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Papers presented at the International Congress cover all aspects of the Earth history in the Carboniferous and Permian periods. Congress participants reported on the boundary definitions of the International Chronostratigraphic Scale and GSSP choices, high-resolution stratigraphy, Late Paleozoic glaciations and interglacials, tectonics and orogenies, the evolution of the marine and continental biotas, sequence stratigraphy, correlation of marine and non-marine strata, and Carboniferous and Permian coal and mineral resources.

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Contents

Middle Permian therocephalians from the South African Karoo

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The Permian was a very important period in the Earth history when modern trophic pyramid structures became established in terrestrial environments. One of the key places to investigate this particular time period is the Beaufort Group of the Karoo Basin, South Africa, which records a continuous sequence of continental deposition ranging from the Middle Permian to the Middle Triassic (a range of approximately 30 million years). The Beaufort group is divided in seven assemblage zones (AZs), defined by their fauna. The three oldest of these are the *Eodicynodon*, *Tapinocephalus* and *Pristerognathus* AZs, which represent the Middle Permian and the transition to the Upper Permian. Therocephalians are a heterogeneous group first recorded in the Middle Permian of the Karoo Basin. Early representatives of this group reached large sizes (dorsal skull length of 370 mm) and some were among the top predators in Middle Permian faunas from South Africa. There are two records of small to medium sized scylacosaurid therocephalians in the *Eodicynodon* AZ representing the oldest members of this group in the world. The two therocephalian families classically represented in the Middle Permian, scylacosaurids and lycosuchids, were abundant in the *Tapinocephalus* AZ, whereas the fauna of the *Pristerognathus* AZ shows a transition with a reduction in the species richness of the basal families. In this AZ are also recorded the first appearance of the smaller therocephalian taxa Hofmeyriidae and Ictidosuchidae, that would become well established in the younger Late Permian faunas. In this work we will present a re-analysis of the taxonomy and the stratigraphic and geographic distribution of the Middle Permian therocephalians from the Karoo Basin, which are crucial for studies of biostratigraphy and of early therocephalian evolution.

The Middle Carboniferous–Permian Stage in the evolution of Radiolaria

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The evolution of radiolarians of the subphylum Polycystina is marked by a cycle of phases, periodically changing between diversification, acme, and extinction phases. We recognized four phases and nine stages in the general dynamic model of the Phanerozoic cyclic evolution of radiolarians. Each stage of evolution was characterized by substantial changes in the composition and quantity of radiolarians and a change in the dominant groups. A global cooling and glaciation in the Middle Carboniferous–Permian, which showed features of a total crisis, led to a reduction in the total number of radiolarians and to a decrease of their taxonomic diversity.

The third stage of radiolarian evolution (Middle Carboniferous–Permian) shows the decrease in the species diversity of radiolarians to 202 species, changing from 25 species in the Middle Carboniferous to 112 species in the Early Permian. The rate of speciation of radiolarians in the Middle Carboniferous–Permian gradually decreased from 4.6 to 2.1 species/Myr at the average rate of 2.7 species/Myr. In the Middle Carboniferous–Permian, 52 genera of radiolarians are known. Most of them (37 genera) existed in the Early Permian. At the third stage of the evolution of radiolarians, two new families (Ruzhencevispongidae, Deflandrellidae) and seven subfamilies of stauraxonic radiolarians appeared.

The third stage of the evolution of radiolarians shows: (1) an intensive development of stauraxonic and bilaterally symmetrical radiolarians, (2) stabilization in the evolution of porous Sphaerellaria, (3) somewhat slower evolution of the spongy Spumellaria, (4) gradual extinction of spiny radiolarians of the orders Fasciculata and Triangulata from the class Aculearia, (5) complete disappearance of radiolarians with a pylome of the order Pylomariata.

The end of the Permian period was marked by the catastrophic extinction of radiolarians. At the end of the Paleozoic, 37 of a total of 59 higher taxa of Paleozoic radiolarians became extinct (4 orders, 2 superfamilies, 14 families, and 17 subfamilies). Of the lower taxa existing at various times during the third stage of the Paleozoic history of radiolarians, 45 (86.5 %) genera and 195 (96.5 %) species died out.

The significant morphological similarity of some Paleozoic and Mesozoic–Cenozoic groups of radiolarians suggests the possibility of general evolution of Phanerozoic radiolarians. At the end of the Late Permian, the diversity of stauraxonic radiolarians sharply decreased. However, many genera among Mesozoic and Cenozoic radiolarians are strikingly similar to the Stauraxonaria, which disappeared at the end of the Paleozoic. Early Pylomariata could be ancestral to Mesozoic–Cenozoic Nassellaria. For instance, Pylentoneminae, the unique skeletal morphology of which is very similar to the tripods of true Nassellaria, or Late Devonian–Carboniferous Popofskyellidae, the tests of which featured a distinct segmentation, delineated cephalis, and a well-developed pylome. The conservative nature of spherical radiolarians is well-known (this includes porous Sphaerellaria and spongy Spumellaria). However, more advanced taxa of these classes exist even now.

This study was supported by the Program of the Presidium of the Russian Academy of Sciences “Problems of the Origin of Life and Formation of the Biosphere” and the Russian Foundation for Basic Research, project no. 15-05-00451.

Early Permian radiolarian assemblages in the Great Urals, Mygodzhary and Peri-Caspian Basin

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Early Permian Radiolaria have been documented in different regions of the Great Urals, Northern Mugodzhary and Pre-Caspian Basin. During Permian time these Uralian regions belonged to a comparatively narrow long marine basin, referred to as the Cis-Uralian Sea. This submeridional paleobasin was connected with the Tethys Ocean (Northern Mugodzhary and Pre-Caspian basins) in the South, and with the Panthalassa Ocean in the North. The Cis-Uralian Sea crossed several climatic zones, and the radiolarians that inhabited it occurred in different paleobiogeographical zones. The spread of radiolarians was controlled and limited by fluctuations in water dynamics, temperature and salinity.

The richest and most diverse Asselian-Artinskian assemblages occurred in the west of the Southern Urals (about 20-30° N Paleolatitude). Less diverse radiolarian assemblages were found: (1) in Novaya Zemlya, northern Great Urals (Asselian, about 55° N), (2) in the Northern Mugodzhary and Pre-Caspian Basin (Artinskian, about 10-15° N), (3) in the west of Middle Urals (Kungurian, about 35° N). The richness and diversity of the South Urals radiolarian associations were determined by the low-latitudinal position of the habitat region, and its direct connection with the Tethys Ocean. Furthermore, the location of habitat water area in the thin flysch zone of Pre-Uralian trough influenced the taxonomic composition of assemblages. The inner shelf waters were inhabited by the most diverse radiolarian faunas (reference sections Krasnousolsk, Sim, Kondurovka, Nikolskoe, Donskoye, Verkhneozernoye, Assel' and Malaya Suren' rivers). The outer shelf was characterized by depleted radiolarian assemblages. There are the North (Novaya Zemlya) and the South (Aktasty of Northern Mugodzhary and Pre-Caspian Basin).

Marine Permian sediments are preserved in fragments, but features of the distribution of radiolarians in the Cis-Uralian Region allow the preliminary regional biostratigraphic scale to be elaborated, based on beds with characteristic fauna. The age of the radiolarian assemblages is recognized based on co-occurrence with conodonts.

Radiolarians of Asselian age can be differentiated into four assemblages: *Latentifistula crux*, Tormentidae, *Copicyntra* sp., and newly allocated beds with *Tetragregnon sphaericus–Latentifistula heteroextrema*. Five biostratigraphically significant radiolarian assemblages can be recognized in the Sakmarian:*Copiellintra bispina*, *Haplodiacanthus perforatus –Helioentactinia ikka*, *Latentidiota circumfusum–Entactinia pycnoclada*, *Camptoalatus monopterygius,* , and newly allocated beds with *Russirad calthrata – Apophysisphaera sakmaraensis*. Artinskian radiolarian fauna are characterized by seven assemblages: *Copicyntra acilaxa–Quinqueremis arundinea, Rectotormentum fornicatum, Paratriposphaera crassicalthrata–Quinqueremis arundinea*, *Tetracircinata reconda, Polyentactinia lautitia*, and two newly allocated beds with *Astroentactinia pinrasensis–Spongentactinia rozhnovi* and beds with *Spongentactinia rigida*. Kungurian radiolarians are represented by the *Ruzhencevispongus uralicus* assemblage. Middle and Late Permian Radiolaria are unknown in the Great Urals.

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A new Kiya – 3 section (Aktyubinsk Oblast, Kazakhstan)

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In recent years, new previously unknown outcrops of limestones were discovered in the Kiya River Valley (left bank), referred to as the Kiya – 3 section. The section is located 1.5 km away from the known Kiya – 1 and Kiya – 2 sections (right bank); the deposits within these sections were dated Upper Viséan–Serpukhovian by previous authors. Limestone beds in the Kiya – 3 sections have a meridional strike and an eastward dip. Lithologically, the section is composed of light grey limestones, rarely with a cream tint, fine- and medium-grained, bioclastic, biomorphic-detrital, recrystallized, (mudstone, wackestone), thick-bedded, with a hummocky surface of bedding, occasionally brecciated. The secondary wackestone is composed of grainstone pelloids. Bioclasts are represented by remains of crinoids, brachiopods, ostracodes, tiny ammonoids (rarely), and calcareous spicules. The thickness of deposits is about 10 m. As per lithological characteristics these deposits are similar to the Dombarian type of limestones identified by V.V. Ruzhentsev and M.F. Bogoslovskaya in this region. We studied deposits of this type in the sections of the Dombar Hills (Alabaital River), Meridional ridge (Zhaksy Kargala River). Conodonts were studied for the purpose of substantiation of the age of the Kiya – 3 section deposits. The complex composition is characterized by a rich assemblage including the following taxa: *Lochriea ziegleri* Nemirovskaya et al. (dominant), *L. cruciformis* (Clarke), *L. senckenbergica* Nemirovskaya et al., *L. commutata* (Branson et Mehl), *L. costata* (Pazukhin et Nemirovskaya), *L. monococtatan* (Pazukhin et Nemirovskaya) , *L. nodosa* (Bischoff), *L. multinodosa* (Wirth), *Gnathodus bilineatus bilineatus* (Roundy), *G. girtyi girtyi* Hass., and *Pseudognathodus homopunctatus* Ziegler. This assemblage is typical of the *L. ziegleri* conodont zone and recognized in the above sections, characterized by the ammonoids of the *Uralopronorites–Cravenoceras* (Nm_1b) Zone. Similar assemblages were studied in the Lower Serpukhovian deposits of the South Urals (Eastern Kardailovka), southern part of the Moscow Basin and in many other regions. Apparently the Kiya – 3 section is a continuation of the Kiya – 1, Kiya – 2 sections. In Kiya – 3 section, there is no contact with the underlying and overlying deposits.

Further study of these sections will allow correlation with the synchronous deeply buried beds in the Peri-Caspian Depression.

Latest Moscovian to earliest Kasimovian (Pennsylvanian) conodont faunas from the Dalnyi Tulkas section, South Urals, Russia

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The definition and global correlation of the Moscovian–Kasimovian boundary remain uncertain. Because of difficulties in recognizing well identifiable and globally comparable conodont taxa at the base of the Kasimovian Stage in the Moscow Basin, the study of the deep-water facies sections of the South Urals is of great significance (Chuvashov et al., 2001, etc.; Syngatulina, 2012). We studied conodonts from the boundary intervals of two sections. The first is Dalnyi Tulkas section 1, near the town of Krasnousolsk (Bashkiria). Limestones of the Zilim Formation. (about 18 m) and lowermost shales and cherts of the Kurkin Formation. (less than 1 m) are visible in this section. The conodont assemblage consists mainly of *Idiognathodus, Swadelina* and *Gondolella.* Five assemblages were recognized in this section. The lowermost assemblage is *Idiognathodus* sp. A (interval 0–9.7 m). The assemblage with *Idiognathodus podolskensis – I. obliquus* (9.7–14.6 m) is characteristic of the interval with the most abundant macrofossils and fusulinids. This assemblage is typical for the Middle Podolskian–Lower Myachkovian of the Moscow Basin (Makhlina et al., 2001). The assemblage with *Idiognathodus* sp. B (14.6–16.9 m) contains most of the species of the *podolskensis–I. obliquus* assemblage. It is possible that this interval is coeval with the Myachkovian of the Moscow Basin, because *Idiognathodus* sp. B morphotype occurs there. The uppermost part of the Zilim Formation. (16.9–18.9 m) contains "*Streptognathodus" subexcelsus* Alekseev et Goreva and *Gondolella magna* Stauffer et Plammer. This interval is of early Krevyakinian (Suvorovo) age. *Swadelina makhlinae* Alekseev et Goreva was found at a level of 18.9 m. This species is typical for the *S. makhlinae* Zone (Voskresensk Formation., Moscow Basin). This conodont data supports the conclusion that the Dalnyi Tulkas section embraces the Moscovian–Kasimovian boundary interval, which is here represented in deep-water facies showing dominance of gondollelids. The topmost samples from silicified limestones and cherts could not be disintegrated or were empty. The second, nearby section is Dalnyi Tulkas 2. The lower part of the section (Zilim Formation, interval 0–2.8 m) belongs to the Upper Moscovian and contains *Idiognathodus podolskensis, Idiognathodus* sp. B and *Gondolella laevis* Kossenko. The uppermost part of the Zilim Formation. (2.8-4.6 m) contains "*Streptognathodus" subexcelsus*, *Gondolella magna* and transitional specimens to *Swadelina makhlinae.* The samples from the interval 4.6–5.8 m contain "*S". subexcelsus*, *Gondolella* and *S. makhlinae.* The shales (5.8–6.2 m) contain *I. turbatus* Rosscoe et Barrick, a potential biostratigraphic marker of the base of the Kasimovian (Villa and Task Group, 2008). This species is characteristic of the *I. sagittalis* Zone in the Moscow Basin (Khamovnikian Substage, Neverovo Formation.). The wide distribution of *I. turbatus* shows its considerable potential for long distance correlation, and this species can be selected as a marker for the lower boundary of the Kasimovian Stage.

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Gzhel section (Moscow Basin, Russia), as a candidate for the GSSP for the global Gzhelian Stage

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The Gzhelian Stage, one of the seven stages of the Carboniferous System, was named by S. Nikitin in 1890 in Russia. The Gzhelian strata in the Moscow Basin are mainly marine carbonates with diverse fossils and are traceable over great distances around the East European Platform and in other regions of the World. The historical stratotype of the Gzhelian Stage – Gzhel section – is located in the Ramenskoe District of the Moscow Region near Gzhel railway station. The most comprehensive description of this section and its biostratigraphical analysis were done by Makhlina and Ivanova (1975) and Alekseev et al. (2009). The nearby, more complete Rusavkino section was re-studied. The former Rusavkino Formation was recently subdivided into the Popovstshino (limestone), the Vyunka (variegated shale), the Novy Milet (white limestone) and the Kosherovo (dolomite, limestone and shales) formations (Alekseev et al., 2015). The Gzhel section has a thickness of about 5 m and shows the Novy Milet white limestone that is overlain by the basal Kosherovo dolomite with an unconformity (a paleosol in the top of limestone and clay with pebbles at the base of the Kosherovo).

In the Novy Milet Formation only scarce conodonts are found, among them *Streptognathodus firmus*. Typical specimens of *Idiognathodus simulator* appear 0.5 m above the base of the Kosherovo Formation. The first appearance of *I. simulator* is selected as the base of the global Gzhelian Stage (Heckel et al., 2008). The ancestor of this species, *I. praenuntius*, is known in the Vyunka Formation at the Rusavkino section. Besides the index species, a rich conodont assemblage 1 m higher includes *Streptognathodus pawhuskaensis*, *Idiognathodus tersus*, *I. toretzianus*, *I. luganicus*, *I. sinistrum*, and *Gondolella bella*. This association occurs in the Volga–Ural Region and the South Urals, and is a good marker for the boundary. The Gzhel section is the *locus typicus* for the fusulinid *Rauserites rossicus,* which has been discussed as one of the additional markers of the lower Gzhelian boundary, but we have to take into the account the polymorphic status of this widely distributed species. The Upper Kasherovo Formation. contains a characteristic diverse macrofossil assemblage: Rugose corals, gastropods, nautiloids, trilobites, bryozoans, brachiopods, crinoids, echinoids and other groups. The data on oxygen and carbon isotope composition of the bulk rocks (Buggisch et al., 2011) and on oxygen isotope ratios in phosphatic material of conodont elements (unpublished data by Joachimski et al.) are available. Carbon isotopic composition shows a shift in $\delta\ ^{13}C_{carb}$ VPDB in the Gzhel and Rusavkino sections from about +2 ‰ at the top of the Novy Milet Formation to almost + 3.7 ‰ in the basal Kosherovo dolomite and again to +1.5 – +2 ‰ at the level of maximum flooding with *Gondolella* bloom and the *I. simulator* assemblage. The Gzhel section has considerable potential for long distance correlations and may be considered as a good candidate for the GSSP. The type Gzhelian exposure is preserved as a natural reserve in the Moscow Region.

This work is supported by the Government Program for Competitive Growth of Kazan Federal University, and Russian Foundation for Basic Research, projects 12-05-00106 and 15-05-00214.

Paleoenvironmental reconstructions for the vicinity of the Moscow sedimentary basin, based on the study of Carboniferous paleosols

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The Carboniferous section of the southern Moscow Basin hosts four global stage stratotypes, and there are indications of an unusually good preservation of primary geochemical and mineralogical signals. It is one of the best examples of epeiric – sea carbonate sedimentary systems with numerous subaerial exposure horizons marked by paleokarsts and paleosols. This work is the result of detailed and interdisciplinary research including bulk geochemistry, mineralogy and magnetic susceptibility of the recently discovered Carboniferous paleosols of the Moscow Basin (~30 profiles of Mississippian and Pennsylvanian paleosols) which aims at landscape reconstruction including types of soils and associated terrestrial sediments, moisture and temperature regime. Besides providing provenance information, bulk geochemistry generally reflects paleoweathering conditions and contributes to paleoclimate reconstructions as well. To quantify weathering intensity, different element ratios have been introduced (Retallack, 2001, Sheldon and Tabor, 2009). Elemental concentrations were determined with a desktop XRF crystal diffraction scanning spectrometer. The lithological heterogeneity of sections with dominating limestones and numerous subaerial disconformities with paleosols is vividly expressed on bulk geochemical and magnetic susceptibility (MS) logs. Chemical element ratios are useful for assessing identification of paleosols in sections, the best correlations to siliciclastic units with paleosols, shows Ba/Sr, iron content and MS distribution in the sections. The geochemical weathering indices may not only serve to quantify paleoweathering intensity, but also to estimate paleoclimate parameters, i.e. mean annual precipitation (MAP) and mean annual temperature (MAT) via empirical transfer functions. Taking into account the most complete geological data and detail paleosols records for Polotnyanyi Zavod and Novogurovsky sections (Viséan–Serpukhovian Stage) the main discussion and preliminary estimation of MAP and MAT was done for these sections.

