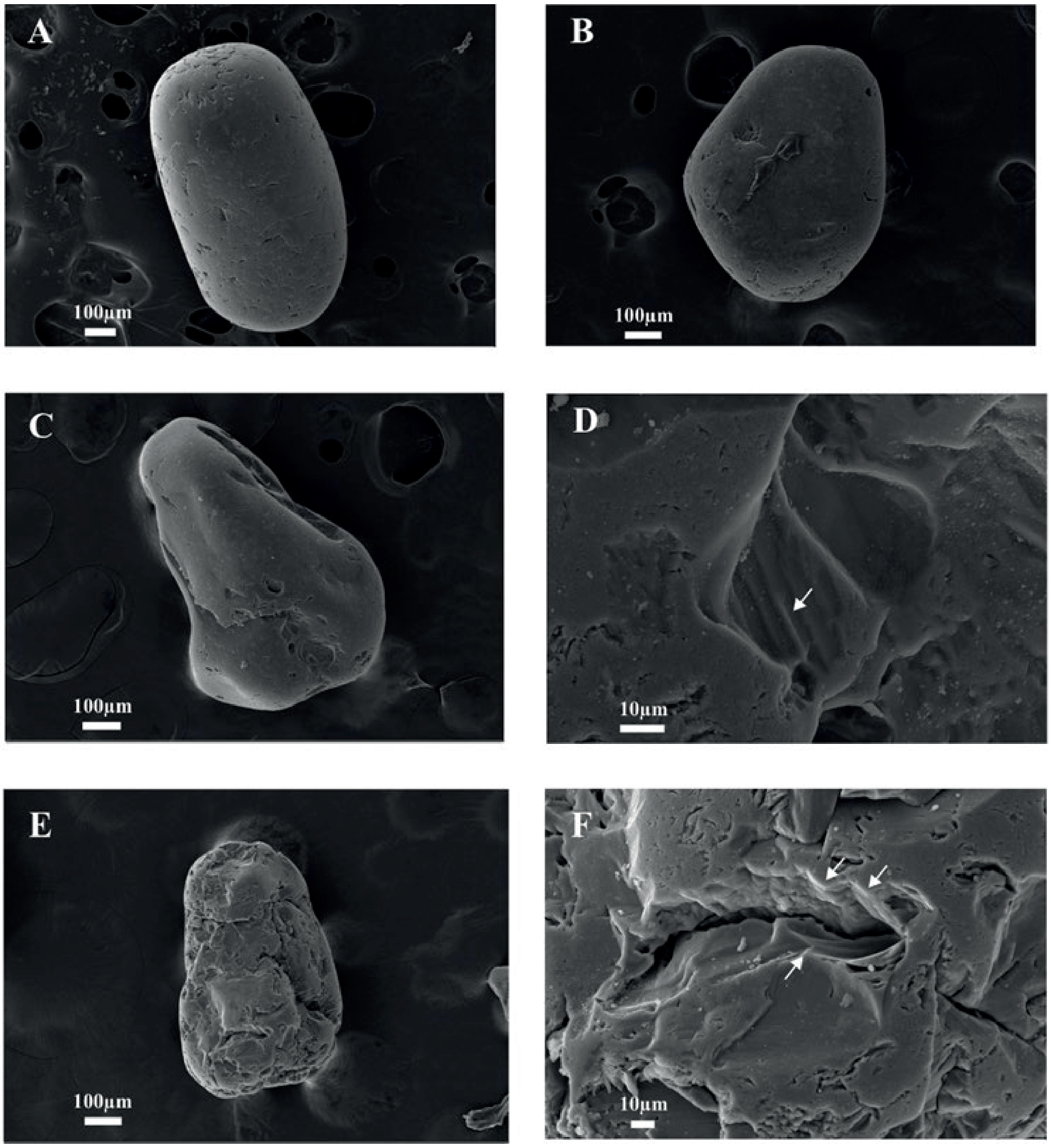

Plate 3. Micrograghs of quartz grains of Kuch-1: *A*, *B* – Well-rounded quartz grain with low relief. Note unoriented crescentic percussion marks on the grains; *C* – Rounded grain with low relief and bulbous edges. Elongated depressions 0.2 mm on the right side of the grain; *D* – Surface showing conchoidal fracture plane with straight steps (arrows). The space between the successive steps of about 2.5 μm; *E* – Rounded grain with low to medium relief and clear aspects of arcs, grooves and scratches. Solution and precipitation both affected the grain surface; *F* – Meandering ridges (arrows), pointing of eolian transportation phase in desert and littoral dunes during the sedimentary history of the grain

