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Determination of the Bashkirian–Moscovian boundary in the Volga region via conodont species *Declinognathodus donetzianus* Nemirovskaya

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Abstract – The selection of the global biomarker of the lower boundary of the Moscovian stages is one of the pressing issues of Carboniferous stratigraphy. Several solutions are suggested for this problem: *Diplognathodus ellesmerensis* Bender, *Streptognathodus expansus* (Igo & Koike) and *Idiognathoides postsulcatus* Nemirovskaya. The conodont species *Declinognathodus donetzianus* Nemirovskaya is one of the most prospective. It was detected in the rock sections of west Europe, the Donets Basin, the Moscow Syneclise, south Ural and the Appalachian Basin. The Volga region is also one of the places where *Declinognathodus donetzianus* Nemirovskaya is often met and this article is dedicated to detailed analysis of this species.

Keywords: conodonts, Bashkirian, Moscovian, Volga region, *Declinognathodus donetzianus.*

1. Introduction

Boundary sediments of the Bashkirian and Moscovian stages are widely developed in the Volga region; they are laid mainly with carbonate rocks and, less frequently, with terrigenous-carbonate rocks. Determination of the Bashkirian–Moscovian boundary in the Volga region is one of the disputed issues in carboniferous stratigraphy of this region. Conodonts, which were first detected there by professor of Kazan University V.G. Khalymbadzha (Gubareva *et al.* 1995), are used to resolve this issue. Alekseev *et al*. (1994) examined Middle Carboniferous sediments of the Melekess-1 borehole and found a maximum congruence between the conodont complex of the upper part of the Bashkirian stage and the lower part of the Moscovian stage. Detailed exploration of conodonts within the Bashkirian–Moscovian boundary in the Volga region has recently been undertaken.

2. Materials and methods

Conodonts were examined in open-pit mines of 8 boreholes (Fig. 1), located on Tokmovian arch (Tengushevo-1 and Chuvashskaya-4 boreholes), north Tatar arch (Kukmor-4 and Kukmor-20010 boreholes), south Tatar arch (Kuakbash-37900 and Kuakbash-37998 boreholes) and in the Melekess depression (Kuznechikha-34 and Cheremshan-33 boreholes). The obtained collection includes about 1200 samples comprising 31 species related to 8 genera (Fig. 2). Photographs of the conodonts were taken in the Laboratory of Scanning Electronic Microscopy of the Interdisciplinary Center of Analytical Microscopy of Kazan University using the Merlin device of CARL ZEISS Company.

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3. Biostratigraphy and conodont zonation

Conodonts are distributed unevenly in Bashkirian and Moscovian deposits of the Volga region; the largest distributions are concentrated in the upper part of the Bashkirian and the lower part of the Moscovian stages. This allowed detailed examination of conodont distribution within the boundary interval.

During biostratigraphic analysis of conodonts, most of the focus was on the exact species since this is a candidate for the role of biomarker of the Bashkirian–Moscovian boundary: *Declinognathodus donetzianus* Nemirovskaya; *Diplognathodus ellesmerensis* Bender; *Idiognathoides postsulcatus* Nemirovskaya (Yuping *et al.* 2010); and *Streptognathodus expansus* (Igo & Koike) (Qi *et al.* 2013). Brief lithological characteristics of the open-pit mines and composition of the conodont complexes is given in Table 1 (Figs 3–10). Conodont zones are listed in Table 2. Lower boundaries of the zones are based upon the occurrence of zonal species; only the lower boundary of the *Idiognathodus sinuosus* Zone could not be determined due to washed sediments in the lower part of the Bashkirian stage in the Volga region.

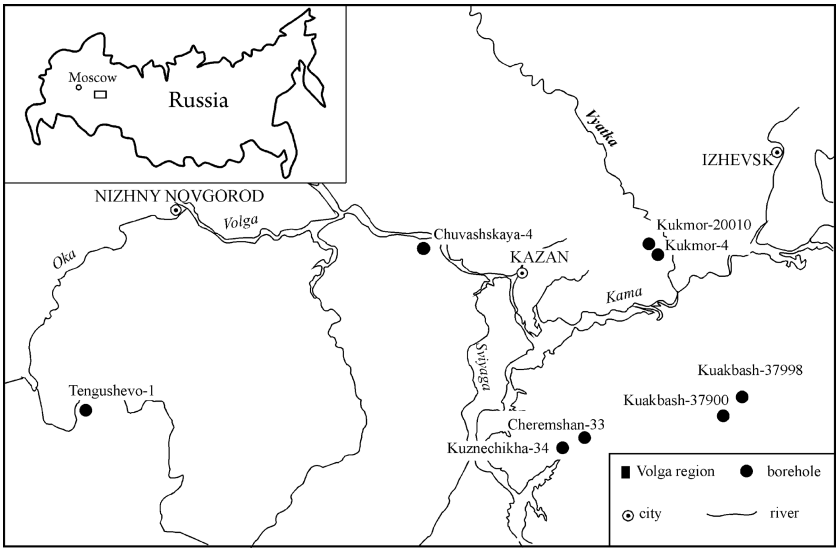

Figure 1. Location of the boreholes, Volga region, Russia.

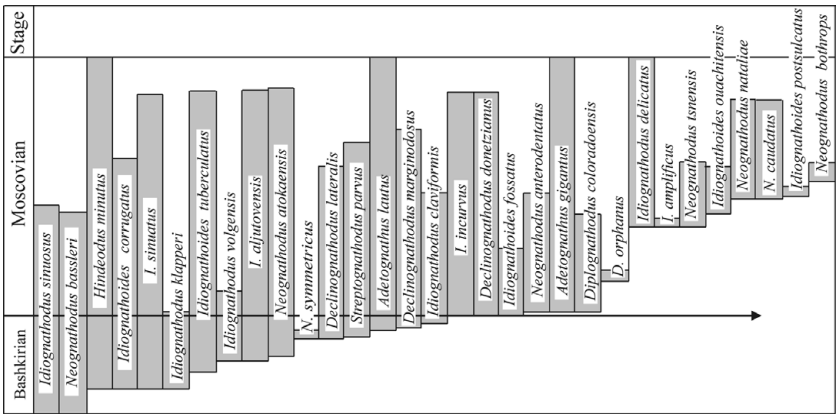

Figure 2. Distribution of the conodonts in the Upper Bashkirian and Lower Moscovian strata in the Volga region.

4. Discussion and conclusion

Quantitative domination of *Declinognathodus* and *Idiognathoides* is typical for Bashkirian and Moscovian stages of conodont development in the Volga region; other genera occur less frequently. Rare species of *Diplognathodus* first occur in the lower part of the Moscow layer. Specific composition of genera *Idiognathodus*, *Idiognathoides*, *Neognathodus* and *Streptognathodus* of the end of the Bashkirian and the beginning of the Moscovian centuries are very close. Species of all the above-mentioned genera, offered as markers of the lower boundary of the Moscovian stage, are either not detected in the Volga region at all (e.g. *Diplognathodus ellesmerensis* Bender and *Streptognathodus expansus* (Igo & Koike)) or else only detected rarely (e.g. *Idiognathoides postsulcatus* Nemirovskaya in the upper part of *Idiognathoides ouachitensis* Zone of Kukmor-4 borehole).

The genus *Declinognathodus* has the biggest stratigraphic potential among conodonts of the Bashkirian–Moscovian interval. There are two key points in its development. First of all, species *Declinognathodus marginodosus* (Grayson) dominates in the lower part of Moscovian stage in most of the explored boreholes (up to 30–60 % of total conodont number). This event within Acme Zone rank may be used for local correlation of open-pit mines (Sungatullina, 2012, p. 53). Secondly, the species *Declinognathodus donetzianus* Nemirovskaya occurs in the Volga region at the base of the Moscovian stage; its first occurrence at the beginning of the Moscovian age was also detected in other regions. It is detected in the lower part of the Moscovian stage in south Ural (Basu section) (Kulagina *et al.* 2009), Donbass (Nemirovskaya, 1999), Appalachian Basin (Work *et al.* 2012) and Moscow Syneclise (Goreva *et al.* 2001).

