PalArch's Journal of Archaeology of Egypt / Egyptology

NEW DATA ON DEVONIAN STRATIGRAPHY AND CONODONTS OF KULDZHUKTAU MOUNTAINS, UZBEKISTAN

Davlatov N.X.[1], Kim I.A.[2], Erina M.V.[3], Samiev A. A.[4], Yusupov A. B.[5]

[1,] SUE 'Regionalgeology', State Committee of the Republic of Uzbekistan on Geology and Mineral Resources, 21 Mustakillik Street, 1111800, Eshonguzar, Uzbekistan;

[2,] SUE 'Regionalgeology', State Committee of the Republic of Uzbekistan on Geology and Mineral Resources, 21 Mustakillik Street, 1111800, Eshonguzar, Uzbekistan;

[3] SUE 'Regionalgeology', State Committee of the Republic of Uzbekistan on Geology and Mineral Resources, 21 Mustakillik Street, 1111800, Eshonguzar, Uzbekistan;

[4,] Mirzo Ulugbek National University of Uzbekistan, Faculty of Geology and Geographic Information Systems;

[5] Mirzo Ulugbek National University of Uzbekistan, Faculty of Geology and Geographic Information Systems;

Davlatov N.X.[1], Kim I.A.[2], Erina M.V.[3], Samiev A. A.[4], Yusupov A. B.[5], New data on Devonian stratigraphy and conodonts of Kuldzhuktau Mountains, Uzbekistan– Palarch's Journal of Archaeology of Egypt/Egyptology 17(9) ISSN 1567-214X.

Keywords: Devonian, stratigraphy, conodonts, sedimentology, carbonate platform, Uzbekistan.

Fundamental revision of geology, sedimentology and biostratigraphy of the Devonian deposits exposed in the Kuldzhuktau Mountains, has been resulted in substational upgrade of the regional lithostratigraphy, including re-definition of the age, boundaries and spatial relationships of the local lithostratigraphical units. The detailed Devonian conodont biozonal scale is elaborated and applied for correlation of the locally developed formations with the regional and international chronostratigraphical scales. The Turkmenkazgan Strata was newly introduced for the Upper Devonian succession of carbonates. It was confirmed that Devonian deposits of the Kuldzhuktau Mountains represent strongly tectonized, dispersed and dismembered remnants of the carbonate platform interior, carbonate platform slope and surrounding basin.

Introduction

Traditionally, biostratigraphy of the Devonian deposits exposed in Uzbekistan was mainly based on representatives of the benthic fauna, e. g. the stromatoporoid sponges, rugose and tabulate corals, brachiopods, crinoids, and occasionally on the goniatite ammonites and fish remains (Kim et al., 2008 and references herein). The application of the conodonts for the Devonian stratigraphy was for a long time confined mainly to the Zeravshan-Hissar Mountain Region. It was started with pioneering studies of Mashkova (1978,

1981) and Apekina (1981, 1984), and subsequently continued by Erina in Kim et al. (2008) and Elkin et al. (2008).

The lithostratigraphic and biostratigraphic subdivision of the Devonian deposits outcropping in the Kuldzhuktau Mountains was developed in course of extensive geological mapping of the area about half a century ago. At that time the age of the lithostratigraphic units was mainly based on the benthic fossil assemblages, including stromatoporoids corals, brachiopods, crinoids, which exhibit a strong biofacies differentiation (Fig. 1).

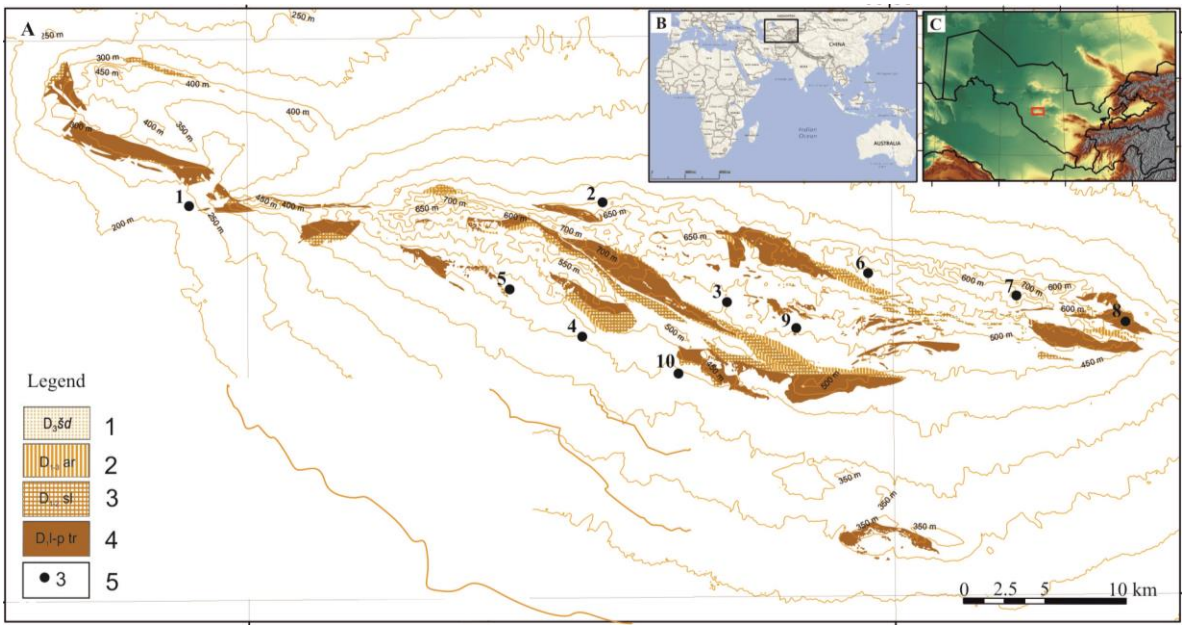

Figure 1. A. Schematic geological map showing geographical distribution of the Devonian deposits in the Kulzhuktau Mountains and position of the studied sections discussed in the paper. B. Schematic geographical map showing position of Uzbekistan. C. Satellite image of Uzbekistan showing location of the Kulzhuktau Mountains. Legend: 1 - Shaydaraz Formasion; 2 - Arapkazgan Formasion; 3 - Sultanbibi Formasion; 4 - Turkmentau Formasion; 5- Research area: 1-Dzhangeldy Village; 2-Shaidaraz Well; 3-Sultanbibi Well; 4-Uchkuduk Well; 5-Tozbulak Well; 6-Izakuduk Well; 7-Bashguzhumdy Mountain; 8-Guzhumdy Mountain; 9-Arapkazgan stream; 10-Botanical Research Station.

It creates problems in definition of relative stratigraphical position of the lithostratigraphic units and their correlation with the Global Chronostratigraphical Time Scale (Aisanov and Egorov, 1978) and was further complicated by the complex regional geology. Only recently, when conodont biostratigraphy was consistently applied for the subdivision and correlation of local lithostratigraphical units, high resolution intraregional and global correlation becomes possible (Davlatov and Erina, 2018; Davlatov et al., 2019; Kim et al., 2019). A major objective of the present paper is to outline first results of the fundamental revision of the Devonian geology and stratigraphy of the Kuldzhuktau Mountains. The paper is focused on the conodont biostratigraphy, while details of sedimentological studies will be a subject of a separate publication.

Materials and methods

The conodont collection used in the present study was sampled from seven individual sections, located at the Shaydaraz, Bashguzhumdy, and

Sultanbibi areas, Uchkuduk, Dzhangeldy, Kyngyrtau and Tozbulak Devonian outcrop areas, during the fieldworks undertaken by the authors between 2015 and 2018. Total 1093 samples, varying in weight from 1 to 1.5 kg, were taken in course of bed by bed sampling, 213 of them were productive for microfossils, including conodonts. Sampling for microfossils was supported by detailed geological and sedimentological observations. The limestone samples were dissolved in dilute (10–15%), buffered acetic acid and after washing in a neutral medium, a residue was handpicked without using heavy liquid separation. Then the specimens of selected biostratigraphically indicative taxa were photographed using stereoscopic binocular microscope (MBS-10) at the photolaboratory of the Stratigraphical Party (SUE 'Regionalgeology').

The conodont collection, including the photographed specimens, is deposited in the Geological Museum of the State Committee on Geology and Mineral Resources of the Republic of Uzbekistan, Tashkent (MGCU) under the accession number 1141.

