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**S. A. Nigmatova¹, B. U. Bayshashov¹, A. K. Zhamangara²,
S. G. Lucas³, K. O. Bayadilov⁴, A. Kasymkhankyzy¹**

¹Institute of Geological Sciences named after K. I. Satpaev, Almaty, Kazakhstan,

²Eurasian university L. N. Gumilyov, Astana, Kazakhstan,

³Museum of Natural History, New Mexico, USA,

⁴Altyn-Emel State National Park, Kazakhstan.

E-mail: nigmatova@mail.ru, bolat.bayshashov@mail.ru, kashagankizi@mail.ru,
slucas@nmmnh.state.nm.us, altynemel.kadr@mail.ru, almashok88@mail.ru

**THE NEW DATA ON BIOSTRATIGRAPHY OF THE BASIC
GEOLOGICAL SECTION OF THE CONTINENTAL
CENOZOIC DEPOSITS OF AKTAU MOUNTAINS
(SOUTH-EAST KAZAKHSTAN, ILI BASIN)**

Abstract. The grant project of the Ministry of Education and Science of the Republic of Kazakhstan «The comprehensive study of the basic stratigraphic sections of the Cenozoic of South-East Kazakhstan as a bases for development of the advanced stratigraphic sequence of sedimentary deposits in Central Asia», gives us a unique opportunity to actualize and complete a the study of the Cenozoic basic geological sections (from the Paleogene to the Quarter inclusive) for practical and theoretical purposes.

The classical section of the Cenozoic deposits is observed in the Aktau mountains located in the Ili basin of the Altyn-Emel National Natural Park. There were many years of research, and it is continuing. It is necessary to decide a lot of issues on stratigraphic partition and facial features of the Cenozoic, the paleogeography of the Ili basin, the correlation of the Paleogene-Quaternary sections of the various basins of the Northern Tian-Shan.

The article contains the most complete materials on paleontological studies of the site, including lists of fauna of shellfish, reptiles, mammals, leaf flora, flora of chara algae. These data allowed identifying the Akbulak, Betpak-dala and Aidarly suits in the Paleogene, the Aktau, Chuladyr, Santash, Ili suits in the Neogene, and the Khorgos suits in the Quaternary.

Keywords: geological basic section, biostratigraphy, paleontology, Cenozoic, Paleogene, Neogen, Quaternary, South-East Kazakhstan, the Aktau mountains.

Introduction. The study of basic sections is of great scientific and practical significance. The main requirement imposed on basic sections is their highest geological and paleogeographic informational content. The grant project financed by the RK Ministry of Education and Science and titled «The comprehensive study of the basic stratigraphic sections of the Cenozoic of South-East Kazakhstan as bases for development of the advanced stratigraphic sequence of sedimentary deposits in Central Asia», became a unique opportunity to actualize and carry out additional appraisal of basic sections of the Cenozoic (from the Paleogene to the Quaternary inclusive).

The Aktau mountains with the observed classical section of Cainozoic deposits are located in the Ili hollow of Southeast Kazakhstan, in the territory of the national Altyn-Emel Natural Park (figure 1). So far, the long-term researches continue periodically, dictated by the need to find solutions to controversial issues of stratigraphic partition and facial features of the Cenozoic, paleogeography of the Ili basin, correlation of Paleogene-Quaternary sections of various Northern Tian-Shan hollows and forecasting of minerals.

The national Altyn-Emel Natural Park is not only the Kazakhstani largest wildlife reserve of a modern biodiversity, but also a true geological and paleontologic museum under the open sky, which,

occupying the rather small territory, represents the geological deposits and structures created during various geological eras from the Paleozoic up to now, richly sated with remains of ancient biota. The site provides the evidence of complex tectonic, volcanic, magmatic, and sedimentation processes, which took place in this area during several hundred millions of years and going on today. The modern appearance of the area begun to shape in the Neogene, in the process of the Alpine tectogenetic cycle, covering the last 30 million years of geological history. Over time, emerged the mountain structure of Zhetyysu (earlier – Dzungarian/ Zhongar) Alatau and the intermountainous Ili hollow.

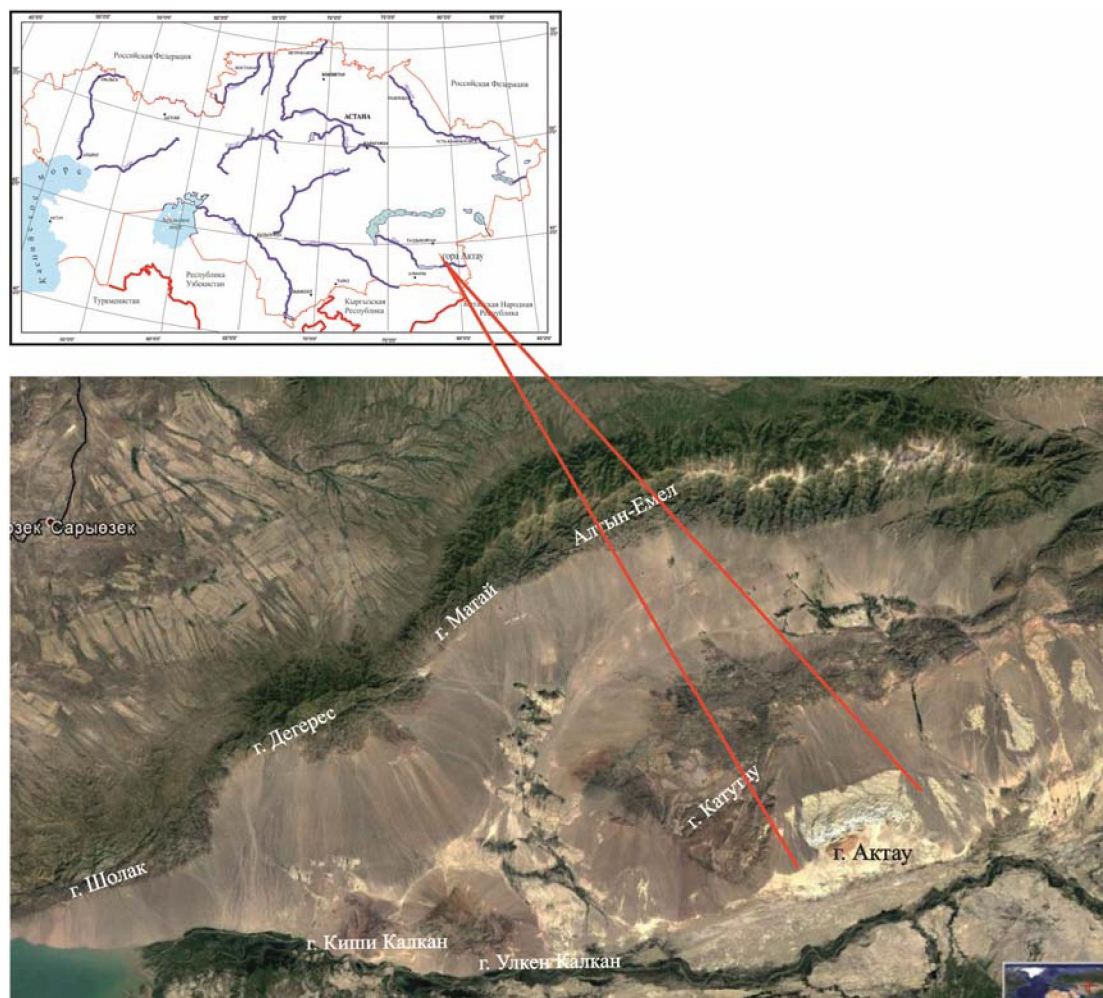


Figure 1 – Space image of the site of Aktau

The geological structure of the Aktau mountains was compiled by various rocks: terrigenous (conglomerates, sandstones and sands), mixed-hemogenous-terrigenous (marl, sandstones with plaster cement, carbonate-clay-anhydrite rocks) and hemogenous (anhydrite-dolomites, glauberite-dolomites), and others (halopelites, anhydrite-gypsum rocks, and other).