We performed detailed analyses of time variations of *Declinognathodus* morphological characteristics and built a single phylogenetic sequence of species

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Table 1. Distribution of conodonts in boreholes

Stage	Interval (m)	Conodonts	Lithology
Tokmovian arch: Tengushevo-1 borehole (Fig. 3)			
C_2m	305–294	*Adetognathus gigantus* (**1**), *Idiognathodus aljutovensis* (**3**), *I. claviformis* (**2**), *I. delicatus* (**10**), *I. praeobliquus* (**21**), *I. sinuosus* (**3**), *Hindeodus minutus* (**6**), *Neognathodus anterodentatus* (**4**), *N. bassleri* (**1**), *N. caudatus* (**1**), *N. nataliae* (**8**)	Marl variegated with beds of dolomite and mudstone
	312–305	*Diplognathodus coloradoensis* (**2**), *Hindeodus minutus* (**6**), *Idiognathodus aljutovensis* (**1**), *I. claviformis* (**1**), *I. delicatus* (**5**), *I. praeobliquus* (**3**), *I. sinuosus* (**8**), *Idiognathoides sinuatus* (**12**), *I. tuberculatus* (**5**), *Neognathodus anterodentatus* (**3**), *N. atokaensis* (**3**), *N. bassleri* (**3**)	Limestone
	330–312	Conodonts not found	Mudstone
C_2b		*Neognathodus bassleri* (**1**)	Limestone
Tokmovian arch: Chuvashskaya-4 borehole (Fig. 4)			
C_2m	877–839	*Declinognathodus donetzianus* (**5**), *D. marginodosus* (**3**), *Hindeodus minutus* (**3**), *Idiognathodus aljutovensis* (**1**), *I. amplificus* (**1**), *I. incurvus* (**1**), *I. sinuosus* (**1**), *Idiognathoides corrugatus* (**2**), *I. ouachitensis* (**4**), *I. sinuatus* (**3**), *I. tuberculatus* (**7**), *Neognathodus caudatus* (**2**), *N. natalia* (**2**)	Limestone and dolomite organogenic, grey, massive, and interbeds of silt stone and mudstone at places
C_2m	887–877	Conodonts not found	Mudstone and clay
C_2m	892–887	*Adetognathus gigantus* (**8**), *A. lautus* (**5**), *Declinognathodus donetzianus* (**3**), *D. lateralis* (**10**), *D. marginodosus* (**121**), *Diplognathodus coloradoensis* (**15**), *Hindeodus minutus* (**6**), *Idiognathodus aljutovensis* (**149**), *I. claviformis* (**2**), *I. delicatus* (**5**), *I. incurvus* (**74**), *I. klapperi* (**9**), *I. sinuosus* (**46**), *I. volgensis* (**17**), *Idiognathoides corrugatus* (**4**), *I. fossatus* (**5**), *I. tuberculatus* (**9**), *I. sinuatus* (**10**), *Neognathodus anterodentatus* (**5**), *N. atokaensis* (**41**), *N. bassleri* (**8**), *Streptognathodus parvus* (**57**)	Limestone
Melekess depression: Cheremshan-33 borehole (Fig. 5)			
C_2m	1074–1055	*Declinognathodus donetzianus* (**2**), *Idiognathoides sinuatus* (**1**)	Limestone
C_2b	1090–1074	*Declinognathodus sp.* (**2**), *Idiognathodus aljutovensis* (**2**), *I. klapperi* (**1**), *I. volgensis* (**1**)	Limestone
Melekess depression: Kuznechikha-34 borehole (Fig. 6)			
C_2m	1182–1180	*Adetognathus lautus* (**1**), *Declinognathodus donetzianus* (**4**), *Hindeodus minutus* (**1**), *Idiognathodus aljutovensis* (**2**), *I. klapperi* (**1**), *I. sinuosus* (**1**), *Streptognathodus parvus* (**1**)	Limestone
C_2b	1198–1182	*Idiognathodus sp.* (**2**)	Limestone
North Tatar arch: Kykmor-4 borehole (Fig. 7)			
C_2m	765–752	*Declinognathodus marginodosus* (**6**), *Idiognathodus delicatus* (**1**), *Idiognathoides ouachitensis* (**11**), *I. postsulcatus* (**1**), *Streptognathodus parvus* (**5**)	Siltstone and mudstone
C_2m	781–765	*Declinognathodus donetzianus* (**4**), *D. lateralis* (**2**), *D. marginodosus* (**10**), *Diplognathodus orphanus* (**1**), *Hindeodus minutus* (**1**), *Idiognathodus aljutovensis* (**4**), *Idiognathoides fossatus* (**2**), *Neognathodus atokaensis* (**1**), *Streptognathodus parvus* (**2**)	Mudstone, siltstone and sandstone
C_2m	788–781	*Declinognathodus marginodosus* (**43**), *D. donetzianus* (**4**), *D. lateralis* (**1**), *Neognathodus atokaensis* (**5**), *Idiognathodus aljutovensis* (**15**), *I. incurvus* (**2**), *I. volgensis* (**1**), *Idiognathoides sinuatus* (**4**), *I. tuberculatus* (**2**)	Limestone with thin interbedded mudstone
C_2b	794–788	*Declinognathodus marginodosus* (**1**), *Idiognathodus aljutovensis* (**1**), *I. volgensis* (**1**)	Limestone
C_2b	799–794	*Adetognathus lautus* (**1**), *Idiognathodus sinuosus* (**1**), *Idiognathoides sinuatus* (**1**)	Limestone
Melekess depression: Kukmor-20010 borehole (Fig. 8)			
C_2m	770–760	*Adetognathus gigantus* (**1**), *A. lautus* (**1**), *Declinognathodus donetzianus* (**12**), *D. marginodosus* (**14**), *Idiognathoides corrugatus* (**3**), *I. sinuatus* (**1**), *Streptognathodus parvus* (**1**)	Limestone
C_2m	792–770	*Declinognathodus donetzianus* (**5**), *D. marginodosus* (**11**), *Hindeodus minutus* (**1**)	Limestone, siltstone and mudstone
C_2b	803–792	*Declinognathodus marginodosus* (**8**), *D. lateralis* (**1**), *Hindeodus minutus* (**1**), *Neognathodus atokaensis* (**1**), *Idiognathodus aljutovensis* (**2**), *I. sinuosus* (**1**), *I. volgensis* (**1**), *Idiognathoides tuberculatus* (**1**), *Streptognathodus parvus* (**1**)	Limestone
C_2b	808–803	*Hindeodus minutus* (**4**), *Idiognathodus klapperi* (**1**), *Idiognathodus sinuosus* (**1**), *Idiognathoides tuberculatus* (**4**), *I. sinuatus* (**7**)	Limestone
C_2b	822–808	*Idiognathodus sinuosus* (**5**), *Idiognathoides corrugatus* (**1**), *Neognathodus bassleri* (**1**)	Limestone
South Tatar arch: Kuakbash-37900 borehole (Fig. 9)			
C_2m	756.5–748	*Declinognathodus marginodosus* (**22**), *Hindeodus minutus* (**2**), *Idiognathodus aljutovensis* (**2**), *I. claviformis* (**1**), *I. sinuosus* (**1**), *I. volgensis* (**2**), *Idiognathoides corrugatus* (**1**), *I. fossatus* (**5**), *I. sinuatus* (**5**), *Streptognathodus parvus* (**1**)	Limestone
C_2b	768–756.5	*Declinognathodus lateralis* (**1**), *D. marginodosus* (**4**), *Hindeodus minutus* (**1**), *Neognathodus atokaensis* (**4**), *N. symmetricus* (**2**), *Streptognathodus parvus* (**1**)	Limestone

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Table 1. Continued.