Updated Devonian stratigraphy of Kuldzhuktau Mountains

The Devonian marine deposits are widespread and well exposed within the Kuldzhuktau Mountains as several folded individual blocks of sublatitudinal strike (Fig. 1) strongly affected by the compressional tectonics. They constitute a tectonically dismembered and dispersed, but more or less continuous succession of variable carbonate and siliceous-carbonate deposits. According to Mirkamalov et al. (2020) the Kuldzhuktau Mountains are the integral part the Zeravshan-Alpine fold-thrust belt which is incorporated in the southwest Tien Shan fold system.

The best Devonian exposures are located at the Beltau and Guzhumdy mountains, in the vicinity of the Dzhangeldy Village, the Uchkuduk, Shaydaraz, Sultanbibi, Arapkazgan, Izakuduk and Bashguzhumdy wells; some isolated exposures of sedimentary rocks of that age are also documented at the areas of the Tuzkoi and Kyngyrtau heights. No stratigraphical contacts with adjacent Silurian and Carboniferous deposits yet documented.

The Devonian lithostratigraphy of the Kuldzhuktau Mountains first elaborated by Aisanov (in Aisanov and Egorov 1978), then it was updated during the aerogeological mapping of the area undertaken in 1984. Subsequently these lithostratigraphic units were formalized in the Stratigraphic Dictionary of Uzbekistan by Abduazimova and Kim (2001) as it is shown on Fig. 2. Consequently, the Devonian succession is presently subdivided into the Lower Devonian Turkmentau Formation, the Lower to Middle Devonian Sultanbibi Formation, the Lower to Upper Devonian Arpakazgan Formation, the Upper Devonian Beltau and Shaidaraz formations, and the Turkmenkazgan Strata, representing lithofacies of the carbonate platform, carbonate platform slope, outer shelf and basin, as it is discussed below.

Turkmentau Formation (D_1l-p tr)

The Turkmentau Formation (Lower Devonian, Lochkovian – Pragian) consists of variably bedded, nodular, dark-gray micritic limestones, total up to 430 m thick. It was deposited in the

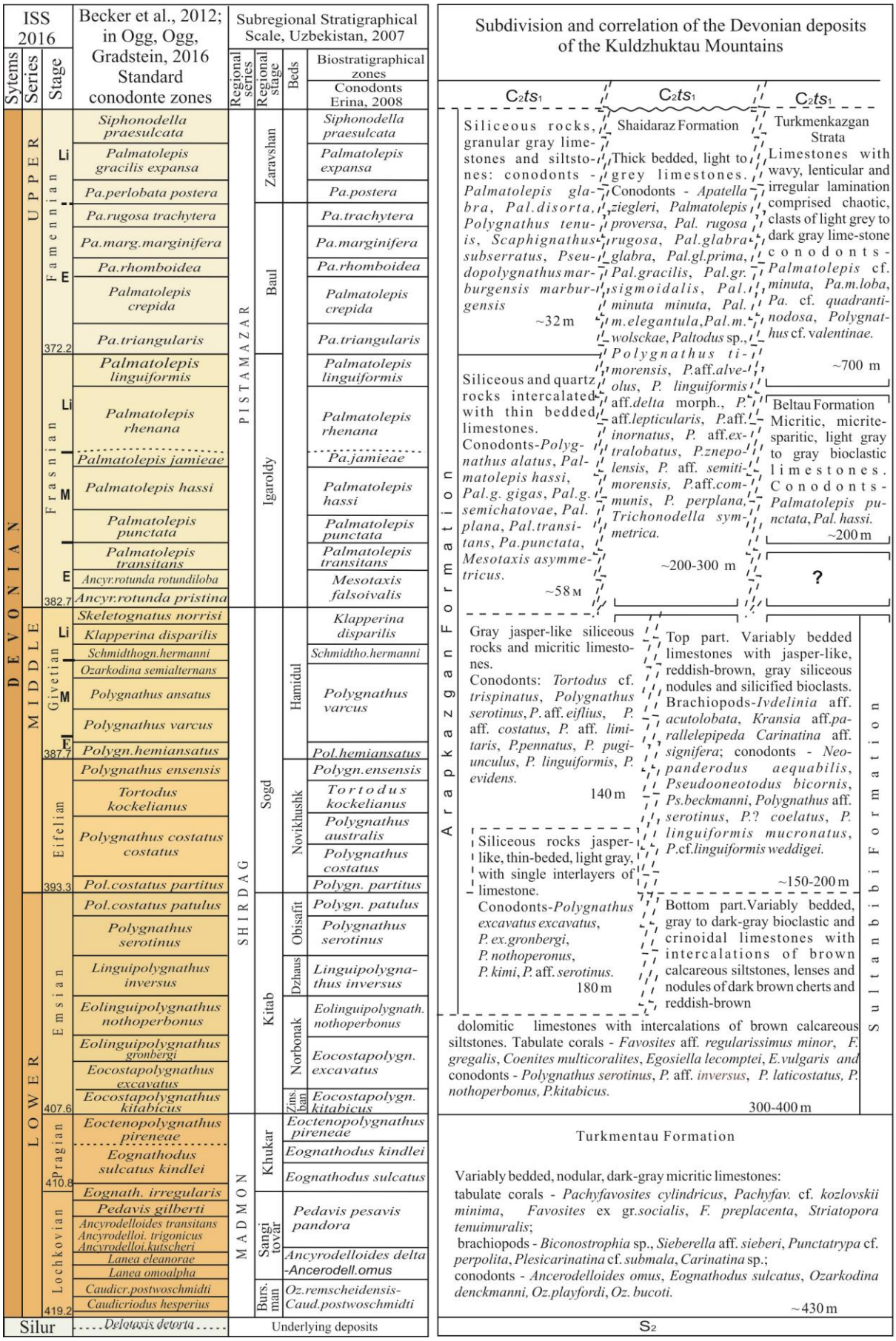

Figure 2. Correlation chart showing the lithostratigraphical subdivision of the Devonian deposits in the Kulzhuktau Mountains and their correlation with the Devonian conodont biozones, regional and international chronostratigraphic scales

shallow marine environment of the carbonate platform interior. The unit has a restricted distribution at the western part of the Kuldzuktau Mountains, on the southern slopes of the Beltau Mountains and Tuzkoi heights, west and east of the Dzhangeldy Village, west of the Tozbulak granitic massif, and south-east of the Bashkuzhumdy Well at the Kuldzhuktau Mountains. The Turkmentau Formation has faulted contacts with the upper Silurian rocks and is overlain conformably by the Lower to Middle Devonian Sultanbibi Formation. Characteristic faunal assemblage (Fig. 2) includes the tabulate corals Favosites ex gr. socialis Sokolov, Favosites preplacenta Dubatolov, Pachyfavosites cylindricus Yanet, Pachyfavosites ex gr. kozlovskii Sokolov and Striatopora tenuimuralis Mironova which are confined in their stratigraphical distribution elsewhere to the Lochkovian - Pragian, the brachiopods - Sieberella aff. sieberi (Buch), Punctatrypa cf. perpolita (Khodalevich), Plesicarinatina cf. submala (Khodalevich), which are known from the Lochkovian - Emsian; the conodonts - Belodina sp., Icriodus sp., Hindeodella sp., Panderodus sp., Paltodus sp. and Eognathodus sulcatus Philip. The latter species is indicative of the Pragian Age.

The Lower Devonian Turkmentau Formation was introduced by Aisanov and Egorov (1978). Originally it was subdivided into three members, including: (1) up to 150 m of dark grey to black limestones with the Early Devonian benthic fauna; (2) up to 300 m of white to light gray limestones with subsidiary dolomite beds; (3) up to 250 m of brecciated, light gray massive limestones. Based on updated conodont biostratigraphy the Early Devonian age has been confirmed only for the Turkmentau Formation lower member, which contains conodont assemblages of the Lochkovian to Pragian Age, while the Turkmentau Formation middle and upper members contain the Late Devonian (Famennian) conodonts. Taking in mind different lithology and age, both these units are excluded from the Turkmentau Formation and assigned to the newly introduced Turkmenkazgan Strata.