The Aktau mountains (“white tops”) were formed by white clays, occupying more than 20 square kilometres. In essence, these are not mountains, but cut in-depth canyons, located in the second terrace, above floodplain of the right bank of the Ili river. They consist of three main through valleys, stretched for about 10 km from north to south and called Ulken Sai, Orta Sai and Kishi Sai (the Big, Middle and Small Sai respectively), each of them branching out with a network of shorter valleys. It is not a very hospitable location, “a poor land” with dry and hot summer (+40°), periodic strong winds and absence of water.

The continental Cainozoic deposits, dating from the Eocene to the Pleistocene inclusively, exposed in the mountains of Aktau, are more than 1000 meter thick and contain the remains of uneven-age fauna of vertebrate and invertebrate animals, imprints of leaf flora, stonewort gyrogonites.

Often geologists suggested various, hardly comparable litologo-stratigraphic sequences, and still, the views on volume and age of certain parts of the Paleogene-Antropogenous section did not arrive to a consensus (figures 2, 4), complicating the geological surveys.

For the first time, bone residues of fossil animals (mastodon) have been found in 1948 in the upper course of the Bulak crack. And since 1950 the staff of the Paleobiology department of the Institute of Zoology at the KAZSSR Academy of Science repeatedly carried out the preplanned collection of paleontologic material [1-3]. Nevertheless, this site is yet poorly studied; the majority of layers are large in the area with concealed thicknesses of the blocked rocks of overlying deposits. Besides, in some places the natural arrangement of layers are broken, which causes inconsistency in determining the deposition ages.

The Aktau geological section was described for the first time in 1958 by the group of geologists under the leadership of N.N. Kostenko together with paleozoologists [4].

The lowermost pack, dated by the authors back to the first half of the Oligocene, consists of light-gray anisometric loose sandstones and red-brown clays, the lower part - of white sands layers. Here defined were: turtles Testudinidae (Clemmys) and Trionychidae; crocodiles Crocodilia; porcine - Suiformes; horn-nosed Ardynia (Yergilia) kazakhstanica; predators Creodonta.

Above is the pack of anisometric polymictic sandstones, interlaid with gravelites, fine-pebblestone conglomerates and the dramatic affluent formations of yellow clays and aleurites. The established fauna here consists of turtles Clemmys and Trionychidae; porcine Suiformes; chevrotains Proremotherium; horn-nosed Rhinocerotidae, Indricotheriidae; chalicotheres Chalicotheriidae (*Schizotherium*). The geological age of this pack was determined as the middle Oligocene. Both of these packs were united in the Aktau suite under condition that further on it should be divided into two sub-suites because the first fauna consists generally of animals, inhabitants of humid tropical climate and the second - of more temperate and arid climate. Later, the Aktau suite has also been divided into the lower Aktau and the upper Aktau sub-suites dated correspondingly to the first and second half of the Oligocene [5].

Above along the section is the saliferous thickness represented by gray-green gypsiferous clays, containing the following shellfish: *Limnaea robustus*, *Gyraulus gredleri*, *Gyraulus* sp., *Planorbis* sp., *P. youngi*, pointing to the beginning of the Neogene. Defining their top part as the Koktal suite, L.E. Bodina [6] described its ostracods: *Ilyocypris* cf. *errabundis* Mandelst., *Cuprinotus vialovi*, Schneider. This thickness corresponds to saliferous suites of the Shol-Adyr mountains in the Karkara hollow. Sporadic and pollen ranges of the Shol-Adyr deposits, according to L.N. Rzhannikova and R.Ya. Abuzyarova, were identified as the lower Miocene [6]. According to S.M. Blyakhova [7], prevailed here is the pollen of boreal angiospermous plants. The amentaceous pollen of the Betulaceae and Juglandaceae families is represented abundantly; also encountered was the pollen of large-leaved species of the Fagaceae and Ulmaceae families (Fagaceae, *Ulmus*, *Castanea*, *Tilia*). Besides, elements of the Mediterranean flora were established: *Zelkova*, *Myrica*, *Paliurus*, *Celtis*.

The next pack consists of predominantly gray plastered clays, aleurolites, marls and anisometric sandstones. Aleurolites were found to contain the fauna of shellfish: *Limnaea sternalis*, *Coretus corneus*, *Planorbis* (*Gyraulus*) *keideli*, *Gyraulus* sp., dated back to the first half of the Miocene. There is a report that E. Kordikova found bones of rodents in the Shol-Adyr suite of Aktau (without indication of the exact place of collecting), but L.A. Tyutkova (more experienced in working on Kazakhstani rodents) does not confirm this.

The next is the pack of banded reddish-brown and green-gray clays, aleurolites and gray anisometric sandstones with tributary marls and limestones. The banded clays contained the following shellfish: *Planorbis* sp., *Coretus corneus*. In these deposits E.L. Bodina [6], calling them the Kokterek suite, defined following ostracods: *Candoniella albicans* (Brady), *Cuprinotus vialovi* Schneider, *Cuprideis littoralis* (Brady), *Cypridopsis convexa* Bodina, *Ilyocypris manasensis* var. *cornea* Mandelst., *Candoniella marcida* Mandelst., *Cyclocypris regularis* Schneider. She juxtaposed this thickness with the Santash suite of the second half of Miocene. The sporadic and pollen complex of these deposits has an increased value of grassy plant pollen of the Asteraceae, Poaceae (Compositae, Gramineae), Chenopodiaceae families, while wood plant pollen decreases in value considerably in comparison with the Shol-Adyr suite [7]. Possibly, at this time, the dominant forest-steppe landscapes included mixed large-leaved woods and steppes on watersheds with pineries, and open spaces were covered with xerophyte plants. The climate was warm, arid continental with periodic humidification.

Above, without an explicit disagreement, the Ili suite was allocated for East Kazakhstan by V.S. Bazhanov and N.N. Kostenko [3] and dated to the lower Quarternary (lower anthropogene, according to N.N. Kostenko), represented by yellow and pale-yellow clays, aleurolites and anisometric sandstones, having interlaid gray marls and blue clays in the lower horizons. V.S. Bazhanov and D.N. Kazanli found here, in the Bulak crack, remains of mastodon of *Anancus arvernensis* close to *A. sinensis*; identified here were the following shellfish: *Limnaea robustus*, *Bathyomphalus* cf. *contortus*, *Coretus corneus*, *Planorbis* sp., *P. youngi*, *P. planorbis*, *Gyraulus* sp., *G. keideli*, *Radix teilhardi* [4]. The ostracods, according to L.E. Bodina (accepted as minaret suite) are *Cuprideis littoralis* (Brady), *C. torosa* Jones [6]. The Ili horizon deposits contained, as per V.D. Nikolskaya [8], the stonewort: *Lychnothamnus barbatus* (Meyen), *Leonh.cf.costulatus* Krassav., *Charites multispiras* (Papp) Madler et Staesche, *Ch. molassicqa* var. *kirgissusis* Maslov, *Ch. postconica* Madler et Staesche, *Brevichara aralica* Kyansep – Rom., *Ch. angustior* Z. Wang *Peckichara callosa* Maslov., *Lamprothamnium aktauensis* V. Nikolsk., *Rabdochara leispireis* V. Nikolsk., *Nitellopsis maedleri* (Rasky).