Stage	Interval (m)	Conodonts	Lithology
South Tatar arch: Kuakbash-37998 borehole (Fig. 10)			
C_2m	838–827	*Adetognathus sp.* (**1**), *Declinognathodus donetzianus* (**3**), *D. lateralis* (**3**), *D. marginodosus* (**14**), *Hindeodus minutus* (**1**), *Idiognathodus aljutovensis* (**9**), *I. klapperi* (**1**), *I. sinuosus* (**1**), *Idiognathoides corrugatus* (**1**), *I. fossatus* (**2**), *I. sinuatus* (**1**), *Neognathodus atokaensis* (**3**)	Limestone
C_2b	842–838	*Declinognathodus lateralis* (**2**), *D. marginodosus* (**2**), *Idiognathodus aljutovensis* (**6**), *I. klapperi* (**3**), *I. volgensis* (**1**), *Idiognathoides tuberculatus* (**2**), *Neognathodus atokaensis* (**2**), *N. bassleri* (**1**), *N. uralicus* (**2**)	Limestone

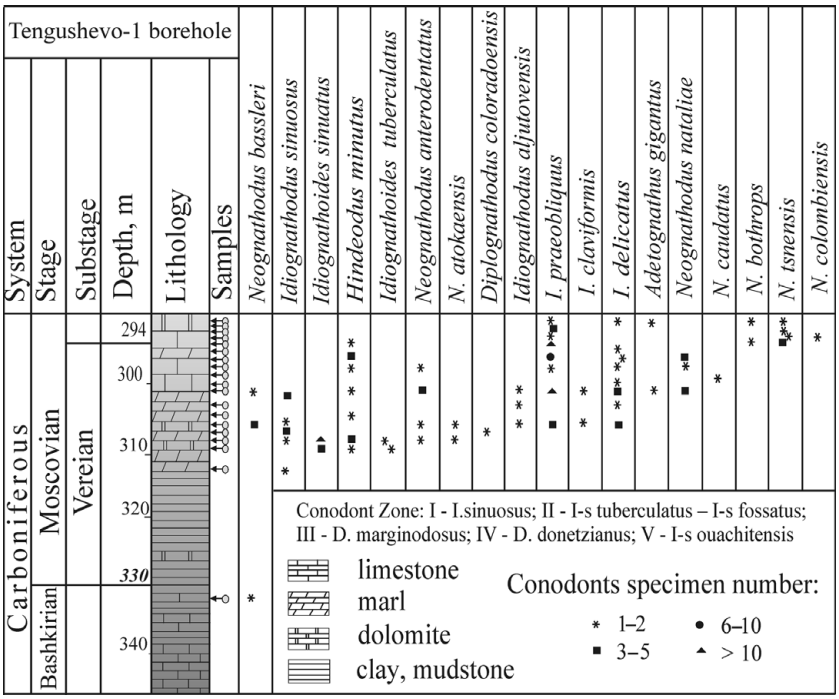

Figure 3. Distribution of the conodonts in the Upper Bashkirian and Lower Moscovian strata of the Tengushevo-1 borehole.

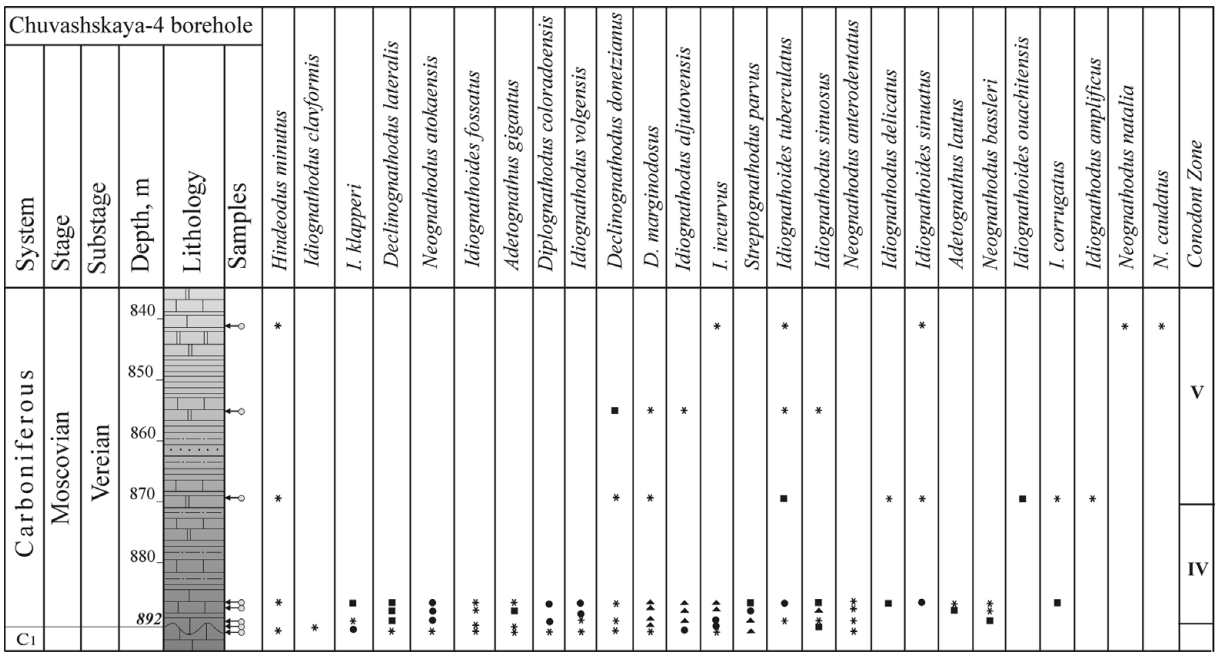

Figure 4. Distribution of the conodonts in the Lower Moscovian strata of the Tchuvashskaya-4 borehole.

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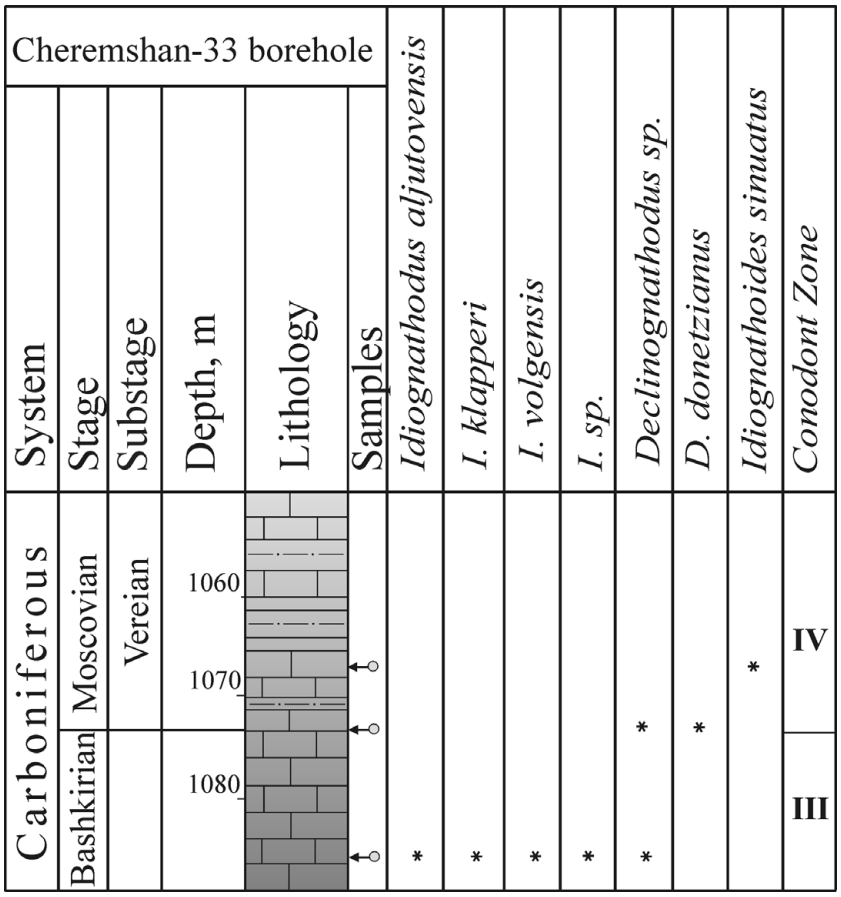