Sultanbibi Formation (D_{1-2} sl)

The Sultanbibi Formation was introduced by Aisanov and Egorov (1984) and originally it was assigned to the Emsian Stage. The unit is outcropping along the western margin of the Beltau Mountains, west and east of the Dzhangeldy Village, west of the Tozbulak granitic massif, at the areas of the Aktosty, Izakuduk, Sultanbibi and Uchkuduk wells, in the Arpakazgan stream basin and at the Guzhumdy Mountain (Fig. 1). Originally it was suggested that Sultanbibi Formation rests conformably on the Turkmentau Formation west of the Tozbulak granitic massif (Aisanov and Egorov 1984), which is not confirmed by our study. Its upper contact with the Devonian Arpakazgan Formation is invariably faulted. The rocks of the Sultanbibi Formation, total 400-500 m thick, are strongly affected by tectonic deformations, intensively folded and faulted (Fig. 3).

Figure 3. Natural exposure of the Sultanbibi Formation lower part northwest of the Uchkuduk Well showing a complex character of tectonic deformations

The Sultanbibi Formation can be subdivided into two informal members (Fig. 2). The lower member, c. 300-400 m thick, consists of reddish-brown dolomitic limestones succeeded upsection by variably bedded, gray to dark-gray bioclastic and crinoidal limestones with intercalations of brown calcareous siltstones, lenses and nodules of dark brown cherts. The unit contains abundant fossils including the tabulate corals Favosites calioporoides Kim, F. gregalis Porfiriev, F. ex gr. karpinskyi Yanet, F. sublatus Dubatolov, Fossoporella hamidulica Kim, Oculipora zeravshanica Kim, Pachyfavosites rariporosus Dubatolov, Pachyfavosites. ex gr. preplacenta (Dubatolov), Paraheliolites vulgaris (Tchernychev), Pachycanalicula ex gr. dentata Mironova, Squameofavosites obliquespinus (Tchernychev) indicative of the Emsian age; the brachiopods Areostrophia sp., Atrypa sp., Biconostrophia sp., Carinatina sp., Chonetes sp., Gypidula sp., Eospirifer sp., Howellella sp., Hysterolites sp., Schizophoria sp., Spirigerina sp., and the conodonts Eognathodus sulcatus Philip, Ozarkodina boucoti Klapper, O. prolata Mawson, Polygnathus kitabicus Yolkin et al., P. nothoperbonus Mawson, P. excavatus excavatus Carls & Gandl, P. excavatus gronbergi Klapperet & Johnson, P. inversus Klapper & Johnson, P. kimi Mashkova & Apekina, P. laticostatus Klapper & Johnson, P. pannonicus Mashkova & Apekina, P. serotinus Telford, indicative for the Emsian kitabicus and patulus conodont biozones.

The Sultanbibi Formation upper member has a relatively restricted distribution east of the Dzhangeldy Village, north of the Uchkuduk Well, southwest and south of the Izakuduk Well, and at the eastern part of the Guzhumdy Mountain (Figs. 1, 2). It comprises grey, bedded micritic and sparitic limestones, occasionally argillaceous and dolomitic with thin layers of brown argillaceous limestone along the bedding surfaces, total 150-200 m thick. Subsidiary beds (varying in thickness from 0.5 to 6 cm), lenses (up to 20 cm thick and 1.5 m wide) and nodules of reddish brown and pinkish cherts are also characteristic (Fig. 4).

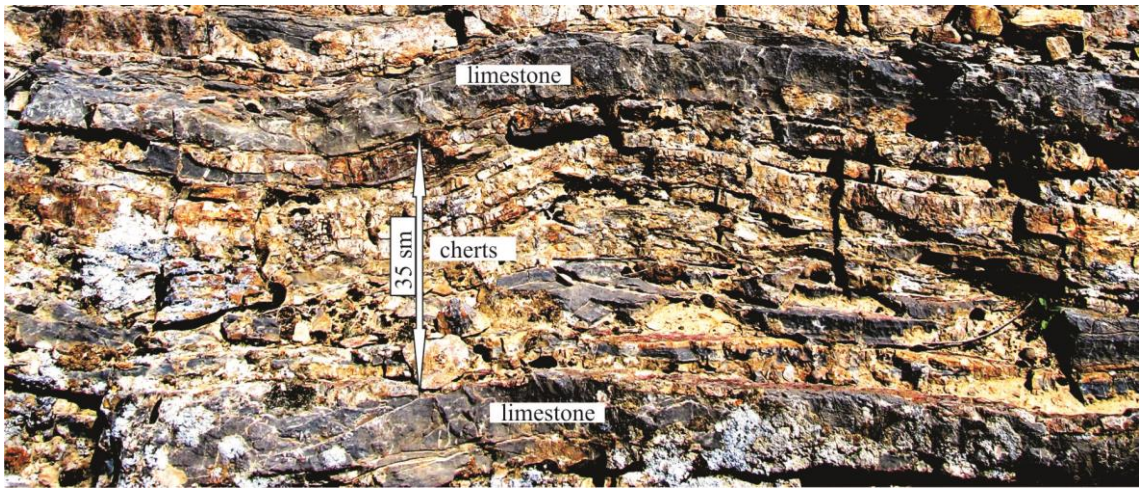

Figure 4. Natural exposure of the Sultanbibi Formation upper part at the eastern Guzhumdy Mountain

The lowermost part of the Sultanbibi Formation upper member best exposed in the tectonic blocks located east of the Dzhangeldy Village and south of the Izakuduk Well (Fig. 1). Here it consists of bioclastic limestones with poorly preserved tabulate corals assigned to Coenites sp., Thamnopora sp., Crassialveolites sp. Associated conodont assemblage includes Hindeodella priscilla Stauffer, Pandorinellina steinhornensis miae Bultynck, Polygnathus ziglerianus Weddige, P. aff. limitaris Ziegler & Klapper, P. aff. costatus Klapper, P. pugiunculus Mawson, P. inversus Klapper et Johnson, P. serotinus Telford, P. aff. parawebbi Chatterton, P. aff. eiflius Bischoff et Ziegler, P. aff. linguiformis sub sp. indet.

The upper part of the Sultanbibi Formation upper member is best exposed at the eastern part of the Guzhumdy Mountain (Fig. 1). Here it comprises bioclastic limestones with intercalations of argillaceous limestones, thin beds, lenses and nodules of cherts. Limestones contain a few poorly preserved fragments of colonies of the stramatoporoid sponges and tabulate corals. The associated conodont assemblage includes Belodella cf. resima (Philip) Neopanderodus aequabilis Telford, Panderodus sp., Polygnathus aff. serotinus Telford, Pseudooneotodus beckmanni Bischoff & Sannemanni, Pseudooneotodus bicornis Drygant characteristic of the Emsian to Givetian serotinus and ensensis conodont biozones. This fauna is replaced upsection by another assemblage, including Polygnathus? coelatus Bryant, P. linguiformis mucronatus Wittekindt, P. linguiformis linguiformis Hinde (gamma morphotype), and P. cf. linguiformis weddigei Leuteritz & Ziegler. In North America (Genesse Formation) similar conodont association is characteristic of the varcus - asymmetricus biozones (Givetian to lower Frasnian). Similar conodont associations were reported also from the Devonian deposits of that age in Morocco and Germany. The uppermost conodont assemblage includes Polygnathus aff. linguiformis linguiformis Hinde, P. aff. linguiformis Hinde, P. linguiformis pinquis Weddige, P. aff. uyenoi Bardashev, P. collieri Aboussalam & Becker Mophotype 2, which are characteristic elsewhere for the transitional Givetian to lower Frasnian boundary beds. Based on the new data conodont biostratigraphy the age Eifelian to Givetian age of the deposits assigned to the Sultanbibi Formation is firmly established, also the Upper Devonian (Frasnian) age of the uppermost part of the formation is also possible, but requires additional confirmation.

Arapkazgan Formation (D_{1-3} ak)

The Arapkazgan Formation was named by Aisanov and Egorov (1978) and originally considered as having the Eifelian - Givetian age. It comprises mainly carbonate rocks with subsidiary cherts and siliciclastic deposits, which form a number of isolated strongly tectonically dislocated blocks with faulted contacts. The unit exposed as isolated tectonic blocks located east of the Dzhangeldy Village, north of the Uchkuduk Well, south of the Aktostt, Sultanbibi, Turkmenkazgan and Izakuduk wells, in the Arapkazgan river basin and at the Rishak heights. (Figs. 1, 2). According to Aisanov and Egorov (1978) the Arapkazgan Formation has stratigraphical contacts with the Sultanbibi Formation; however, it is not confirmed by our field observations and in all observed cases the lower and upper contacts of the unit with Sultanbibi and Taushan formations are faulted (Fig. 1). Estimated thickness of the Arapkazgan Formation is 300-330 m.