The Aktau mountains section is crowned by the Khorgos suite of gray conglomerates with sandy-argillaceous cement dated to the lower Quarternary.

Thus, according to the known paleontologic data, V.S. Bazhanov and N.N. Kostenko [4] identified in the Aktau deposits the following suites, from up downwards: Aktau (Paleogene); saliferous is twisted Shol-Adyr, Santash (Neogene); Ili, Khorgos (Quarternary).

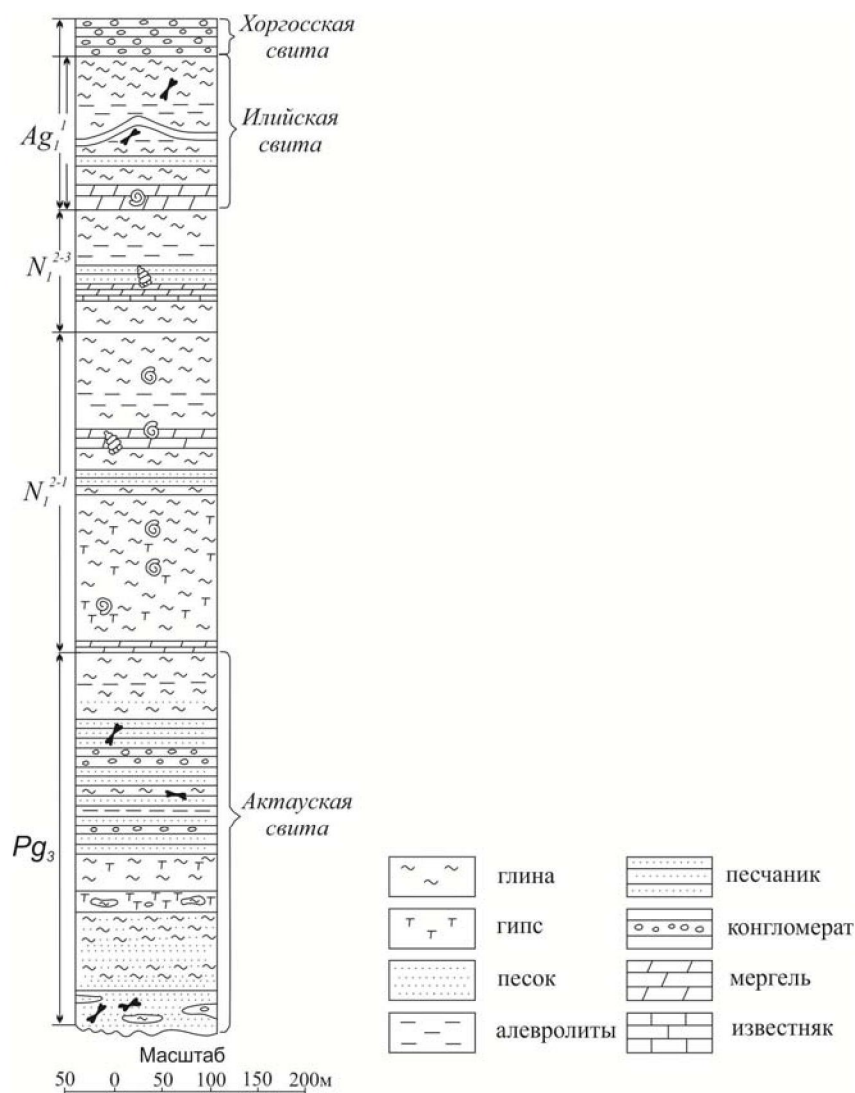


Figure 2 – Section of the site of Aktau (according to N.N. Kostenko 1961 [4])

Later, in process of replenishment of paleontologic materials, paleontologists and geologists-stratigraphists have repeatedly reconsidered eras of the described deposits and their binding to certain suites (formations). Thus, in 1982, E.L. Dmitriyeva and S.A. Nesmeyanov [9], on the basis of the known data, split the lifetime of fossil mammals of the Aktau site into the early Oligocene with remains of Ardynia (=Yergilia) and the late Oligocene with Schizotherium, Paraceratherium Proremotherium.

In 1970s-1980s, V.V. Kuznetsov, L.T. Abdrakhmanova, G.S. Rayushkina, and B.U. Bayshashov collected the materials from the second faunistic horizon (the upper pack) which allowed to replenish, specify the list of fauna and revise the age of host rocks. Among one-hoofed, two rhinoceroses were defined here: Paraceratherium prohorovi (Borissiak), 1939 and Diaceratherium (Brachypotherium) aurelianensis (Nouel), 1866 [10-12]. P. prohorovi was for the first time attributed to the upper Oligocene – lower Miocene deposits of the Ak-Yespe site (Agysp) in North Aral (later finds of this Aktau rhinoceros were redefined as Paraceratherium zhajremensis).

In Aktau, deposits with the remains of this huge rhinoceros are located on an opposite ridge from the main site, at islands of ferruteros sandstone and structurally lower, than deposits with other animals. Diaceratherium (Br.) aurelianensis in Kazakhstan was earlier found in lower Miocene of Kushuk layers in the Torgay plateau. The study of Chalicotheriidae bones shows, that they belong to the genus Borissjakia, described in lower Miocene deposits of the Askazan-Sor site [12]. The Aktau fauna was defined to contain: artiodactyls - deers Lagomeryx vallesensis Crusaf. et Vill., 1955; Procervulus gracilis Vislobokova, 1983; Stephanocemas aralensis Beliajeva, 1974; Stephanocemas actauensis Abdrakhmanova, 1993; giraffes Prepalaeotragus actauensis; Caprinae. Proboscidean - mastodons Gomphotherium angustidens (Cuvier.), 1806; G. cf. angustidens; [13], reptiles - turtles Ocadia iliensis, Khozatzky et Kuznetsov, 1971 [14]. The majority of these animals were inhabitants of wetlands and forest-steppe landscapes with warm and humid climate. The study of ruminants resulted at first in dating the fauna by L.T. Abdrakhmanova to early-middle Miocene. The host rock was attributed by N.N. Kostenko to Shol-Adyr suite [10]. Upon revision of some ruminants and the analysis of the full faunistic complex it was specified as early Miocene [13].

In 1979, the imprints of plants were found in deposits of the same level (fig. 3) by V.V. Lavrov [15], later this very rich (about 56 species) and still the only early Miocene flora of Northern Tian-Shan and the Dzungarian Alatau, was studied and described by G.S. Rayushkina [16, 17]. The rarefied, kserofilny woods were the main type of vegetation: various ancient poplars, ancestors of modern turangue species, stiff-leaved and fine-leaved xerophyite oaks, pro-riparian forest, prashiblyak, perhaps evergreen prachaparel, pramakvis, etc. [16, 17].

