CHARACTERISTICS AND CONDITIONS OF ACCUMULATION OF THE UPPER JURASSIC SEDIMENTS IN THE SOUTH-EASTERN CAUCASUS

The article discusses characteristic structural features of the Southeastern Caucasus region and some geochemical aspects of the lithogenesis of the Upper Jurassic deposits. It studies and characterizes sediments of the various zones (Sudur, Shahdagh-Khizi and Guton-Gonagkend) based on the sections exposed in the river valleys of Gilgilchay, Babachay and Jimichay. Although many studies had covered tectonics, structural geology, stratigraphy and paleontology of the Jurassic succession in the Southeastern Caucasus, there are still questions that require more detail investigations of the stratigraphy, genesis and typification of various rhythmically bedded successions as well as sources of the clastic material. Experienced difficulties in these studies are caused, firstly, by the complex tectonic structure of the region and, secondly, by the lack of necessary paleontological data.

Upper Jurassic succession in the studied areas is composed of conglomerates, sandstones, siltstones, mudstones, and carbonate rocks, all combined in the local suites. In general, the color and lithological patterns of these terrigenous-carbonate and carbonate sequences differ in the various localities.

Based on chemical and mineralogical analysis of the rocks, and the collection and interpretation of archive and published materials, the article provides a ground for the lithochemical characterization of the studied sections in the Shahdagh-Khizi zone, stratigraphically identified as the Upper Oxfordian-Kimmeridgian (Gyzylgazma Formation).

Keywords: Southeastern Caucasus, facies variability, Gyzylgazma Formation, Shahdagh-Khizi zone, geochemical indicators, felsic provenance

Z.N. Mehdiyeva

Institute of Geology and Geophysics, Ministry of Science and Education Republic of Azerbaijan, Baku, AZ1143, H.Javid av., 119
E-mail: zabita.mehdiyeva@gmail.com

Introduction

In the Southeastern Caucasus, relatively complete and well exposed sections of Upper Jurassic deposits are recorded within the boundaries of Sudur, Shahdagh-Khizi and Guton-Gonagkend zones. These well visualized and accessible sections are the appropriate objects for studying and identifying the structural-facies and geodynamic formation conditions of the Late Mesozoic sedimentary complexes of the Greater Caucasus basin. Represented by terrigenous and carbonate deposits with sharp facies variability in the rocks' horizontal and vertical composition, the Upper Jurassic complexes are almost devoid of any faunal remains. This circumstance greatly complicates the task of breaking down and correlating the different sections.

The problems of stratigraphy, facies peculiarrities, lithology and petrography were studied by many prominent geologists (Abich, 1865; Bogdanovich, 1902, 1906; Vassoyevich, 1938, 1940; Weber, 1936; Alizadeh, 1939; Khain, 1937, 1939; Shikhalibeyli, 1956; Shardanov, 1957; Isaev et al., 1981; Kangarli, 1978, 1982, 1986, 1997).

The first microsection-based petrographic studies of the Jurassic deposits of the Southeastern Caucasus region were implemented by K.I.Bogdanovich. In his work "System of Dibrar in Southeastern Caucasus", Bogdanovich had described microsections of the separate types of Mesozoic limestones and sandstones, supporting the coverage with microphotos.