For calculations, we took the layers of paleosols with high clay and low carbonate content. The comparison of results for the same stratigraphic layers of the studied sections (Polotnyanyi Zavod and Novogurovsky and Malinovsky) demonstrate equal results in MAP and MAT. The common trend is an increase of aridity from the middle Mississippian (Viséan, Mikhailovian regional substages; with MAP ~1150 mm; MAT ~15°C) to late Mississippian (Serpukhovian, Steshevian and Protvian regional substages; with MAP ~500 mm and MAT~ 12°C). The mineralogy of the studied paleosols also confirms climatic changes. While the middle and late Mississippian paleosols are smectitic, in Pennsylvanian paleosols palygorskite (sometimes sepiolite) became the principal mineral testifying to the aridity (MAP ~ 300 mm) of the Late Carboniferous climate in the territory of the Moscow sedimentary basin.

The Upper Viséan (Mikhailovian–Venevian boundary) paleosols in the southern regions of the Moscow Basin (Russia)

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In our talk we describe the complex disconformity at the Mikhailovian–Venevian boundary from 4 quarries in the southern part of the Moscow Basin (Russia): Polotnyanyi Zavod, Novogurovsky, Malinovka and Zmeinka. The main part of this disconformity is the black "rhizoidal" limestone of palustrine origin ("Akulshino palustrine bed"). These shallow water carbonate deposits are underlain by karst limestone with a pronounced relief at the surface. At Polotnyanyi Zavod quarry (Kaluga Region) in the bottom of the palustrine bed the pedocomplex of two paleosols (PS) has been recently discovered. A detailed multidisciplinary study of these deposits included basic soil properties, mineralogy (XRD), chemistry (XRF), isotopic composition of C in carbonate and organic matter (mass-spectrometry), solid state ^{13}C NMR spectroscopy of organic matter, SEM. The obtained data show the presence of two following additional intermediate units (from the bottom to the top): Rendzina type PS developed from the subaerially altered marine limestone (PS1) and subaerial-subaqueous soil developed from bog marl (PS2). The latter has an "island" distribution probably coursed by the karst paleorelief or due to denudation. Both PSs are carbonaceous, have a more clayish upper organo-mineral horizon, well preserved roots, invertebrate faeces, plant imprints, contain micritic carbonate, and show features of Fe redistribution. Isotopic composition of carbonate in both PSs is relatively light, non-marine (- 6.28 ‰ < $\delta^{13}C$ < - 4.55 ‰). PS1 is rich in organic matter (up to 2 % of OC) and clay (up to 78 %) which is montmorillonitic. The $\delta^{13}C$ of OC is – 21.72 ‰ for PS1, −21.31 ‰ for PS2 and – 24.44 ‰ for the palustrine bed. All these values are specific for C3 plants. ^{13}C NMR study shows that organic matter in PS1 is aliphatic – alkyls dominated (aromaticity index is 33 %), whereas that of PS2 is aromatic (aromaticity index is 58 %). The upper horizons of both PSs are enriched in kaolinite, goethite, show the enhancements of PWI, CIA and CIA-K geochemical indices, Ba/Sr and Rb/Sr values and Ga concentration. The maximal values of these geochemical indices and Ga concentration (2.8 $*10^{-3}$ %) were observed for the A-horizon of PS1 which all support its subaerial nature. Palustrine beds from all four studied quarries have similar characteristics: rich in fresh water carbonates (- 4.34 ‰ < $\delta^{13}C$ < -2.19), free from marine fauna and terrigenous material, contain authigenic smectite, rich in organic matter detritus. OC content is 0.3–0.7 %. It is aliphatic in nature (aromaticity index is 35 – 42 %). The vertical succession of discovered PSs together with the covering palustrine bed testifies to the slow immersion of the studied territory at the boundary of the Mikhailovian – Venevian interval. The development of the described pedocomplex only in the Kaluga Region may suggest its occupation of the elevation of paleorelief, or the island position of this part of the studied territory. The described units of the complex disconformity at the Mikhailovian–Venevian boundary are comparable with the components of the modern marsh landscape of the Everglades National Park in Florida (USA).

Permian coal deposits of the Witbank Coalfield (South Africa): Inter-seam facies patterns and implications for palaeoenvironment and palaeoclimate reconstructions

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The northeastern part of the Main Karoo Basin hosts South Africa's coal resources, where after more than a century of mining the Witbank Coalfield is still one of the most important coal mining districts in the country, supplying more than 50 % of South Africa's coal. These coals are part of the Permian Ecca Group and have been deposited during the terminal retreat of the Dwyka ice, during a phase of climate amelioration. Previous studies mainly addressed the coal seams themselves and little work has been done on the inter-seam deposits. However, for palaeoenvironmental and palaeoclimatic reconstructions the inter-seam facies changes need to be addressed in detail. Here, we report on stratal and lateral facies patterns documented in the inter-seam deposits of coal seam No. 1 (the lower-most minable seam) and coal seam No. 2 of the Witbank Coalfield. Outcrop and borehole data are used to reconstruct the depositional environment and detect climatic signatures. Short-term, local to regional changes of postglacial lacustrine-fluvial settings are recognized. Laterally, a transition from braided to meandering river systems is documented. Changes in sedimentary organic matter content and preservation enable to refine previous depositional models and climatic reconstructions.

Bashkirian-Moscovian boundary beds in central Taurides (Turkey): foraminiferal biostratigraphy and position of the boundary within a glacio-eustasy driven sequence stratigraphic framework

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Bashkirian–Moscovian boundary beds, made up of carbonate and mixed siliciclastic-carbonate lithologies, are widely exposed along the Tauride Belt in Southern Turkey. Three overlapping sections spanning the Lower Bashkirian (Askynbashky) to Lower Moscovian (Solontsovsky) beds have been measured and collected on a bed-by-bed basis.

The Bashkirian portion of the sections has been divided into five zones: namely *Pseudostaffella praegorskyi-Profusulinella staffellaeformis* Zone (Askynbashky); *Pseudostaffella gorskyi-Eoschubertella obscura* Zone (lower Tashastinsky); *Ozawainella pararhomboidalis* Zone (upper Tashastinsky); *Pseudostaffella subquadrata-Profusulinella tashliensis* Zone (Asatausky); and *Profusulinella praeprisca* Zone (Asatausky). The lower Moscovian (Solontsovsky) is characterized by the *Profusulinella prisca-Aljutovella aljutovica* Zone. The Bashkirian– Moscovian boundary is delineated by the first occurrence of *Profusulinella prisca*, one of the end members of the *P. staffellaeformis-P. paratimanica* lineage. This level also coincides with the first occurrence of *Aljutovella aljutovica*. The datum corresponding to the first occurrence of the genus *Eofusulina* is slightly higher than that of the zonal markers of the basal Moscovian.

Stacking patterns of upward-shoaling meter-scale cycles in the measured sections indicate the presence of two third-order sequences dated as Askynbashky to lowermost Asatausky and Asatausky to Solontsovsky. A prominent quartz arenitic sandstone intercalated within the Upper Bashkirian carbonate succession has been interpreted as a falling stage systems tract corresponding to stratal offlap during the culmination phase of the second glacial interval in the Carboniferous. Following the sea-level fall in the earliest Asatausky, a new carbonate regime was installed in the Asatausky–Solontsovsky interval by a glacio-eustatic sea-level rise. The Bashkirian–Moscovian boundary seems to be located within the transgressive systems tract of this new carbonate regime.Timing of a glacio-eustatic sea-level data derived from the sequential development of the Bashkirian–Moscovian boundary beds supports the previously introduced scenario arguing that the diachronous appearances of the genus *Profusulinella* and related fusulinid taxa in the Midcontinent–Andean Province are migratory appearances from the Eurasian–Arctic Province. These migrations were probably facilitated by a glacio-eaustatic sea-level rise starting from the latest Bashkirian (Asatausky) as evidenced from this study.

Characteristics of Late Carboniferous–Early Permian organic buildup environments (Timan–Northern Ural Region)

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The history of Paleozoic reef-formation in the north of the Urals has included some intervals of rather long distribution of atypical biogenic frameworks, reflecting essential reorganisations of the biosphere. The most impressive examples of such atypical organic constructions are the Upper Carboniferous–Lower Permian skeletal mounds. The ecological succession of reef ecosystems in these constructions does not reach the mature stages: diversification and domination (climax). In the studied sections of the Northern Urals it was revealed that after the colonisation stage there was a new stage – a collapse or a destruction stage – characterized by massive limestones with an abundance of skeletal fragments. Bioclastic limestones essentially prevail over biohermal ones in the skeletal mound frameworks, and clastic facies are absent inside and on the slopes around the mounds. The skeletal mounds are widely developed in sections on the western slope of the Northern, Subpolar and Polar Urals, and the Pre-Urals Foredeep. In the Kasimovian, Gzhelian, Asselian, and Sakmarian intervals of the skeletal mounds on the Kos'u, Kozhym, Shuger, Podcherem, Ilych and Un'ya rivers taxonomically and genetically various bioclastic and biohermal biocementolites are often observed. They are characterized by various configurations of incrustate crusts of biologically induced calcite cement, which give the massive limestones the appearance of ancient petroglyphic patterns (for example, the Pisanyj Kamen' buildup on the Un'ya River, Northern Urals). The global fall in sea level was connected with the largest Late Paleozoic glaciation on Gondwana, formation of the Uralian folded system (the Uralian phase of the Hercynian orogeny), and increase in activity of the Pechora Plate inversion processes. They caused occurrence of erosion extensive areas in the western territories of the Timan-northern Ural region. The deformation of the carbonate platform margin developed under changing basin, paleolandscape and paleoecological conditions, increase in continental flow and trophic levels that resulted in the replacement of oligotrophic waters with mesotrophic ones. These factors caused the intensification of microbial communities, biochemical activity and occurrence of eutrophic conditions in depressions of the epicontinental shallow-water sea. Since the Early Carboniferous the Mg/Ca ratio in sea water was displaced by an aragonite regime, and new reef-forming communities began to prevail. The mineral composition of bryozoans, green algae, foraminifers, hydroids, and calcisponge skeletons was primarily aragonite, high-Mg-calcite, or calcite-aragonite. The role of corals as reef-forming organisms during this time sharply decreased as they had calcite skeletons. In the Late Paleozoic, specific geo-biological conditions, big skeletal mounds (up to 330 m thick) formed on the slopes of the Northern-Uralian shelf and on the slopes of the newly formed uplifts in environments of depressions with anoxic near-bottom waters during the period of carbonate platform degradation. Small sessile organisms in these seas could not build rigid frameworks and only the formation of extensive early diagenetic calcite encrustation crusts around them supported the generation of large organic buildups in the shallow-water sea. According to studies of ancient and modern reefs, the maximum volume (up to 30 %) of such cements that was reached in the Late Carboniferous-Early Permian suggests the initiation of biospheric events at this time.

C- and O- isotope evidence of Late-Permian cooling in the continental deposits of the East-European Platform

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Carbon ($\delta^{13}C$) and oxygen ($\delta^{18}O$) isotope composition of pedogenic, organogenic and sedimentary carbonates from post-Kazanian (post-Roadian) Permian and Triassic continental red beds were studied. Wide-scale $\delta^{13}C$ (from -14.0 ‰ to 5.8 ‰, PDB) and $\delta^{18}O$ (from 19.5 to 35.5 ‰, SMOW) values are evidence about climatic and paleo environmental changes in the Middle and Late Permian. Lower $\delta^{18}O$ values (≤24 ‰) of sedimentary carbonates and pedogenic nodules allow us to conclude about climate cooling and the presence of fresh-water basins.

Evidence of cooling on the east of the Russian platform in the post-Kazanian deposits was present in different studied layers. Earlier decrease of $\delta^{18}O$-values of sedimentary (to 22.6 ‰) and pedogenic (to 23.3 ‰) carbonates was determined in Urzhumian (Wordian) deposits (Kazanian District of the Volga River). This isotope trend correlated with Kiaman-Illavarra paleomagnetic Superchron change and probably with the beginning of the P4 glaciation in Gondwana. The next negative $\delta^{18}O$ shift is shown in the Severodvinian (Capitanian) sediments (to 24.2 ‰ in sedimentary carbonates; to 22.4 ‰ in pedogenic carbonates). This isotope excursion corresponds to the Kamura cooling event in marine deposits.

Stratigraphically above, the oxygen isotope composition of different carbonates becomes lighter. $\delta^{18}O$ values in pedogenic carbonates in the Lower Vyatkian (Middle Wuchiapingian) Substage of the Sukhona River (east part of the Moscow basin) are decreased to 20.9 ‰, and in sedimentary carbonates – to 23.0 ‰. But, oxygen isotope values are increased (to 26.4–31.0 ‰) in the pedogenic carbonates of the top of the Lower Vyatkian (Upper Wuchiapingian) Substage.

Pedogenic carbonates of the Upper Vyatkian (Changhsingian) Substage by different outcrops (Aristovo–Kuzino, Nedrubrovo, Astashikha, all east part of the Moscow Basin) are characterized by lower $\delta^{18}O$ values (to 20–25 ‰).

Lower $\delta^{18}O$ (20.6 and 21.2 ‰) and $\delta^{13}C$ (-8.8 and -8.3 ‰) values in the sedimentary and pedogenic carbonates of the Nedubrovo and Astashikha outcrops are correlated with the Late Permian Great Extinction event at the top of the Changhsingian layers.

A sharp negative excursion of $\delta^{18}O$ values in sedimentary and pedogenic carbonates is observed in deposits of the transition zone from Vyatkian to Induan Stage. This isotope shift is due to a climate cooling (humidization) before the end of the Changhsingian geological time. But, warming of climate occurred on the P-T boundary because the positive oxygen isotope trend determined in pedogenic carbonates from the Nedubrovo Member (the top of the Changhsingian) to the Ryab Members (the bottom of the Induan).

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The redefinition of the Devonian–Carboniferous boundary: Recent developments

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Since in the GSSP section at La Serre, Southern France, the marker fossil for the base of the Carboniferous, the conodont *Siphonodella sulcata*, was found below the boundary just above a facies change, the definition of the base of the Carboniferous has been back on the agendas of the Devonian and Carboniferous subcommissions. A joined SDS/SCCS Task group was established in 2009 to redefine the base of the Carboniferous and thus to regain stratigraphical stability in this critical interval of the Earth history. Task group members have been active in various aspects related to the boundary definition and a wealth of new data has become available. Characteristic for many studies are multi-disciplinary approaches, which combine palaeontological, sedimentological, geochemical and petrophysical methods and data.

It is not the aim to report all task group activities of the last years herein, but to summarize some and especially to present a brief summary on the discussions and results, which will arise just before the congress at Kazan. At the 2nd International Congress on Stratigraphy (Strati, 2015) in July the task group organizes a session on the Devonian–Carboniferous boundary. Given the fact, that not many people will attend both meetings in Graz and Kazan, it is important for the success of the task group that an exchange of ideas and opinions will take place at both meetings.

The task group is still gathering data and no decision has so far been made on a suitable level, an index taxon or a section. There are still many options to check. The task group is committed to stratigraphical stability, but also to a user-friendly definition of the base of the Carboniferous. In this respect the extinction events in the global Hangenberg Crises, which in the current definition predates the boundary, have been among many others one focus of our work.

In any case, the recent works demonstrated that the GSSP section and the auxiliary stratotype sections in China and Germany are most likely not suitable for the definition of a new boundary. Hence, the discussions are open in all directions and they require the input from all interested researchers.

Distribution pattern of Mississippian corals and reefs: Contribution of modelled oceanic currents and temperature data to this problem

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Distribution patterns of corals and reefs are controlled by biotic and abiotic factors. Important abiotic factors are temperature, salinity, turbidity, ocean currents, oxygenation and geography. Herein, global distribution data of Mississippian corals and reefs are compared to maps of ocean water temperatures and current patterns resulting from numerical modelling using the Fast Ocean Atmosphere Model (FOAM).

High endemism of the Eastern Australian coral fauna has been correlated to geographical isolation along the continental margin of Eastern Gondwana. This isolation of Eastern Australia is well seen in the modelled ocean currents for a Tournaisian–Viséan palaeogeography. Currents originate in the Panthalassa Ocean and prevent the exchange with the Prototethys Ocean by bypassing poleward the eastern continental margin of Gondwana. They bring warm water in relatively high latitudes (gulfstream effect), which enable the development of diverse coral assemblages and reefs. Those are progressively destroyed through the Serpukhovian, when that part of Gondwana shifts into higher latitudes and the current pattern breaks down.

In western North America, the high endemism of the coral fauna and the absence of coral-framework in reefs are a result of geographic isolation along the western margin of the Laurussian continent. A strong East-West current blocks the exchange with the Prototethys along the southern margin of Laurussia and thus corals, including colonial rugose corals as successful reefbuilders, are trapped in the Prototethys. Migrations to the western margin of Laurussia via its northern margin are not well supported by the current patterns. Distance and water temperatures may have limited the exchange. However, the North American coral faunas with the most Prototethyan aspects are known from Alaska.

Reef formation in Mississippian times is concentrated in an equatorial belt. Thus, water temperature seems to be one important controlling factor. Most reefs found outside this belt are situated in the southern Prototethys. These reefs have the same composition than their equatorial counterparts. According to the numerical model, these reefs formed in the transition zone towards more temperate or even colder waters. Their presence can be explained partly by temperature differences in consequence of glacial and interglacial cycles in the upper half of the Mississippian, which periodically opened and closed the window for reef formation in these more transitional areas.

In conclusion, the modelled current and temperature data can help to interpret the distribution of Mississippian corals and reefs. However, in further steps more palaeoecological limitations have to be incorporated in this analysis.

Dynamics of insect diversity in the Paleozoic

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Occurrence of 327 insect families is considered in 40 local or, sometimes, regional assemblages worldwide, dated from the Namurian A to the P/T boundary (PTB). Taxonomic dynamics are calculated after (i) number of first and last family occurrences per assemblage (normalized by logarithm of number of insect specimens collected there) taken as indicators of origin and extinction processes respectively, (ii) sum of first and last occurrences per number of all families in the assemblage, indicative of dynamic intensity irrespective of its direction, (iii) four Lyellian curves displaying loss dynamics through time in cohorts of families extinct by end of (a) Carboniferous, (b) Early, (c) Middle, and (d) Late Permian. No mass extinction is recorded: instead, it is found that the normalized number of last occurrences per assemblage varies little through time, except for being somewhat higher during the Carboniferous through the Middle Permian, and lower thereafter. In contrast, first occurrences decrease from Namurian to C/P boundary and again from beginning to end of the Permian, with some rise strictly at the PTB. As a result, first occurrences mostly prevailed, except for a short interval before C/P and another thoighout the Middle and Late Permian. Accordingly, the intensity of general dynamics of diversity roughly follows that of diversification (as indicated by first occurrences). Data for the Early Triassic are meager and inconclusive, but the rarity of Induan and Olenekian insect fossils does not mean mass extinction at the PTB because many Late Permian families occurred again in the Middle and/or Late Triassic. Lyellian curves also demonstrate no specific event at PTB. Results obtained suggest that Paleozoic dynamics of insect biodiversity depends on inhibition of diversification rather than on increase of extinction. Decrease of diversification can be explained by internal (organismic) and not external (environmental) mechanisms. We propose an explanation based on the epigenetic theory of evolution and particularly on the adaptive trade-off concept which predicts inhibition of diversification due to accumulation of highly adapted forms resisting further modification. The Permian–Triassic biotic crisis does not look like just a case of mass extinction. Instead, it appears, at least with respect to insects, as event of deep reorganization of the whole system, opening the way to unprecedented and unlimited (at least by now) diversification which raises it high above the Late Paleozoic plateau. Unlimited Meso-Cenozoic diversification is characteristic of the Biosphere as a whole rather than only of insects, this may suggest the above results and inferences are applicable to evolution in general. The reported study was partially supported by RFBR, research project No. 15-34-20745.