The staff of the Paleozoology laboratory of the Institute of Zoology at the RK Ministry of Education and Science (1995, 1996 B.U. Bayshashov, L.A. Tyutkova), (1997 P.A. Tleuberdina, B.U. Bayshashov, A.K. Zhamangara, D. Malakhov) together with geologists of the Institute of Geological Sciences named after K.I. Satpayev, B.Zh. Aubekero, A. Slovar and the american paleontologists S.G. Lucas (the Natural History Museum of the State of New Mexico, Albuquerque) and R. Emri (te Smithsonian Institute, Washington) re-investigated all of the Aktau section and carried out excavations in Eocene deposits.

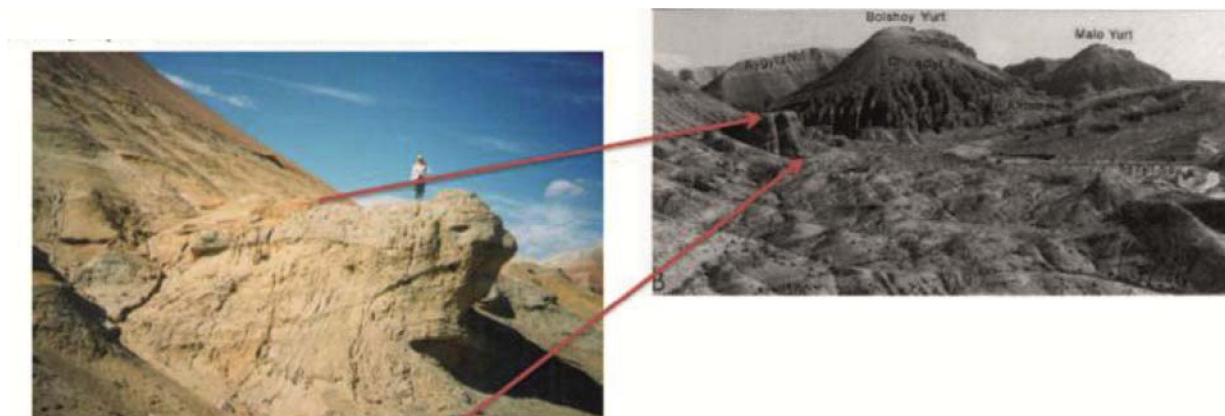


Figure 3 – The only site of Miocene flora in the mountains of Aktau

As a result of the full-scale field works carried out by the Kazakhstan-American joint expedition, the first ever faunistic deposits of the Eocene period were revealed in the Aktau. Here, findings included three skulls and almost full skeleton of a brontoteride, described as a new species and a new type of Aktautitan hippopotamopus by Mhlbachler, Lucas, Emry and Bayshashov, 2004 [18]. Because of the complete and unique material, the American paleontologists called this find a discovery of the century. Also, for the first time bones of a marsh rhinoceros, Sharamynodon Kretzoi, 1942 [19], earlier known only from the middle Eocene deposits in China, were revealed in this site. The animals established here lived in wetlands and water landscapes, under the predominantly tropical climate [20].

In the deposits, called the lower Aktau sub-suite, on the left board of the ravine Kyzyl Sai, called "Kumzhota", we found a fragment of the lower jaw and bones of a postcranial skeleton of a gigantic rhinoceros. This find allowed establishing them as *Paraceratherium zhajremensis* Bayshashov, 1988 [21], described for the first time in the upper Oligocene deposits of the Zhana-Arka suite in the Zhaiem site, Central Kazakhstan [22]. Huge rhinoceroses 5 m high and 8 m long lived in forest landscapes and fed on leaves. Possibly, at this time the climate was warmer and more arid, than before. Evolutionally, the Zhaiem rhinoceros holds the position between the early Oligocene *Paraceratherium* (*Indricotherium*) *transouralicum* (M.Pavlova), 1922 and the early Miocene *Paraceratherium prohorovi* Borissiak, 1939 [23]. Therefore, the deposits corresponding to remains of the huge rhinoceros in the Aktau site should be considered as the upper Oligocene.

Judging by samples of remains of the stonewort presented by gyrogonite of the Aktau A.K. Zhaman-gara, it was established a complex of the Santash suite (late Miocene - early Pliocene) with the Ili suite (Pliocene). **The Santash complex** *Nitellopsis meriani* contains the species as such: *Nitellopsis merianii* (Al.Braun ex Unger) L.Grambast & Soulié-Märsche, *Chara sadleri* Unger, *C. molassica* var. *kirgisensis* Maslov, *C.vulgaris* L., *Lychnothamnus barbatus* var. *bicarinatus* Soulié-Märsche, *Hornichara* sp.

The Ili complex *Chara pappii* - *Lychnothamnus barbatus* is represented by: *Lychnothamnus barbatus* (MEYEN) v. Leonh., *Chara pappii* Soulié-Märsche, *Chara globularis* Thuillier, *C.molassica* var. *kirgisensis* Maslov, *C.vulgaris* L., *Nitellopsis obtuse* (Desvaux) J. Groves, *N.aubekerovii* Dzham. [24, 25].