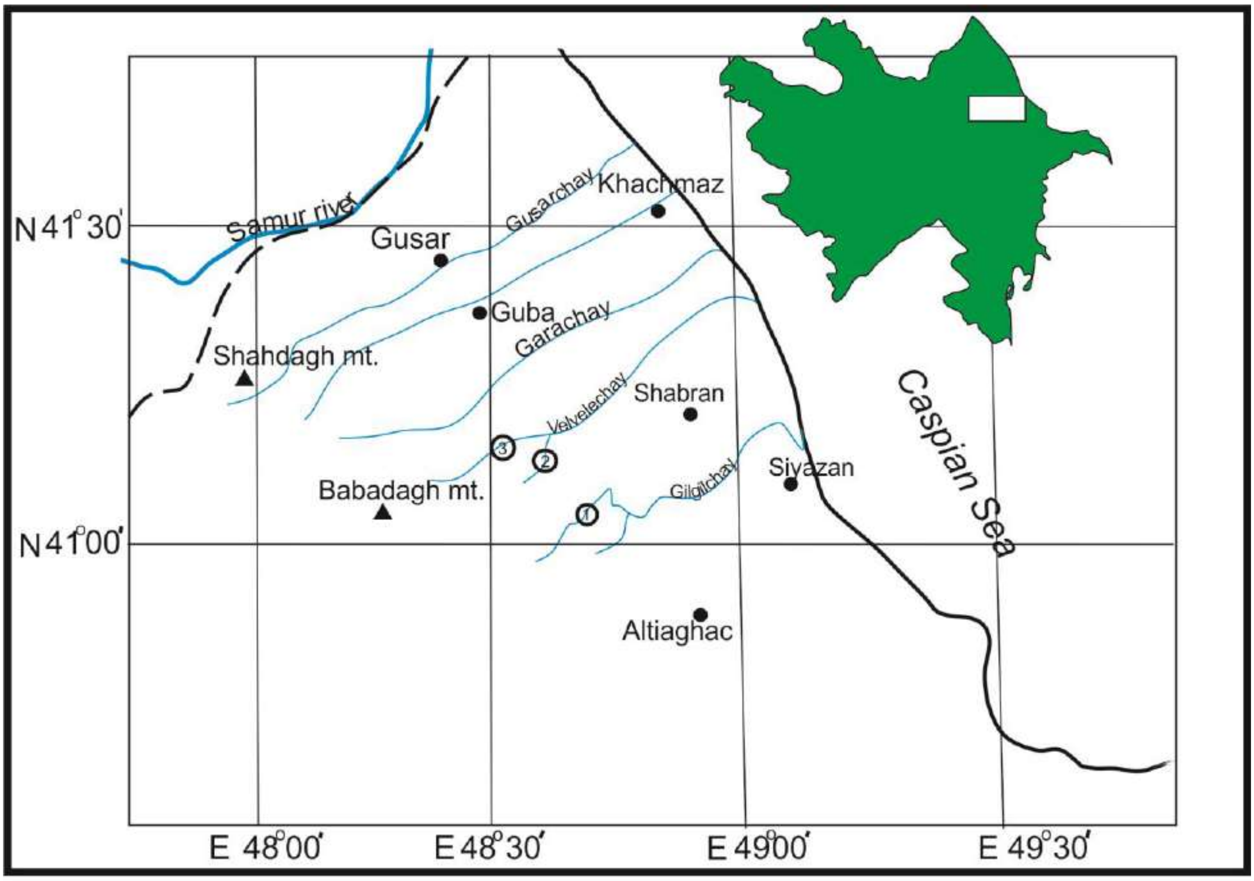
The purpose of this article is to study material constitution of the Upper Jurassic deposits of the sections exposed in the Southeast Caucasus region, to highlight their facies variability and accumulation environment, to clarify a nature of the source of terrigenous deposits based on the study of the rocks' chemical composition, and to compare them with literature data.

Study materials and methodology. The study is based on the results of fieldwork implemented in 2014–2018, and on the analysis of archive and literature materials.

On the northern slope, survey routes were drawn from Derk village upstream of the river Babachay, and from the Istisu (thermal sulphide spring) down the river Jimichay. The studies also covered the sections detected in the river valley of Gilgilchay (Figure 1). The total number of survey points exceeded 15. The detected outcrops were described and about 60 samples were taken for chemical and petrographic tests. On the southern slope, the surveys were conducted in the river valley of Akhokhchay.

Characteristics of the deposits from the various structural-facies zones

Shahdagh-Khizi zone occupies central position on the Northern slope of the Side megazone. Despite a plenty of published studies dedicated to a stratigraphy of this interval of the Southeastern Caucasus region, there are too few publications that would complexly describe the sections of this zone.



1 - Gilgilchay intersection; 2- Jimichay intersection; 3-Babachay intersection

Figure 1. Location scheme of the studied sections

Callovian – Upper Jurassic section of the zone is divided into Molt, Gyzylgazma and Shahdagh formations.