Фотопластинка 3. Микрофотографии зерен кварца Куч-1: *A*, *B* – зерно кварца хорошо округлой формы с невысоким рельефом. Обратите внимание на неориентированные серповидные следы от перкуссии на зернах; *C* – округлое зерно с низким рельефом и выпуклыми краями. Удлиненные углубления 0,2 мм с правой стороны зерна; *D* – поверхность, показывающая раковистую плоскость излома с прямыми ступенями (стрелки). Пространство между последовательными ступенями около 2,5 мкм; *E* – округлое зерно с рельефом от низкого до среднего и четкими дугами, канавками и царапинами. Раствор и осаждение повлияли на поверхность зерна; *F* – извилистые хребты (стрелки), указывающие на эоловую фазу преобразования в пустынях и прибрежных дюнах в течение осадочной истории зерна

The manifestation and frequency of these microtextures can signify diverse depositional environments, such as eolian, subaqueous (beach zone), mixed subaqueous-eolian (coastal dunes) [6, 9, 11, 12]. For instance, meandering ridges are regarded as prevailing in eolian environments within deserts and littoral dunes, where grains endure repetitive cycles of abrasion and silica cementation [13, 14]. V-shaped percussion cracks are engendered in highly energetic subaqueous environments with substantial grain-to-grain interaction, such as the littoral zone (beach zone). Crescentic percussion marks are distinctive for eolian environments, where grains collide at shallow angles. The presence of bulbous edges is also linked to eolian transportation, wherein grains acquire rounded forms due to abrasion and silica precipitation. The formation of solution pits and solution crevasses is associated with dissolutional pedological horizons and diagenetic processes in relatively low-energy environments, such as continental or soils [7, 13]. Silica globules and flowers arise in relatively low-energy settings,