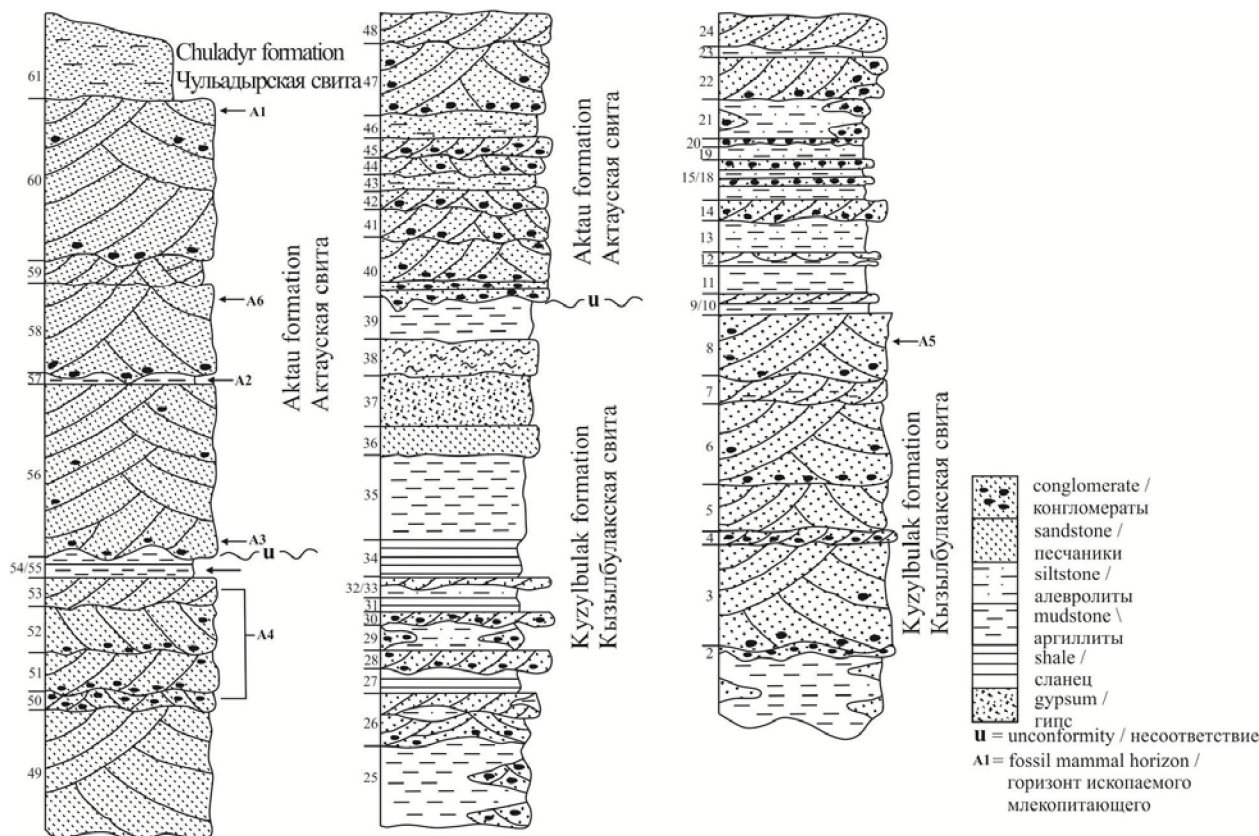


Figure 4 – Section of the site of Aktau by S. Lucas et al. (Lucas et al. 1997 [28])

According to the Aktau stratigraphic sequence [26, 27], the lowermost paleogene deposits with remains of vertebrata were believed to be the lower Oligocene and were attributed to the lower Aktau sub-suite, and the deposits with remains of mainly Neogene vertebrata located structurally higher – to the lower Miocene and attributed to the upper Aktau sub-suite.

The studies of 1995-1997 resulted in a split of a Tertiary deposit pack with remains of vertebrata into two large suites: Kyzyl Bulak and Aktau [28]:

The Kyzyl Bulak suite, studied on the site and called by N.N. Kostenko "Kyzyl Muryn", thicker than 100 m, consists generally of sandstones and clays. In its lowest part, remains of Eocene fauna biota were found in two layers (white quartz sands and green hardpan clay). Its comparison with fauna, earlier known from the adjacent territories, proved to be analogous to the Yergilin fauna of Mongolia. The very thick top of the suite consists of brown, pink, red-brown sandstones and clays; the material "in situ" was not found but the rhinoceros remains of *Ardynia* (=Yergilia) and porcine *Suiformes* which appeared in the lower horizon talus, evidently, from the same thickness. Its lithology and geological age interval is comparable to Shandgol of Mongolia; it shows similarity to the Chelkar-nur suite of lower Oligocene in Central Kazakhstan, to the so-called indrikoterous fauna and the Betpakdala suite studied in the southwest lowland of the Lake Balkhash.

In our view, it is rational to divide Kyzyl-bulak suite into two parts. Besides, since this title was earlier used for middle Miocene deposits of North Aral [29] it should be renamed. The lower part with fauna should be left unchanged as the Akbulak suite allocated by N.N. Kostenko and R.B. Baybulatova to the Eocene deposits of Aktau, revealed in wells [30] and the stratigraphic sequence [26, 27], and the top part should be recognized as an analogue of the Betpak-dala suite.

2. The Aktau suite located on the left and right boards of the so-called Kyzyl Say ravine is slightly less thick than Akbulak "Kyzyl Bulak" (about 134 m), but contains the vertebral remains also of two different ages: the late Oligocene (the lower Aktau sub-suite on the left board of the ravine Kyzylsay/Kumzhota) and the early Miocene (the upper Aktau sub-suite, generally the right board of the ravine). In our view, the upper Oligocene deposits, consisting generally of fine-grained sands and polymictic sandstones of ochreous-yellow colour, with remains of huge rhinoceroses (lower aktau sub-suite), should be split into two suites: an independent one of Aidarly (our suggestion) as per the near settlement of Aidarly, and the Aktau suite proper. The last is characterized by deposits interlaid with gravellite, red fine-pebblestone conglomerates and gray lamellar and hardpan silty clays of the lower Miocene age. There are exposures of uniform upper Oligocene deposits also in the Kyzylzhar site, located about 100 km westward of Aktau, near the Kyzylzhar settlement [31].

As a result, on the base of credible organic fossils, revealed in the Aktau site, in more than 30 collection points, seven uneven-age deposits were defined (table).

Regarding the stratigraphic partition of Cainozoic deposits of the Aktau mountains, in this work we rely on finds of fossils of fauna and flora. According to the principles of stratigraphic partition as per N.A. Golovkinsky, each organism in its historical development (phylogenesis) undergoes the beginning (level of the first emergence), the full blossom in development and fading away. As a rule, because of breaks in sedimentation or facial conditions persisting over a long period, lithologic characteristics of deposits do not reflect fully their stratigraphic features: by landscape-climatic conditions, they might have homologous composition in different geological periods. Colour of rock generally reflects a geological situation in which existed the biota in question. Paleontological remains contained in even-aged deposits represent an incontestable fact for their correlation.

Basing on results of geological and paleontological studies of the section of nearly continuous Cainozoic deposits of the Aktau mountains, the following suites could be identified. Below we provide basic specification and arrangement of suites of these deposits from below to the top:

1. The Akbulak suite (figure 5) is represented by white quartz sands and gray-green hardpan solid clays. The visible thickness exceeds 130 meters. The age refers to the middle-late Eocene.

2. The Betpak-dala suite / Betpak-dala formation (Fig. 6). Red-brown clays and sandstones, thickness is about 50 meters. Age: early oligocene.

3. The Aidarly suite (figure 6) is represented by red, fine-grained sands with ferruteros and manganese concretions up to 20 meters thick. Age: late oligocene. Stratigraphic type is described by the