The Molt formation (Upper Callovian – Oxfordian) is incompletely exposed on the northern limb of Gyzylgazma anticline, where it constitutes basement of the Upper Jurassic section on Girdimanchay River (Figure 2). On the basement of the formation, there are the outcrops of small and medium pebble conglomerates alternating with brownish-black, ash-gray on surface, argillites. Higher in the succession, there is a transition into arhythmic alternation of muddy sandstones, small pebble gravelites, small and medium pebble conglomerates, rarely argillites. Having thickness of nearly 300 m, the formation transgressively overlies the Upper Jurassic series. Its' roof is brought to a tectonic contact with the Valanginian carbonate rocks (Isayev et al., 1977; Kangarli, 1982; Kangarli et al., 2013).

The Gyzylgazma formation (Kimmeridgian-Tithonian) was distinguished by N.B.Vassoyevich from the structure of the Khaltan formation identified by K.I.Bogdanovich (1906) and was dated as Tithonian according to its' stratigraphic position (Vassoyevich, 1938; Khain, 1947). In the Shahdagh-Khizi zone, the formation is represented by more than 200 m thick alternation of gravelites, sandstones and argillites, coarse-grained muddy sandstones, and greenish-grey clays. The roof of the formation is transgressively overlapped by Neocomian basal conglomerates.

The Shahdagh formation (Middle Oxfordian – Tithonian). The lower part of the formation is nearly 260 m thick and built by gray coarsely stratified massive rift dolomitized limestones. The upper part is about 550 m thick and constituted by pink coarsely stratified brecciate limestones and dolomites with layers of red calcareous breccias and conglomerates.

Sudur zone. Callovian – Upper Jurassic section of the zone is represented by muddy Tahirjal, gypsum-bearing argillo-arenaceous Gushgala formation and carbonate Gukhur formation. Upper Jurassic section of the zone begins with Callovian – Lower Oxfordian Tahirjal formation consisting of a variegated alternation of lilac-pink, yellowish and bluish-green sandy clays with interlayers of calcareous sandstones and nodules of crystalline limestones and dolomites. The Tahirjal formation was first described in 1975 in the river valley of Tahirjal (Isayev et al., 1977; Kangarli et al., 2013). The formation is unconformably overlapped by 60–80 m thick Upper Oxfordian Gushgala argillo-arenaceous formation. The Upper Jurassic section of the zone is crowned by a seamless series of limestones and dolomites of the Gukhur formation dated as Kimmeridgian-Tithonian according to its' stratigraphic position (Kangarli et al., 2013).

Outcrops of Callovian-Upper Jurassic deposits occur only in the eastern structures of the Guton-Gonagkend zone. They are exposed as part of the section of Girdimanchay-Valvalachay flexure-rupture zone, and to the east of it. On the Jimichay River, there is an outcrop of the member of alternation of dark gray sandstones, argillites and rarely limestones. The member is parallelized with the upper part of the Molt Formation and the conformably superstructed over 200 m thick alternation of greenish-gray sandstones and argillites.

There are the following three formations distinguished within the Upper Jurassic section of the zone: Garovulustu (Oxfordian), Gyzylgazma (Kimmeridgian) and Khashi (Tithonian).

In a centroclinal closure zone of the Garovulustu brachysyncline (the southern outskirts of Gonagkend village, the right riverbank of Jimichay, both limbs of Yerfi-Khashi anticline), exposed is a member of alternating gray, greenish-gray argillites, poorly graded, calcareous, fine- and medium-grained sandstones, and limestones. Dated as Oxfordian according to its' stratigraphic position, the member was identified as the Garovulustu Formation (Kangarli, Mehdiyeva, 2017). Thickness of the formation varies within the range of 145–224 m.