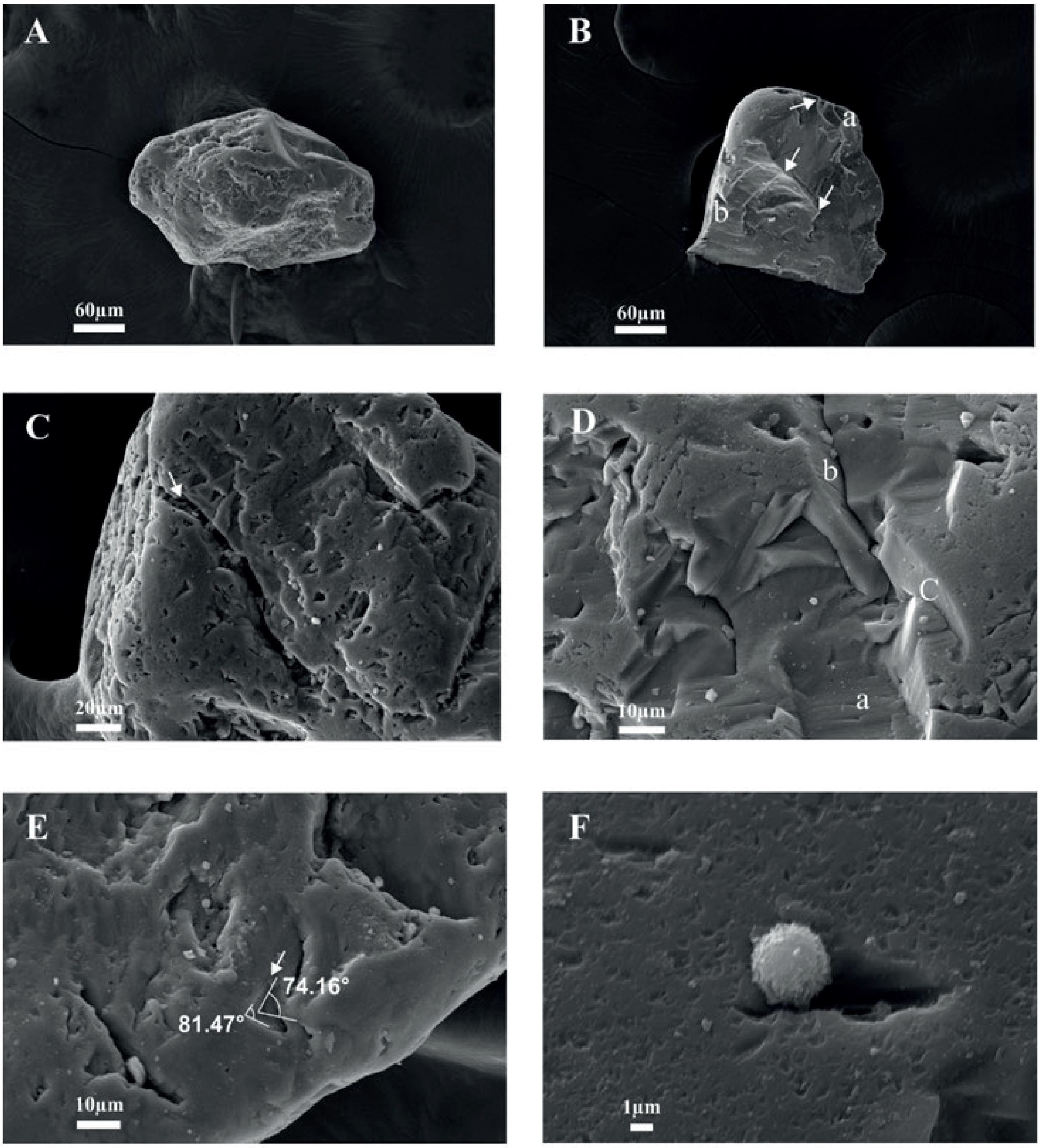

Plate 4. Micrograghs of quartz grains of Kuch-1: *A* – Rounded grain with low relief. The grain surface affected by solution and precipitation; *B* – A broken part of rounded grain. Note meandering ridges (arrows) and conchoidal fracture planes with arcuate (*a*) and straight (*b*) steps; *C* – Surface showing numerous oriented triangular etch pits. Note a deep crack on the surface (arrow), 1 mm long and 3 µm wide, which indicates the intensity of chemical activity; *D* – Detail of triangular etch pits (2 µm). The crystallographic control on the orientation of the extremely regular etch triangles is clearly expressed by the presence of this microtexture on three different crystal planes (*a*, *b*, *c*); *E* – Detail of triangular etch pits. Note their extremely regular outline and crystallographic orientation (arrow). The apical and basal angle size of triangular etch pit (74 to 81°, respectively); *F* – Silica flowers (1.5–2 µm) on an old fracture plane

Фотопластинка 4. Микрофотографии зерен кварца Куч-1: *A* – округлое зерно с невысоким рельефом. Поверхность зерна, подверженная воздействию раствора и осадков; *B* – отломанная часть округлого зерна. Обратите внимание на извилистые гребни (стрелки) и раковистые плоскости излома с дугообразными (*a*) и прямыми (*b*) ступенями; *C* – поверхность с многочисленными ориентированными треугольными ямками травления. Обратите внимание на глубокую трещину на поверхности (стрелка) длиной 1 мм и шириной 3 мкм, что указывает на интенсивность химической активности; *D* – чертеж ямок травления треугольной формы (2 мкм). Кристаллографический контроль ориентации чрезвычайно правильных треугольников травления ясно выражен в присутствии этой микротекстуры на трех разных кристаллических плоскостях (*a, b, c*); *E* – чертеж треугольных ямок травления. Обратите внимание на их чрезвычайно правильный контур и кристаллографическую ориентацию (стрелка). Размер апикального и базального углов ямки травления треугольной формы (от 74 до 81° соответственно); *F* – цветки кремнезема (1,5–2 мкм) на старой плоскости излома

such as continental, pedological, and diagenetic domains [9]. Elongated depressions are attributed to high-energy eolian transport, where direct collisions between saltating or creeping grains frequently transpire, often accompanied by bulbous edges, and are frequently smoothed-over by silica precipitation amidst upturned plates. Rounded grains are often linked to eolian phases, where grains undergo prolonged abrasion, leading to the loss of their angularity [7, 13]. Low relief is predominantly instigated by grain collisions and/or alteration processes, where the grain's relief is ultimately reduced by solution and precipitation mechanisms, which fill depressions and dissolve protrusions [6].