The names of formation (suites) with organic residues

System	Series	Suites	Fauna and flora
NEO-GENE	PLIO-CENE	Ili	Fauna of mammals: <i>Anancus arvernensis, A. cf. cinesis</i> Shellfish: <i>Limnaea robustus, Bathyomphalus cf. contortus, Coretus corneus, Planorbis sp., P. youngi, P. planorbis, Gyraulus sp., G. keideli, Radis teilhardi</i> Stonewort: <i>Lychnothamnus barbatus</i> (Meyen) v. Leonh., <i>Chara pappii</i> Soulié-Märsche, <i>C. globularis</i> Thuillier, <i>C. molassica</i> var. <i>kirgisensis</i> Maslov, <i>C. vulgaris</i> L., <i>Nitellopsis obtuse</i> (Desvaux) J. Groves, <i>N. aubekerovii</i> Dzham.
		Santash	Shellfish: <i>Planorbis sp., Coretus corneus</i> Stonewort: <i>Nitellopsis merianii</i> (Al. Braun ex Unger) L. Grambast & Soulié-Märsche, <i>Chara sadleri</i> Unger, <i>C. molassica</i> var. <i>kirgisensis</i> Maslov, <i>C. vulgaris</i> L., <i>Lychnothamnus barbatus</i> var. <i>bicarinatus</i> Soulié-Märsche, <i>Hornichara</i> sp.
	MIO-CENE	Shol-Adyr	Shellfish: <i>Limnaea robustus, Gyraulus gredleri, Gyraulus sp., Planorbis sp., P. youngi</i>
		Aktau	Fauna of reptiles: <i>Ocadia iliensis</i> Khozatzky et Kuznetsov, 1971 Fauna of mammals: <i>Diaceratherium (Brachypotherium) aurelianense</i> (Nouel), <i>Chalicotheriidae</i> (<i>Borissjakia</i> sp.), <i>Lagomeryx vallesensis</i> Crusaf et Vill., <i>Procervulus gracilis</i> Vislobokova, <i>Stephanocemas aralensis</i> Beliajeva, <i>S. actauensis</i> Abdrakhmanova, <i>Prepaleotragus</i> sp., <i>Caprinae</i> , <i>Gomphotherium angustidens</i> (Cuvier), <i>G. cf. angustidens</i> Leaf-flora: <i>Osmunda minutes</i> Rajushkina, <i>Picea aktauca</i> Rajushkina, <i>Thuja</i> sp., <i>Laurophyllum tianshanicum</i> Rajushkina, <i>Nelumbo protospeciosa</i> Sap., <i>Cocculus</i> sp., <i>Berberis</i> sp., <i>Celtis japati</i> Ung., <i>Quercus lavrovii</i> Rajushkina, <i>G. katutauca</i> Rajushkina, <i>Guercus</i> sp., <i>Pagus</i> sp., <i>Caprinus</i> sp., <i>Betula</i> sp., <i>Juglans lavrovii</i> Rajushkina, <i>Rumex</i> sp., <i>Populus actauensis</i> Rajushkina, <i>P. orlovskiae</i> Rajushkina, <i>P. lavrovii</i> Rajushkina, <i>P. zongarica</i> Rajushkina, <i>Salix varians</i> Goepp., <i>S. lavateri</i> Heer., <i>S. ulkensaica</i> Rajushkina, <i>Salix</i> sp., <i>Cydonia</i> sp., <i>Pyrus</i> sp., <i>Spiraea</i> sp., <i>Cotoneaster praracemiflora</i> Rajushkina, <i>Gliditsia alleanica</i> Heer., <i>Cytisus</i> sp., <i>Cesneya actauensis</i> Rajushkina, <i>Amorpha kazakhstanica</i> Rajushkina, <i>Robinia regelii</i> Heer var. <i>actauca</i> varnov., <i>Leguminosites cordifolia</i> Rajushkina, <i>Leguminosites</i> sp., <i>Myrtophyllum kapchagaica</i> Rajushkina, <i>Elaeagnus</i> sp., <i>Hippophae</i> sp., <i>Pistacia kornilovia</i> Rajushkina, <i>Rhus kostenkoi</i> Rajushkina, <i>Anacardiaceae</i> gen. et sp., <i>Allantus confucii</i> Ung., <i>Acer</i> sp., <i>Cedrella</i> sp., <i>Koelreuteria</i> sp., <i>Cornus dubius</i> Rajushkina, <i>Rhamnus</i> sp., <i>Paliurus zaporogensis</i> Krysh., <i>P. iliensis</i> Rajushkina, <i>Ziziphus miojuba</i> Hu et Chaney var. <i>iliensis</i> raxinus eriploca kryshstovovichii Kornilova, <i>Lonicera miocenica</i> Rajushkina
PALEO-GENE	OLIGO-CENE	Aidarly	Fauna of reptiles: Trionychidae Fauna of mammals: <i>Paraceratherium zhajremensis</i> Bayshashov, 1988
		Betpak-dala	Fauna of reptiles: Testudinidae (<i>Clemmys</i>) Fauna of mammals: Creodonta, Suiformes, <i>Ardynia (Ergilia) kazakhstanica</i>
	EOCENE	Akbulak	Fauna of reptiles: Crocodilia Fauna of mammals: <i>Aktautitan hippopotamopus</i> , Mhlbachler, Lucas, Emry and Bayshashov, 2004. <i>Sharamynodon</i> sp.



Figure 5 – Eocene deposits at the site of Aktau, the Akbulak suite

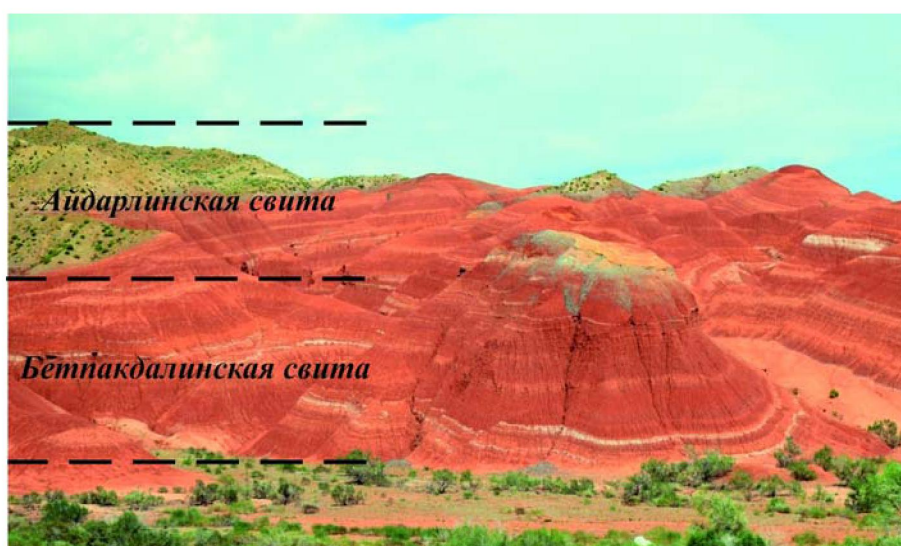


Figure 6 – Oligocene deposits in the site of Aktau, the Betpak-dala suite and the Aidarly suite

thick orange sands with ferruginized brown concretions located in the brick-red clays of the Betpak-dala suite, on the left board of the Kyzyl Sai, the Kumzhota site.

4. The Aktau suite (figure 7). Uneven-grained polymictic sandstones, interlaid with gravelites, fine-pebblestone conglomerates, sharply affluent clays and alevrites of ocherous-yellow colour, more than 60 meters thick. Age: lower Miocene.

5. The Shol-Adyr suite (figure 7). The saliferous thickness represented by gray-green gypsiferous clays, with the thickness exceeding 150 meters. Age: middle Miocene.

6. The Santash suite (figure 7) is represented by bonded reddish-brown and green-gray clays, alevrolites and gray uneven-grained sandstones with tributary marls and limestones, up to 200 meters thick. Age: the second half of Miocene.

7. The Ili suite (figure 7) is presented by yellow and pale-yellow clays, aleurolites and uneven-grained sandstones with interbeds of gray marls and blue clays in the lower horizons, with basic thickness of about 400 meters. Age: upper Pliocene.