Late Permian brachiopods from Central Iran and correlation with Julfa section (NW Iran)

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A very fossiliferous succession of Guadalupian to Early Triassic age that crops out in the Shahreza-Esfeh area is briefly described. The section, named Shahzadeh Ali Akbar, is located 16 km NE of Shahreza and 5 km N of Esfeh village (32˚07'30"N; 51°57'00''E) (Figs. 1–2). It comprises three formations: Surmagh Formation, Abadeh Formation and Hambast Formation (Fig. 3). The Shahreza section has been studied by Partoazar (1995) and Mohtat Aghaii and Vachard (2005). Upper Permian–Lower Triassic strata in the Shahreza section consist of nearly pure limestone. Although now composed of calcite, the sediment may originally have consisted of either aragonite or calcite.

Also, the Julfa area of Northwestern Iran, in the Ali Bashi Mountains, is very rich in brachiopods. The brachiopod fauna described herein was collected along the main valley of the Ali Bashi section. The correlation of these two famous sections in Iran, based on brachiopods, is one of the aims of this research work.

Magnetostratigraphy and biostratigraphy of the Permian–Triassic boundary interval in European Russia

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Sections spanning the Permian–Triassic boundary beds are studied in the basin of the Oka River (Vyazniki, Zhukov Ovrag, and Slukino (Vladimir Region) and Okskiy Syezd (Nizhny Novgorod City)). The middle part of the section contains the Vyazniki biotic assemblage (Zhukovian Regional Stage), whereas the upper part contains the Vokhma biotic assemblage (Vokhmian Regional Stage). The transition from the Vyazniki assemblage to the Vokhma corresponds to a period of ecosystem turnover in the East European Platform, the largest in the Permian–Triassic. The stratigraphic level of this change, which is the boundary between the Zhukovian and Vokhmian regional stages, is traditionally accepted as the Permian–Triassic boundary. A complex pattern of paleomagnetic properties observed in multiple change of subzones of normal and reversed polarity is established within the Zhukovian-Vokhmian interval. There are three intervals of reversed polarity and two intervals of normal polarity. Rocks of the lower part of the Zhukovian Regional Stage and the underlying beds of the upper part of the Nefyodovian Regional Stage with a total thickness of 12–18.5 m have reversed polarity. These beds correlate with the r_2R_3P Subzone. The upper part of the Zhukovian beds (2.5–6 m) shows normal polarity. These are overlain by beds with reversed polarity (1.5–2.5 m) with remains of Vokhmian vertebrates, suggesting the Vokhmian Regional Stage of the Lower Triassic. These are overlain by beds with normal polarity (2.5–3 m), containing Lower Triassic ostracods and conchostracans. The section is terminated with a relatively large interval (over 24 m) of reversed polarity corresponding to R_1T Zone. The uppermost part of this interval contains vertebrate fossils of Vokhmian age. Beds between the paleomagnetic zones R_3P and R_1T can be recognized as the NPT Zone, the lower part of which (n_1NPT) is Upper Permian (Zhukovian), whereas the middle and the upper parts (r_1NPT and n_2NPT) are Lower Triassic (Vokhmian). The position of the P-T boundary within the zone of normal polarity observed in the sections studied does not contradict its position in the stratotype in the Meishan, South China.

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The ontogeny of the Early Carboniferous acanthodian *Acanthodes lopatini* Rohon

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The acanthodiform *Acanthodes lopatini* Rohon occurs in the Lower Tournaisian of Minusinsk Trough and is represented in the material studied by numerous articulated specimens of both juvenile and adult individuals. Such growth / size series are also known in a few species of *Acanthodes* (*A. bronni*, *A bridgei*, *A. lundi*, *A. gracilis* and *A. ovensi*) and some other acanthodiforms (*Howittacanthus kentoni*, *Lodeacanthus gaujicus* and *Triazeugacanthus affinis*). In contrast to these, the development of squamation in *A. lopatini* spread more rapidly. Even in the smallest specimens, with total length ca. 20 mm, most of the body is covered by scales. Squamation is absent only on the fin webs, head and the anterior third of the body. The lenses (eye imprints), mandibular bones, branchiostegal rays, gill rakers, otoliths, scapulocoracoids and fin spines could be recognized at the same stage. The pectoral spine is characterized by the presence of fine serration along its anterior edge. A similar feature is also known in juveniles of the mesacanthid *L. gaujicus*. The ossification of sclerotic ring starts with several narrow sectorial zones, which subsequently unite into four plates when the body length reaches 35–40 mm. In adult individuals with length exceeding 60 mm, the squamation covers the whole body, head region and webs of the unpaired fins. Further ossification involves the Meckelian cartilage and palatoquadrate. The most fully ossified skeleton, with partly calcified hyoid and gill arches, is observed in the largest individuals with estimated length exceeding 120 mm. Changes in body proportions were not measured due to taphonomic alterations.

U-Pb zircon age constraints on the Capitanian (Middle Permian) "glacial" deposits of the Atkan Formation in the Ayan-Yuryakh anticlinorium, Magadan province, NE Russia

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Bipolar ice caps are a major feature of many models of Earth's glaciations, including the Late Paleozoic ice age. The Capitanian Atkan Formation in the Ayan-Yuryakh anticlinorium and correlative units in the Omolon microcontinental block, North-East Russia are of great interest for studying ice bipolarity due to the occurrence of deposits with apparent "dropstones" and ice rafted debris that have been previously interpreted as glacial. We document here the first high-precision U-Pb zircon ages for an intercalated volcanic tuff (262.5 ± 0.2 Ma) and a boulder clast (269.8 ± 0.1 Ma) within the diamictites of the Atkan Formation, which constrain the age of the Atkan Formation as Capitanian. These results are compared with a new high-precision U/Pb calibration of Guadalupian-Lopingian glacial episodes P3 and P4 in Eastern Australia; the Atkan Formation is clearly diachronous with these southern hemisphere glaciations. By contrast, a previously proposed climate proxy record based on warm-water foraminifera, which respond closely to global climate fluctuations, is phased with the glacial record of Eastern Australia and indicates that the Capitanian was a time of a global warm climate. Therefore, the Capitanian age of the Atkan Formation casts doubt on the glacial nature of these diamictites. The data in this report provided additional hints on the nature and origin of syngenetic volcanic and volcano-clastic sediments that are a major component of the Atkan Formation and may aid in the understanding of gold and platinum mineralization and genesis in the region.

Here, the age of the Atkan Formation is precisely constrained for the first time and the presence of synsedimentary volcanic and volcanoclastic rocks in the unit is confirmed. These data provided additional constraints on the nature and origin of syngenetic volcanic and volcano-clastic sediments that are a major component of the Atkan Formation.

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Carboniferous to Permian closing history of oceanic basins between Tarim and Junggar: Geodynamics, tectonic patterns and stratigraphic records

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The Upper Palaeozoic (Pennsylvanian and Permian) in Tien-Shan begins in the Early Bashkirian with: (a) cessation of spreading in the oceanic basins (the youngest ophiolites are 324 Ma), (b) initiation of subduction, HP-UHP metamorphism and thrusting in the South Tien-Shan, and (c) uplift and deformation of the continental shelves along southern continental margin of the Kyrgyz Middle- and Chinese Central Tien-Shan. The region between Tarim and Junggar is characterized by several types of the upper Paleozoic sequences formed in various environments.

1. *Carbonate platforms and bathyal complexes of passive margins, overlain by turbidites and molasses of the foreland basins*, are typical for the Kyzylkum-Alai microcontinent and Tarim. Pennsylvanian sequences of carbonate platforms in the northern Tarim often lack the upper Bashkirian but stabilized during the Moscovian. Later events developed in typical collisional scenario. Northern margin of Tarim was buried by thick turbidites and olistostromes during the Kasimovian(?) and Gzhelian and then overthrusted by a nappe complex. This also caused progressive shrinking of the carbonate shelf and southward migration of the foreland basin in Tarim. The youngest turbidites are Asselian or Artinskian in the southernmost parts of the basin. The time interval of the flysch is usually short. The flysch already deformed was then overlain by coarse molasse of the Early Permian. In the northern Tarim the molasses coexist with felsic volcanic rocks of 285–275 Ma age and cut with A-type granitoids synchrobbous with plume-related basalt magmatism.

In the Uzbekistan to Kyrgyzstan part of the South Tien-Shan, southern foreland of the fold-and-thrust belt demonstrates similar order of tectonic events, including deposition of carbonates, flysch sedimentation and overthrusting growing younger in the north-to-south direction. Bashkirian to Asselian Rear Basin also emerged.

2. *Continental arcs* of Kazakhstan initiated in the Serpukhovian (ca 330 Ma) in the western Chatkal and Kurama Ranges, and about 320 Ma to the east. Subduction-related calc-alkaline and sub-alkaline volcanic rocks, associated with non-marine clastic facies and active granitoid magmatism are broadly developed in Pennsylvanian and continued till the late Permian in the Chinese Tien-Shan. Late Palaeozoic arc on the northeastern margin of Kazakhstan continent in Yili area formed mainly during the Mississippian and Pennsylvanian (305–355 Ma). Volcanism occurred both in continental and marine settings with carbonates. In the Permian time, sub-alcaline syn-collisional magmatism in the Yili area continued in continental settings.

3. Accretionary complexes of the Yili arc in the Borokhoro Range eastern slopes and southwest of the Junngar Basin (i.e. Chinese North Tien-Shan) are dominated by intensively deformed and sheared deeper-marine fine-grained siliciclastics, tuff, chert and shale, with olistostromes and mélanges, dated at 340–320 Ma. Stratigraphic ages of involved rocks can be constrained within Early to Late Carboniferous, based on the occurrence of the Early Carboniferous ophiolites and Bashkirian bioherms (Aiweyergou River).

4. Island arcs in the south-east Junggar Basin and Bogdoshan Range are of Lower Carboniferous (347–344 Ma) age and ceased at 315 Ma. Volcanic rocks of Bogdoshan are overlain with conglomerate layer and shallow-water limestone with lower Moscovian brachiopods, foraminifera, algae and corals. Cessation of arc volcanism may reflect beginning of the collision with either the Yili arc in the west or Altai arc in the east, though no significant deformation noted in the Bogdoshan arc at that time. Later the island arc was buried by shallow-water volcaniclastic sandstones. Rifting episode with bi-modal volcanism is recorded in the Early Permian 297–288 Ma. The Early Permian angular unconformity essentially does not exist in the Bogdoshan. The Bogdoshan arc located within the lower plate in the collisional zone with respect to Tien-Shan, and experienced subsidence which also led to formation of the foreland basin.

Worldwide End Permian Tsunamis: Their deposits and genesis

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At least three coarse intrabioclastic limestones at the base of the Khunamuh Formation (Latest Permian) in Kashmir, India, show features typical features of wave reworking of sediments too deep to be affected by storm waves. These are now interpreted as the deposits of large tsunamis by inferring the wavelengths and amplitudes of the waves from basic wave theory. The same three beds are found in the Latest Permian shallow marine to moderately deep slope environments throughout the southern Neotethy, as well as further afield in the Alps, East Greenland, and possibly even in the lowland deposits of the European Buntsandstein. Such tsunamis can also account for the contemporary marine erosion surfaces in China and elsewhere in shelf and slope environments. Tsunami waves, unlike storm waves, can also cause reworking of fine sediment and ventilation in deep-sea deposits, and there is some evidence for this in the Latest Permian oceanic sediments in Japan, New Zealand and western North America. The inferred huge size of the tsunami waves requires marine extraterrestrial impacts or large slumps into and / or under the sea, to generate them. The lack of good evidence for marine extraterrestrial impacts in the Latest Permian, and the presence of seismically disturbed beds below the tsunami deposits in some sections suggest that large earthquakes preceded the formation of the tsunamis. These earthquakes might have triggered tsunami-generating large submarine landslides, such as are seen in Quaternary deposits at continental margins and around the Hawaiian and other oceanic volcanic islands. Large slumps of the appropriate age occur in some latest Permian sections in East Greenland and New Zealand.

Sedimentary features of Upper Paleozoic deposits in the north-eastern Siberian Platform

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Upper Paleozoic deposits are widespread in Siberia. They compose the lower parts of the terrigenous complexes of the Siberian Platform sedimentary cover, troughs adjacent from the north and east, and are developed into fold belts. In the Tunguska Basin we deal with the relatively thin coal-bearing Upper Paleozoic. These units were formed in the so-called “inland” paleobasin. In the marginal platform depressions and fold belts, the thicker Carboniferous and Permian deposits were accumulated in the near flank zone of the Late Paleozoic marine paleobasin.

In the eastern platform, the essentially coarse-grained deposits of the thick Paleovilyui delta, with which the gas potential of the Upper Paleozoic Vilyui Basin is associated, grade eastward through a delta complex, the front of which wedges deeply into the paleobasin, into finer-grained coastal and open sea deposits, forming the sections of the Verkhoyansk Ridge eastern slope. This sedimentation model of most known fold belts is typical of passive continental margins.

The cyclic pattern of sedimentary strata accumulation in the Upper Paleozoic of Siberia is an important problem. In the Permian and Carboniferous sections of the Verkhoyansk Region, this phenomenon is recognized by structural, material and genetic aspects of the sedimentary strata. It is related to reciprocating motion of the shore line resulting from sea-level fluctuations against a background of gradual progressive wedging of the delta front into the paleobasin, filling the latter with sedimentary material.

Almost fifty years ago this pattern was used a basis for preparation of a rhythmostratigraphic chart, where medium-scale geological mapping of the given region was performed. Each rhythmic suite represents a transgressive-regressive stage corresponding approximately to an age and patterns, which vary laterally. It has been established that considerable changes in the composition of the fossil assemblages, particularly in ammonoids, are related to the levels of the large-scale transgression maxima. It proves the synchronism of sedimentary and biotic events and suggests that these levels can be considered as global chronostratigraphic benchmarks.

The analysis of the data available allows smaller stages of different ranks to be revealed, as well as three larger stages within the framework of the system divisions. These are traced throughout Siberia. The lateral succession of facies environments and facies from the west to the east is distinctly repetitive in the sections of any rhythmic suite and larger transgressive-regressive stages as well as in the formations and ranges of the Upper Paleozoic cyclic complex on the whole.

This sedimentation model, established by N.A. Golovkinsky more than 140 years ago during the study of the Permian in the Volga–Ural Province, gives a clue to the understanding of the cyclic process in sedimentation. Levels of major transgressions, traced ubiquitously, and regressions, represented as regional stratigraphic unconformities, give us a rigid “framework” to address and resolve problems of the Upper Paleozoic stratigraphy of Siberia.

New female peltaspermous fructifications from the Permian of the Samara Region (Novy Kuvak locality)

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Peltaspermales is a group of extinct gymnosperms that have played a significant role in the Late Palaeozoic floras of the world. This group reached its greatest flourishing at the end of the Permian in the Subanga area of the Angara kingdom. The detailed taxonomic and phylogenetic studies of peltasperms are very important for palaeoecological and palaeobiogeographical reconstructions. From the point of view of morphology and taxonomy the evolution of female fructifications is of particular interest, since these organs play a major role in the systematics of Palaeozoic and Mesozoic gymnosperms.

During the study of the flora of New Kuvak, a recently discovered locality for plant remains in the Kazanian (Guadalupian) of the Samara Region, we found several specimens of female reproductive organs of peltasperms. In terms of general morphology these ovuliferous shoots are comparable to *Peltaspermum* Harris, 1937 and *Peltaspermopsis* Gomankov, 1986. The difference between typical elementary ovuliferous structures (peltoides) of *Peltaspermopsis* and *Peltaspermum* is mainly in the shape and size of seed scars that are visible on the lower surface of the seed-bearing disk. Peltoides assignable to *Peltaspermopsis*, had relatively small, often rounded seed scars far apart from each other. In *Peltaspermum,* seed scars are relatively large and close to each other. They may be oval, as in *P. rotula* (the type species), or linear, slit-like, as in *P. incisum* and *P. monodiscum.*

The female fructifications studied were compared with the Permian and Triassic species, namely *Peltaspermum incisum* Stanislavsky, 1976, *Peltaspermum qualenii* Naugolnykh, 2002, *Peltaspermum usense* Dobruskina, 1980, *Peltaspermum townrovii* Retallack, 2002, *Peltaspermum. monodiscum* J. M. Anderson et H. M. Anderson, 2003, *Peltaspermopsis buevichiae* (Gomankov et S. Meyen) Gomankov, 1986, *Peltaspermopsis magna* Gomankov, 2010 and *Peltaspermopsis tuberculata* Gomankov, 2010. Additionally, plant remains described as “*Peltaspermum morovii* Naugolnykh, 2014” (which should be assigned to *Peltaspermopsis*) and “*Peltaspermum martinsii* (Germar) Poort et Kerp, 1990” (which should be described as a new species of *Peltaspermum*) were involved in the comparison. The resulting observations have shown that new specimens of ovuliferous organs in many ways differ significantly from the above mentioned representatives of *Peltaspermum*. We have come to the conclusion that a crucial role should be assigned to morphological characters such as the form of the seed scars, and on these grounds the new female peltaspermous fructifications should be attributed to *Peltaspermopsis*.