Recent geological studies of the Kuldzhuktau Mountains supported by the new data on the conodont biostratigraphy make possible to build a composite stratigraphical succession of the Arapkazgan Formation, as well as to review its age, spatial extension, sedimentology and characters of lithofacies changes.

The lowermost part of the formation is best exposed in several isolated blocks between the Arapkazgan stream basin at the west and the area of the Izakuduk Well at the east, with the maximum thickness up to 180 m observed within the area of the Arapkazgan stream (Figs. 1, 2, 5). The succession consists of thin to medium bedded cherts and jaspers with subsidiary beds of light gray, thin bedded, micritic, platy limestones and reddish-gray calcareous siltstones. This part of the Arapkazgan Formation is easily recognizable due to its distinct lithology and predominantly white to light grey color of sediments (Fig. 5). The late Emsian conodont fauna recovered from the unit at the area south of the Izakuduk Well comprises Polygnathus excavatus excavatus Carls & Gandl, P. nothoperbonus Mawson, P. inversus Klapper & Johnson, P. aff. serotinus Telford, P. kimi Mashkova & Apekina which are characteristic for inversus to serotinus biozones. Thus, it is considered as synchronous to the Obisafit Beds of the Zeravshan – Gissar Mountinous Region.

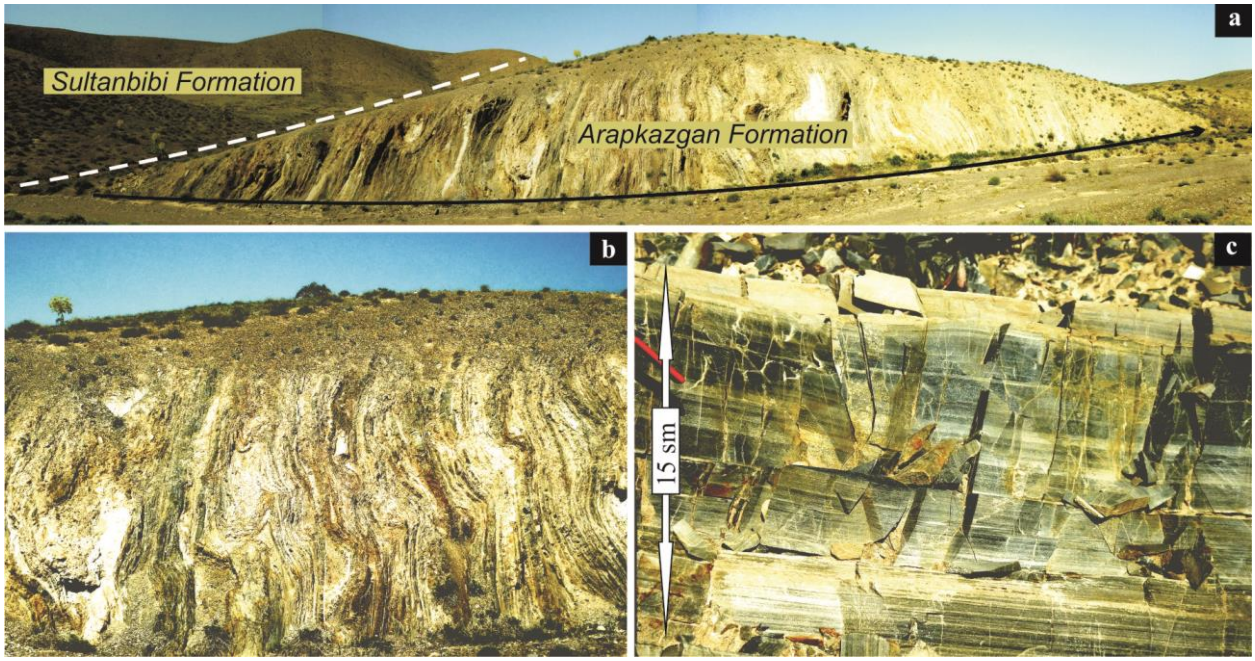

Figure 5. Field photographs of the Arpakazgan Formation lower part on the right hand side of the Arpakazgan stream: a, general view of the natural outcrop; b, enlarged view of fold deformations in bedded cherts; c, faint lamination in gray cherts

The middle part of the Arapkazgan Formation is exposed east of the Dzhangeldy Village, north of the Uchkuduk Well and south of the Izakuduk Well where it is up to 140 m thick (Figs. 1, 2). It consists of cherts and variably bedded limestones with siliceous nodules and silicified bioclasts. The Eifelian - Givetian age of the formation is supported by the rich conodont fauna, including Hindeodella priscilla Stauffer, Neopanderodus aequalis Telford, Polygnathus aff. eiflius Bischoff & Ziegler, P. aff. limitaris Ziegler & Klapper, P. aff. costatus Klapper, P. cf. serotinus Telford, P. linguiformis subsp. indet, P. pugiunculus Mawson, P. evidens Klapper & Lane, Tortodus cf. trispinatus Abussalam, Webbinelloidea? sp. suggesting partitus - disparilis biozones. It is succeeded by a somewhat younger assemblage, including such taxa as Nothognatella sp., Polygnathus dubius Hinde, P. pennatus Hinde, P. subsymmetricus Aboussalam & Becker, which are characteristic for the Givetian – Frasnian boundary beds in Europe and North America.

The Upper Devonian part of the Arapkazgan Formation is outcropping east of the Dzhangeldy Village and at the area of the Izakuduk Well (Figs 1, 2). Its lower, Frasnian part consists of detrital limestones intercalated with thin bedded black cherts and jaspers and reddish-brown calcareous siltstones, total up 58 m thick, with conodonts Enantiognatus? gantharii Ziegler, Klapperina disparalvea (Orr & Klapper), Mesotaxis falsiovalis Sandberg, Ziegler & Bultynck, M. asymmetricus (Bischoff & Ziegler), Tischoff et Ziegler Neoprioniodus alatus Hinde, Nothognatella magna Tchernysheva, N. aff. ziegleri (Clark & Ethington), Palmatolepis barba Ziegler & Sanderg, P. aff. ederi Ziegler & Sanderg, P. gigas gigas Muller & Joungquist, P. gigas semichatovae Ovnatanova, P. hassi Muller & Muller, P. kireevae Ovnatanova, P. cf. kleyserlingi Kuzmin, P. aff. limitaris Ziegler & Klapper, P. mucronata Klapper, Kuzmin & Ovnatanova, P. muelleri Klapper & Foster, P. orbicularis Ovnatanova & Kuzmin, P. orlovi Khruscheva & Kuzmin, Pl. ormistoni Klapper, Kuzmin & Ovnatanova, P. plana Ziegler et Sandberg, P. punctata

(Hinde), P. rhenana rhenana Bischoff, P. rhenanua marija Huddle, P. aff. subrecta Muller & Joungquist, P. transitans Muller, Polygnathus aequalis Klapper & Lane, P. alatus Haddle, P. dengleri Bisch & Ziegler, P. dubius Hinde, P. gracilis Klapper & Lane, P. housei Aboussalam, P. linguiformis subsp. indet., P. aff. morgani Klapper & Lane, P. pennatus Hinde, P. aff. timorensis Klapper, Philip & Jackson, and P. uchtensis Ovnatanova & Kuzmin.

The uppermost, Frasnian part of the Arapkazgan Formation has a limited distribution east of the Dzhangeldy Village where it is exposed as narrow strips along the fault separating the unit from the siliciclastic rocks of the Carboniferous Taushan Formation. Characteristic lithologies are gray, thin to thick bedded detrital limestones intercalated with gray to dark-gray bedded and laminated cherts and jaspers, and siliceous-calcareous shales. Conodont fauna, recovered from this deposits, includes Palmatolepis inflexoides Ziegler, P. schleizia Helms, Polygnathus sp. Indet., and Pseudopolygnathus marburgensis marburgensis Biscoff & Ziegler, characteristic for the rhomboidea - postera biozones in Europe and Central Asia.