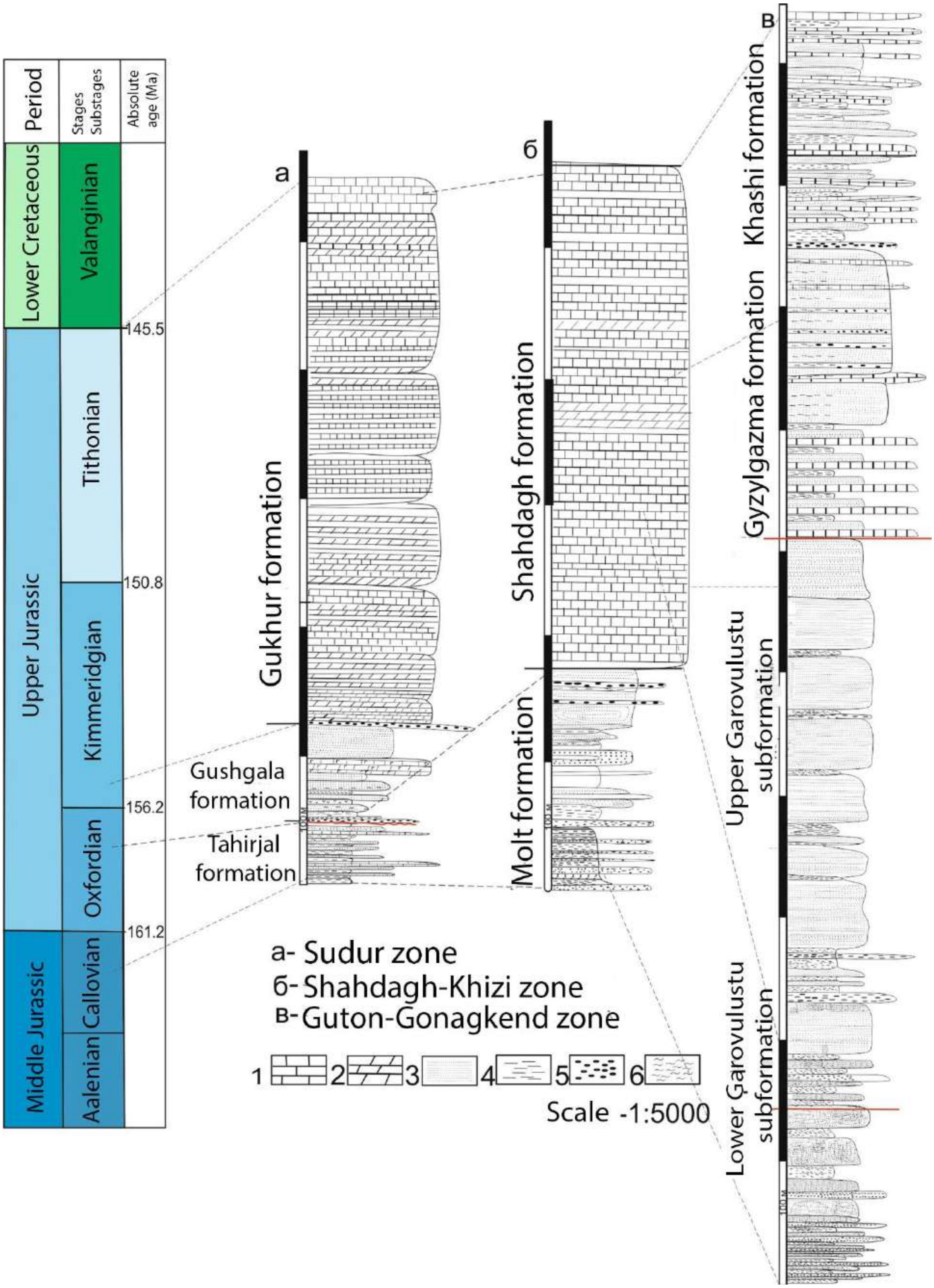


Figure 2. Correlation chart of sections in the studied zones (Azerbaijan)

***Symbols: 1** – limestone; **2** – dolomite; **3** – sandstone; **4** – clays and argillites; **5** – gravelites and conglomerates; **6** – siltstones*

The Gyzylgazma formation consists of three subcomponents. The lower subformation is represented by greenish-gray, gray, relatively sandy massive limestones, as well as medium-bedded, fine- and medium-grained sandstones and argillites.

Tithonian stage of the zone is represented by the Khashi formation, exposed at the more western intersection of the Yerfi-Khashin anticline along the Dahnachay River (Kangarli, Mehdiyeva, 2017). Significant part of the formation is composed of rhythmically alternating gray and greenish-gray sandy argillites, calcareous sandstones, limestones, and conglomerates.

Main rock types and dissemination

The studied Upper Jurassic sections of the Southeastern Caucasus region are mainly represented by coarse clastic, sandy, silty, muddy and carbonate rock types. Colour and lithological properties of these terrigenous-carbonate and carbonate rocks generally vary across sections. Detected rock types vary from coarse-grained conglomerates to fine-grained sandstones, siltstones and clays.