The dental system morphology of the Middle–Late Permian seymouriamorph amphibians

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Seymouriamorphs are only known from the Permian of Laurasia. All the Early Permian genera demonstrate the simple pattern of the dentition inherited from the ancestral condition of the Carboniferous Anthracosauria *sensu lato.* So, they are characterized by a large number of marginal homodont teeth with slightly curved crowns, few enlarged palatal teeth surrounding the internal nares, and fields of small teeth on the coronoids and palatal elements. The accumulated data suggest that most of the Early Permian seymouriamorphs hunted different aquatic invertebrates; the presence of the “canine region” in seymourids, however, indicates the capture of larger prey, such as small vertebrates. The knowledge of the Middle–Late Permian history of the group comes from the material obtained in East European localities. Most known genera assigned to the superfamily Kotlassioidea (Bulanov, 2003) were paedomorphic and maintained a constantly aquatic mode of life even at the adult stage. The dental system of kotlassioids is rather modified, indicating qualitative changes in trophic preferences. In the leptorophid genera (*Biarmica, Leptoropha*), the tooth crowns are essentially complicated; the serrated cutting edge made the teeth similar in shape with teeth of extant herbivorous iguanids and some other lizards that consume vegetation of all kinds. In addition, the enlarged palatal teeth are increased in number, and arranged in regular rows, crossing the lateral elements of the palate (vomer, palatine, and ectopterygoids) along the marginal dentitions. The shape of the crowns indicates an adaptation to herbivory, and more particularly to algophagy, taking into consideration the aquatic habit of the animals and the absence of life-time destruction of teeth (avoided because of the softness of the trophic object). In contrast to that, all species of the genus *Microphon* (*M. exiguus*, *M. gracilis*, *M. arcanus*) show an inclination to sclerophagy in their diet that is inferred from the bulbous shape of the marginal tooth crowns, extensive surface ornamentation of enameloid tissue, and extensive abrasion. The genus *Kotlassia* is the only taxon with simple flat-conical teeth in the jaws, with no enameloid ornamentation; in our opinion, this results from a secondary simplification of teeth prompted by a return to predation. The kotlassioids with multicuspid teeth show the gradual complication of the tooth crowns in ontogeny (the most anterior teeth were modified earlier in larvae and look more specialized in adults), and the diet was changed respectively in the life cycle. In evolution, the multicomponent nature and wide ontogenetic variability of the dental system were the reasons for its easy optimization when circumstances changed; because of this, seymouriamorphs occupied some new niches in the structure of the Permian tetrapod assemblages hardly accessible for others amphibians. For a long time, the extensive variability of dentition in seymouriamorphs, having no analogues among other amphibians, had no satisfactory explanation. New data suggest that the jaw articulation in the group was atypical and allowed the significant movements of the elongated articular along the quadrate condyle in an anteroposterior direction. The construction is only known in herbivorous reptiles, and is reported for the first time in amphibians. This, together with the relatively short and high skull, points at more multiplex jaw apparatus in the Seymouriamorpha in comparison with the ancestral state; all the above data can lead to a more comprehensive understanding of the morphological reasons for the origin of the order discussed.

New data on the morphology and systematics of the Late Permian gliding reptiles

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The first gliding reptiles, the Weigeltisauridae, are known in the fossil record of Gondwana and Laurasia as early as the Late Permian, and are the oldest known vertebrates adapted to flight. For a long time, our knowledge of this group came mostly from few specimens from Madagascar and the Kupferschiefer of Germany. The Madagascar material (genus Coelurosauravus) includes only three skeletons preserved as prints on the enclosing sandstone with poorly observed skull structures, so the data on the cranial morphology of weigeltisaurid reptiles were mostly based on the specimens from Germany, collected through the last century and mostly housed in the private collections; in recent years, there is a tendency to assign the German material to the genus *Coelurosauravus* as well (Evans and Haubold, 1987). For a long time, the small number of collected specimens and their preservation made it difficult to recognize the cranial construction of weigeltisaurids that gave rise to a lot of concepts of origin of the family. The excavation of recently discovered weigeltisaurid localities in the Orenburg region of European Russia firstly provided more material, composed mostly of separate bones of the gliding reptiles of different ontogenetic stages (Bulanov and Sennikov, 2005). In spite of the absence of articulated specimens, this material, assigned to the new genus *Rautiania*, clarifies many of the morphological peculiarities of this enigmatic group, including adaptations for the flight and an arboreal mode of life, and some disputable aspects of the cranial construction. In the light of new data, the single enlarged temporal fenestra in these reptiles is bordered by squamosal, parietal, quadratojugal, jugal, and presumably postorbital; the postfrontal and supratemporal are believed to be reduced. Unfortunately, the strongly enlarged temporal fenestra masks the initial type of skull fenestration and assists little with establishment of the ancestral lineage. The nasolacrimal duct in weigeltisaurids was well developed and pierced the maxilla; the skull retains the small lacrimal placed just anterior to the orbit. For the first time, a small preorbital fenestra was established in all members of the family at the maxillar-nasal boundary. The sacrum is composed of three vertebrae and additionally consolidated through the expanding of the ends of the adjoined ribs, coming in contact distally. The manual phalangeal count is 2-3-4-5-4, i.e. more complicated relative to the reptilian normative pattern. The claws are curved, crescentic, and the second phalanges in the pes and manus are elongated similar to those of typical arboreal vertebrates. All the bones, including the framework elements of the lateral fold, are hollow, essential for reducing the weight of the skeleton. This comparison led us to the conclusion that the genus *Weigeltisaurus* is a valid taxon, in spite of the fact that it had earlier been rejected (Evans and Haubold, 1987); in our opinion, the majority of finds from the Kupferschiefer can be assigned to this genus, including the unique specimen from Karlsruhe (Schaumberg at all, 1997). So, at least three valid genera (*Coelurosauravus, Weigeltisaurus*, and *Rautiania*) can be recognized in the family, which are differentiated from each other mostly by ornamental outgrowths on the bones surrounding the orbit, tooth morphology and, to a lesser extent, proportion of the skull roof bones. From the material collected in East European localities, it follows that the type series of *Coelurosauravus elivensis* is represented by juveniles; this corresponds well with the small size of the available individuals.

Energy resource analysis of Permian Karoo deposits: An outcrop analogue study on the Ecca Pass section (Eastern Cape Province, South Africa)

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The Karoo Basin of South Africa contains potential energy resources namely conventional and unconventional hydrocarbons and geothermal. Black shales of the Permian Whitehill Formation are the main target horizons for shale gas exploration. Estimated 390 Tcf recoverable reserves of shale gas in the southern and southwestern parts of the basin would make it the 8th-largest shale gas resource in the world. Turbidites of the Ripon Formation have the potential to act as a conventional hydrocarbon reservoir as well as being a source of geothermal energy. Evaluation of these potential resources has been limited due to the lack of exploration and a scarcity of existing drill core data. Thus, outcrop analogue studies serve as a first approach to identify and evaluate potential target horizons. The Ecca Pass section north of Grahamstown, Eastern Cape Province, exposes the entire Permian succession of the southern basin. Detailed field logging and lab analyses on selected samples covering all lithologies for mineralogy, porosity, permeability, and TOC as well as thermal conductivity and thermal diffusivity were conducted.

The Whitehill and Collingham formations in the southern portion of the Karoo Basin have experienced organic matter loss due to low grade metamorphism as well as burial to extreme depths, thus reducing shale gas potential. The Ripon Formation is an unsuitable conventional reservoir along the southern basin boundary due to low permeabilities caused by extensive cementation and filling of pore spaces.

However, the thermophysical properties of the Ripon Formation qualify this formation as a promising target horizon for geothermal energy production. The low permeability lithotypes may be operated either as hot-dry rock (HDR) or as enhanced geothermal systems (EGS). Depending on (1) the degree of fracturing and the occurrence of dykes and sills within the deeper part of the basin and (2) the degree of water saturation of the rocks, the sandstones could represent transitional or hydrothermal systems, respectively. A volumetric approach of the formation's resource potential leads to a first estimation of 930 TWh (3.3 EJ) of power generation within the southern part of the Karoo Basin.

Permian–Triassic evolutionary dynamics of the Brachiopoda: paleobiogeography, extinction-survival-recovery, latitudinal diversity gradients, body size variation, and longevity changes

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A critical review on global brachiopods from the Late Permian to Middle Triassic reveals that the Permian–Triassic (P-Tr) brachiopod provincial changeover exhibits a tendency towards simplification from the latest Changhsingian to Induan, and then diversification from the Olenekian to Anisian. Brachiopods diversified in the Anisian and retained a very high provinciality. Their radiation, however, cannot be readily related to the lineages that initially recovered during Olenekian. Brachiopods experienced extremely high extinction rates and the greatest loss of biodiversity during the first phase of the P-Tr mass extinction (PTME). Frequent speciation was probably an important survival strategy for the survivors populating the devastated environments of the Early Triassic. Two significant biodiversity increases, coupled with high origination rates, coincided with the initial recovery of the clade during the Smithian and full recovery during the Anisian. Nevertheless, final recovery or radiation of the clade did not occur until the Pelsonian of the middle-late Anisian, about 8–9 myr after the PTME. Four of the nine Changhsingian orders, the Orthotetida, Orthida, Productida and Spiriferida, eventually became extinct in the PTME and its aftermath, although they had a few Dead Clade Walking (DCW) forms persisting into the Griesbachian. Moreover, four lifestyles of the six lifestyles common in Changhsingian were lost in the PTME: body cementation, body spines anchoring on substratum, clasping spines on other shells / or objects, and pedicle attaching on objects. Of the five orders that diversified during the Anisian, the Rhynchonellida particularly proliferated around the world. Pedicle attaching on substratum is the commonest life mode among the recovery faunas. Ecologic selectivity of the P–Tr brachiopods suggests that rapidly elevated seawater temperature, rather than anoxia and ocean acidification, may be accountable for the morality of the clade in the P–Tr biocrisis.

The Changhsingian, Induan and Anisian faunas in the northern hemisphere show pronounced latitudinal diversity gradients, exhibiting a decline in biodiversity from tropics toward high latitudes. Latitudinal controls on brachiopod extinction and origination rates are also conspicuous in the Changhsingian faunas in the northern hemisphere, indicating that elevated seawater temperature may have facilitated speciation. Increasing extinction rates from high latitudes toward the tropics also indicate that elevated temperature may have impacted niches in high to moderate latitudes more seriously than in the tropics. The high origination rate in tropics may have facilitated faunal radiation in the Anisian. Like other benthos, brachiopods have also suffered the Lilliput effect in the P-Tr biocrisis, which not only resulted in a dramatic reduction in body size, but also narrowed size variation range. Several extinct orders, i.e., the Productida and Spiriferida, severely suffered the Lilliput effect, whereas the mean body size of recovery groups, such as the Lingulida, Athyridida, Rhynchonellida and Spiriferinida, were less affected by the crisis. The post-extinction increase in body sizes, coupled with a broadening size variation range, coincided with initial to final recovery process through the Smithian to Anisian. Longevity of brachiopod genera was relatively short prior to the PTME, but increased significantly during Early Triassic, and returned to a reasonably low level after final recovery in the Anisian. The Early Triassic genera usually lived an average of 24–34 myr longer than both pre-extinction and the recovery genera. This is probably because the post-extinction faunas are dominated by long-range, opportunistic taxa, and also implies that slower evolutionary rates, hence a longer mean longevity, was an important life strategy for the genera that survived the PTME. The recovery brachiopods show slightly shorter longevity than the pre-extinction faunas.

Conodont-based definitions of the GSSPs for the bases of the Cisuralian stages (Lower Permian)

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A decision on the base of the Lower Permian cannot be made without recourse to the results of the long-term studies of Permian stratigraphy. All stages of the Lower subdivision of the Permian were established in the Urals. These studies slowly progressed through various fossil groups, including corals, brachiopods, fusulinids and ammonoids. However, the lower boundaries of the Sakmarian, Artinskian and Kungurian Stages of the International Stratigraphic Scale (ISS) have remained unratified.

We propose as a limitotype for the base of the Sakmarian in the section of carbonate-clay deposits on the right bank of the Usolka River located near Krasnousolskiy health resort. The boundary is fixed by the FAD of the conodont *Mesogondolella uralensis* in the evolutionary succession *M. pseudostriata*–*M. arcuata*–*M. uralensis*–*M. monstra.* The FAD of *M. uralensis* almost coincides with that of *Sw. merrilli* in the evolutionary lineage of *Sw. expansus*–*Sw. merrilli*–*Sw.binodosus*–*Sw. whitei*.

We propose the section of the Sakmarian–Artinskian boundary beds at Dal'ny Tyulkas Creek as the limitotype of the base of the Artinskian. This section is located near the eastern outskirts of Krasnousolskiy Village (Bashkortostan). The boundary is defined based on the FAD of the cosmopolitan conodont *Sw. whitei* (Rhodes) in the evolutionary lineage *Sw. merrilli*–*Sw. binodosus*–*Sw. whitei*–*Sw. clarki*.

A section of Artinskian–Kungurian sandy-shale deposits with rare interbeds of limestone on the right bank of the Yuryuzan River near the village of Mechetlino is proposed as the limitotype of the lower boundary of the Kungurian. Of greatest interest is the eastern part of this section, where in 2011 sandy-carbonate deposits were excavated in a small quarry. All carbonate beds in this section contain conodonts. In the Lowermost Kungurian, the abundance of conodonts remains approximately the same as in the Upper Artinskian, i.e., they are rare. However, almost immediately above the boundary, the frequency of conodonts increases significantly. More than 100 specimens were recovered in bed 12 in this section, whereas up the section the number of specimens recovered usually exceeds 40. Altogether, more than 200 specimens were found in 5 meters of transitional beds.

The lower boundary of the Kungurian is fixed by the appearance of the conodont *Neostreptognathodus pnevi* in the evolutionary lineage *N. pequopensis*–*N. pnevi*–*N. clinei*. A gradual reduction of the anterior carinal nodes is observed in this lineage. A reduction of carinal nodes also occurs synchronously in the succession, which relates to *N.* ex gr. *ruzhencevi* (*N. ruzhencevi*–*N. aff. ruzhencevi*–*N. lectulus*) and to *N.* ex gr. *labialis* (*Sw. somniculosus*–*N. pseudoclinei*–*N. labialis*).

The beds also contain ammonoids and fusulinids. The ammonoids include *Uraloceras tchuvaschovi* Bogoslovskaya, *U. fedorowi* (Karpinsky), *Paragastrioceras verneuili* Ruzhencev, and *P. karpinskii* (Fredericks). In this assemblage, *Uraloceras tchuvaschovi* is the most prominent species. According to M. Boiko it has never been found below the Saranian Horizon in the Urals. In the Urals and specifically in the Mechetlino section, fusulinids cannot be used to designate the proposed boundary like they can in Tethys and Nevada, North America.

Lilliput effect in freshwater ostracods during the Permian–Triassic extinction

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The Lilliput effect following the Permian–Triassic mass extinction and its aftermath has been documented in a variety of marine animal groups, but it is less known in terrestrial and freshwater invertebrates. Our investigation of the size variations of terrestrial ostracods belonging to the genus *Darwinula*, which is one of the most typical invertebrates during the Permian–Triassic transitional interval, from a Permian–Triassic section on the northern limb of the Dalongkou Anticline section in Northwest China. Quantitative analyses reveal that ostracod test sizes decreased sharply through the terrestrial Permian–Triassic mass extinction interval. The Lilliput effect in terrestrial ostracods is characterized by the extinction of large taxa and the rise of small-sized and elongate new forms, coupled with the dramatic loss of conchostracans, charophytes, and the blooming of lycopod spores. The size decrease in terrestrial ostracods according with the biotic crisis through the Permian–Triassic interval was probably triggered by several interacting events, including global warming, anoxia, and enhanced sediment input following acid rain and wildfire. The result demonstrates that the Lilliput effect did occur in terrestrial aquatic organisms following this severe event and proves that the fossil records from non-marine facies show a similar response to the environmental events across the Permian–Triassic crisis as those in the marine ecosystems.

Reconstruction of the main stages of palynoflora in the Ufimian and Kazanian in the North-Western part of the Timan–Pechora petroleum province

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The study aimed to examine the development of palynoflora and specific features of paleoclimatic and paleogeographic conditions evolution in the Ufimian and Kazanian in the North-Western part of the Timan–Pechora petroleum province. The units of analysis are Ufa and Kazan deposits of the area of the study (more than the 10 wells).

Three palynomorph assemblages were identified. They characterize three stages of the palynoflora in the Ufimian and Kazanian and allow to reconstruct paleoclimatic conditions on this territory.

During the Ufimian (the palynomorph assemblage Ventralvitatina vittifera – Weylandites sp.) coniferous forests dominated on the examined area, the climate was hot and dry. This is evidenced by the dominate striate pollen grains in the entire succession.

The second stage is characterized by the palynomorph assemblage Protohaploxypinus dvinensis - Piceaepollenites sp., identified in transition Ufa–Kazan deposits. At that time, gymnosperms orders Peltaspermales and Cordaitanthales with a small admixture of fern, horsetails the studied area were mainly distributed. Minor content dispute in the palynomorph assemblage may indicate more arid climate.

Kazanian (the palynomorph assemblage Vitreisporites pallidus – Vesicaspora ex. gr. magnalis) is characterized by the ubiquitous appearance of the first primitive conifers. Spores of ferns, lycopsids and horsetail are characterized by great abundance, but low species diversity. The number of striate pollen grains dramatically reduced. In our opinion, climatic conditions were characterized high humidity and relatively low temperature.

The reduction in the number of striate pollen grains in Kazanian and the emergence of a large number of spores in the palynomorph assemblage were determined more probably by climatic reasons and the associated migration of plants than by evolutionary reasons. The evolution of the plant world in the Ufimian and Kazanian in the North-Western part of the Timan–Pechora petroleum province was too slow to entail some evolutionary events reflected in the composition of the palynomorph assemblage for the studied time interval.

Biotic paleo-thermometry constrains on the Arctic plates reconstructions: Carboniferous and Permian time

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Paleomagnetic studies, lithofacies, zircon provenance, and biota are among the major tools plate of the motion reconstructions in the geologic past, although the role of the latter is generally underutilized. Paleomagnetic reconstructions potentially may provide a very precise position at any measured locations; however post-sedimentary alteration, in addition to generally poor geochronologic constrains, often make primer signal recovery unreliable, questionable or impossible. Zircon provenance shows the age and trend distribution within the rocks, but lack of any data on paleo-position and paleoinvironments. In contrast to geophysical and geochemical methods that are very sensitive to post-sedimentary fluids, temperature and pressure, biota preserved even in greenschicht facies; it is generally document well paleoenvironments, particularly temperature, depth, salinity, redox etc. Within a margins of biogeographic provinces and paleoclimatic belts, fauna changed quite sharply and may provide precise paleoposition of the climatic zones and associated provinces. Two major shallow-water assemblages are exists in Carboniferous and Permian foraminifera: warm-water tropical-subtropical larger foraminifera and cool to cold water smaller calcareous and agglutinated forms. The former biome distributed up to 35–40° N/S (living temperature limits at least < 12–15° C for several weeks), whereas the latter has no lateral or bathymetrical limits in distribution, except these forms are extremely rare in shallow warm-water settings. In the series of the recent paleogeographic reconstructions the Siberian Craton and surrounding microplates and islnads during Pennsyllvanian time positioned outside the tropic belt within 40 to 70 N paleolatitudes. All these paleogeographic maps generally lack of the biota data. The following have been recognized from recent study of the limestone found in Zhokhov Island, New Siberian Archipelago (NSI) and analyses of the existed data:

1. Distributions Carboniferous and Permian warm-water foraminiferal fauna from the different parts of the Arctic suggest paleogeography that is quite different from many existed reconstructions.

2. The studied limestone block from Zhokhov Island New Siberian Archipelago, reveals very high taxonomic diversity of the middle Pennsylvanian Moscovian foraminifera and algae.

3. The recovery of green algae and several fusulinid genera undoubtedly indicate the location of the island at that time within tropic-subtropics, no further than 25–30° N.

4. The analyses of the existing data on the fusulinid distribution within the Arctic Region indicates that Zhokhov Island as well Chukotka microplate and Wrangel Island by Artinskian time could still be close to Arctic Alaska Plate.