Beltau Formation (D_3 bl)

The Beltau Formation is exposed southeast of the Bashguzhumdy Well and northwest of the Dzhangeldy Village (Figs. 1, 2) as scattered narrow strips of sub-latitudinal strike with faulted contacts. Its best section located southeast of the Bashguzhumdy Well (Figs. 2). It consists of thin to medium bedded, micritic, micrite-sparitic, light gray to gray bioclastic limestones with late Famennian conodonts, like Palmatolepis hassi Muller et Muller and P. punctata (Hinde). When the Beltau Formation first introduced by Aisanov and Egorov (1978) its age was considered as early Carbonifierous (Tournaisian); however, after the formal approval the position of the lower boundary of the Tournaisian Stage and Carboniferous System at the base of the Siphonodella sulcata by IUGS, the age of the formation was reconsidered as the late Famennian.

Shaidaraz Formation (D_3 šd)

The Shaidaraz Formation was introduced by Aisanov and Egorov (1978) for the Upper Devonian sediments exposed in the isolated tectonic blocks 2 km southwest of the Shaydaraz Well, where it has faulted contact with the Carboniferous Taushan Formation. Here the Shaidaraz Formation is represented by thick bedded, light to grey limestones about 100 m thick with abundant echinoderm ossicles. Subsequently it was found that rocks of the Shaidaraz Formation have a patchy distribution as small blocks with faulted contacts within the outcrop area of the Lower Devonian Turkmentau Formation at the vicinity of the Shaydaraz Well (Figs. 1, 2, 6), where it consists of variably bedded, gray and light-gray to white limestones, slightly affected by metamorphism with estimated thickness approaching 400-500 m. Occasional conodonts recovered from the unit are represented by such taxa as Palmatolepis cf. proversa Ziegler, and Paltodus sp. suggesting the Frasnian age within falsiovalis - linguiformis biozones.

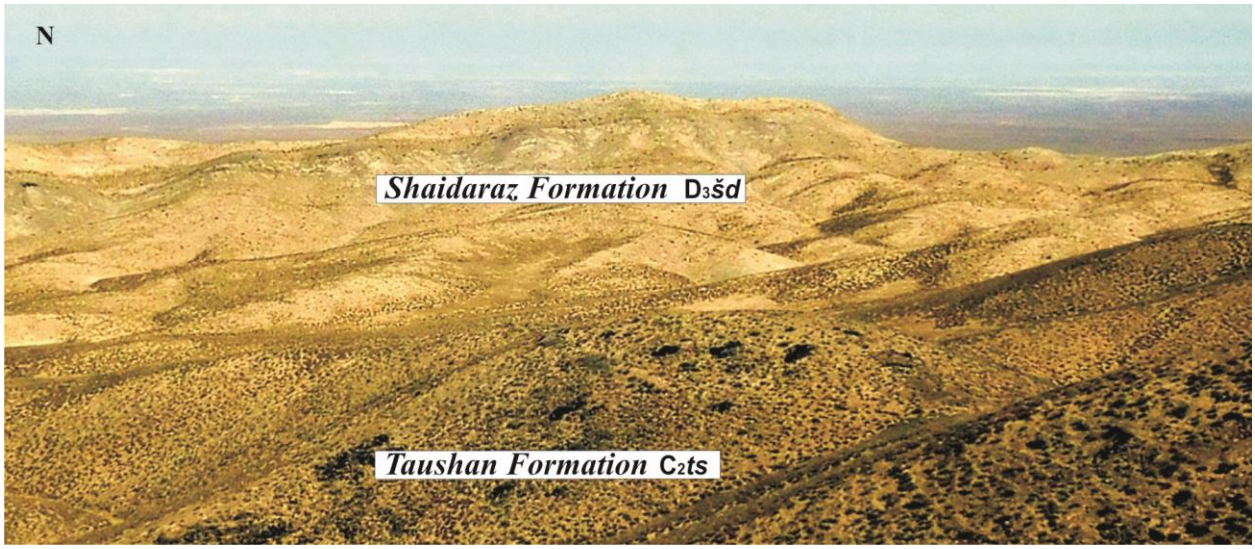

Figure 6. Natural exposure of the Shaidaraz Formation west of the Shaidaraz Well

The Shaydaraz Formation is also present at the eastern part of the Kuldzhuktau Mountains, east of the Bashguzhumdy Mountain where it forms a carbonate massif on the summit of the height 716.0 m (Fig. 7), which is build of light gray, medium to thick bedded, marbleized limestones with lenses of echinoderm limestone, total up to 200 m thick.

These limestones contain the Famennian conodonts, including Nothognatella sp., Palmatolepis glabra glabra Ulrich & Basler, P. aff. glabra Ulrich & Basler, P. glabra prima Ziegler & Haddle, P. gracilis sigmoidalis Ziegler, P. minuta minuta Branson & Mehl, P. minuta elegantula Wang & Ziegler, P. minuta wolsckae Szulezewski, P. rugosa rugosa Branson & Mehl, Polygnathus aff. communis (Branson & Mehl), P. perplana Branson & Mehl, P. znepolensis Spassov, P. znepolensis Spassov, and Trichonodella (Branson & Mehl).

Turkmenkazgan Strata (D_3 tk)

The Turkmenkazgan Strata is here designated for a variety of carbonate deposits originally included into the Turkmentau Formation by Aisanov and Egorov (1978) as the middle and upper

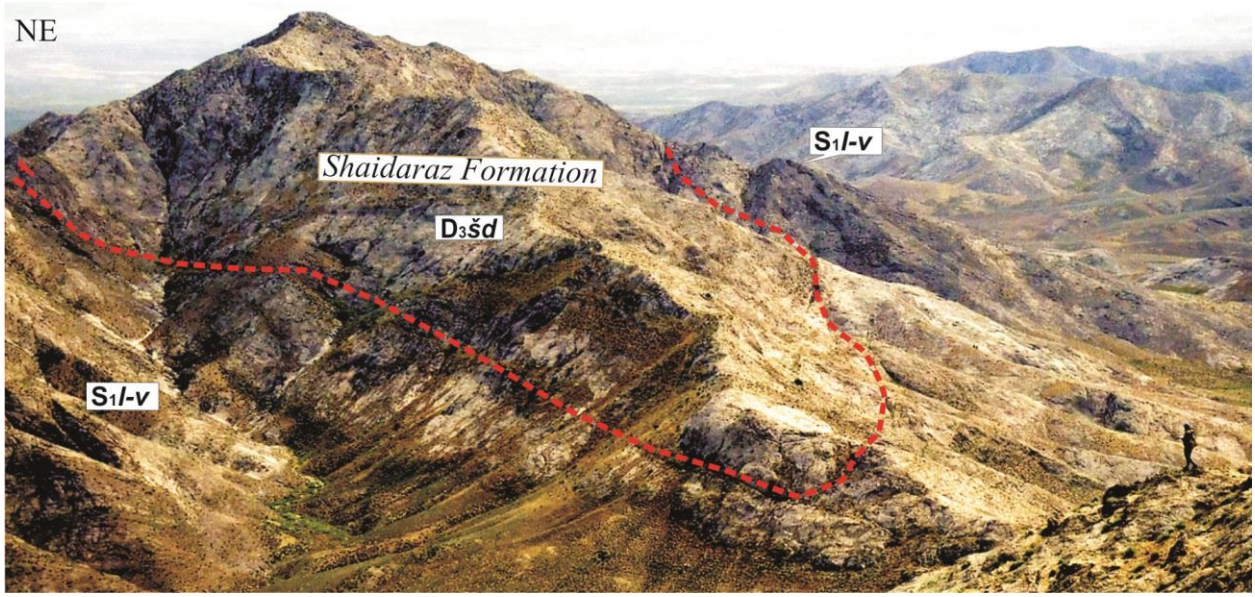

Figure 7. General view of the natural outcrop of the Shaidaraz Formation east of the Bashguzhumdy Well

members. By analogy with the lower member their age was conditionally considered as Early Devonian (Pragian). The unit is named after the Turkmenkazgan Well [geographic coordinates: 40º45'34.20"N, 63º51'28.27"E], situated on the southern slope of the Kuldzhuktau Mountains. The Turkmenkazgan Strata is strongly tectonized and exposed west and east of the Dzhangeldy Village, north of the Uchkuduk and Ayakgujumli wells, west of the Shaydaraz Well, south of the Aktosty and Sultanbibi wells, in the Turkmentag and Guzhumdy mountains (Figs. 1, 2) as exotic blocks about 0.7-1.2 km wide and 5-12 km long with faulted contacts. Stratigraphical contacts with underlying and overlying deposits are yet unknown. The Turkmenkazgan Strata includes white, grey to light grey 'patterned' and spotted limestones with wavy, lenticular and irregular