The coarse clastic rocks are detected in all studied sections and in all stages of the Upper Jurassic period. These rocks are mainly represented by thin layers of basal conglomerates found at the basements of some formations (Kangarli et al., 2013), as well as by separate layers inside the Shahdagh formation (Aghayev, 1990). In the Sudur zone, there are thin layers of basal small-pebble conglomerates and gravelites with pebbles of crystalline and marbled limestones, argillites and loose sandstones. The conglomerates are also widespread in the structure of Shahdagh-Beshbarmag allochthonous complex. According to literature data (Gavrilov, 2018), the basal sedimentary complex of the Shahdagh massif is characterized by a rather complex and heterogeneous structure. They show significant facies changes observed towards the southwest.

The coarse clastic rocks are widely developed at the basement of the Upper Jurassic section on the Gilgilchay River, and on the northern limb of the Gyzylgazma anticline. Alternation thick (5–8 m) stratas of small and medium-pebble conglomerates with the argillites constitutes 75 m thick lower segment of the Molt formation.

The coarse clastic rocks are most developed in the Tithonian series of the Ugakh section, amounting to 200 m of the section thickness. Thickness of the Tithonian rocks of this type is 58 m in Khaltan, and 32 m in Gizilchay sections.

In the Kimmeridgian stage, the coarse clastic rocks are of sharply subordinate significance, being observed in the form of individual thin interlayers of gravel and pebble conglomerates. The pebble conglomerates are represented by the layers composed of compacted, well-rounded pebbles (3–5 cm in size, up to 40 cm in diameter) of dark muddy shales, as well as small pebbles of sandstones and limestones.

Coarse clastic rock types are widely developed in the Tithonian deposits. According to size of a clastic material, these rocks are represented by boulders and blocky, pebble and gravel conglomerates. Most of them are composed of unrounded, sometimes noticeably rounded fragments of carbonate rocks, forming 100–150-meter strata of conglomerates. The pebble and gravel conglomerates are commonly developed in almost all of the sections.

Muddy deposits are widely developed. They are one of the key components of the Callovian-Upper Jurassic sections of the studied area. They are abundant in the lower and middle parts of the sections exposed in the Sudur (river valley of Tahirjal) and Shahdagh-Khizi (river valley of Gilgilchay) zones. Forming up to 10–15 m thick stratas, the muddy rocks are mainly represented by mainly gray, dark gray, greenish-gray dense, non-soaking, partly calcareous argillites.

Muddy rocks of the Kimmeridgian stage are represented by gray, greenish-gray, light gray arenaceous varieties. These rocks are most developed in the river valleys of Tahirjal, Gilgilchay and its' right-bank tributaries, and in the section of Babachay. A characteristic feature of these rocks is their siliceous content. Interlayer thicknesses vary from fractions of a centimeter to 10–20 cm or more. Muddy rocks of the Tithonian stage are represented by gray, dark gray, grayish-brown and reddish-brown varieties. Thickness of the clay interlayers varies from 1–2 cm to 1–2 m and more. Individual parts of the sections are mainly built by muddy deposits.

Sandy and siltstone rocks in a general complex of the Callovian – Upper Jurassic deposits had developed greatly in the Kimmeridgian stage. Macroscopically the sandstones are represented by gray, dark gray and greenish gray densely cemented varieties. They are always calcareous and muddy, often passing to the siltstone varieties. A characteristic feature of the sandy and silty rocks is their lamination.

Erosion grooves, marks of a runoff and fucoids, which are typical textural features of sandy and, to the great extent, silty rocks of the region, speak for the existence of a basin with significant near-bottom flows (Aliyev, Akayeva, 1957). Such flows had stimulated an even distribution and sorting of terrigenous material at the bottom of the basin, which had significant slopes in some areas. The coarsest grained sandy rock varieties were found in the Callovian-Oxfordian stages. The sandy series of the Kimmeridgian stage are silty.