Figure 5. Distribution of the conodonts in the Upper Bashkirian and Lower Moscovian strata of the Tcheremshan-33 borehole.

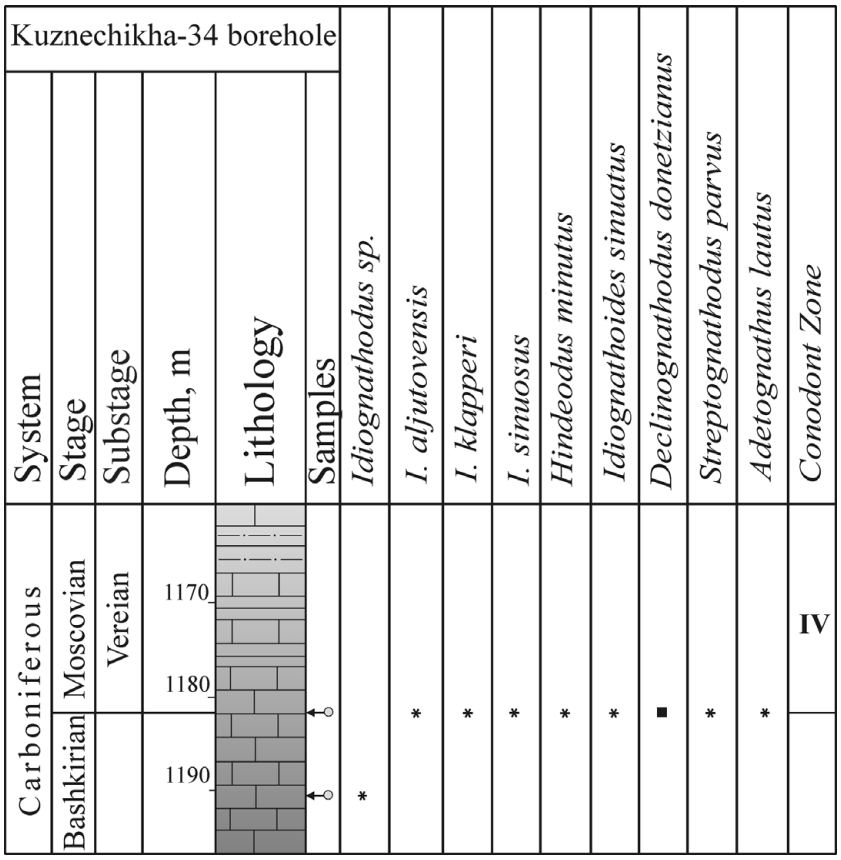

Figure 6. Distribution of the conodonts in the Upper Bashkirian and Lower Moscovian strata of the Kuznechiha-34 borehole.

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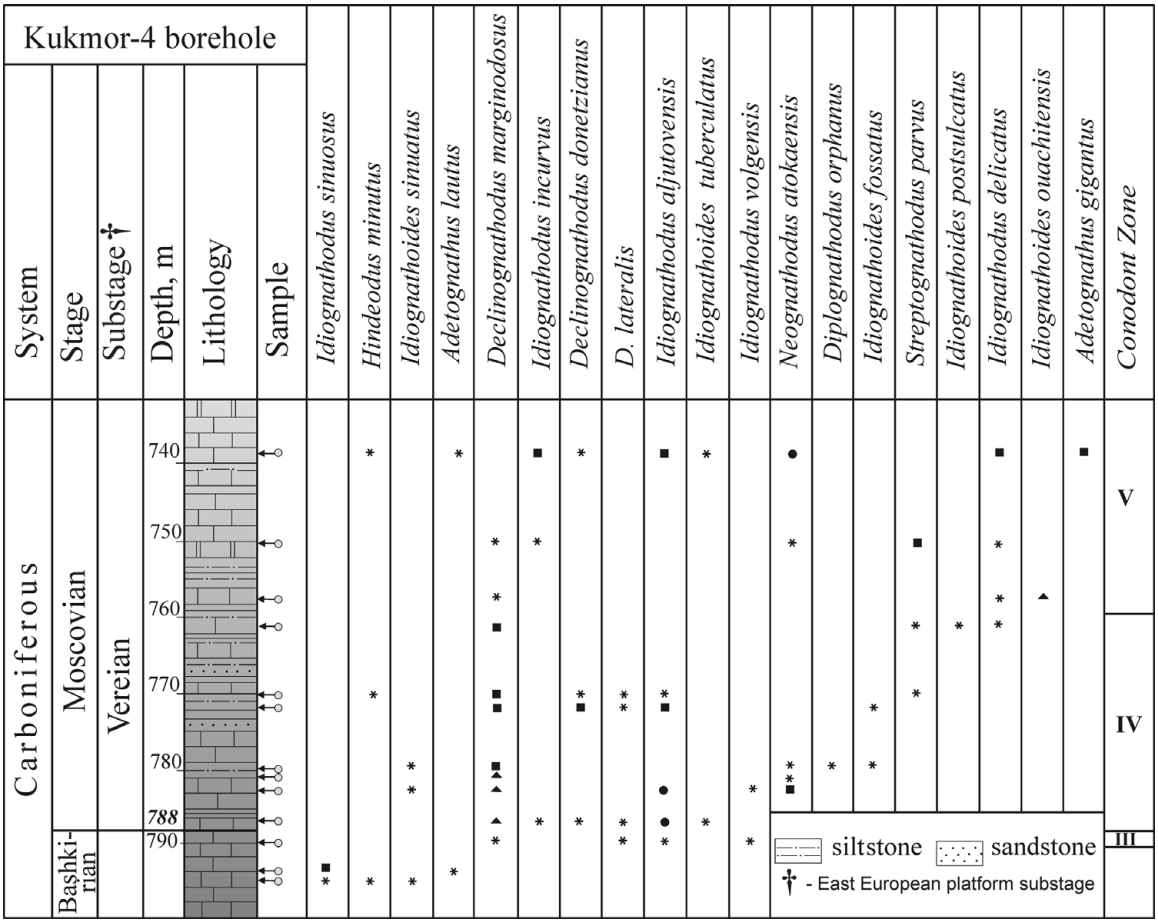

Figure 7. Distribution of the conodonts in the Upper Bashkirian and Lower Moscovian strata of the Kukmor-4 borehole.