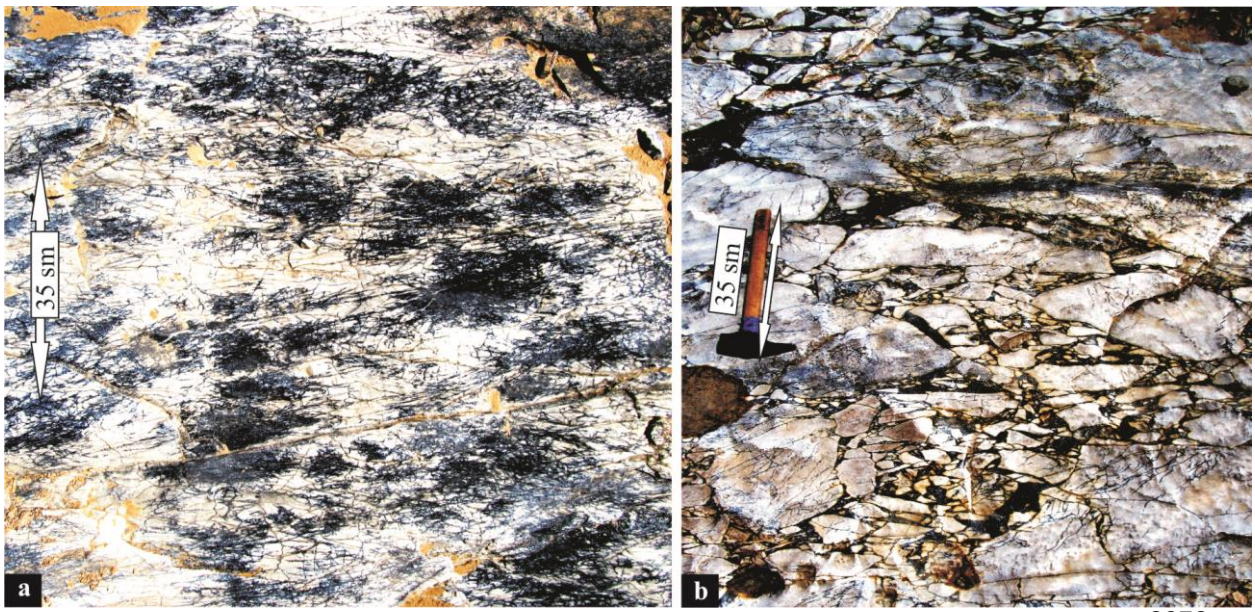

Figure 8. 'Atterned' limestone (a) and intraformational breccia (b) of the Turkmenkazgan Strata north of the Uchkuduk Well

lamination comprised chaotic, angular and subangular clasts of white, light grey to dark gray limestone, varying in size from 0.05 to 1.5 m and included in the carbonate matrix (intraformational breccia) (Fig. 8).

Estimated thickness of the Turkmenkazgan Strata approaches 1000 m. Characters of lithofacies suggest that the unit was formed on the slope of a collapsing carbonate platform. The Late Devonian age is confirmed by sporadic occurrences of conodonts in the matrix, including Palmatolepis cf. quadrantinodosa Branson & Mehl, P. cf.minuta Branson & Mehl, Polygnathus cf.valentinae Kuzmin, P. minuta loba Helms.

Discussion

The Kuldzhuktau Mountains is the region with complex geological history. Its Paleozoic rocks are strongly affected by the compressional tectonics, expressed in extensive folding and faulting, development of thrust faults, shearing zones, olistostromes, tectonic and sedimentary mélanges. Not surprisingly, when the first litostratigraphic subdivision of the Devonian deposits was here introduced about half a century ago, time and spatial relationships between individual units were poorly understood. The studies curried out by our research team for the first time demonstrated that the Devonian deposits in the region were dismembered and displaced parts of the carbonate platform interior, carbonate platform slope and surrounding basin. The discovery of diverse and locally rich conodont faunas were a key factor in this research. A relatively complete succession of the Devonian conodont biozones was reconstructed. Application of the conodont biostratigraphy was helpful in precise determination of the age of individual lithostratigraphical units, their stratigraphical relationships and correlation with the regional and international geochronological time scales. It was also demonstrated that previously reported stratigraphical relationships between some Devonian formations cannot be confirmed and their contacts are invariably faulted.

In particular, significant changes made to original interpretation of the Turkmentau Formation, which is clearly recognized as heterogeneous unit. The Early Devonian (Lochkovian – Pragian) age is confirmed only for the lower member of the Turkmentau Formation, as defined Aisanov and Egorov (1978), which was deposited within the carbonate platform interior. Two upper members are deposits of the carbonate platform slope. They are strongly tectonized, and have a different, Late Devonian age, their estimated thickness approach 1000 m, which differs considerably from the original estimates. Here the Turkmentau Formation middle and upper members are excluded from the unit and assigned to the Turkmenkazgan Strata, which is a new lithostratigraphical subdivision introduced for

a thick succession of strongly dislocated Upper Devonian deposits formed on the slope of the carbonate platform.

The age and spatial distribution of the Sultanbibi Formation are also revised considerably. While originally these sediments dated as Emsian (Aisanov and Egorov, 1978), they contain conodont faunas indicative for the Emsian, Eifelian and Givetian stages. Also based on sedimentological features, in particular abundance of cherts, the Devonian strata at some tectonic blocks previously mapped as the Arapkazgan Formation are re-assigned to the Sultanbibi Formation.

The Arpakazgan Formation is a lithologically distinct, but strongly dismembered unit deposited in the basinal environment. Based on the newly obtained data on the conodont biostratigraphy it is now possible to reconstruct the composite succession and to define the age of the unit in a broad stratigraphic interval from the late Emsian to Frasnian. Therefore in the lower part it is synchronous with the uppermost Sultanbibi Formation deposited in a shallow marine environment, while its upper part is the time equivalent of the Turkmenkazgan Strata, Shaidaraz and Beltau formations.

The age of the Beltau Formation was originally dated as Tournaisian based on sporadic occurrences of foraminifera (Aisanov and Egorov, 1978). The recent discovery of the Famennian conodonts e.g. Palmatolepis hassi Muller & Muller and Palmatolepis punctata (Hinde) approves its Late Devonian age.

The Shaydaraz Formation is a distinct lithostratigraphical unit characterized by thick bedded and massive limestones with subsidiary echinoderm limestone beds. Its Late Devonian (Frasnian – Famennian) age is now firmly supported by the conodont occurrences. The age of fragments of sallow marine succession in some tectonic blocks previously mapped as the late Silurian Bashguzhumdy and the Lower Devonian Turkmentau Formation is reconsidered due to the Late Devonian conodont occurrences and they are re-assigned to the Shaydaraz Formation.

Detailed sedimentological studies of the Devonian deposits at the Kuldzhuktau Mountains supported by the high resolution conodont biostratigraphy clearly demonstrate that the entire Devonian succession represents dismembered and displaced remnants of a carbonate platform and sedimentary cover of a surrounding basin. It was established that the Lower Devonian Turkmentau Formation was deposited in shallow marine environments of the carbonate platform interior; the Lower to Middle Devonian Sultanbibi Formation includes lithofacies characteristic of the middle and lower slope of the carbonate platform; while the Devonian Arapkazgan Formation includes lithofacies of the surrounding basin. The appearance the units of thick bedded bioclastic limestones and carbonate breccia representing mass flow deposits considered as signs of the slope progradation. The Upper Devonian carbonates of the Shaydaraz and Beltau formations are deposited in the environments the carbonate platform outer margin and transition to the upper slope. They are formed synchronously with the Turkmenkazgan Strata, which was deposited on the slope of the collapsing carbonate platform.

Conclusion

In a course of bed by bed sampling and taxonomical study of the conodont faunas recovered from the Devonian deposits of the Kuldzhuktau Mountains, total 14 genera and 81 conodont species have been identified and the detailed conodont based biostratigraphic scale was for the first time applied for the age discrimination and correlation of the local lithostratigraphic units with the regional and international geochronological time scales.