Based on these criteria, the quartz grains from the Sosnov Formation show evidence of multiple transport phases and mixed provenance sources. The presence of meandering ridges, crescentic percussion marks, bulbous edges, elongated depressions and rounded grains suggests a significant eolian phase in the sedimentary history of the formation. The presence of solution pits, silica globules and flowers indicate that some of the quartz grains were also transported in relatively low-energy environments with dissolutional pedological horizons. The fact of the continental pedological conditions, prevailing during the formation of Sosnov sandstones, has already been in agreement with Zorina et al. [15]. V-shaped percussion cracks reported in Kuchurovsky quarry are evidence of subaqueous environments (beach zone), where some of the quartz grains were transported in relatively high-energy environments. These processes could have occurred either before or after the eolian phase, depending on the local tectonic and climatic conditions. For example, some of the quartz grains could have been reworked by fluvial systems from older eolian deposits or exposed bedrock, or some of the eolian sediments could have been deposited in lacustrine basins or buried and cemented by groundwater. The presence of mechanical/chemical microtextures, such as meandering ridges, bulbous edges and elongated depressions, suggests that abrasion and silica precipitation were active during both eolian and fluvial phases, resulting in complex microtextural patterns on the quartz grains.

The SEM analysis of quartz grain microtextures in the Sosnov Formation provides valuable information on the sediment provenance and transport processes in the USVR during the Paleogene. The microtextures reflect a complex sedimentary history involving multiple phases of eolian, subaqueous (beach zone), mixed subaqueous-eolian (coastal dunes) and continental pedological settings. The microtextures can be used to discriminate between different depositional environments and to infer the paleoclimatic and paleogeographic conditions of the region.

Conclusions

In conclusion, the SEM analysis of quartz grain microtextures in the Paleogene Sosnov Formation has provided valuable insights into sediment provenance and transport processes in the USVR. The classification of microtextures into mechanical, chemical, and mechanical/chemical types has enabled the identification of diverse depositional paleoenvironments, including eolian, subaqueous, mixed subaqueous-eolian, and pedological settings.

A significant eolian phase is reported in the formation of sedimentary history, consistent with the region of paleogeographic reconstruction during the Paleogene. This eolian phase prevailed by high energy due to predominance of subrounded to well-rounded with bulbous edges.

Quartz grains from the Paleogene Sosnov Formation have significant proportions of solution pits, silica globules and flowers indicate transport in relatively low-energy environments. These processes may have occurred before or after the eolian phase, depending on local tectonic and climatic conditions.

The presence of mechanical/chemical microtextures further indicates the influence of both abrasion and silica precipitation during eolian, subaqueous, mixed subaqueous-eolian, and pedological phases, resulting in complex microtextural patterns on the quartz grains.

Overall, the SEM analysis of quartz grain microtextures provides valuable information for discriminating between different depositional environments, inferring the paleoclimatic conditions and reconstructing paleoenvironments of the USVR during the Paleogene.

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Микротекстуры зерен кварца в сосновской толще палеогена: значение для реконструкции питающих провинций на востоке Русской плиты

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Аннотация

Цель исследования. Основная задача данного исследования — изучение микротекстуры зерен кварца палеогеновой сосновской свиты — группы осадочных пород, расположенной в регионе Ульяновско-Сызранского Поволжья на Русской плите. При изучении микротекстуры, включающей в себя механические, химические и механохимические особенности, становится возможным выяснить механизмы, с помощью которых зерна преобразовывались и впоследствии модифицировались.

Актуальность. Актуальность данного исследования объясняется тем, что анализ микротекстуры кварцевых зерен дает ценную информацию о происхождении осадочных отложений, что имеет решающее значение для реконструкции прошлой геологической среды и раскрытия истории отложений.

Методы исследования. Двадцать зерен кварца отобраны из песков палеогеновой сосновской свиты, на Восточно-Ташлинском и Кучуровском карьерах на глубине 5 и 7,5 м соответственно. Методика исследования заключалась в использовании сканирующей электронной микроскопии (СЭМ) для исследования микротекстуры зерен кварца.

Результаты и выводы. В результате исследования выявлено 19 типов микротекстур, которые были разделены на механические, химические и комбинированные механохимические микротекстуры. Анализ СЭМ показал наличие в палеогеновой сосновской свите химических микротекстур, что позволило предположить, что пески при преобразовании прошли через низкоэнергетическую фазу. Полученные данные позволяют реконструировать разнообразные осадконакопительные палеообстановки, в том числе эоловые, субаквальные, смешанные субаквально-эоловые и педологические.

Ключевые слова: микротекстуры, сканирующая электронная микроскопия, кварц, сосновская свита, палеоген, Русская плита.

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