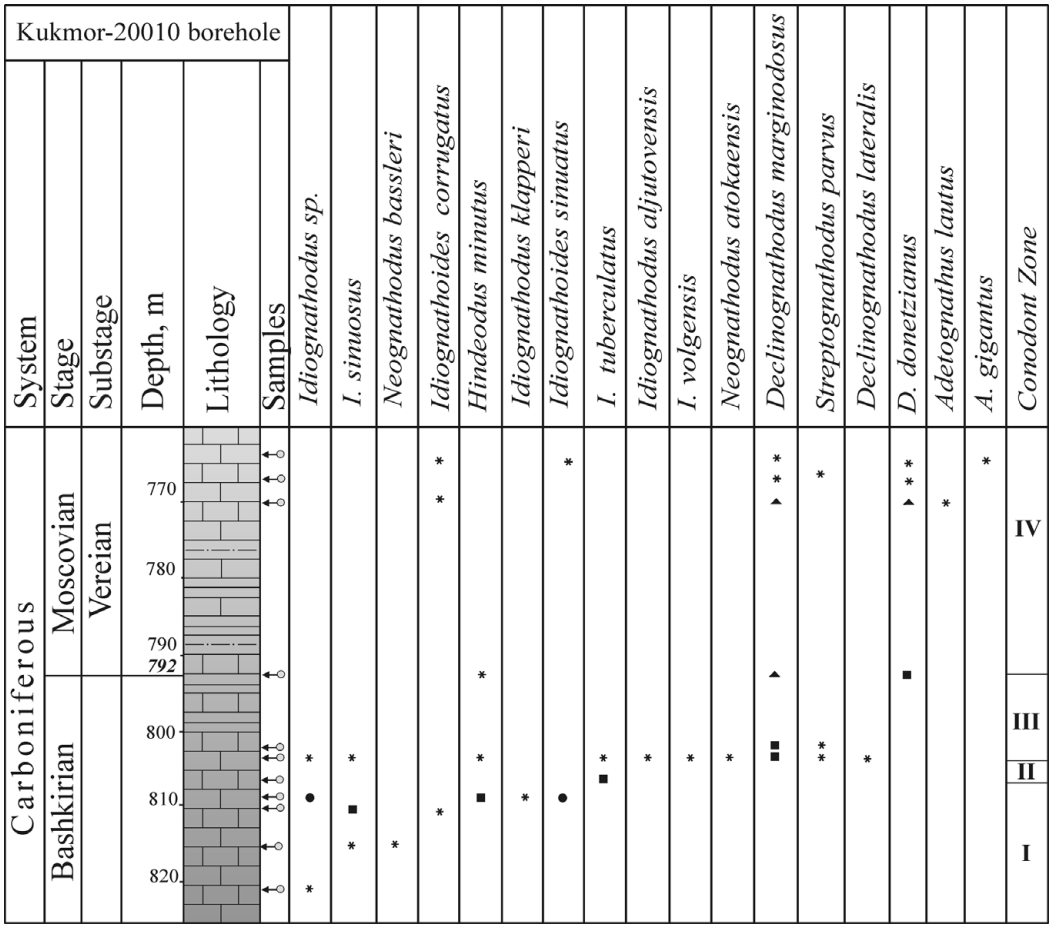

Figure 8. Distribution of the conodonts in the Upper Bashkirian and Lower Moscovian strata of the Kukmor-20010 borehole.

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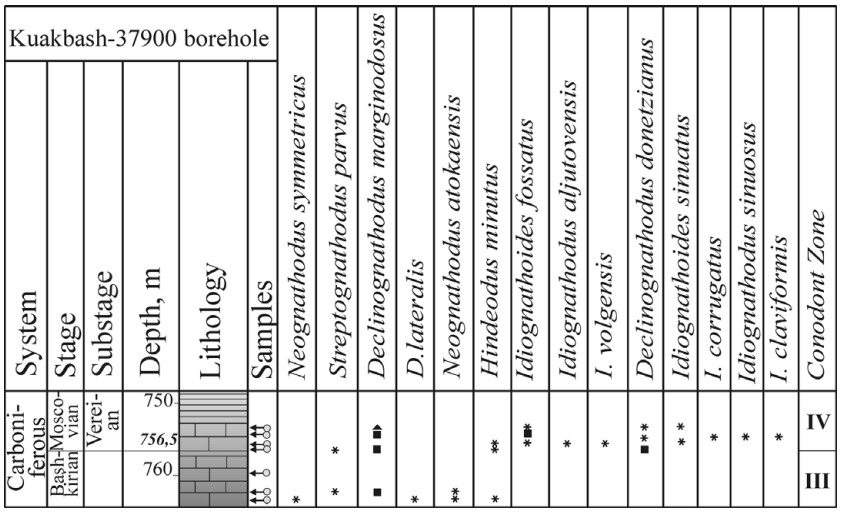

Figure 9. Distribution of the conodonts in the Upper Bashkirian and Lower Moscovian strata of the Kuakbash-37900 borehole.

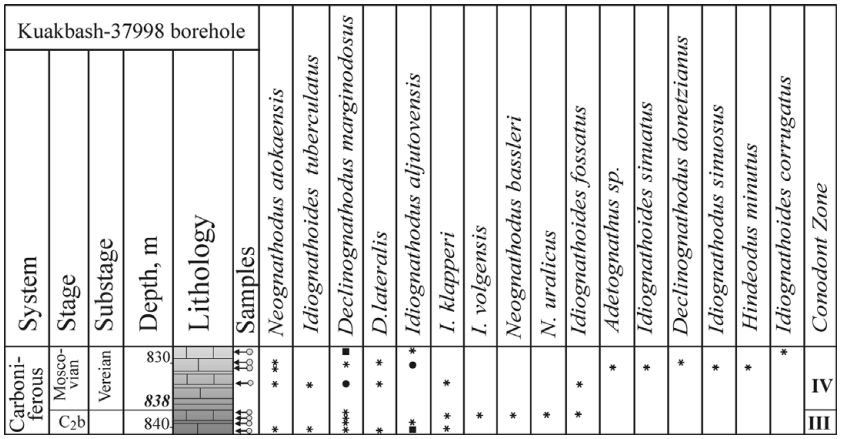

Figure 10. Distribution of the conodonts in the Upper Bashkirian and Lower Moscovian strata of the Kuakbash-37998 borehole.

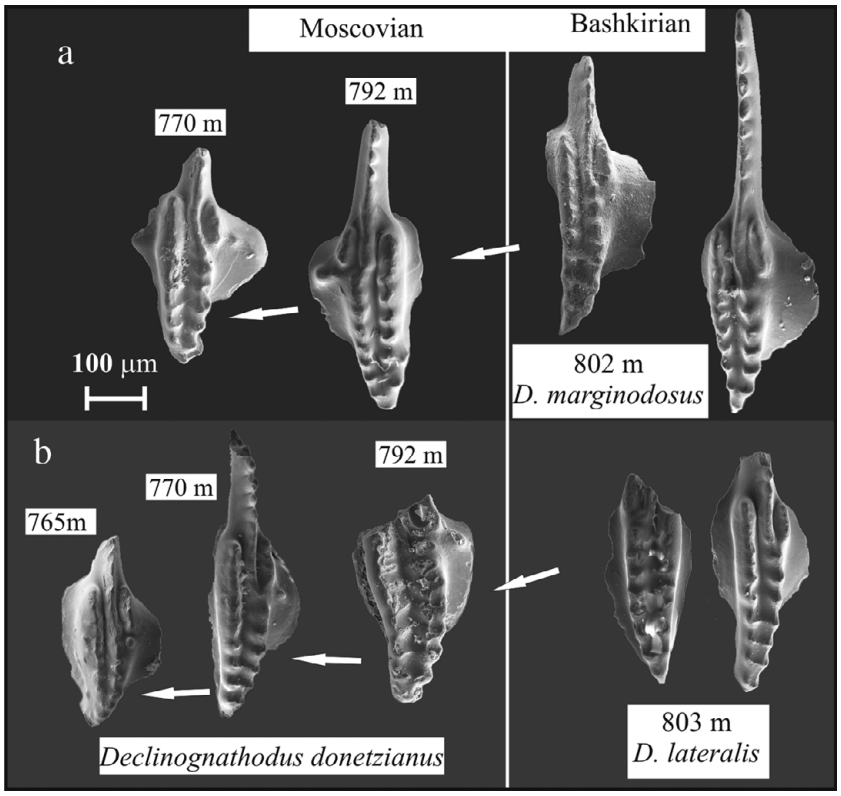

Figure 11. Lineage changes of conodonts *Declinognathodus* across the Bashkirian–Moscovian boundary in the Kukmor-20010 borehole: (a) the front part of the outer parapet separates and then the tubercles are formed; (b) the tubercles are formed and then the front part of the outer parapet separates.