It was established that the Devonian formations applied within the region significantly overlap in time and they were originally deposited in the environments of the carbonate platform, carbonate platform slope and surrounding part of the deep shelf.

It was confirmed that the Lower Devonian Turkmentau Formation is a heterogeneous unit and in original interpretation includes unrelated Upper Devonian deposits formed in the different depositional environment; thus the Turkmenkazgan Strata was newly introduced.

The Beltau Formation, formerly considered as Carboniferous (Tournaisian), is now considered as the Upper Devonian (Famennian) based on the indicative conodont occurrences

References

Aisanov, Y.B., Egorov, A.I. Geological structure and main features of minerageny of the Paleozoic

deposits of the Kuldzhuktau Mountains. FAN, Tashkent, **1978**, 120 pp. [In Russian]
Apekina, L.S. Conodonts. In: Devonian biostratigraphy of the Zaravshan-Hissar mountainous region. Eds. Alferov. FAN, Tashkent, **1984**, 73-87. [In Russian]

Biozonal Stratigraphy of Phanerozoic in Russia / Ed. by T.N. Koren'. St. Petersburg: VSEGEI-Press, 2006, 000 p. [In Russian]

Bischoff, G. and Sannemann, D., Unterdevonische Conodonten aus dem Frankenwald. Notizbl. hess. L. - Amt. Bodenforsch. Wiesbaden, **1958**, p. 87-110.

Bultynck, P., Pelagic and neritic conodont successions from the Givetian of pre-Sahara Morocco and the Ardennes. Bull. Del' institut Royal des sciences natur. de Belgique, 1987, 57, p. 149-181.

Bultynck, R., Conodonts from the La Grange Limestone (Emsian), Armorican Massif, North-Western France.1st International Senckenberg Conference and 5th European Conodont Symposium (Ecos V) Contributions 3; Frankfurt a. M., **1989**, p. 173-204.

Davlatov, N.Kh., Erina, M.V. On the age of the lower part of the Arapkazgan Formation at the Kuldzhuktau Mountains (Central Kyzylkum), Vestnik NUUz, 3(1), **2018**, 347-350. [In Russian]

Davlatov, N.Kh., Erina, M.V., Kim, I.A. The first finds of the Upper Devonian conodonts in the Kuldzhuktau Mountains (Central Kyzylkum). In: Collection of materials of the International Scientific and Practical Conference, October 10-11, 2019, Republic of Uzbekistan. Abdullaev,G.S, JSC "IGIRNIGM", Tashkent, **2019**, 302-307. [In Russian]

Klapper, G. and Johnson, J.G., Sequence in conodont genus Polygnathus in Lower Devonian at Lone Mountain, Nevada. Geol. et Paleont. N9, **1975**, p. 65-83.

Mashkova, T.V. New conodonts of the pesavis-optima zone from the Lower Devonian of the Urals and Zaravshan. Paleontological Journal. 1978(2) (1978). 91-96. [In Russian] Mashkova, T.V., Apekina, L.S. Conodonts. In: Atlas of paleontological plates. Supplement to a guide of the field excursion). Eds.Sokolov, B.S.and Garkovets V.G., Ministry of Geology, Uzbek SSR, Tashkent, 19, **1978**, 73–78. [In Russian]

Mashkova, T.V., Apekina, L.S.. The oldest polygnathuses from the Zeravshan Range as the Lower-Middle Devonian boundary indicators. Izvestia Akademii nauk SSSR, Seria geologicheskaya, 1981 (2) (**1981**), 88-94. [In Russian]

Mawson, R., Early Devonian (Lochkovian) conodont faunas from Windellasma, New South Wales. Geologica et Paleontologica 20, Marburg, **1986**, p. 39-71.

Mirkamalov R.Kh., Divaev F.K., Temurov B.Z., Uzokov R.T. On the tectonic structure of the Kuldzhuktau Mountains. In: Actual problems of geological education in the Republic and prospects for the development of earth sciences. Eds. Umurzakov, R.A.,"Fan va texnologiya", Tashkent, **2020**, 241-245. [In Russian]

Müller, S. and Müller, E.M., Early Upper Devonian (independence) conodonts from Iowa. Part 1, Journal paleontology, vol 31, N6, **1957**, p. 1069-1108.

Stratigraphic Dictionary of Uzbekistan. Trudy IMR., Eds.Abduazimova, Z.M., "IMR"-Tashkent: GIDROINGEO, **2001**, 580 p.[In Russian]

Yolkin, E. A., Kim, A. I., Talent, J. A. Devonian sequences of the Kitab Reserve area. Field excursion guidebook. International Conference 'Global Alignments of Lower Devonian Carbonate and Clastic Sequences' (SDS/IGCP Project 499 joint field meeting). Kitab State Geological Reserve, Uzbekistan, August 25-September 3, 2008. Siberian Branch, Russian Academy of Sciences, Novosibirsk, **2008**, 100 p.

Ziegler W., Sandberg C.A. Conodont phylogenetic-Zone Concept //Newsletters on Stratigraphy. **1994**, V. 30. P. 105–123.