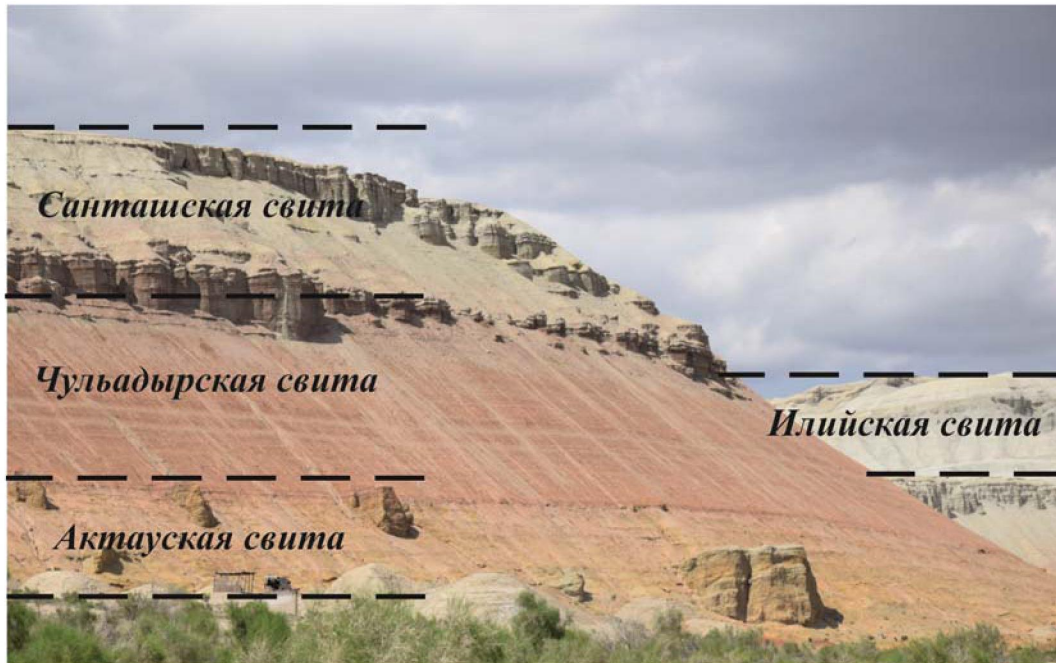


Figure 7 – Miocene - Pliocene deposits at the site of Aktau, the Aktau suite, the Shol-Adyr suite, the Santash suite and the Ili suite

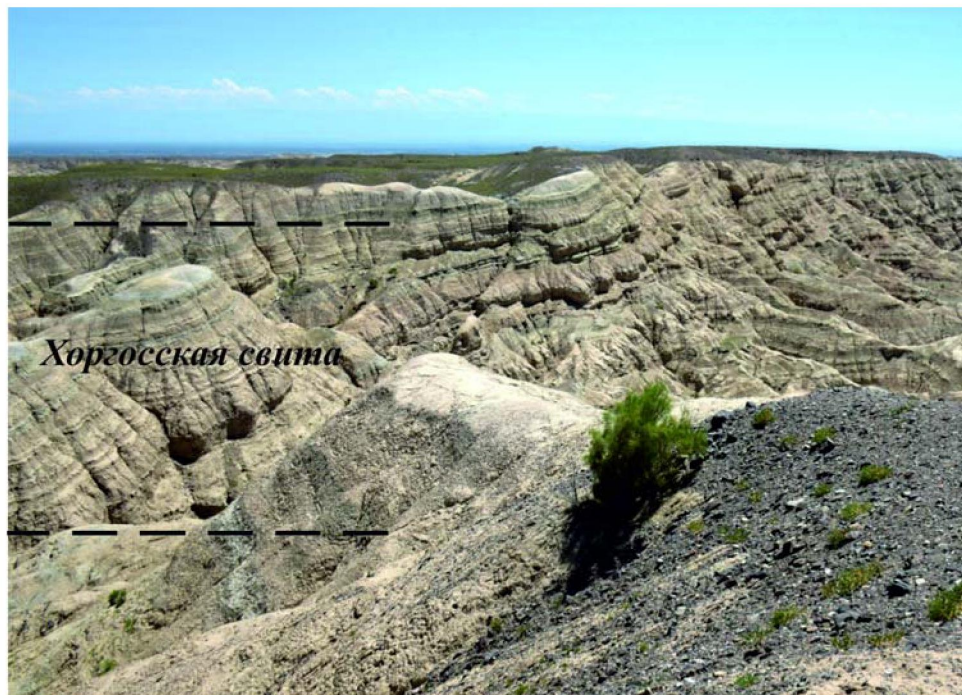


Figure 8 – Eopleistocene deposits at the site of Aktau, the Khorgos suite

The full section of the continental Cainozoic deposits, studied in the Aktau site, taking into account the 1961-2018 research materials, is shown in the figure 9. Thus, the Aktau site section can be considered as a basic stratigraphic section of the Southeast Kazakhstan, where the continental Cainozoic deposits of the region are represented consistently.

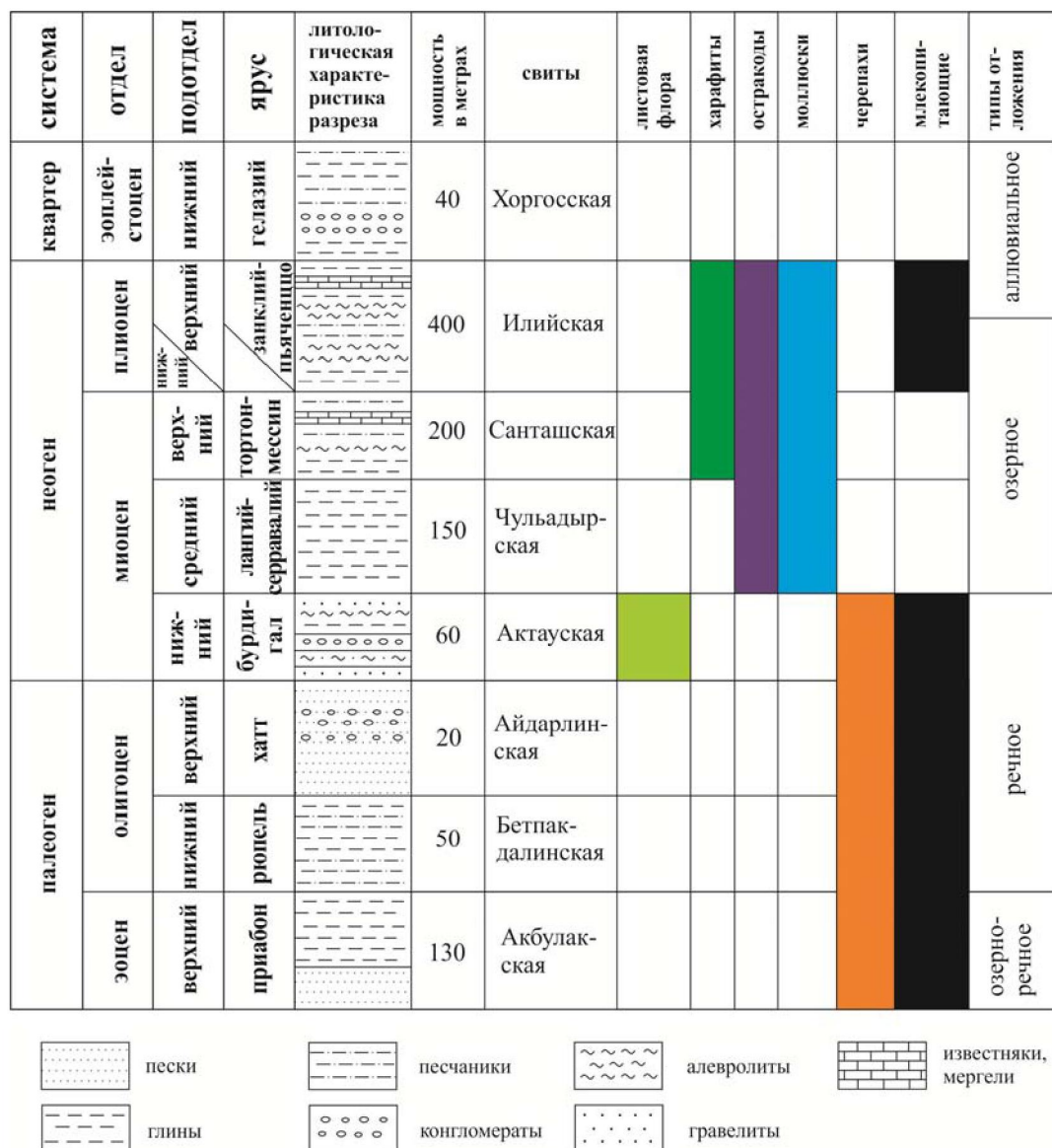


Figure 9 – Schematic cross-section of lithostratigraphic, paleontological characteristics, designations of suites and types of Aktau deposits