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Table 2. Conodont Zones of Volga region (*A – Adetognathus, H – Hindeodus, D. – Declinognathodus, Dip. – Diplognathodus, I. – Idiognathodus, I-s – Idiognathoides, N. – Neognathodus, S. – Streptognathodus*)

	Conodonts		
Zone	First appearance species	Transitional species	Correlation of the zones
I-s ouachitensis	*I. amplificus* Lambert, *I. delicatus* Gunnell, *I. incurvus* Dunn, *I. praeobliquus* Nemirovskaya, Perret-Mirouse & Alekseev, *I-s ouachitensis* (Harlton), *N. caudatus* Lambert, *N. natalia* Alekseev & Gerelzezeg	*A. gigantus* (Gunnell), *D. donetzianus* Nemirovskaya, *D. marginodosus* (Grayson), *I. aljutovensis* Alekseev, Barskov & Kononova, *I. sinuosus* Ellison & Graves, *I-s postsulcatus* Nemirovskaya, *I-s sinuatus* (Harris & Hollingsworth), *I-s tuberculatus* Nemirovskaya, *N. anterodentatus* Alekseev & Gerelzezeg, *N. atokaensis* Grayson, *N. bassleri* (Harris & Hollingsworth), *N. bothrops* Merrill, *S. parvus* Dunn	1. I-s ouachitensis Zone of Moscow Syneclise (Goreva & Alekseev, 2001)
D. donetzianus	*A. gigantus* (Gunnell), *D. donetzianus* Nemirovskaya, *Dip. coloradoensis* (Murray & Chronic), *Dip. orphanus* Merrill, *I. delicatus* Gunnell, *I-s postsulcatus* Nemirovskaya, *N. anterodentatus* Alekseev & Gerelzezeg	*A. lautus* (Gunnell), *D. marginodosus* (Grayson), *I. aljutovensis* Alekseev, Barskov & Kononova, *I. claviformis* Gunnell, *I. incurvus* Dunn, *I. klapperi* Lane & Straka, *I. sinuosus* Ellison & Graves, *I. volgensis* Alekseev, Barskov & Kononova, *I-s corrugatus* (Harris & Hollingsworth), *I-s fossatus* (Branson & Mehl.), *I-s sinuatus* (Harris & Hollingsworth), *I-s tuberculatus* Nemirovskaya, *N. atokaensis* (Grayson), *N. bassleri* (Harris & Hollingsworth), *S. parvus* Dunn	1. N. atokaensis Zone of Askyn Section, Bashkirian (Nemirovskaya & Alekseev, 1994) 2. D. donetzianus Zone of Donets Basin (Nemirovskaya, 1999) 3. D. donetzianus Zone of Moscow Syneclise (Goreva & Alekseev, 2001) 4. D. donetzianus Zone of South Ural (Kulagina *et al.* 2009)
D. marginodosus	*A. lautus* (Gunnell), *D. marginodosus* (Grayson), *I. aljutovensis* Alekseev, Barskov & Kononova, *I. volgensis* Alekseev, Barskov & Kononova, *I-s sulcatus* Higgins & Bouckaert, *N. atokaensis* Grayson	*D. lateralis* (Higgins & Bouckaert), *H. minutus* Ellison, *I. klapperi* Lane & Straka, *I. sinuosus* Ellison & Graves, *I-s fossatus* (Branson & Mehl), *I-s tuberculatus* Nemirovskaya, *N. bassleri* (Harris & Hollingsworth), *N. symmetricus* Lane, *S. parvus* Dunn	1. D. marginodosus Zone of Askyn Section, Bashkirian (Nemirovskaya & Alekseev, 1994) 2. D. marginodosus Zone of Donets Basin (Nemirovskaya, 1999) 3. D. marginodosus Zone of South Ural (Kulagina *et al.* 2009)
I-s tuberculatus – I-s fossatus	*D. lateralis* (Higgins & Bouckaert), *I. klapperi* Lane & Straka, *I-s* fossatus (Branson & Mehl), *I-s tuberculatus* Nemirovskaya, *S. parvus* Dunn	*H. minutus* Ellison, *I. sinuosus* Ellison & Graves, *I-s sinuatus* (Harris & Hollingsworth), *N. bassleri* (Harris & Hollingsworth), *N. symmetricus* Lane	1. I-s tuberculatus – I-s fossatus Zone of Donets Basin (Nemirovskaya, 1999)
I. sinuosus	*D. noduliferus* (Ellison & Graves), *H. minutus* Ellison, *I. sinuosus* Ellison & Graves, *I-s sinuatus* (Harris & Hollingsworth), *N. bassleri* (Harris & Hollingsworth), *N. symmetricus* Lane	1. I. sinuosus Zone of Askyn Section, Bashkirian (Nemirovskaya & Alekseev, 1994) 2. I. sinuosus– I-s sulcatus parvus Zone of Donets Basin (Nemirovskaya, 1999) 3. N. symmetricus Zone South China (Qi *et al.* 2013) 4. I. sinuosus Zone of Midcontinent North America (Barrick *et al.* 2013)	

at the Bashkirian–Moscovian boundary. The occurrence of the species in chronological order is as follows.

Declinognathodus lateralis (Higgins & Bouckaert) appears in the second half of the Bashkirian age. It has a short carina, which is pressed to the outer parapet and continues to the posterior end. At the end of the Bashkirian century a new species of *Declinognathodus marginodosus* (Grayson) appears, the front part of the outer parapet of which is totally separated. At the beginning of the Moscovian age, the outer part of the basal cavity of *Declinognathodus* widens and additional nodes appear on its surface. This process occurs in two related species simultaneously: *Declinognathodus marginodosus* (Grayson) and *D. lateralis* (Higgins & Bouckaert). In the first case, isolation of the front part of the outer parapet occurs at first, and then nodes appear on it (Figs 11a, 12, 13, 14a, 15a). In the second case, nodes on the external surface of the basal cavity appear first, and only after that does the parapet front part separate (Figs 11b, 14b, 15b). In both cases the process completes with the forming of nodes on

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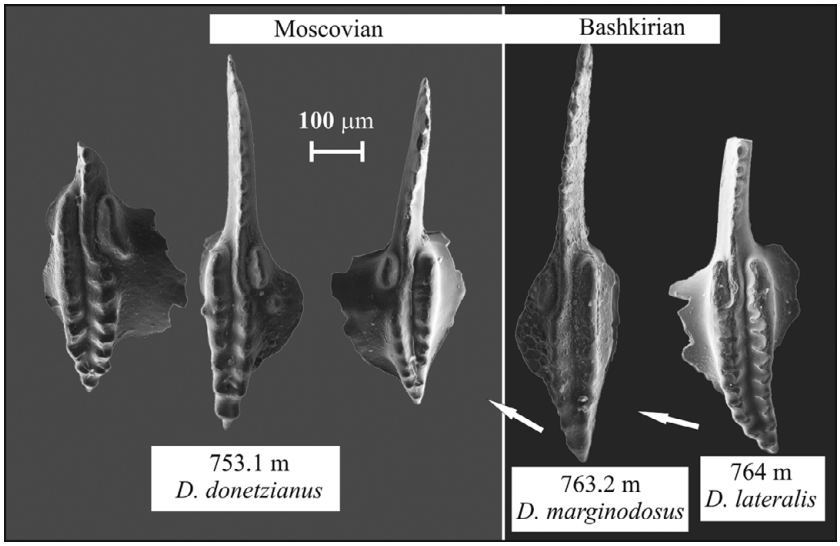

Figure 12. Lineage changes of conodonts *Declinognathodus* across the Bashkirian–Moscovian boundary in Kuakbash-37900 borehole (the front part of the outer parapet separates and then the tubercles are formed).