Carbonate rocks. Development degree of the carbonate rocks changes from a minimum at the basement to the maximum on the top of the Upper Jurassic section. The main rock types of the Oxfordian-Kimmeridgian age are muddy, organic and brecciated oolitic limestones. Rocks from the middle parts of the sections are represented by flaglike and thin flaglike, microgranular gray, greenish-gray and sometimes dark gray limestones. The fragmentary oolitic limestones are developed all over the studied sections, forming as thin as 5–10 cm thick interlayers. The sandy and silty limestones are less commonly developed than the oolitic and fragmentary oolitic varieties. Carbonate rocks of the Tithonian stage are represented by mainly limestones and less commonly marls. The limestones are represented by fragmentary, oolitic, sandy, crystalline and pelitomorphic varieties (Aliyev, Akayeva, 1957).

Geochemical studies. Analyzing geochemical composition of the sedimentary rocks is an important tool for understanding the nature of primary rocks, as well as the weathering and erosion dynamics and the tectonic environment of sedimentation basins (Nesbitt and Young, 1982).

Collected rock samples were tested at the Analytical Center of the ANAS Institute of Geology and Geophysics. The testing resulted in a data on the composition of the main oxide compounds and chemical elements of the Upper Jurassic deposits. The muddy rock samples were mainly collected from the outcrops exposed in the Gilgilchay valley, whereas the samples of sandstone were taken from the Babachay section.

Chemical analysis results has shown that the material composition of the muddy rocks (argillites – 12 samples) is characterized by the following components: SiO_2 – 44.23–66.27, Al_2O_3 – 12.89–19.53, Fe_2O_3 – 4.04–9.88, CaO – 0.74–11.21, MgO – 1.39–2.50, Na_2O – 0.97–1.50, K_2O – 2.94–4.28. According to a ratio of the molecular amounts of SiO_2 to Al_2O_3, these rocks belong to hydromicas and mixed muddy rocks. SiO_2 and Al_2O_3 values of the hydromicaceous clays are intermediate as compared to kaolinite and montmorillonite. The SiO_2:Al_2O_3 ratio of these clays is equal to or lower than montmorillonite (Frolov, 1965).

The main component in the chemical composition of sandstones is SiO_2, concentration levels of which varied from 51.13 to 67.70% in the analyzed samples.

Na_2O was less than K_2O in all tested samples. This indicates that the deposits were accumulated because of the erosion of the felsic rocks. Another indicator of the felsic provenance is the titanium module (TM = TiO_2 / Al_2O_3), which equals 0.05–0.06 in all muddy samples.

Among geochemical indicators, the hydrolysate module is the most universal weathering maturity indicator (HM = TiO_2 + Al_2O_3 + Fe_2O_3 + Fe_2O_3 + MnO) / SiO_2). The higher the HM value, the more "mature" the sedimentary material is (Yudovich, Ketris, 2011). GM>0.55 characterize the products of humid (rarely arid) eolation.

All the studied samples are characterized by the hydrolysate module of less than 0.55, averaging at 0.43 in muddy, 0.59 in carbonate, and 0.28 in sandy and silty rock samples. These parameters indicate an arid sedimentation.

The alkaline module (AM = Na_2O/K_2O) can be used to distinguish between maffic and felsic sources (Yudovich, Ketris, 2011). For most sedimentary rocks, the AM value remains in the range of 0.30–1.50. Exceeding this value data indicate a significant admixture of plagioclases occurring due to erosion of the maffic rocks. The alkaline module of almost all studied samples is 0.23–1.75, which is an evidence of the erosion of felsic parent rocks. The only exception was a couple of carbonate rock samples, in which extremal AM values were recorded (15.8 in the sample #104, and 3.06 in the sample #207). In our opinion, this rare case is related rather to the saline Na than to the sodium silicate, which testifies to the erosion of evaporites.

The SiO_2 /Al_2O_3 ratio is a widely used indicator of rocks maturity. This ratio indicates an increase in the quartz values at the expense of the less stable components such as feldspar, etc. A ratio greater than 5 or 6 in sedimentary rocks testifies to their maturity. Average ratio values for the studied samples varies in the range of 2.25–7.48, making up 3.4 for muddy rocks, 4.6 for sandstones and 3.3 for carbonate rocks. All these values point at the moderate maturity of the rocks.

Increased alumina content of the Callovian – Upper Jurassic sedimentary rocks from one hand, as well as low alumosilicic module values (AM = Al_2O_3/SiO_2) from the other, indicate the erosion of arid weathering rinds.