Table 1

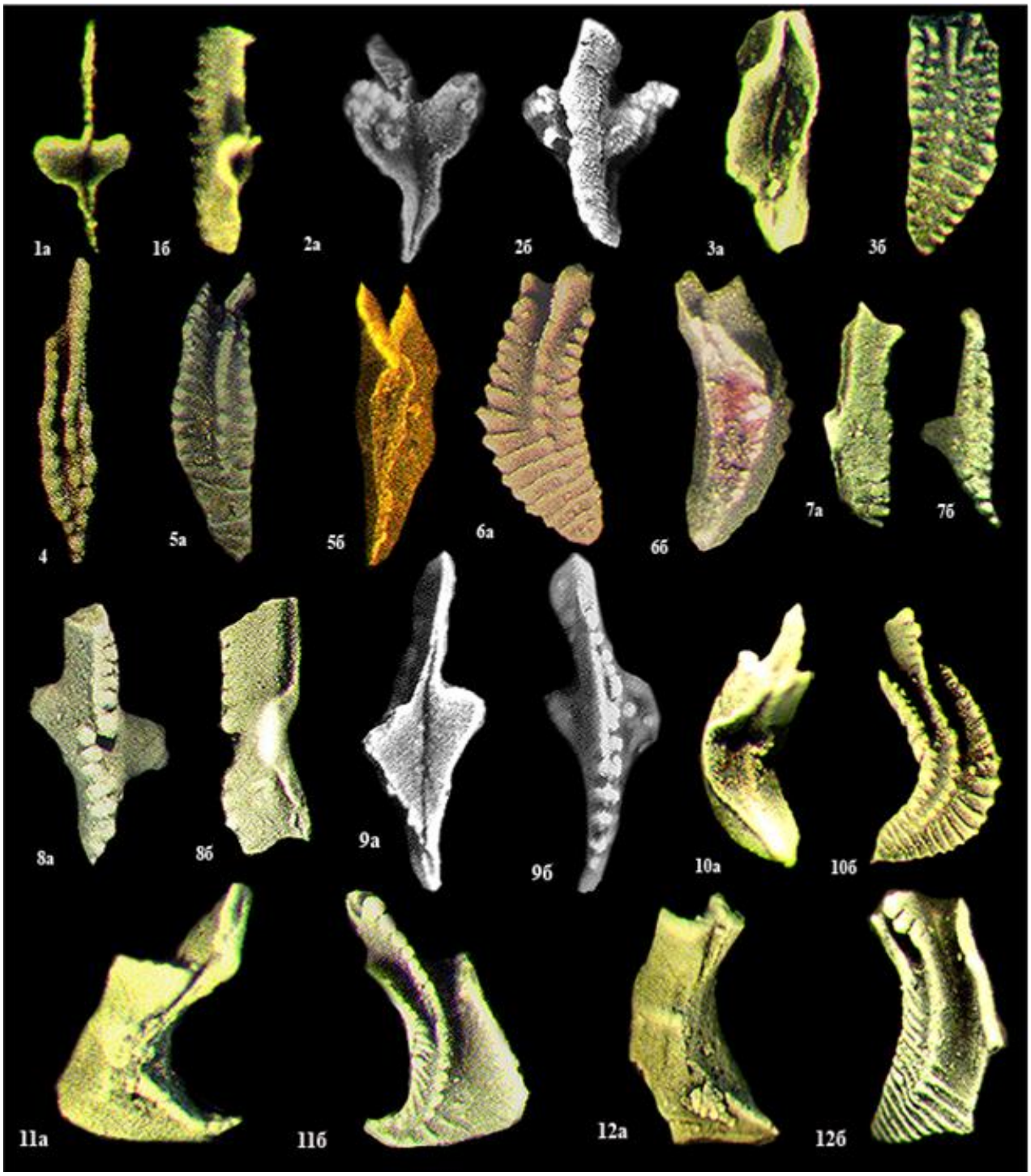

Table 1. Sultanbibi Formation, Emsian Stage, Lower Devonian

1, 2 - Ancerodelloides postomus Erina, 2007; 1a, b - specimen N61/1141, side and lower views; 2a, b - specimen N191/1141, lower and upper views; ×60, southeast of the Dzhengeldy Village; 3 - Polygnathus pannonicus Mashkova et Apekina, 1980, specimen N67/1141, a, b - lower and upper view, ×70, southeast of the Dzhengeldy Village; 4, 5 - Polygnathus kitabicus Yolkin, Weddige, Izokh at Erina, 1994, 4 specimen N132/1141, upper view; 5a, b - specimen N134/1141, upper and lower view, ×60, Izakuduk Well; 6 - Polygnathus excavatus excavatus Carls et Gandl, 1969, specimen N43/1141, a, b - upper and lower views, ×60, Uchkuduk Well. 7 - 9 - Eognathodus sulcatus Philip,

1965, 7a, b - specimen N48/1141, side and upper view, 8a, b - specimen N47/1141, upper and side views, 9a, b - specimen N179/1141, lower and upper views, ×60, southeast of the Dzhengeldy Village; 10 - Polygnathus nothoperbonus Mawson, 1987, a, b - specimen N44/1141, lower and upper views, ×60, Uchkuduk Well; 11, 12 - Polygnathus serotinus Telford, 1975, 11a, b - specimen N50/1141, lower and upper views, ×60, 12 a, b - specimen N51/1141, lower and upper viewS, ×60, east of the Dzhengeldy Village;

Table 2

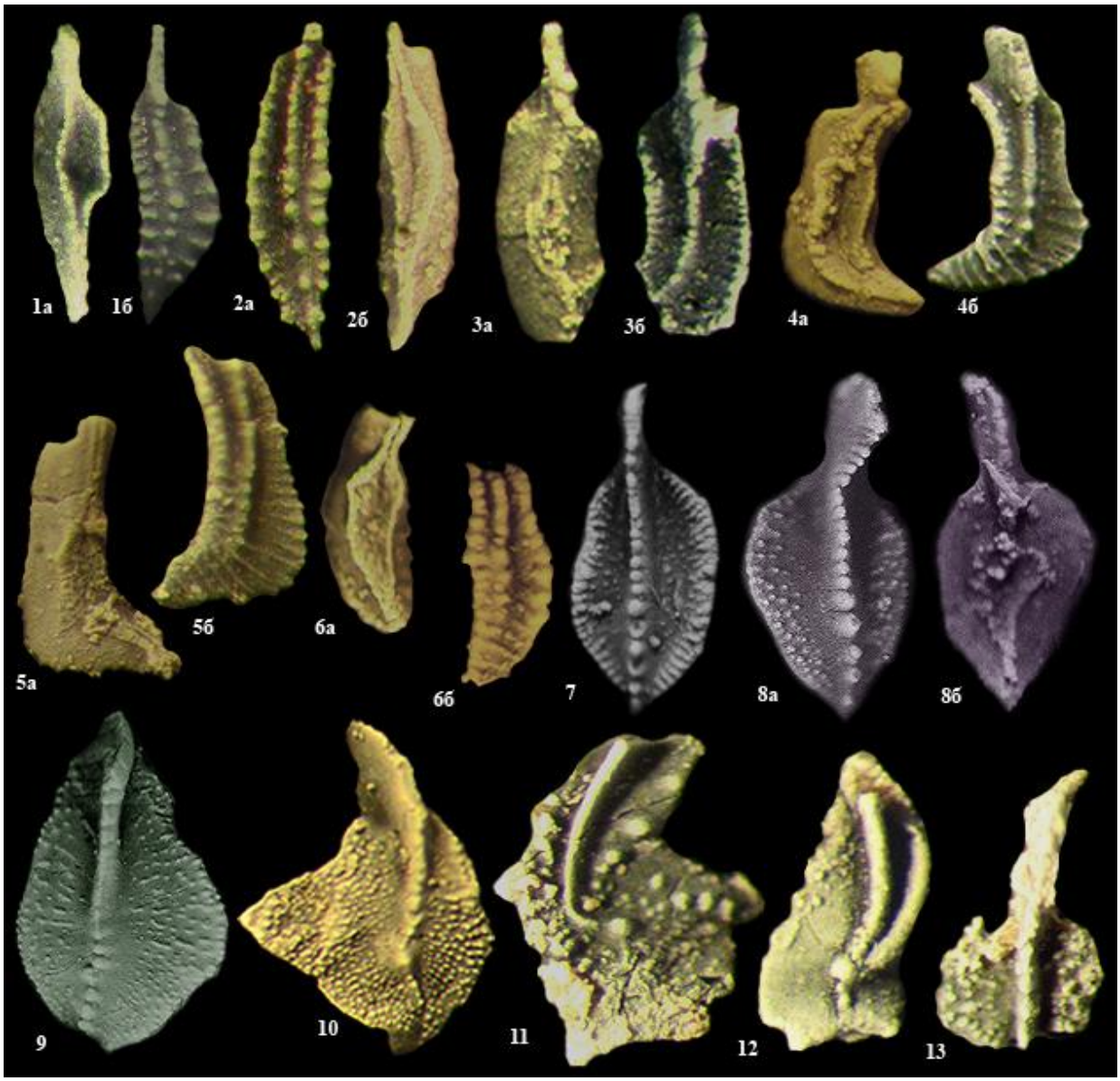

Table 2. 1, 2 - Polygnathus kimi Mashkova et Apekina, 1981, 1 a, b - upper and lower views, specimen N300/1141, Sultanbibi Formation, Emsian Stage, Lower Devonian, south of the Izakuduk Well; 2 a, b - upper and lower views, specimen N301/1141; ×60; 3 - Polygnathus costatus patulus Klapper, 1971, specimen N303/1141, a, b - lower and upper views, ×60, Sultanbibi Formation, Emsian-Eifelian stages, Devonian, south of the Izakuduk Well; 4, 5 - Polygnathus mashkovae Bardashev, 1986, 4a, b - lower and upper views, specimen N312/1141, ×40; 5a, b - lower and upper views, specimen N311/1141, Arapkazgan Formation, Lower Devonian, south of the Izakuduk Well; 6 - Polygnathus excavatus gronbergi Klapper et Johnson, 1975, specimen N308/1141, ×40, a, b - lower and upper views, Arapkazgan Formation, Emsian Stage, Lower Devonian, south of the Izakuduk Well; 7 - Mesotaxis falsiovalis Sandberg, Ziegler et Bultynck, 1989, specimen N215/1141, 7 - upper

view, ×50, Arapkazgan Formation, Frasnian Stage, Upper Devonian, south of the Izakuduk Well; 8 - Klapperina disparilis (Zigler et Klapper), 1976, specimen N216/1141, a, b - upper and lower views, ×50, Arapkazgan Formation, Frasnian Stage, Upper Devonian, south of the Izakuduk Well; 9 - Palmatolepis transitans Muller, 1956, upper view, specimen N239/1141, ×60, Arapkazgan Formation, Frasnian Stage, Upper Devonian, south of the Izakuduk Well; 10 - Palmatolepis hassi Müller et Müller, 1957, specimen N265/1141, 10a, b - lower and upper views, Arapkazgan Formation, Frasnian Stage, Upper Devonian, south of the Izakuduk Well; 11 - Palmatolepis rugosa rugosa Branson et Mehl, 1934, upper view, ×60, Shaydaraz Formation, Famennian Stage, Upper Devonian, specimen N5/114; 12 - Palmatolepis glabra pectinata Ziegler, 1962, upper view, ×60, Shaidaraz Formation, Famennian Stage, Upper Devonian, specimen N7/114; 13 - Protognathodus kockeli (Bischoff, 1957) a, b - upper and lower views, ×60, Shaydaraz Formation, Famennian Stage, Upper Devonian, specimen N13/1141;