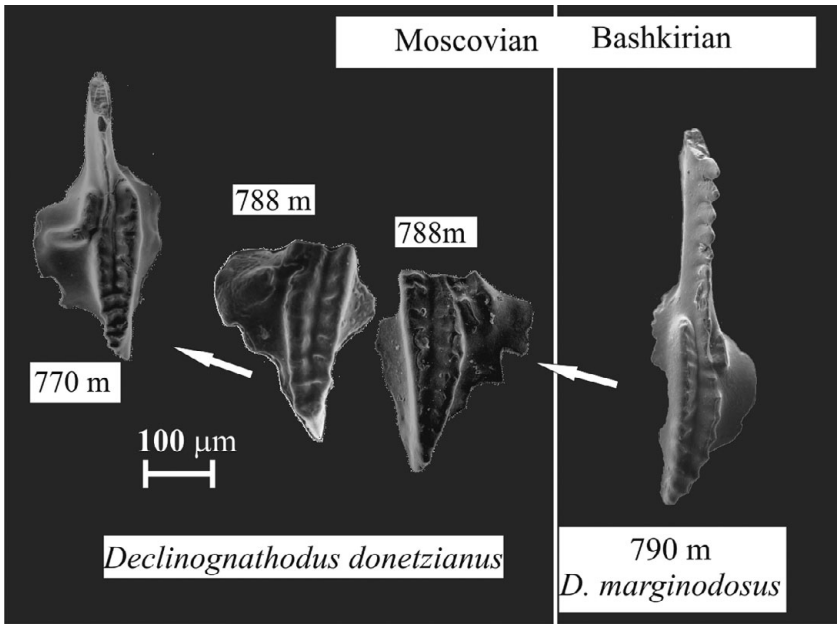

Figure 13. Lineage changes of conodonts *Declinognathodus* across the Bashkirian–Moscovian boundary in Kukmor-4 borehole (the tubercles are formed and then the front part of the outer parapet separates).

the external surface of the basal cavity, and the species *Declinognathodus donetzianus* Nemirovskaya appears. This morphogenesis, affecting a small sector of the conodont surface, shows itself as a short-period (at the beginning of the Moscovian age) and simultaneous event (within a significant territory of the Volga region). *Declinognathodus donetzianus* Nemirovskaya is therefore a good biomarker of the Bashkirian–Moscovian boundary in the Volga region (Fig. 16); its global potential is also huge.

Examples of occurrences of separate morphological characteristics within various species of conodonts were frequently detected in boundary intervals and a number of other stratigraphic subdivisions, for example the formation of asymmetrically located furrow at the beginning of the Gzelian age and the formation of nodular lobe at the beginning of the Asselian age of conodonts of genus Streptognathodus (Chernykh, 2006, 2009, 2010). Such peculiar but precise measurements of geological time in the form of separate leading

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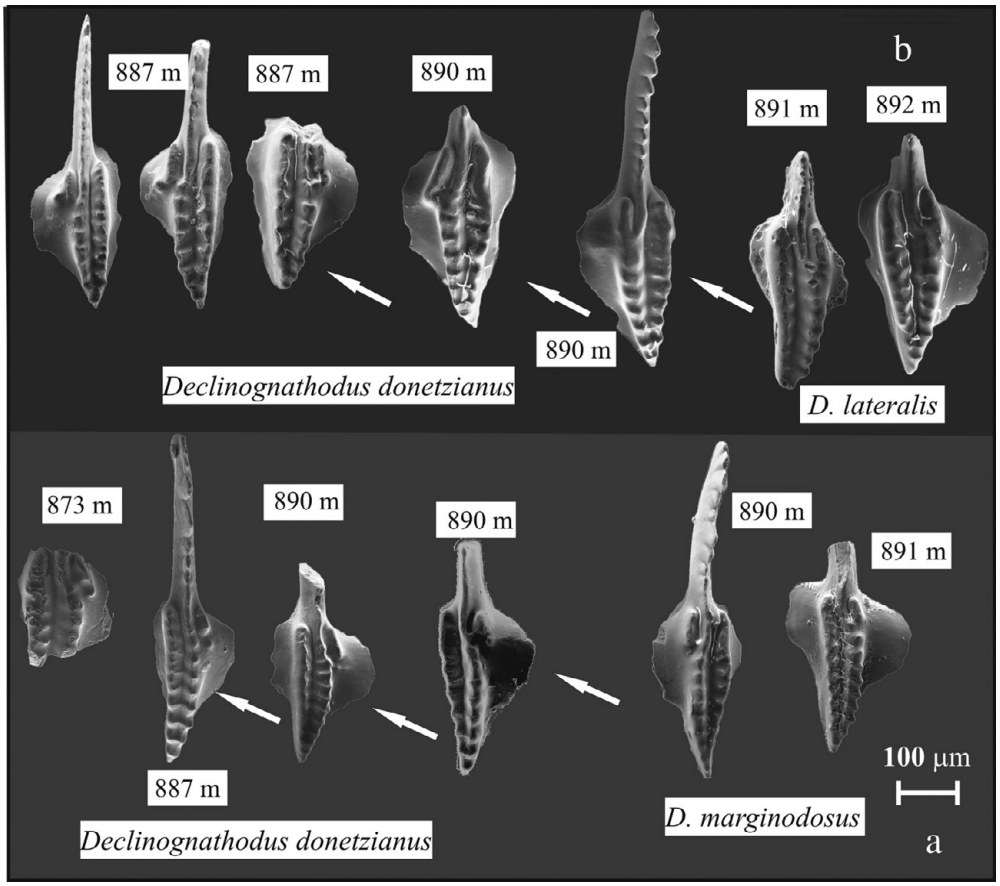

Figure 14. Lineage changes of conodonts *Declinognathodus* across the Bashkirian–Moscovian boundary in Tchuvashskaya-4 borehole: (a) the front part of the outer parapet separates and then the tubercles are formed; (b) the tubercles are formed and then the front part of the outer parapet separates).