5. If the Lower Triassic sills and intrusions in the Lyakhov Island NSI belong to Siberian trap magmatism, that would mean the extremely fast drift of Chukotka and NSI terranes towards Siberia at an unrealistic rate of approximately 0.3m/year.

6. The fusulinids from the Mancomen Formation and other formations in Wrangelia show strong affinity with the Uralo-Franklinian province regions such as Sverdrup, Spitsbergen, Barent Sea, Timan–Pechora and N-C. Urals, rather than with Northern Panthalassa.

Late Paleozoic climate fluctuations: The proxies from benthic Foraminifera record of the western Pangaea tropical shelves

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Shallow warm water benthic foraminifera (SWWBF), including all larger fusulinids (symbiont-bearing benthic foraminifera), are among the best indicators of paleoclimate and paleogeography in the Carboniferous and Permian. The distribution of benthic foraminifera in space and time constrain important tectonic, paleogeographic and climatic events at a regional and global scale. The North American shelves during the Pennsylvanian and Permian time – though geographically within the tropical belt – are characterized by temperate environments with significantly lower foraminifera diversification and rare occurrences of warm water Tethyan forms, that are in general appear in the region as a migration entities. Such environments allow documentation of warming episodes associated with sudden immigration of warm water and exotic forms of SWWBF that evolved elsewhere into the area. First occurrence datum (FOD) of the forms exotic to North America during warming episodes are always delayed in respect of their First Appearance Datum (FAD) elsewhere. The time of delay and taxonomic diversity of fusulinids in North America shelves depended on the scale and intensity of the warming episodes. Cooling events, on the other hand, are associated with increasing provincialism, decreasing taxonomic diversity and appearances of endemic forms characteristic of temperate water provinces only. The occurrence of these forms in Boreal and North American provinces appears to be isochronous, as their environments are uniform and induce their uniform and isochronous distribution. Several warming and cooling episodes during the Pennsylvanian–Permian time are recognized. The differences between taxonomic variations in each event could potentially be used for provisional estimation of the degree of climatic change. A strong link between biotic and climatic events in the North American province and the similarity of biotic changes in the North American and other provinces suggests that paleoclimatic events in the North American province were controlled by global factors.

The terrestrial Middle–Late Permian transition: The *Pristerognathus* Assemblage Zone of South Africa

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The South African Karoo Basin uniquely records the transition from the dinocephalian-dominated fauna of the Middle Permian to the large dicynodont-dominated faunas of the Late Permian. The *Pristerognathus* Assemblage Zone (AZ) represents the tetrapod ecosystem in the immediate aftermath of the dinocephalian extinction and is often described as an impoverished continuation of the preceding *Tapinocephalus* AZ. This has led to reservations about its utility in biostratigraphic correlation but the biozone remains at least locally useful and provides the only glimpse of the terrestrial Middle–Late Permian transition on land. It is thus crucial that this part of the Karoo biostratigraphy be robust, both for palaeobiological research within the basin and correlations with tetrapod-bearing deposits elsewhere in the world. Extensive fieldwork and a review of existing fossil collections sheds new light on the *Pristerognathus* AZ.

Lithology and sedimentology of the Upper Carbonic of the Eastern Peri-Caspian Depression

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The eastern edge of the Peri-Caspian Depression has a complex structure, associated with the zone of conjunction of the Precambrian East European Platform and the embedded Hercynian folded buildups of the southern continuation of the Urals, and is a major hydrocarbon-bearing region. The Carboniferous carbonate formations are one of the main targets for oil and gas production.

The Upper Carboniferous deposits found in the Kasimovian and Gzhelian were formed against a background of tectonic processes, the activity of which was completed by the closing of the Uralian Paleocean. The influx of terrigenous material into some regions (Aktyubinsk Cisuralia and Ostansukskiy trough) increased. The deposits are represented by thin beds of argillites, often siliceous, siltstones, sandstones, rarely limestones and dolomites. Carbonate sedimentation heavily prevailed in the rest of the Eastern Peri-Caspian Depression.

The central part of the Zhanazhol-Tortkol structural and facies zone is characterized by shallow marine sedimentation with biomorphic and detrital, grumous, algal and foraminiferal, algal and micro-grained limestones, often dolomitized. Interlayers of dolomites, thin-grained, alternating with pelitomorphic limestones with traces of ichnofacies are found, showing that this is part of the Kasimovian deposits was formed within the littoral tidal zone.

The top part of the section is represented by bioclastic and lump limestones, recrystallized, compact, hard, with stylolitic sutures. Fossils include foraminifera, fragments of crinoids, brachiopods, ostracodes, and algae. Interbeds of terrigenous and sulphate-carbonate rocks occur in some structural and facial zones (Urikhtau, Zhanazhol), and also fill pores and cavities, which is interpreted as a deposition in the stagnant hydrogeological environment with increased salinity. The Upper Carboniferous part of the section was deposited in the environment of a shelf lagoon and a restricted tidal flat.

Paleozoic to Mesozoic high-relief carbonate platforms: Depositional geometry and microbial boundstone growth

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High-relief carbonate platforms with steep slopes and microbial boundstone growth do not occur in present-day tropical marine environments, but they were well-represented in the late Paleozoic (post-Frasnian) and Mesozoic geological record, following mass extinction events. This study aims to outline some common characteristics of high-relief microbial platforms with respect to platform geometry and lithofacies types based on several case studies of the Late Devonian, Carboniferous, Permian, Middle Triassic and Early Jurassic age. Microbial boundstone includes all those reef lithofacies consisting of variable proportions of microbially-mediated precipitated micrite and microspar, early marine cement, and skeletal biota. The fundamental difference with modern coralgal reefs is that the microbial carbonate factory is not limited by light penetration and can extend beyond the depth of the photic zone. Skeletal biota can vary from nearly absent to abundant and their relative proportion increases through time from the Late Paleozoic to the Jurassic.

Depositional geometry is characterized by high-relief (several hundred metres), steep slopes (> 30^0), lack of raised rim at the margin, a flat platform interior and a gradual transition from the platform top into the slope, through a set of basinward-dipping outer platform beds. Cement-rich microbial boundstone can accumulate *in situ* on the slope to depths greater than 300 m, contributing to the stability of the steep clinoforms. Upper slope boundstone tongues interfinger with lower slope detrital breccias, mostly made of slope-derived microbial boundstone clasts.

Microbial platform slopes largely consist of sediment produced in place down to subphotic depths rather than being the site of prevalent accumulation of platform-derived detrital material. This has significant implications for platform geometry, growth style and the responses to changes in accommodation space. Rates of carbonate accumulation and progradation of microbial platforms are estimated to be equivalent to, or even higher, than present-day tropical carbonate systems.

The development of microbial platforms seems to be associated with confined starved, anoxic to dysoxic basins, which might have provided favourable chemical, physical and biological conditions to sustain microbial and early marine cement precipitation, such as high supersaturation of seawater, nutrient levels, weak competition by skeletal metazoans and availability of stable substrates for microbial growth.

In terms of reservoir potential microbial boundstone facies at platform margins and along slopes are characterized by large-size primary porosity and they might be associated with adjacent anoxic organic-rich basinal deposits. Microbial boundstone depositional pore network might be poorly connected or occluded by early marine cementation unless secondary diagenetic dissolution and fractures enhance pore connectivity.

The Mid-Carboniferous boundary in continental sections of Angaraland (Minusinsk Depression; Siberian platform)

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At present we have every reason to propose the Carboniferous sections of formations in the Minusinsk Depression as alternatives to the Kuznetsk ones, for the palynostratigraphic standard of the continental Carboniferous in the Angara paleogeographic area. The boundary deposits of the Lower-Middle Carboniferous here contain transitional spore-pollen complexes, traced both in time and place on the territory of ancient Angaraland (Kuznetsk, Minusinsk, Tunguska coal Basins), fully evidenced by floral and faunal remains and linked with abiotic developments. During the Carboniferous, against a background of constant flexure, thick, mainly continental, deposits accumulated. The Lower Carboniferous is represented by a telepyroclastic formation, and the overlying one by coal-bearing series. Boundary deposits contain the terminal stage sediments of Lower Carboniferous sedimentogenesis (Baynovskaya and Podsinskaya formations of the Lower Carboniferous) and sediments forming the beginning of coal-bearing series in the Upper Palaeozoic sedimentogenesis (Solyonoozerskaya, Sarskaya, and Chernogorskaya formations of the Middle Carboniferous) up to the Masur transgression (Poberezhnaya Formation), that covered Angaraland (non-marine bivalvian zone *Abacaniella magna - Abacaniella prima*).

A prominent change in the palaeoecosystem of the Angara palaeogeographical area is observed at the Mississippian-Pennsylvanian boundary. Here in sections of the SMS we can observe the succession of palynofloras from lepidophytes through archaic pteridosperms, pteridospermo-cordaites to cordaites. This palynoflora succession is connected with the new landscapes, making and occupying them with the Angara flora. Study of the stratigraphic range of miospore distribution in the section under coal-bearing and non-coal-bearing parts within the Minusinsk Depression allowed six palynocomplexes (PC) to be determined. Their analysis, alongside adjoining regions of the Kuznetsk and Tunguska Basin, allowed two palaeoecosystems (Mississippian and Pennsylvanian), and four stages development of the transitional environment, to be identified. In the first stage (Baynovsko-Podsinskiy time of Serpukhovian age) the the Early Carboniferous structural plan remained and a tendency toward climate humidification began to show: the quantity of red beds decreased, the first horizons of paleosols appeared, and the first pollen migrants *Florinites* spp. appeared in the lepidophyte PC composition. The second stage (Solyonoozerskiy time of Early Bashkirian age) was a restoration of the previous palaeogeographical settings, abrupt climate change towards humidification, development of permanent river networks, and of alluvial facies in a narrow valley. Due to the presence of relict lepidophyte associations, the PC contained a high proportion of lepidophyte spores. The third stage (Sarskiy, Early Chernogorskiy time of Bashkirian age) was marked by the development of stable palaeogeographical settings in the system of Minusinsk sags, its colonization by palynoflora of a new, pteridospermo-cordaitalean type, containing archaic pteridosperms throughout the stage, a somewhat renewed palynoflora composition and total absence of lepidophyte spores. The fourth stage (Late Chernogorskiy time of Bashkirian age) was marked by an evident change in the character of sedimentation and abrupt increase in diversity of the PC. From that time the cordaitalean flora became progressively dominant not only in the Minusinsk Basin, but throughout the entire Angara paleophytogeographical area.

A paleoecodynamic model showing the Angara palynoflora in space “intermountain Minusinsk Depression – Siberian Platform” and in time at the end of the Early and the beginning of the Middle Carboniferous allowed the recognition of Mississippian-Pennsylvanian boundary in continental sections of Angaraland.

Boundary Bashkirian–Moscovian Foraminiferal assemblages in the South Tien-Shan

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Globally, the issue of the placement of the boundary between the Bashkirian and Moscovian stages has not yet been conclusively resolved. There are two viewpoints on this issue. One is to draw the boundary at the top, and the other – at the base of the Melekess Horizon of the Russian Platform and its age analogues in other regions. In the South Tien-Shan, as well as in the Russian Platform, the major viewpoint always was to place the boundary at the top of age analogues of the Melekess horizon. This view was held by M.N. Solov'eva, F.R. Bensh, Z.S. Rumyantseva, and A.V. Dzhenchuraeva. It his early works A.D. Miklukho-Maklai adopted the former point, and later advocated the latter one. The latter view was also supported by L.A. Ektova, A.I. Nikolaev, and lately E.I. Kulagina.

In 2010–2014, we re-examined reference sections of the South Tien-Shan. As a result, the faunistic characterization of the boundary interval was further elaborated. The base reference section for them is the Akhuntau section, located in the South Fergana, along southern framing of 40th parallel depressions, in the Akhuntau Mountains, on the left bank of the Karasai River.

In this continuous section two foraminifera zones: Verella spicata, Tikhonovichella tikhonovichi, and Aljutovella aljutovica, Eofusulina triangula are distinguished in the boundary interval.

Coeval foraminifera occur in various facial rocks, from which generic and species compositions of foraminifera assemblages are dependent. Earlier, we studied their habitats in various bathymetric zones. Supra-, epi-, and intra-neritic assemblages associated with different depths of foraminifera habitats were identified. Therefore, characteristics of the boundary zonal assemblages are given for those zones.

Zone Verella spicata, Tikhonovichella tikhonovichi

In supraneritic deposits prevail Pseudostaffella antiqua, and Staffellaeformes staffellaeformis, in epineritic ones – Verella spicata and Tikhonovichella tikhonovichi, and in infraneritic ones – Ozawainella pararhomboidales and Verella spicata. The thickness of the zone deposits is 30 m.

Zone Aljutovella aljutovica, Eofusulina triangula

As in other cases, index species of this zone are distinguished by their first appearance. Foraminifera assemblage renews by 70 % as compared with the underlying zone. In supraneritic deposits prevail Shubertella obscura and Shubertella pauciseptata. Eofusulina triangula and Aljutovella aljutovica have their first appearance. Epineritic complex is represented by Depratina prisca, Neostaffella subquadrata, and Eofusulina triangula. Ozawainella mosquensis and Neostaffella subquadrata commonly occur in infraneritic deposits. The thickness of the deposits is 64 m.

To sum up, the markers for placing Bashkirian–Moscovian boundary are:

1. Disappearance from the assemblage representatives of genus Verella and first occurrence of species of genus Eofusulina.
2. Disappearance of the Bashkirian Tikhonovichella and appearance and development of representatives of the group Aljutovella aljutovica.
3. Almost complete disappearance of Archaediscidae, as well as Pseudostaffella, and the first appearance of representatives of genus Neostaffella.
4. Replacement of Donezella algae association by representatives of genus Beresella.

Deep-marine invertebrate ichnoassemblages from the Early Carboniferous strata of the Aït Tamlil Inlier (Central High Atlas, Morocco)

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Late Palaeozoic sediments are well-exposed in the central Meseta and High Atlas Mountains of Morocco. They provide evidence of the evolution of this territory during the formation of the Mauretanide part of the Hercynian orogeny and the post-orogenic platform development. In the Central Western Meseta and Central High Atlas of Morocco, late Visean to early Westphalian marine turbiditic sequences reveal the early stages of foreland basin development. The pure continental intra-mountainous and peri-mountainous basins developed during the Late Pennsylvanian (Westphalian, Stephanian) and Early Permian time followed by Late Permian post-orogenic basins.

The Aït Tamlil Basin, extended EW, consists of four formations, mainly autochthonous and allochthonous Palaeozoic successions of silicoclastic and carbonate sediments, which are, from the base to the top: (1) Jbel Imgant Formation, (2) Jbel Abberonech Formation and (3) Iguer n'Igherm Complex Formation. The invertebrate trace fossils described herein come from the Late Visean Jbel Abberonech Formation that unconformably overlies the Ordovico-Devonian deposits. It is considered to comprise negative megasequences consisting of laminated claystones and siltstones intercalated with sandstones and conglomerates. Jbel Abberonech Formation is also rich in foraminifera and plant remains. Moderately diverse invertebrate ichnofossils of pascichnia and agrichnia were reported, including the ichnogenera *Chondrites*, *Paleodictyon*, *Nereites*, *Spirorhaphe*, assigned to the *Nereites* ichnofacies. Vertical burrows are almost entirely absent. The *Nereites* ichnofacies indicate deep-water environments of well-oxygenated settings as bathyal to abyssal environments with pelagic to hemipelagic sedimentation that is supported by slope and turbiditic sedimentation.

These results may be an important tool to correlate the Non-marine–Marine Carboniferous in Morocco due to the co-occurrence of plant remains, foraminifera and invertebrate ichnofossils. Future exploration in this basin should be focused on stratigraphic cross-correlation using other fossil groups (vertebrates, insects, palynomorphes, foraminifera and plant remains) and isotopic ages in order to link them to the Global Time Scale.

The Carboniferous basins of Morocco will be a key for the understanding of the complex interferences of tectonics, climate and biota before the Permian / Triassic biotic crisis.

Sedimentology and ichnology of a Middle Permian alluvial-fan and playa-lake system (Hornburg Formation, Germany)

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The Middle Permian (Guadalupian) syn- to post-Illawarra Hornburg Formation of NE Germany was deposited in a small playa basin south of and transitional to the mega-playa system of the Southern Permian Basin (SPB). Facies architecture and fossil biota of the formation indicate an alluvial-fan and playa-lake system as it is rarely exposed for deposits of this age in central Europe and beyond. Coarse-grained fan deposits are represented by fanglomerates and pebbly sandstones with the former ones often containing up to 1.5 m deep clastic dykes of fine-grained, partially pebbly infill. The dykes are interpreted as earthquake-induced dewatering structures related to contemporaneous volcanic activity in the SPB. Large-scale cross-bedded, coarse-grained sandstones show bar forms that point to flash-flood origin. Well sorted fine to medium-grained but irregularly bedded sandstone may be the result of fluvially reworked eolian sand. Pin-striped laminated, tabular bedded sandstone with single-grain caviar-sand laminae (very well rounded coarse sand grains) are interpreted to be deposited on dry sand flats. Caviar-sand has been transported by saltation. Interbeddings of lenticular to flaser-bedded sandstone and mudstone with patchy sand fabric point to deposition on wet muddy sandflats. Well bedded to fine laminated claystones and siltstones of the so-called Blätterton ("leafy clay") Member are typical sediments of playa lakes and ponds. Rippled to flaser-bedded sandstones, that form a few decimeter-thick but laterally extensive beds surrounded by fine-grained playa deposits, probably represent feeder channels of the playa lake. Load casts, fillings of desiccation cracks as well as tetrapod tracks can be observed at the base of these sandstone beds. Halite pseudomorphs may be common on mudstone and sandstone surfaces. The pseudomorphs together with yellowish calcitic and dolomitic clayish-sandy residual horizons (dissolution of former evaporites) point to temporarily hypersaline conditions. Up to two meter deep sand-filled desiccation cracks are an outstanding feature of the Blätterton Member.

Most fossils come from playa-lake mudstones and fine-grained sandstones. Typical and common are 2−10 mm large circular imprints of the freshwater jellyfish *Medusina limnica* and imprints of the conchostracan *Pseudestheria graciliformis*. The beds are locally rich in arthropod traces attributed to 21 different ichnospecies. Apart from poorly preserved imprints of aquatic insect nymphs there is no indication of potential trackmakers and especially no body fossil remains. Tetrapod tracks (≤4 cm) are preserved in concave epirelief (siltstone) and convex hyporelief (sandstone). Six different types of walking and swimming tracks and traces are discerned among this material but kept in open nomenclature due to poor preservation.

Contemporaneous deposits from the mega-playa system of the SPB, that covered an area of about 2,500x600 km from England to Poland, are almost exclusively known by subsurface data. The outcrops of the Hornburg Formation are an exceptional window into the continental environment and biota of the Euramerican mid-Permian tropics to subtropics. Sedimentary and paleontological features of the Hornburg Formation are indicative for the semiarid to arid dry red beds that are in contrast to the Late Carboniferous–Early Permian wet red-beds of the study area.