Chemical composition (%) and geochemical indicators of sandstones of the Gyzylgazma formation

№№ Sample / Oxides	503	505	506	507	508	509	511	512	513	514
Na_2O	0.32	0.28	1.55	0.76	0.36	1.21	1.39	1.17	1.32	1.60
MgO	1.36	0.84	1.03	1.71	1.38	1.16	0.94	0.90	1.50	0.99
Al_2O_3	4.91	2.69	6.51	7.82	4.51	6.40	5.57	4.64	9.46	7.69
SiO_2	19.14	15.96	42.08	33.60	23.97	47.01	38.15	29.65	52.29	46.48
P_2O_5	0.04	0.05	0.10	0.10	0.08	0.07	0.08	0.08	0.14	0.09
SO_3	0.05	0.03	0.50	0.04	0.11	0.47	0.14	0.03	0.04	0.03
K_2O	1.29	0.60	1.12	1.77	0.94	1.13	0.93	0.82	1.74	0.82
CaO	40.20	44.26	27.08	28.23	37.60	23.36	31.02	36.28	12.84	23.24
TiO_2	0.24	0.14	0.39	0.45	0.22	0.36	0.34	0.26	0.55	0.30
Fe_2O_3	2.57	1.74	2.43	4.60	3.14	2.90	2.63	2.04	5.26	3.61
MnO	0.09	0.10	0.07	0,09	0,09	0,07	0.09	0,13	0,16	0,30
SiO_2/Al_2O_3	3,90	5,93	6,46	4,30	5,31	7,34	6,85	6,39	5,53	7,48
K_2O/ Na_2O	4.03	2.14	0.72	2.32	2.61	0.88	0.67	0.70	1.32	0.51
K_2O /Al_2O_3	0.26	0.22	0.17	0.22	0.21	0.18	0.17	0.18	0.18	0.13
CIA	75	75	70	75	77	73	76	69	75	71
HM	0,41	0,29	0,22	0,38	0,33	0,21	0,23	0,24	0,30	0,22

Results

When studying lithologically similar rocks characterized by lack of faunal remains, it is insufficient just to use the traditional methods. It is required to apply an integrated study approach to determine the formation conditions and environment of such geological bodies.

Callovian – Upper Jurassic series of the Southeastern Caucasus region demonstrate facies variability both in the area and sections, which is associated with structural and morphological elements of the paleobasin. The studied deposits are exposed in the different modern structural zones. There is a regular lateral lithofacies change observed in their distribution, varying from coarse flysch in the south to lagoon in the north. Such a change in the facies character testifies that these deposits had formed under the continental slope and shallow shelf environment of the northern flank of the Greater Caucasus marginal sea of Jurassic.

The main transport of the terrigenous material at that time was from the northeast.

Distribution nature of the main elements reflects mineralogy of the studied samples. Al_2O_3 content of the sandstone samples is lower than that of the samples enriched in microgranular silt.

According to the X-ray diffraction analysis results, deposits of the studied region mainly consist of calcite, quartz, feldspar, dolomite, hematite and muddy minerals such as chlorite, illite, montmorillonite and kaolinite. Values of the weathering index speak for a moderate weathering in the source area and deposition of the terrigenous material in an area with relatively high uplift. Judging by the ratio of the main elements, the eroded substrate was probably characterized by a felsic and/or intermediate rock composition.

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CƏNUB-ŞƏRQİ QAFQAZIN ÜST YURA LAY DƏSTƏLƏRİNİN XARAKTERİSTİKA VƏ FORMALAŞMA ŞƏRAİTLƏRİ