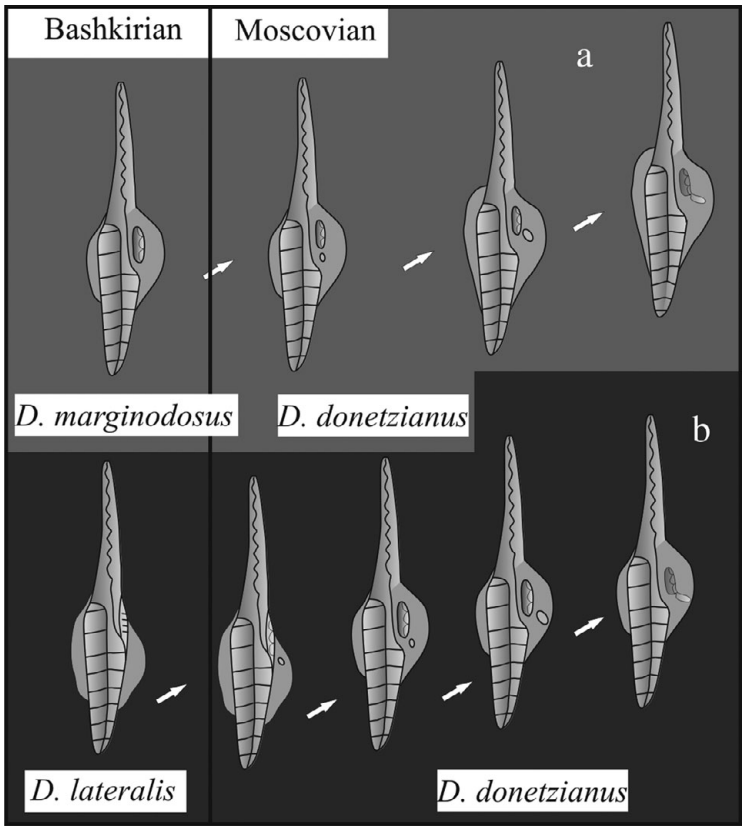

Figure 15. Process of additional basal tubercles forming on the surface of the cavity: (a) *Declinognathodus marginodosus* (Grayson) in *D. donetzianus* Nemirovskaya; (b) *D. lateralis* (Higgins & Bouckaert) in *D. donetzianus* Nemirovskaya.

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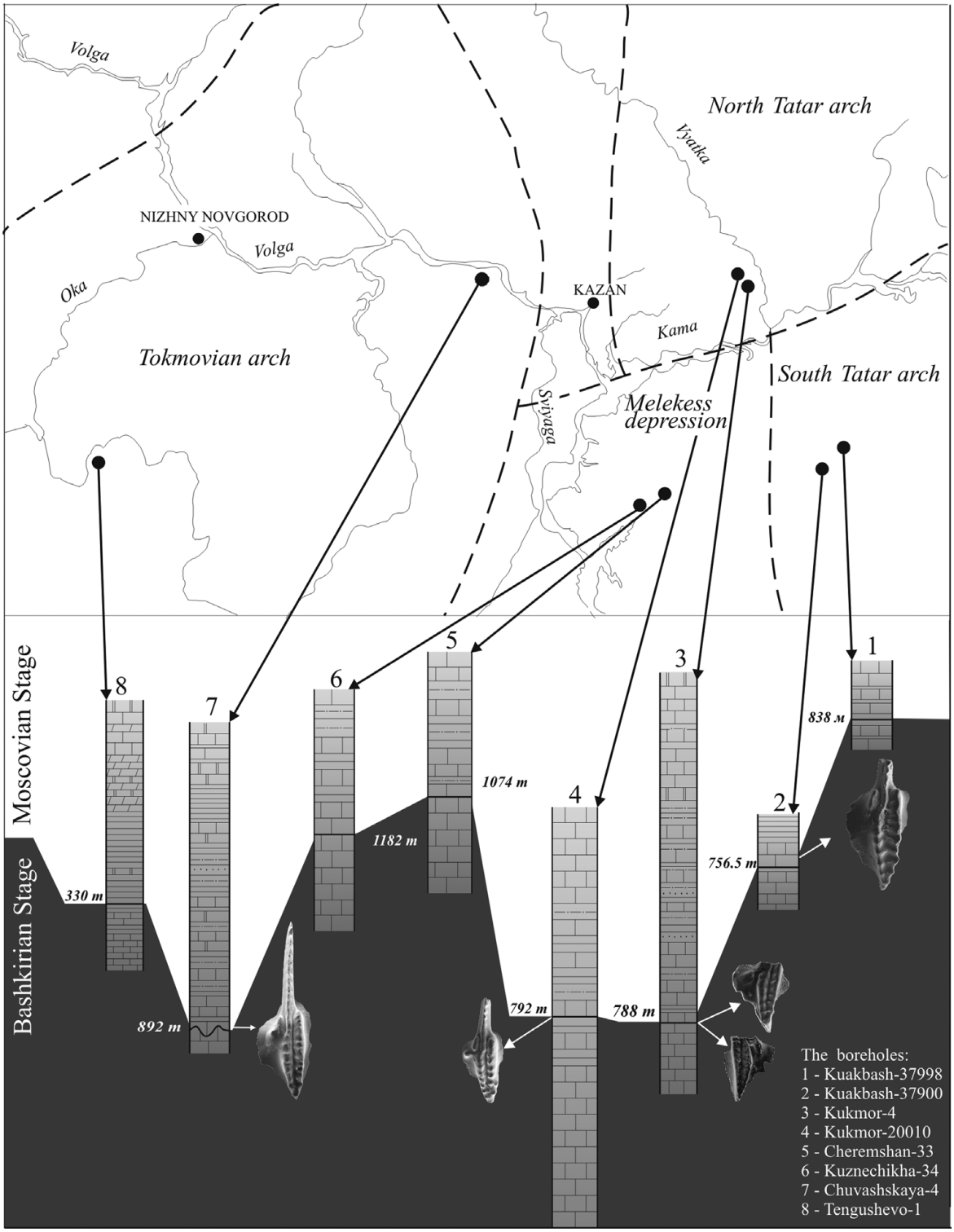

Figure 16. Bashkirian–Moscovian boundary from the studied boreholes and its correction in Volga region.

characteristics, fixing crucial moments of geological history on Earth, serve as reliable instruments of correlation.

5. Systematic Palaeontology

Table 3 describes the systematic palaeontology of *Declinognathodus lateralis* (Higgins & Bouckaert, 1968), *Declinognathodus marginodosus* (Grayson, 1984) and *Declinognathodus donetzianus* Nemirovskaya, 1990.

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Table 3. Description of conodonts of genus *Declinognathodus* from the Volga region.

	Declinognathodus lateralis (Higgins & Bouckaert, 1968) (Figs 11, 12, 14)	*Declinognathodus marginodosus* (Grayson, 1984) (Figs 11–14)	*Declinognathodus donetzianus* Nemirovskaya, 1990 (Figs 11–14)
Platform	Long, narrow	Long, narrow	Elongate, narrow
Carina	Short, pressed to the outer parapet and continuing to the posterior end	Short, deviates towards external parapet and merges with it in the front part of the platform	Very short, bends and merges with the outer parapet at once
Parapets	Straight, with parallel transverse ridges	The front part the outer parapet is isolated from the rest of the platform with a stria	Outer parapet in the front part of the platform is ornamented with 2–6 isolated nodes
Middle furrow	Narrow, pressed to the internal parapet, extends to the back end of the platform	Wide and deep	Narrow, not deep, becomes hollow towards the back end of the platform
Comparison	Distinct from *D. Donetzianus* Nemirovskaya, *D. Marginodosus* (Grayson) carina of *D. Lateralis* pressed to the outer parapet	Differs from *D. Donetzianus* Nemirovskaya, with the absence of additional nodes located at the outer flange of the platform	Differs from other species of the genus *Declinognathodus* by the presence of additional nodes on the outer flange of the platform
Distribution	Bashkirian stage of Donets Basin (limestones D_5^9–G_1; Nemirovskaya 1999), Ural and Central Asia; Bashkirian and Moscovian (Vereian substage) stages of the Volga region; Namur of western Europe; Pennsylvanian (Morrowan) of North America; Kodani formation of Japan; Weiningian of China	Upper part of Bashkirian – lower part of Moscovian of the Volga region and Donets Basin; Moscovian stage (Vereian substage) of Moscow region; Pennsylvanian (upper Morrowan – Atokan) of North America, Westfal of western Europe	Moscovian stage (Vereian substage) of Moscow region, the Volga region, South Ural; Donets Basin (limestones K_2 – K_7; Nemirovskaya 1999); Pennsylvanian (Atokan) of North America

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