A new Asselian (basal Permian) fusulinid fauna from the Abadeh Region, the Sanandaj–Sirjan Zone, Iran

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The presence of an Early Permian calcareous and terrigenous sequence (the Vazhnan Formation) has long been known from the Sanandaj–Sirjan Zone, although it has not been investigated in detail. The Vazhnan Formation, apparently extending from latest Carboniferous through up to Asselian, is underlain by the sandstone group (probable Late Carboniferous) and is overlain by the Surmaq Formation (late Early–Middle Permian). An Asselian (Earliest Permian) fusulinid deposit is newly recovered from the Vazhnan Formation of the Abadeh Region. This fauna consists of sixteen fusulinid species (both identified and unidentified). They are *Anderssonites?* sp., *Nonpseudofusulina* cf. *modesta* Scherbovich, *Nonpseudofusulina* sp., *Praepseudofusulina* sp., *Praepseudofususlina kljasmica* Sjomina, *Praepseudofusulina incomperta* Scherbovich, *Praepseudofusulina impercepta* Jagofarova, *Praepseudofusulina?* sp., *Praepseudofusulina saratovensis* T.Tschernova, *Pseudoschwagerina?* sp., *Eoschubertella lata* Lee & Chen, *Grovesella tabasensis* Davydov & Arefifard, *Grovesella* sp., *Eoparafusulina?* sp., *Eoschubertella?* sp., and *Schellwienia?* sp.; the two species *P. incomperta* and *P. saratovensis* are found in the Sanandaj–Sirjan Zone for the first time. This Abadeh fauna appears comparable with the coeval Emarat fauna of the Alborz Mountains, North Iran, in having multiple species of *Praepseudofusulina* (four in Abadeh; six in Alborz Mountains). This is a notable difference from another Asselian fauna of East Iran and Central Iran, which are dominated by species of *Ruzhenzevites, Pseudoschwagerina,* and *Sphaeroschwagerina* but don't include the diverse species of *Praepseudofusulina* in.

First find of a late Vereian (Moscovian) fusulinid fauna from the basal part of the Absheni Formation in the Shahreza area, the Sanandaj–Sirjan Zone, Iran

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A late Vereian (early Moscovian / Late Carboniferous) fusulinid fauna is for the first time found from the basal part of the Absheni Formation in the Shahreza Region, the Sanandaj–Sirjan Zone, Iran. The fauna is relatively rich, consisting of sixteen identified and unidentified species; namely, *Millerella* cf. *uralica* Kireeva, *Ozawainella paratingi* Manukalova, *Ozawainella pararhomboidalis* Manukalova, *Ozawainella?* sp., *Aljutovella* cf. *cafirniganica*, *Aljutovella?* sp., *Aljutovella subaljutovica* Safonova, *Aljutovella cybaea* Leontovich, *Aljutovella* cf. *tumida* Bensh, *Pseudostaffella compressa* Rauser, *Pseudostaffella* sp., *Pseudostaffella subquadrata* Grozdilova & Lebedeva, *Profusulinella (Depratina)* cf. *timanica* Kireeva, *Profusulinella parahomboides* Rauser & Belljaev, *Profusulinella (Depratina)* cf. *omiensis* Watanabe, and *Profusulinella (Depratina) prisca* Deprat. This fauna is somewhat comparable to another fauna previously known from the immediately overlying Kashirian beds in the same formation. However, considering from the two lines of evidence: 1) the present assemblage lacks typical Kashirian genera such as *Hemifusulina*, *Taitzehoella*, and *Neostaffella*, and 2) the three current species *Pseudostaffella subquadrata, Profusulinella pararhomboides*, and *Profusulinella (Depratina) prisca* are most common in the Vereian, we conclude a late Vereian age for this new assemblage and thus the basal Absheni Formation extends down to the Vereian. Species of *Aljutovella* are recorded in the Sanandaj–Sirjan Zone for the first time.

Late Permian paleomagnetic results from the Southern France: Magnetostratigraphy and geomagnetic field morphology

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Paleomagnetic results are presented from 271 stratigraphically-ordered horizons at four locations in Southern France. Our focus is mainly on the Late Permian (258 horizons), but results from 13 horizons in the Triassic Buntsandstein are also reported. We argue that the Permian results extend magnetostratigraphic coverage up to the upper Capitanian Stage, some 6 million years after the end of the Permo-Carboniferous Reversed Superchron defined by the Illawarra Reversal in the Wordian Stage. When combined with published data, an overall mean paleomagnetic pole at 49 N, 161E (A95=4, N=9) is obtained. This is virtually identical to the Upper Permian pole obtained by M. Bazhenov and A. Shatsillo (2010) using the intersecting great-circle method. Agreement between the two procedures, which are based on entirely independent data, supports the geocentric axial dipole (GAD) model for the Permian–Triassic boundary.

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New paleomagnetic data from two Permian–Triassic sections of the Volga River region and magnetostratigraphic correlation with other regions of the East European Platform

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Two sections of the Upper Permian–Lower Triassic sedimentary rocks have been studied: one is located near Puchezh City (Ivanovo Region) and another one, called “Zhukov ovrag”, is in the Vladimir Region. The studied sections are represented by reddish and gray clays, sandstones and marls of the Vyatkian and Induan stages (stratigraphic divisions given in accordance with the Russian stratigraphic scale, 2013). In order to obtain reliable paleomagnetic data, the samples were taken at small intervals, on average every 0.2–0.5 m; 215 oriented samples in total from Puchezh city section and 300 samples from “Zhukov ovrag” were treated in the paleomag lab. Paleomagnetic signal of good quality was found in almost all samples and characteristic components of magnetization were isolated. Comparison of the Lower Triassic and Upper Permian mean paleomagnetic directions with each other indicates the presence of a hiatus in the sedimentary sequence corresponding to the Paleozoic–Mesozoic boundary. Additionally, magnetostratigraphic analysis shows that there are no new magnetic zones, other than those that were previously marked.

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On the new Late Paleozoic genus *Lateenoglobivalvulina* nov. gen., its paleobiogeographic distribution and phylogenetic position in the Biseriamminoidea (Foraminifera)

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In the genus *Globivalvulina* Schubert, 1921 (subfamily Globivalvulininae Reitlinger, 1950, family Globivalvulinidae Reitlinger, 1950, of superfamily Biseriamminoidea Chernysheva, 1941) (nomen translat. Marfenkova, 1991 from family), following the new taxonomy by Gaillot et Vachard (2007), is a group of species with biserial test of globular chambers and different kinds of wall, thus differing from other species of *Globivalvulina*. These species are *Globivalvulina pergrata* Konovalova, *G. arguta* Konovalova, *G. nassichuki* Pinard et Mamet. Their tests differ from others by the presence of two stages of development – the initial spiral (as in *Globivalvulina*) and the terminal – uncoiled part. Thus, these species were united in *Lateenoglobivalvulina* gen. nov. *Lateenoglobivalvulina* is part of the subfamily Paradagmaritinae, Gaillot et Vachard, 2007, because the shells of this subfamily have two stages, too: the initial coiled and the final uncoiled.

The test of *Lateenoglobivalvulina* is biserial, usually trochospiral, rarely planispiral, in the initial part and uncoiled in terminal part. Chambers are globular, progressively increasing in dimension. Shell resemble equilateral or obtuse (rarely) triangle in axial sagittal section and and tongue-shaped in lateral section. The transverse section is oval bifid. The test height-to-width ratio is less than 1. The wall is sometimes microgranular, rarely containing agglutinated particles or “diaphanotheca”, divided into two or three layers. The aperture is simple.

Lateenoglobivalvulina is similar to *Globivalvulina* in the initial coiled part of the test and globular chambers, but differs in the presence of the final uncoiled part. *Lateenoglobivalvulina* is similar to *Paradagmarita* in the presence of two stages of development and inflated chambers, but differs by more spherical chambers and the shape of the shell. The shape of *Paradagmarita* is more elongated in the final part (the test height-to-width ratio greater than 1). *Lateenoglobivalvulina* is similar to *Paradagmaritopsis* in the structure of the test, but differs in the wider shape in the axial section of the terminal stage of the test and rapidly increasing in size, snd globular towards subelliptical shaped chambers. We see that in the process of evolution of the biserial test of Globivalvulinidae the unfolding of the terminal spiral part of the test took place. Then the uncoiled part became longer and the size of the chambers increased less, so the chambers became subelliptical rather than globular. Thus, *Globivalvulina* is the ancestor of a new genus *Lateenoglobivalvulina*. *Lateenoglobivalvulina* is a relative of the genus *Paradagmarita* of the subfamily Paradagmaritinae and may represent the missing link in the phylogenetic evolutionary lineage *Globivalvulina – Paradagmarita*.

Lateenoglobivalvulina is very conservative, it has only three species. And two of them exist from the Moscovian to the Kungurian whithout changes in morphology in the whole Boreal Realm (Timan-Pechora Province, Cis-Urals, Islands of Arctic Canada, Ukon, Spitsbergen, Wrangel and Kotelny Is.). Their variability depends on the environmental conditions and is expressed in changes of their dimensions. Only *Lateenoglobivalvulina arguta* is founded in the Boreal Region in the Asselian, and in the Notal Region in the Sakmarian (Central Pamir), and on the west of Tethyan Region in the Kubergandian (Armenia).

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The Artinskian assemblages of smaller foraminifers and brachiopods from Kotelnyi Island (New Siberian Islands, Russia)

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Palaeozoic sections from different Arctic regions and their correlation have recently attracted much attention. In 2009–2013 two of the authors visited the Upper Paleozoic exposures in the north-west and central parts of Kotelnyi Island. Sites where the fauna was found are located within the undivided Middle Carboniferous-Permian (MCP) unit. In the central part of the Island this unit consists of shallow-marine limestone about 30 m thick, but in the north-west it is very thick and is divided into two subunits. The lower one (not less than 70 m thick) is made of carbonate rocks which were thought to be Carboniferous in age. The upper part of the section (Permian) is represented by mudrocks and subdominant sandstones (more than 200 m) and is separated from the lower subunit by a fault.

The first of the new localities (N75°59’34’’, E137°48’41’’) belongs to the terrigenous (Permian) section on the north-west coast of Kotelny Is. (Domashny Cape). The brachiopods *Anidanthus burgaliensis* Zav., *Achunoproductus achunovensis* (Step.), and *Spiriferella* sp. are associated with the Jakutroproductus rugosus Zone of the Upper part of the Munugudjak Horizon of North-East Asia (Lower Artinskian).

The second site is located on the Pryamaya River (N75°27’59’’, E138°45’05’’) in the central part of the island. The fossils were found in talus of light-gray grainstone. The brachiopod assemblage (*Arctochonetes* cf. *transitionis* (Krot.), *Spiriferella* sp., *Schrenkiella* sp. indet., *Rhynchopora* cf. *nikitini* (Tschern.), *Beecheria* sp., *Karnellia* sp.) is similar to the Djelta Facies of Omolon Province (Jakutoproductus burgaliensis–Litophaga gigantea Zone of the Koargychan Horizon (Middle Artinskian)).

The third site is located near Domashny Cape (N75°59’38’’, E137°47’38’’). Fossils were found in brownish-grey bioclastic limestone within the lower subunit of the Upper Palaeozoic, represented by packstone-grainstone with the remnants of bryozoans, brachiopods, smaller foraminifers, gastropods, echinoids and conodonts. The brachiopods *Taimyrella flaebelliformis* (Lich.), *Tumarinia* sp., *Neospirifer* sp., *Rhynchopora* sp. are characteristic of the Jakutoproductus burgaliensis–Litophaga gigantea Zone (Middle Artinskian). This age is not consistent with the Lower Artinskian age of the fauna in the first locality and makes the relationship of carbonate and terrigenous subunits of MCP unit uncertain. Additional field observations are needed to solve this problem. Smaller foraminifers are represented by the species *Tuberitina maljavkini* Mikh., *Lateenoglobivalvulina nassichuki* (Pinard et Mamet), *Globivalvulina* sp. 1, *Protonodosaria praecursor* (Raus.), *Tetrataxis shikhanensis* Mor., *T. hemisphaerica* Mor., *Earlandia* ex gr. *elegans* (Raus.-Chern.), *Neohemigordius* ex gr. *tenuithecus* (Kir.). The foraminiferal assemblage is poor in taxonomic structure, it contains Pennsylvanian–Cisuralian, Cisuralian and Artinskian species. The age of the assemblage is Artinskian. Almost all species were found in the assemblages from the Sakmarian–Lower Artinskian (Spitsbergen), the Saranian Horizon of the Cis-Urals, the Moscovian–Sakmarian of Yukon, Arctic Canada and Timan–Pechora Province, the Cisuralian of north-east Asia. Only the species *Lateenoglobivalvulina nassichuki* is absent in the last region. For the first time, the zonal brachiopod assemblages of the Regional Stratigraphic Scale for the North-East of Asia were distinguished on Kotelnyi Island. They belong to the Pechora-Kolyma type of benthos association. Smaller foraminifers are associated with the Biarmian Realm.

Orbital forcing in continental Upper Carboniferous red beds of the intermontane Saale Basin, Germany

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The Saale Basin is a SW–NE elongated continental sedimentation area that was created during the Late Carboniferous time as a subcollisional structure of the Variscan Orogeny. It was palaeogeographically located in the central parts of the Variscides, having moved to the north from the equator to ca. 10° during the Stephanian due to the general drifting of the continents. The resulting climate changes led to an overall reddening of the sediments during the Stephanian and later on during Rotliegend times. At the same time, the river character changed from overall permanent and meandering rivers during the Carboniferous to mostly periodic braided river systems during Rotliegend times. These processes were superimposed by glaciations mainly occurring in the Southern Hemisphere. These kinds of glaciations cause strong eustatic sea-level fluctuations, on the one hand, while, on the other, affecting the position of the climate belts causing intercalations of mainly grey sediments near the equator. Based on these premises, Milankovich-cycles should be reflected not only in coastal or marine, but in fluvial sediments as well.

Stratigraphical correlation within fluvial continental red beds is hampered by uniformity of sediments and the lack of fossils. Therefore classical lithostratigraphical and biostratigraphical methods often fail. For a drilled section of Upper Carboniferous non-marine sediments of the intermontane Saale Basin, almost 800 m in thickness, wavelet-based time-series analysis is used to identify the internal organization of the cyclicity, and to distinguish cycles of different magnitude and origin as being autocyclically, tectonically or climatically controlled. Based on this distinction, basin-wide correlations of fluvial red beds are possible using a combination of high-resolution stratigraphy, biostratigraphy and classical lithostratigraphy. We identified for the first time that the genetic nature of some cycles in the fluvio-lacustrine Carboniferous of the Saale Basin is climatically driven and used this to solve longstanding stratigraphical problems: the analyses of well Querfurt 1/64 suggest the presence of wavelengths in the rate of 1:4 representing long (400000 a) and short (100000 a) eccentricity cycles, and an overall duration of 5–7 Ma if the grey facies at the base of the section is to be correlated with the Grillenberg Subformation sediments. This subformation is of the Stephanian or Barruelian age, respectively, such that the well Querfurt 1/64 exposes a nearly complete section of the Mansfeld Subgroup and the complete Stephanian Stage.

Discovery of Upper Devonian and Lower Carboniferous conodonts in the Kinta Limestone, Western Belt of Peninsular Malaysia: Implication for continuous sedimentation in the Palaeo–Tethys

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The palaeogeography of the juxtaposed terranes in the Southeast Asia that were derived from the western margins of the Gondwana during the Carboniferous–Triassic resulted in a complex basin evolution and the deposition of massive pelagic carbonates on the margin of the Palaeo-Tethys. However, due the structural complexity and tectono-thermal events, discovery of diagnostic microfossils from these carbonates was never been done. This is particularly true for the Kinta Limestone, a massive Paleozoic carbonate succession which covers most of the Kinta Valley in the Western Belt of Peninsular Malaysia. Owing to these complex structural and volcanic events, and extensive alteration by Mesozoic granitic intrusions establishing precise age constraints for these carbonates has not been possible to date. Furthermore, this thermal alteration has masked the history of sedimentation of these deposits. Three boreholes of totaling to 360 m thickness, were drilled either end of the valley on a north-south transect. The lithology was composed chiefly by carbonate mudstone which was sampled for microfossils. Five hundred conodont elements where extracted. Eight diagnostic conodont genera and 16 diagnostic conodont species were discovered. The discovery of the conodonts such as the *Pseudopolygnathus triangulus triangulus*, and *Declinognathodus noduliferus noduliferus* indicated that the sequence are Lower (Tournaisian) and Upper Carboniferous (Bashkirian). This high-resolution conodont biostratigraphy suggests the prevalence of continuous carbonate deposition during the Late Devonian–Early Pennsylvanian. Thus, the discovery of diagnostic conodont species for the first time and genera has helped improve the biostratigraphic resolution and establishes depositional continuity of the Kinta Limestone. These data could provide clues to the Palaeo–Tethys palaeogeographic reconstruction and palaeodepositional conditions, the palaeothermal history of the region and throw light on regional correlation at higher temporal resolution than previously realised.

Biostratigraphy and correlation of the Upper Viséan–Serpukhovian (Lower Carboniferous) of the Moscow Basin using Foraminifera

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Upper Viséan (V_3) and Serpukhovian (S) deposits are widespread in the south, west, and northwest of the Moscow Basin. Both stages are characterized by packstones and wackestones, containing diverse foraminifers, many of which are in common with those of the Dinantian Basin. However, the correlation, especially in the Upper Viséan, is debatable, largely because the taxonomy of the index species of the foraminiferal zones is not resolved. In the Dinantian Basin, these are Palaeotextulariidae and *Janischewskina*, and in the Moscow Basin *Eostaffella* and *Eostaffellina*, which are currently not known from the Dinantian Basin. In the Moscow Basin, the biostratigraphic potential of *Janischewskina* Mikhailov, 1935 and Palaeotextulariidae was not taken into account in identifying potential markers of foraminiferal zones. The use of the phylogenetic lineage of the genus *Janischewskina* and especially the first appearance of *J. delicata* allows the substantiation of the base of the Serpukhovian. The phylogenetic lineage of the order Palaeotextulariidae Hohenegger et Piller, 1975, and especially the succession of the genera *Palaeotextularia*, *Cribrostomum* → *Koskinotextularia* → *Koskinobigenerina* → *Climacammina* allows correlation of the regional substages (foraminiferal zones) of the Moscow Basin with the Upper Viséan subdivisions of the Dinantian Basin.

The Tulian (*Endothyranopsis compressa* Zone), apart from the presence of the index species, is characterized by the first appearance of *Palaeotextularia longiseptata* (Lipina), *Cribrostomum* sp. and correlates with the lower part of the Cf6 α-β Zone of Belgium.

The Aleksinian (*Eostaffella proikensis–Archaediscus gigas* Zone), apart from the index species, is characterized by the appearance of *Janischewskina minuscularia* (Ganelina) and *Koskinotextularia bradyi* (Lipina). Based on the presence of *Koskinotextularia,* it correlates with the upper part of the Cf6 α-β Zone of Belgium.

The Mikhailovian (*Eostaffella ikensis* Zone), apart from the index species, is characterized by the first appearance of *Koskinobigenerina prisca* (Lipina) and based on the presence of *Koskinobigenerina* correlates with the Cf6 γ_{1}- γ_2 Zone of Belgium.