Z.H. Mehdiyeva

Təqdim olunan məqalədə Cənub-Şərqi Qafqaz regionun üst yura yaşlı süxur komplekslərinin quruluşu və geokimyəvi xarakterinin bəzi məsələləri nəzərdən keçirilir. Gilgilçay, Babaçay və Cimiçay çayları ilə açılmış kəsilişlərin struktur quruluşuna əsaslanaraq ayrı-ayrı zonaların hüdudlarında (Sudur, Şahdağ-Xızı və Quton-Qonaqkənd zonaları) təşəkkül tapmış süxur tiplərinin təsviri verilir. Regionun tektonikası, geoloji quruluşu, stratiqrafiyası və paleontologiyası məsələləri uzun illər bir çox tanınmış geoloq və alimlər tərəfindən tədqiq olunmuşdur. Buna baxmayaraq, burada hələ də bir sıra qeyri-müəyyən məsələlər mövcuddur. Bu qeyri-müəyyənliklər ilk növbədə üst yura süxurlarının detallı yaş bölgüsü, müxtəlif süxur komplekslərinin mənşəyi, terrigen məhsulun daxili və xarici mənbəyi məsələlərini əhatə edir. Regionun mürəkkəb tektonik quruluşu və süxur komplekslərinin paleontoloji yoxsulluğu bu məsələlərin həllini daha da çətinləşdirir.

Tədqiq olunan kəsilişlərdə üst yura maddi-kompleksləri yerli lay dəstələrində birləşdirilmiş kobudqırıntılı terrigen, qumdaşılı, alevrolitli, gilli və karbonat süxurlarla təmsil olunurlar. Ümumilikdə, burada iri çaqıllı konqlomeratlardan tutmuş narındənəvər qumdaşılara və gillərə qədər süxur tiplərinə rast gəlinir. Müxtəlif kəsilişlərdə lay dəstələri fərqli litoloji tərkibli süxurlardan təşkil olunurlar.

Keçən əsrin ortalarından başlayaraq litologiya və sedimentologiya məsələlərinin həllində geokimyəvi diaqnostikanın rolu artmışdır. Süxurların kimyəvi tərkibinin öyrənilməsi, bir sıra geokimyəvi indikatorların hesablanması və təhlili çöküntü qatlarını formalaşdıran obyektiv prosesləri izah etməyə kömək edir.

Məqalədə Şahdağ-Xızı zonasının stratiqrafik vəziyyətinə görə üst oksford-kimmeric intervalına aid edilən gilli və qumlu süxurlarının (Qızılqazıma lay dəstəsi) kimyəvi və mineraloji analizinin əsasında litokimyəvi səciyyəsi verilmişdir.

ХАРАКТЕРИСТИКА И УСЛОВИЯ ФОРМИРОВАНИЯ ВЕРХНЕЮРСКИХ ОТЛОЖЕНИЙ ЮГО-ВОСТОЧНОГО КАВКАЗА

З.Н. Мехтиева

В статье рассмотрены характерные особенности строения и некоторые вопросы геохимии литогенеза верхнеюрских отложений Юго-Восточного Кавказа. На примере разрезов, расположенных в долинах рек Гильгильчай, Бабачай и Джимичай, изучены и охарактеризованы отложения отдельных зон (Судурская, Шахдаг-Хызы и Гутон-Гонагкенд). Несмотря на обилие работ по тектонике, структурной геологии, стратиграфии и палеонтологии юрских отложений Юго-Восточного Кавказа, еще существуют вопросы, требующие более детального возрастного расчленения, генезиса и типизации, разнообразных ритмично построенных комплексов, выявления внутренних и внешних источников сноса кластического материала. Трудности решения этих вопросов связаны, во-первых, со сложной тектонической структурой региона и во- вторых, с отсутствием необходимых палеонтологических данных.

В изученных разрезах верхнеюрские отложения представлены грубообломочными, песчаными, алевролитовыми, глинистыми и карбонатными породами, которые объединены в местных свитах. В целом цвет и литологические свойства пород, представленных терригенно-карбонатной и карбонатной фациями, различаются в разных разрезах, и здесь наблюдаются типы пород от крупнозернистых конгломератов до мелкозернистых песчаников, алевролитов и глин.

В статье описаны выделенные местные свиты, развитые в вышесказанных зонах.

С недавних пор геохимическая диагностика отложений стала актуальным вопросом литологии и седиментологии. Изучение химического состава пород дает информацию об объективных процессах, контролирующих формирование осадочных чехлов. На основании проведенного химического и минералогического анализа пород, а также сбора и обобщения фондовых и опубликованных материалов, осуществлена литохимическая характеристика глинистых и песчаных отложений Шахдаг-Хызынской зоны, стратиграфически определенных как верхний оксфорд-кимериж (Кызылгазминская свита).