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С. А. Нигматова¹, Б. У. Байшашов¹, А. К. Жамангара², С. Лукас³, К. О. Баядилов⁴, А. Касымханкызы¹

¹К. И. Сәтбаев атындағы геологиялық ғылымдар институты, Алматы, Қазақстан,

²Л. Н. Гумилев атындағы Еуразия университеті, Астана, Қазақстан,

³Табиғат Тарихы Муражайы, Нью-Мехико, АҚШ,

⁴«Алтын-Емел» МҰС, Қазақстан,

АҚТАУ ТАУЛАРЫНЫҢ ҚҰРЛЫҚТЫҚ КАЙНОЗОЙ ШӨГІНДІЛЕРІНІҢ ТІРЕКТІ ҚИМАСЫНЫҢ БИОСТРАТИГРАФИЯСЫ БОЙЫНША ЖАҢА МӘЛІМЕТТЕР (ОҢТҮСТІК-ШЫҒЫС ҚАЗАҚСТАН, ІЛЕ ОЙПАТЫ)

Аннотация. ҚР БҒМ-нің «Орталық Азия шөгінді түзілімдерінің жетілдірілген стратиграфиялық шкаласын өңдеудің негізі ретінде Оңтүстік-Шығыс Қазақстанның кайнозой тіректі стратиграфиялық қималарын кешенді зерттеу» гранттық жобасы көмегімен ауқымды ғылыми және тәжірибелік маңызы бар тіректі кайнозой қималарын (палеогеннен квартерге дейін) жандандыру және қосымша зерттеу мүмкіндігі пайда болды.

Кайнозой түзілімдері қимасының нақты үлгісі «Алтын- емел» ұлттық табиғи паркі аумағындағы Іле ойпатында орналасқан Ақтау тауларында байқалады. Көп жылдық зерттеулерге қарамастан, оларды зерттеу қазіргі уақытқа дейін жалғасып келеді, бұл стратиграфиялық бөлу және Іле бассейнінің палеогеографиясы мен кайнозойдың фациалды ерекшеліктері, Солтүстік Тянь-Шаньның әртүрлі ойпаттарының палеоген-төрттік қималарының корреляциясына байланысты көптеген даулы мәселелерді шешу қажеттілігімен түсіндіріледі.

Мақалада Ақтау орнын палеонтологиялық зерттеу бойынша ең толық мәліметтер ұсынылған, оның ішіне моллюскалар, бауырымен жорғалаушылар, сүтқоректілер, жапырақты флора, хара балдырлар флорасы кіреді. Осы мәліметтер негізінде палеогенде – акбулак, бетпақдала және айдарлы свиталары, неогенде – ақтау, шөладыр және санташ свиталары, квартерде – қорғас свитасы анықталған.

Түйін сөздер: тіректі геологиялық қималар, биостратиграфия, палеонтология, кайнозой, палеоген, неоген, квартер, Оңтүстік- Шығыс Қазақстан, Ақтау таулары.

С. А. Нигматова¹, Б. У. Байшашов¹, А. К. Жамангара², С. Лукас³, К. О. Баядилов⁴, А. Касымханкызы¹

¹Институт геологических наук им. К. И. Сатпаева, Алматы, Казахстан,

²Евразийский университет им. Л. Н. Гумилева, Астана, Казахстан,

³Музей Истории Природы, Нью-Мехико, США,

⁴ТНПП «Алтын-Эмель», Казахстан

НОВЫЕ ДАННЫЕ ПО БИОСТРАТИГРАФИИ ОПОРНОГО РАЗРЕЗА КОНТИНЕНТАЛЬНЫХ КАЙНОЗОЙСКИХ ОТЛОЖЕНИЙ ГОР АҚТАУ (ЮГО-ВОСТОЧНЫЙ КАЗАХСТАН, ИЛИЙСКАЯ ВПАДИНА)

Аннотация. Благодаря грантовому проекту МОН РК «Комплексное изучение опорных стратиграфических разрезов кайнозоя Юго-Восточного Казахстана, как основы разработки усовершенствованной стратиграфической схемы осадочных отложений Центральной Азии» получена уникальная возможность актуализировать и провести доизучение опорных кайнозойских разрезов (от палеогена до квартера включительно), имеющих огромное научное и практическое значение.

Классический разрез кайнозойских отложений наблюдается в горах Ақтау, расположенных в Илийской котловине на территории национального Природного Парка «Алтын-Эмель». Несмотря на многолетние исследования, их изучение продолжается до настоящего времени, что диктуется необходимостью разрешения многих спорных вопросов стратиграфического расчленения и фациальных особенностей кайнозоя, палеографии Илийского бассейна, корреляции палеоген-четвертичных разрезов различных впадин Северного Тянь-Шаня.

В статье приводятся наиболее полные материалы по палеонтологическому изучению местонахождения Ақтау, включающие списки фауны моллюсков, пресмыкающихся, млекопитающих, листовой флоры, флоры харовых водорослей. На основе этих данных выделены в палеогене акбулакская, бетпақдалинская и айдарлинская свиты, в неогене – ақтауская, чульдырская, санташская и илийская свиты, в квартере – хоргосская свита.

Ключевые слова: геологические опорные разрезы, биостратиграфия, палеонтология, кайнозой, палеоген, неоген, квартер, Юго-Восточный Казахстан, горы Ақтау.

Information about authors:

Nigmatova S. A. – Institute of Geological Sciences named after K.I. Satpaev, Almaty, Kazakhstan; nigmatova@mail.ru; ORCID 0000 0002 3199 1658

Bayshashov B. U. – Institute of Geological Sciences named after K. I. Satpaev, Almaty, Kazakhstan; bolat.bayshashov@mail.ru; ORCID 0000 0001 8395 4384

Zhamangara A. K. – Eurasian University L. N. Gumilyov, Astana, Kazakhstan, kashagankizi@mail.ru; ORCID 0000 0002 2348 1171

Lucas S. G. – Museum of Natural History, Mexico, USA; slucas@nmmnh.state.nm.us; ORCID 0000 0002 0407 9276

Bayadilov K. O. – Alтын-Emel State National Park, Kazakhstan; altynemel.kadr@mail.ru; ORCID 0000 0001 7349 0440

Kasymkhankyzy A. – Institute of Geological Sciences named after K. I. Satpaev, Almaty, Kazakhstan; almashok88@mail.ru; ORCID 0000 0001 8908 2409.