The Venevian (*Eostaffella tenebrosa* Zone) apart from the index species is characterized by the first appearance of Climacammina *simplex* Rauser-Chernousova, and also contains *Janischewskina typica* Mikhailov and *Loeblichia paraammonoides* Brazhnikova. Based on the presence of these species, the Venevian correlates with the Cf6 δ of Belgium.

All the above correlations are based on foraminiferal distributions in actual section in the two basins.

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New genera of Bryozoa from the Wargal Limestone (Wuchiapingian, Permian) of the Salt Range, Pakistan

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Several new genera of extremely small bryozoans occur in the Wargal Limestone (Wuchiapingian, Lopingian, Permian) of the Salt Range of Central Pakistan. The zoarial diameter of these bryozoans ranges from 0.2 to 0.43mm. They are characterized by a central axial zoarial tube of constant size and shape without diaphragms or interzoarial structures. Budding of autozooecial chambers from the central axial tube occurs in at least four different budding patterns: at 45 degree intervals; at 60 degree intervals; at 90 degree intervals; and spirally.

In order to obtain the three views needed (transverse, longitudinal, and tangential) to identify these very small bryozoans, a technique was established to prepare serial sections using transverse sections. A total of 240 serial peels were used to reproduce 1.7 mm of zoarial length. This required approximately 6,000 caliper measurements to create tangential views of the four sides of the quadrate colony.

The Sundyr tetrapod assemblage and effects of the Severodvinian (Late Capitanian) crisis on the Eastern European tetrapod community

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From the Late Ufimian (Late Kungurian) to the Middle Severodvinian (Middle Capitanian), Eastern Europe was inhabited by a dinocephalian tetrapod fauna. The final stage in the evolution of this fauna is represented by the Sundyr Assemblage. In the Sundyr fauna, large terrestrial vertebrates are represented by dinocephalians: herbivorous tapinocephaloids and predatory anteosaurids and syodontids and also predatory gorgonopians close to burnetioideans. These taxa formed a dominant block of the Sundyr community. The subdominant block included diapsids, therocephalians, and galeopid anomodontians. The aquatic community was formed of chroniosuchid and enosuchid anthracosaurs, dvinosaurian brachiopoid temnospondyls, karpinskiosaurid and kotlassiid seymouriamorphs. The time range of the Sundyr Assemblage is probably limited to the middle part of the Severodvinian age (Middle Capitanian). The Sundyr Assemblage characterizes a crisis stage in the development of the tetrapod community of Eastern Europe. It is transitive from the Middle Permian dinocephalian fauna to the Late Permian theriodontian fauna. In Eastern Europe, transformation of tetrapod faunas passed several stages. In the Early Severodvinian, the aquatic dinocephalian community was disrupted; archegosauroid temnospondyls and lanthanosuchoid parareptiles disappeared. In the Middle Severodvinian, a new aquatic community with typical representatives of the theriodontian fauna was formed, including chroniosuchians, seymouriamorphs, and brachiopoids. This stage is represented by the transitional Sundyr Assemblage, in which the terrestrial community remains dinocephalian but the aquatic community is already theriodontian. The next stage of the crisis is connected with the complete destruction of the dominant block and disappearance from the fossil record of dinocephalians and other groups typical for the dinocephalian fauna. At the final stage, a new terrestrial tetrapod community formed. The dominant blocks of theriodontian communities were made up of herbivorous pareiasaurian parareptiles, herbivorous dicynodontian therapsids and predatory gorgonopian therapsids. These groups are not known in Middle Permian tetrapod faunas of Eurasia, but were widespread in dinocephalian communities of Gondwana. It is evident that the new dominant community of Eastern Europe is completely formed of Gondwanan immigrants, which penetrated into Eurasia at the very end of the Guadalupian, in the middle of the Late Severodvinian, probably almost immediately after the extinction of the dinocephalian fauna. The reason for the extinction of the dinocephalian fauna remains uncertain. The crisis in the tetrapod community struck during essential reorganization of the whole Eastern European Geosystem. Reconstructions indicate a fall in temperature in the Middle Severodvinian time. This probably had an essential effect on the continental biota, although its mechanism is uncertain.

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The Permian General Stratigraphic Scale of Russia and its correlation with the International Stratigraphic Scale

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The Urzhumian, Severodvinian, and Vyatkian stages of the Russian General Stratigraphic Scale of the Permian System (GSS) are based on continental sequences of the East European Platform. This makes correlation of GSS and International Stratigraphic Scale (ISS) difficult. In recent years combined biostratigraphic, magnetostratigraphic, and chemostratigraphic studies of the type and reference sections of GSS stages were undertaken in the Middle Volga River, Vyatka River, and Sukhona River regions. As a result, the probable positions of the boundaries of the ISS stages in the Permian-Triassic continental sequence of the East European Platform were established. On the basis of paleomagnetic data, the lower boundaries of the ISS Wordian and Capitanian stages probably correspond to the lower boundaries of the GSS Urzhumian and Severodvinian stages. Based on biostratigraphic, magnetostratigraphic, and chemostratigraphic data, the lower boundary of the ISS Lopingian series and Wuchiapingian Stage is located in the upper part of the Upper Severodvinian. Based on paleomagnetic data, the lower boundaries of the ISS Changhsingian are placed in upper part of the Lower Vyatkian. Modern paleontological and geological data provide no evidence for the previously proposed stratigraphic gap at the Permian–Triassic boundary in the East Russian Basin. The PT boundary occurs within a normal polarity chron (NPT Magnetozone) near the ecosystem crisis level, which separates the Zhukovian (Permian) and Vokhmian (Triassic) regional stages.

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Rhipidopsis in the *Tatarina* flora

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The notion of the *Tatarina* flora was introduced by S.V. Meyen and A.V. Gomankov to accommodate the plants which had inhabited the territory of the Russian Platform (the Subangara palaeofloristic area) in the Wuchiapingian. This flora received its name after the main dominant, the peltaspermacious pteridosperm *Tatarina*. The detailed analysis of the composition and distribution of the *Tatarina* flora as well as its role in the florogenesis was carried in the book with the same name issued in 1986. However, *Rhipidopsis* was not mentioned in this book as it did not occur in any locality of the *Tatarina* flora known at that time. Two localities containing remains of *Rhipidopsis* were discovered since then in the Wuchiapingian of the Russian Platform, i. e. Bolshoye Kalikino and Aristovo II. Both of them are confined to the Vyatka Horizon of the Vologda Region. Leaf impressions of *Pursongia angustifolia* and stem remains of *Equisetites-Neocalamites* type usual for the *Tatarina* flora were found together with *Rhipidopsis* in Bolshoye Kalikino, whereas Aristovo II was a monodominant locality containing nothing but mass accumulation of *Rhipidopsis* remains. In both cases *Rhipidopsis* is represented by impressions of digitate leaves or their isolated segments. Each leaf consists of about 10 wide wedge-shaped segments with almost straight or slightly convex apices. Due to their morphology these leaves can be assigned to *Rhipidopsis ginkgoides*.

A number of species of *Rhipidopsis* has been described from the central parts of the Angaraland (Pechora, Kuznetsk and Tunguska basins) as well from China and India. So the occurrence of this genus in the *Tatarina* flora has a considerable correlative potential. Two morphologically different groups of species can be distinguished within the genus. One of them is represented by *R. ginkgoides* (the type species) and *R. triassica* and characterized by rather wide and wedge-shaped segments with almost straight apices which are not very numerous (6–10 per leaf). The difference between both species does not seem to be significant enough suggesting their consolidation under the single name *R. gikgoides*. The second group of species (*R. palmata, R. laxa, R. xingunensis*, et al.) is characterized by leaves with numerous (up to 16 per leaf) nearly linear segments with strongly convex or dichotomous apices. A kind of intermediate morphological position occupy such species as *R. lobata* and *R. tongwanghensis*.

R. ginkgoides (s. l.) occurs, on the one hand, in the Permian of the Pechora Basin together with abundant and diverse cordaites and, on the other hand, in the "post-cordaitalean" flora of Kuznetsk and Tunguska Basins which is sometimes considered as Triassic. The presence of this species in the *Tatarina* flora at the stratigraphic level devoted of any remains of cordaites endorses the correlation of this level with the "post-cordaitalean" strata of the Central Angaraland and thereby the opinion of their Permian age.

Conodonts and the position of the lower boundary of the Kasimovian Stage in the type region (Moscow Basin)

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The Kasimovian Stage (the Upper Pennsylvanian Series of the Carboniferous System) was established in the early 1920s in the Moscow Basin of Russia not far from Moscow. It spite of its name, type area is in the vicinity of downstream of the Moscow River and, for the upper part, the Moscow City region. According to the unified Carboniferous stratigraphic chart of the Russian Platform (1990), the Kasimovian Stage includes three regional substages: Krevyakinian, Khamovnikian, and Dorogomilovian. Biostratigraphical analysis of the Krevyakinian and Khamovnikian conodonts was done at the neostratotype of the Kasimovian Stage (Afanasievo section), Perkhurovo borehole (Voskresensk Region) and Domodedovo and Myachkovo sections. For the more detailed characteristics of the Dorogomilovian Substage, conodonts were studied in the key wells of the Moscow City region. Also, we studied conodonts collected in the Oka-Tsna Swell, Ryazan Region east of Kasimov (Stsherbatovka section). The conodont assemblage of the Kasimovian is essentially different from the Moscovian. The difference is pronounced in the complete disappearance of *Neognathodus.* Conodont elements sharply increase in abundance but assemblages are poor and include only 3–6 species. Krevyakinian contains abundant *Swadelina* and *Idiognathodus* and rare *Gondolella*. Characteristic genera of the Khamovnikian and Dorogomilovian substages are *Idiognathodus* and *Streptognathodus*. The stratigraphic distribution of the species allows recognizing 6 conodont zones: subexcelsus, makhlinae, sagittalis, cancellosus, toretzianus and firmus.

The paleographic reorganizations during this interval led to provincialism and high degree of endemism of most fossil group, therefore, problems of definition and global correlation of the Moscovian–Kasimovian boundary is still uncertain and a biostratigraphic marker and GSSP for it have not yet been designated. The Task Group to establish the Moscovian–Kasimovian and Kasimovian–Gzhelian boundaries reached agreement to focus work on *I. sagittlis* and *I. turbatus* as potential biostratigraphic markers of the base of the Kasimovian (Villa and Task Group, 1998). Biostratigraphical analysis of the conodonts from the type region have shown a presence *Idiognathodus sagittalis-Id. turbatus* plexus in the middle part of the Neverovo Formation of the Khamovnikian Stage. But this level is higher then the tradition boundary of the Kasimovian at the base of the Krevyakinian. Relatively abundant conodonts of the *Idiognathodus sagittalis-Id. turbatus* plexus were discovered in more deepwater facies of the Neverovo Formation in the Stsherbatovka section (Oka-Tsna Swell). Also, *Id. turbatus* was found in the deepwater Dalnyi Tulkas 2 section (South Urals, Bashkiria). Thus, FAD of *I. turbatus* reflects global transgressive pulse and this taxon have good potential for the correlation.

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Voskresenka carbonate massif in the Southern Pre-Urals as an example of the drowned Late Carboniferous shelf margin

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It is shown that Voskresenka carbonate massive in the Pre-Uralian Foredeep is a tectonic horst type block in the center of the Tabynsk anticline composed of the Late Carboniferous brachiopod-bryozoan bioherm limestones uplifted in sub-meridional? southern? strike-slip zone. Biostratigraphic foraminifer data together with conodont data confirm the almost continuous succession of the Kasimovian–Early Gzhelian shelf – biohermal limestone overlain by the Late Gzhelian–Asselian dark-grey bedded limestone. The section is interpreted as drowned Late Carboniferous carbonate platform margin overlain by condensed Late Gzhelian–Asselian deep water carbonates and then by the Artinskian siliciclastic turbidite flysch sediments.

The Upper Viséan and Serpukhovian beds of the southeastern regions of the East European Platform

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The Viséan–Serpukhovian (V-S) boundary beds are studied in boreholes in the southeastern East European Platform on the fringes of the Sol-Iletsk Swell. In the northern regions of the swell, they are studied in the West-Orenburgskaya and Oktyabrskaya fields; in the south, in the regions adjacent to the Peri-Caspian, in the Peschanaya, Tchiliksaiskaya, Kainsaiskaya, and Vershynovskaya fields; in the east, in the zone adjoining the Uralian Foredeep, in the Nagumanovskaya field; and in the Uralian Foredeep, in the Kornilovskaya field. The succession is mainly composed of shallow, open shelf facies, except for Borehole 2 Kainsaiskaya, which contains deeper shelf facies. In Borehole 102 West-Orenburgskaya, the Upper Viséan is composed of dolomitized limestone with remains of corals, crinoids, and oncolites, 192 m thick. In Borehole 106 Oktyabrskaya, the Upper Viséan includes a 289 m foraminiferal-algal limestone and dolomite series. In Borehole 20 Peschanaya, the Upper Viséan contains bioclastic limestones, 356 m thick, dominated by grainstone with algae, crinoids, and foraminifers, whereas in Borehole 30 East-Peschanaya, the limestone is nodular (pelsparite) with crinoids and foraminifers, 308 m thick. In Boreholes 35 Tchiliksaiskaya, 501 Vershinovskaya, 150 Kornilovskaya, the Okian Superhorizon is represented by crinoid-algal and foraminiferal-crinoid packstones and grainstones, from 214 to 500 m thick. In Borehole 2 Kainsaiskaya, in the Peri-Caspian flank zone, the Upper Viséan is represented by depression facies 32 m thick. The Tulian Horizon is composed of black argillites with layers of dolomitized crinoid packstones with conodonts of the *Gnathodus austini* Zone in the upper part. The overlying Viséan beds are composed of bryozoan-crinoid limestone with dolomites. The Serpukhovian Stage is recognized based on fossil data and well-logging in Boreholes 106 Oktyabrskaya, 102 West-Orenburgskaya, 20 Peschanaya, 30 East-Peschanaya, 2 Kainsaiskaya, 35 Tchiliksaiskaya, 501 Vershinovskaya, 2 Nagumanovskaya, and 150 Kornilovskaya, and it thickness varies from 19 to 239 m. The Lower Serpukhovian (Tarusian and Steshevian) is established in Borehole 17 Peschanaya, 20 Peschanaya, and 150 Kornilovskaya, based on the entry of *Janischewskina delicata*, and is composed of algal-foraminiferal grainstone with *Calcifolium okense*, less commonly *Koninckopora* sp. In Borehole 106 Oktyabrskaya, the V-S boundary is drawn as the base of the dolomitic series overlying the Upper Viséan algal-stromatolitic limestone. In Borehole 2 Kainsaiskaya, the Serpukhovian is 19 m thick and is represented by dark, crinoid limestone with brachiopods (packstone) with layers of black argillite. In Borehole 102 West-Orenburgskaya, the Serpukhovian is recognised by well-logging and is 64 m thick. The Protvian in Boreholes 30 East-Peschanaya, 2 Nagumanovskaya, and 501 Vershinovskaya is composed of bioclastic packstone, foraminiferal-crinoid, brachiopod-crinoid, crinoid-algal, sometimes with oncolites (Borehole 30 East-Peschanaya), from 7 to 30 m thick. Borehole 2 Nagumanovskaya possibly contains the equivalents of the Zapaltyubian. Lithologically, the V-S boundary is revealed by a change in the texture-structure features of the limestone. The Upper Viséan is usually represented by crinoid-foraminiferal shoal grainstone, cavernous, porous, with characteristic crustification cement. The Serpukhovian carbonates are more compact, nodular-algal, suggesting a relatively calm environment. This study is supported by the Russian Foundation for Basin Research, project no. 14-05-00774.

Climatic signals recorded in Permian palynomorph assemblages: High-resolution correlation tool and key to late Palaeozoic palaeoclimate reconstruction

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Our knowledge on mid-Permian biodiversity patterns, preceding the end-Guadalupian crisis and end-Permian biotic diversification, is still very little, since most recent studies focus on the Permian–Triassic boundary events. However, the palynological record of different terrestrial and marine depositional environments and of different palaeogeographical settings reveals major climatic changes during early mid-Permian (Roadian) times. Here, we report on new palynological data from Roadian reference sections in Tatarstan (East European Platform) and South Africa (Main Karoo Basin). The different palynomorph assemblages record prominent climatic signals: in the northern hemisphere a shift from warm temperate to warm dry climate is documented whereas the southern hemisphere underwent a postglacial change from cool to warm temperate climate conditions during Roadian times. In both palaeogeographical settings, the detected climatic signals are used for interregional marine – non-marine correlations on high time resolution.

Gases associated with magmatic rocks in the coal basins of the Russian Far East

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The chemical composition of natural gases of magmatic rocks in the coal basins (Yuzhno-Yakutsky, Ziryansky, Arkagalinsky, Omsukchansky, Uglovsky, Sakhalinsky, Middle-Amursky, Partizansky, Anadirsky, Olyutorsky, Bureinsky basins) of the Far East is studied. The basic patterns of the 5 main groups (predominantly hydrocarbon gases, hydrogen-hydrocarbon gases, hydrogen gases, carbon dioxide-hydrocarbon gases, hydrocarbon-carbon dioxide gases) of magmatic gases are revealed. The molecular balance of the hydrocarbon gas fraction clearly separates these groups: group 1 has values 16.57÷16.63 (average 16.60); 2 – 16.59÷16.66 (16.62); 3 – 16.68÷16.79 (16.72); 4 – 16.56÷16.58 (16.58) and 5 – 16.33÷16.43 (16.39). The $d^{13}C$ isotope and accompanying gases (helium, nitrogen, radon and others) follow and support details in this system. Also, thermal and contact-thermal impact can result in high gas bearing coals, bearing up to 28 cubic meters per ton, and accumulations of natural gases. The results show that magmatic and deep gases have a significant influence on the natural gas balance in the modern gas composition of the coal basins of different geological ages in the Russian Far East. The study is partially supported by the Russian Foundation for Basic Research FBR (grants 14-05-00294 and 15-05-06638).

Permian–Triassic biotic crisis: A multidisciplinary study of Armenian sections

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Permian–Triassic (PT) successions in the southern Armenia were deposited in relatively deep-water environments in the northernmost part of the Cimmerian Iranian Plate close to equator. Several sections are known since the XIX century with the Chanakhchi and Vedi-2 sections being the most well known ones. At Chanakhchi, condensed Late Permian (15 m) dark grey limestones of the uppermost Khachik Fm. and reddish nodular limestones of the Akhura Fm. are developed. Above a thin (up to 0.3 m) "boundary clay", characteristic microbial (stromatolitic) limestones (up to 3 m) occur. *H. parvus*, marker species of the Triassic, occurs in the uppermost stromatolitic limestones, which are overlain by dark thin-bedded limestones with intercalated thin clays (Karabaglyar Fm., up to 275 m). The *I. isarcica* Zone spans an interval of 1.7 m about 1 m above the microbialites, the *H. postparvus* Zone comprises the following 3.5 m. The *N. dieneri* Zone (<165 m, upper part faulted and covered by talus) and the *P. costatus* Zone with rare specimens of *N. waageni* (80 m) are relatively thick. The topmost limestones of the section (15 m) contain only ramiform conodont elements. Macrofossils are generally very rare and only scarce specimen of the bivalve *Claraia* are found in the lowermost Karabaglyar Fm. No bioturbation is observed in the lower 65 m of the Karabaglyar Fm, but intensively bioturbated beds occur from 88 m above the PT boundary together with spherical components (2–3 cm) resembling lissakid sponges described from the Early Dienerian and Late Smithian (Brayard et al., 2011). Fish microremains are abundant in the Khachik and lower Akhura Fm., but extremely rare in the Upper Akhura and Karabaglyar Fm. However, an incomplete paleoniscoid fish skeleton was found in interval around 88 m. The restoration of bottom water communities only occurred in the Late Dienerian. Carbon isotope values of the Late Permian carbonates are relatively constant with values between +2 and +3 ‰ VPDB. Starting with the *Clarkina nodosa* Zone, $\delta^{13}C_{carb}$ begins to decrease to values of –3 ‰ VPDB in the microbial limestone and basal strata of the Karabaglyar Fm., i.e. at the PT boundary. After this minimum, $\delta^{13}C$ increases again to +1 ‰ VPDB at 8 m above the top of the microbial limestone. Between 8 and 15 m above the PT boundary, the values fluctuate between 0 to +1.4 ‰ VPDB. Following, $\delta^{13}C_{carb}$ increases up +4 ‰ VPDB with relatively constant values measured in lower part of *N. dieneri* Zone and values up to +5 ‰ VPDB in middle *N. dieneri* Zone. After a gap with no data, $\delta^{13}C_{carb}$ increases to values of almost +8 ‰ VPDB in the early Smithian *P. costatus* Zone and decreases again to +5.5 ‰ VPDB at the top of this zone. However, most samples from the Karabaglyar limestone show a relatively high variability in $\delta^{13}C_{carb}$ which attributed to intense surface weathering. Oxygen isotopes measured on conodont apatite are homogeneous in the Permian part of the succession with values of +19.5 to +20 ‰ VSMOW, indicating mean water temperatures of around 27–30° C. $\delta^{18}O_{phosphate}$ shows a major decrease in the "boundary clay" (to values of +17 ‰ VSMOW) and varies between +17 and +18.5 ‰ VSMOW in the lower 15 m of the Karabaglyar Fm. To date, only few oxygen isotopes measurements are available from the higher part of Karabaglyar Fm., but these values vary in the same range between 16.8 to 18.0 ‰ VSMOW suggesting water temperatures of 35 to 40° C. The oxygen isotope record is comparable to those documented from Chinese sections (Joachimski et al., 2012; Sun et al., 2012) and adjacent areas of Iranian Dzhulfa (Schobben et al., 2014).

Brachiopods from the Vøringen Member of Kapp Starostin Formation (Permian, Spitsbergen)

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Permian brachiopods from Spitsbergen are well known from the old monographs of Toula, Wiman, Frebold, Stepanov, as well as recent publications by Gobbett, Ustritsky, Sarytcheva, Grigorjeva, Afanasjeva, Nakamura, Angiolini, and others.

The lowermost part of the Kapp Starostin Fm. (Vøringen Mb.), formed of highly fossiliferous, open-marine limestone, with a rich brachiopod fauna, suggests marine, nearshore to transitional offshore areas of a temperate, storm-dominated ramp. A biostratigraphic review of the brachiopod assemblage, containing *Arctitreta macrocardinalis* (Toula); *Thuleproductus subarcticus* Sarytcheva; *Svalbardoproductus striatoauritus* Ustrtsky; *Burovia fredericksi* Grunt; *B. auriculata* Grunt; *Horridonia granulifera* (Toula); *Wimanoconcha angustata* (Sarytcheva); *Yakovlevia impressa* (Toula); *Spiriferella drashei* (Toula); *Timaniella festa* Barkhatova; *Pinegathyris amdrupi* (Dunbar) yields the Late Kungurian (Ufimian) age (approximately 278–272.3 Ma) instead of the Late Artinskian–Kungurian estimate based on conodont determinations: *Neostreptognathodus pequopensis* Behnken; *N. svalbardensis* Scaniawski, 1979; *N. pnevi* Kozur et Movschovich; *Sweetognathus whitei* (Rhodes) by Nakrem in 2013.

If compared with the conodont zonation used in the recent Time Scale, it is clear that *S. whitei* marks the lower boundary of the Artinskian; *N. pequopensis* – its upper part, but *N. pnevi* – the Lower Kungurian. This means that the conodont assemblage coming from the Vøringen Mb. Is mixed and probably reworked. The named complex is a type warm-water, broadly spread Artinskian Assemblage. It must be accompanied by a lot of fusulinids and a very characteristic warm-water brachiopod association. Meanwhile, fusulinids are completely absent, but the brachiopods, as well as the environment as a whole, are characteristically cool-water. The upper boundary of the Vøringen Mb. must correspond to the lower boundary of the Roadian.

Both biostratigraphic and environmental data suggest a correlation of Svalbard’s Vøringen Mb. with the Sabine Bay Fm. of Arctic Canada, containing the advanced ammonoid *Epijuresanites*, the Mallemuk Mountain Group of NE Greenland, the Kozimrudnik Fm from the Timan–Pechora Basin and *Burovia fredericksi* layers from the Kanin Peninsula (both the Ufimian in the terms of the East-European Scale). The middle part of the Kapp Starostin Formation corresponds to the Kazanian of the East European reference Scale (=Roadian of Global time Scale) and Assistance Fm. of Arctic Canada, containing the ammonoids *Sverdrupites* and *Daubichites* as well as the Kazanian of the Russian Platform (Kremeshki section).

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Climate influence on Carboniferous–Permian marine sedimentation in the East Gondwana Interior Rift

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The East Gondwana interior rift, along which the Indian Ocean formed during the Middle Jurassic to Early Cretaceous, included major intracratonic Carboniferous and Permian basins that are preserved on the western margin of the present Australian continent including the Outer Banda Arc, as well as in various dismembered and now accreted terranes in South-East Asia. The basins of this rift system provide an archive into the climatic history of the interior of East Gondwana. The northern basins of the interior rift record a fully marine succession, with known marine facies becoming more restricted and progressively disappearing toward the south.

This talk reviews major climatic trends evidenced by significant changes in sedimentary patterns, floral and faunal distributions as well as limited stable isotope data. Studied basins lay on a N–S transect of over 2000 km along which climate signatures are interpreted across a range of marine and terrestrial palaeoenvironments with variable temporal control.

An overall trend from a dry Mississippian to a wet Permian in East Gondwana contrasts with increasing aridity in Central Pangea. The Mississippian was warm whereas the Pennsylvanian included a substantial period of lowland ice cover (represented by a significant sedimentary hiatus). The Pennsylvanian glaciation was broadly co-incident with the start of a major episode of rifting that changed basin architecture from broad sags to narrow rifts and initiated major volcanism in northern parts of the interior rift. Rapid de-glaciation followed a global warm spike in the Gzhelian and proceeded in cycles during the Asselian and into the Sakmarian. A temperate wet climate prevailed during the remainder of the Permian, although there were warm-temperate, perhaps drier, phases in the Late Sakmarian to Early Artinskian, Late Artinskian to Early Kungurian, and in less well-defined parts of the Wordian–Capitanian, Wuchiapingian and Changhsingian. A cool interval, with sea ice, was present during the Mid Artinskian.

Bryozoan ecology along a 2000 km S-N climatic gradient in the Lower Permian of the East Gondwana Interior Rift

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High- to mid-latitude basins of the East Gondwana Rift System in Western Australia and Timor Leste archive the climatic history associated with the Southern Hemisphere deglaciation during the Early Permian. Prominent physical S-N gradients within the rift are *Cold to Warm*, *Non-marine to Marine,* and *Siliciclastics to Carbonates*, and similarly the S-N gradient in biogenic sediments range from *Coal to Mounds.*

As should be expected such gradients are mirrored in the biotic communities along the rift, not only in the taxa present, but also in morphological variations within and among taxa, reflecting adaptations to the changing ecological conditions along the S-N gradient. Direct biogenic evidence of climatic gradients will commonly be restricted to the simple absence / presence of particular clades with well-established ecological requirements; however, climatic signals may be indirectly recognizable through analysis of specific adaptations to changes in the physical environment, which are themselves controlled by this gradient.

Two richly fossiliferous depositional systems are selected to illustrate this interplay between fossils, depositional environment, and climate:

<u>High latitude example</u> – Callytharra Formation [Late Sakmarian to early Artinskian; Merlinleigh Basin, part of the Southern Carnarvon Basin] comprises a series of shallowing upward cycles with an overall progradational pattern. Each shallowing upward parasequence is dominated by mudstone, sandy mudstone or muddy sandstone at the base with a thin unit (usually < 10 cm thick) of skeletal packstone or grainstone at the top. At the top of each parasequence set, amalgamated limestone beds (up to 0.75 m thick) are present. The limestones have a very rich benthic invertebrate fauna dominated by bryozoans and crinoids, with subordinate brachiopods. Tubiphytes are rare; dasycladacean algae, cyanobacteria, colonial rugose corals, sponges, and fusulinid foraminifera are absent.

The skeletal packstones terminating individual parasequences are overwhelmingly dominated by collapsed, cone-shaped colonies of fenestrate bryozoans with a clear dominance of fragile species, typically with very prominent supportive rods.

The composition of the amalgamated grainstones terminating parasequence sets is dominated by highly fragmented, delicate fenestrate and rhabdomesine bryozoans, allowing only limited ecological analyses. However, a few taxa are consistently present as very large, conspicuous, well-preserved colonies, which are commonly buried in life position.

<u>Low latitude example</u> – Maubisse Group (*partim*) [Late Artinskian to Kungurian (?); Timor Leste] includes a number of structurally isolated, massive limestones composed in part by amalgamated biogenic mounds. These limestones have a very rich benthic fauna dominated by bryozoans and crinoids, with locally common fusulinid foraminifera, rare tubiphytes, brachiopods, colonial rugose corals, sponges, as well as dasycladacean and red algae.

Locally, a notable constituent in these limestones are 'ghosts' of minute, soft-bodied organisms interpreted to be green algae(?) preserved through the encrustation of their thalli by very thinly calcified rhabdomesine/trepostome bryozoans. The depositional environment of these limestones is therefore suggested to be a mosaic of amalgamated mounds with a Late Paleozoic parallel to modern sea-grass meadows interspersed.

Carbonate Mudmounds from the Serpukhovian of the Southern Urals and the Bashkirian of Northern Spain – Examples of a waning Mississippian ecological window

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Carbonate mudmounds *s. l.* were widespread during the Early Carboniferous. Such matrix-dominated, poly-micritic buildups miss a framework constructed by skeletal macroorganisms, contain only isolated biota, mostly from filter-feeding communities (crinoids, bryozoans, brachiopods), and frequently spar-filled stromatactoid cavities. Often they are addressed as "microbial buildups", or subsumed as "Waulsortian Mounds". Although deposition is mostly assumed to be deeper water, other examples demonstrate rigid microbial framework and deposition in agitated shallow-water. This ecological window seems to wane at the end of the Mississippian. Pennsylvanian mounds are frequently skeletal-rich, with major contribution by a variety of algae (in part problematical), and often with considerable portions of cementstone, though in certain cases microbial facies might be of continued importance. Herein, we add two examples of carbonate mudmounds to show the diversity of that waning microbial facies in the Late Mississippian / Early Pennsylvanian. First example is from the Middle Serpukhovian (Khudolazovian) of the section Verkhnyaya Kardailovka (eastern slope of the Southern Urals), the proposed GSSP for the base of the Serpukhovian. This is a small, about 4.5 m thick, internally almost undifferentiated auloporid mound. Due to clotted peloids and predominantly small, spar- and peloid-filled cavities, the mostly dense micritic matrix is apparently of microbial origin; in few cases also bioturbated matrix occurs. Most conspicuous are dispersed auloporids and small disarticulated crinoid ossicles. Singular favositid tabulates, cyathaxonid rugosans, thin shells, gastropods, ostracodes, and sponge spicules are associated. Hexactinellid root tufts were observed close to the top. Larval ammonoids and *Rectangulina*, a supposed ammonoid coprolite, stress a deeper water setting, as well as the published interpretation of the section as deeper outer shelf. The mound is overlain by fine-grained turbiditic intraclastic-bioclastic grainstone / packstone and supposedly initiated on same facies. The second example is a latest Bashkirian, 7–12 m high and 18 m wide microbe-sponge mudmound from Villafeliz (N León), Southern Cantabrian Mts., Northern Spain. It is situated directly below an erosional unconformity separating Valdeteja Fm. and overlying San Emiliano Fm. Subaerial exposure caused strong dissolution features resulting in intraclast and spar-filled cavity systems. Distinct synsedimentary, stromatactoid cavities are not proved. Also obvious internal zonation is missing. Instead, irregular spaces with more abundant bioclasts (predominantly disarticulated crinoid ossicles and fenestrate bryozoans, and subordinate brachiopod fragments) exist within general microbial facies. This pattern might result from the coalescence of smaller mound knolls, but in places also from fossil-rich infill of dissolution cavities. General microbial facies is fossil-poor peloidal mudstone / wackestone. It consists of clotted peloids grading into micrite; sponge spicules are quite common. From literature also complete sponges are known. Bedded off-mound facies is not exposed. A single sample of intraclastic-bioclastic packstone points to resedimentation in deeper water at the flanks of the mound. Deeper water formation of the mound is also indicated by the sponge relicts and general scarcity of algae.

Taxonomic and palaeobiogeographic affinities of Late Viséan cerioid tabulates, eastern Central Meseta, Morocco

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Late Palaeozoic cerioid tabulate corals with big coralla and relatively large corallites are generally referred to as “micheliniids” during sampling, i.e. based on their external appearance. Supposedly, these are what quite a number of “*Michelinia* sp.” in faunal lists refer to. However, data on wall microstructures from study of thin-sections show that smaller morphs might in fact belong to other favositid genera. We elucidate this using three taxa from the Latest Viséan (Brigantian) Upper Tizra Formation of the Adarouch Region (Northern Azrou-Khenifra Basin, eastern Central Meseta, Morocco). The corals were embedded in bioclastic packstone / floatstone with abundant crinoid ossicles, less common brachiopods, cyathaxonid corals, trilobites, further “micheliniid” fragments and undifferentiated bioclasts. Bioclasts are not sorted, not orientated and strongly fragmented. In accordance with the general geological setting in that foreland basin, this indicates a debrisflow origin. Since shallow-water indicators are absent, the corals apparently lived below the wave-base in low-energy muddy environments. The biggest and most abundant taxon is a true *Michelinia* with a wall structure showing a dark microcrystalline median line and parallel aligned calcite fibres. A continuous growth rate from colonies with small corallites (mean diameter of adults 4.15 mm) to colonies with large corallites (mean diameter of adults 8.9 mm) is documented. New corallites develop in the angles between adjacent corallites. Wall pores are common, occurring more often along the sides of the corallites. Relatively loosely spaced tabulae are complete (horizontal or inclined) and incomplete, consisting of 2-3 globose tabellae / row, mostly convex upward. The taxon is well comparable with the somewhat smaller *Michelinia rectotabulata* Vassiljuk, 1960 from the Serpukhovian of the Donets Basin. One colony is intergrown with a taxon showing a different wall structure, thus proving the primary nature. The wall consists of an interrupted (partly preserved?) dark microcrystalline median line and calcite fibres growing orthogonally on both sides. Mean diameter of adult (hexagonal to roundish) corallites is 1.85–2.05 mm. Mural pores are often at central position along the sides of the corallites. Narrow-spaced tabulae are complete, approximately horizontal or convex upward, or incomplete. These consist of 2-3 tabellae, often forming a tent-shaped structure; loose cessations of tabellae are common. In its extremely developed squamulae, the taxon resembles *Sqameofavosites megasquamatus* Nowinski, 1976, although it might be a new genus. The rare third taxon is also a favositid according to the orthogonal fibrous wall, but of unknown taxonomic affinity. It has small corallites with mean diameters of 5.4 mm and mostly complete tabulae. “Micheliniids” are quite widespread in the Mississippian of the Saharan basins and the Moroccan Meseta. They are common in the British Isles, apparently less common in Belgium and rare further east (e.g. in Poland). They are absent in the Western Mediterranean massifs (Ghomarides–Malaguides, Pyrenees, Montagne Noire (S France), which obviously forms an independent palaeobiogeographic entity. They are also absent in the deeper water Iberian basins (South Portuguese Zone, Catalonian Coastal Ranges and Cantabrian Mountains) due to unfavourable facies. The indicated palaeobiogeographic relations are also supported by rugose corals.

Bashkirian conodonts from the Luokun section, Southern Guizhou, South China

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A detailed conodont data from the Bashkirian strata of the Luokun section, Southern Guizhou, South China are recorded. 46 conodont species and subspecies, including 2 new species, which belong to 10 genera were identified. Some of these species were never reported from China, for example, "*Streptognathodus*" *einori*. Seven conodont zones were recognized, in ascending order they are *Declinognathodus noduliferous*, *Idiognathoides sulcatus sulcatus*, *Idiognathoides sinuatus*, *Idiognathoides sulcatus parvus*, "*Streptognathodus*" *expansus* M. 1, "*Streptognathodus*" *expansus* M. 2, and *Diplognathodus* cf. *ellesmerensis* zones. The lower Bashkirian boundary or the Mid-Carboniferous boundary in the Luokun section is recognized by the first occurrence of *Declinognathodus noduliferus s.s.* In underlying beds Declinognathodus bernesgae occurs. The upper Bashkirian boundary can be recognized by the first occurrence of *Diplognathodus* cf. *ellesmerensis,* which is one of the most potential biomarkers for the Bashkirian–Moscovian boundary in China. An updated range chart of the Bashkirian conodonts from the Luokun section is given. The conodont zonation is described and compared with the Naqing section nearby, as well as with the other coeval sections of the South Urals, Donets Basin and North America.

Pennsylvanian–Early Permian Paleokarst on the Yangtze Platform, South China: A Window into northeastern Paleotethys environment during the Permo–Carboniferous Glaciation

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Paleokarst is a most important feature of the Pennsylvanian–Early Permian strata in Madiyi, Hunan Province, along the margins of Xuefeng ancient land in South China, caused by high-frequency glacio-eustatic sea level change in the Late Paleozoic. The Madiyi section is mainly composed of limestones, interbedded with conglomerates and sandstones. A number of macroscopic sedimentary features of paleokarst can be ovserved, including molds of corals and brachiopods, brown argillaceous lamina, calcareous breccias, uvala, cave, sandstone dyke, and brown calcareous paleosoil. Meanwhile, the pendant cement and vadose silt, as well as coloured cement also indicate that the shallow-water carbonates in Madiyi underwent exposed. Furthermore, the obviously negative values of the $\delta^{13}C$ (2.54 ~ -3.74 %, mean: -2%) and $\delta^{18}O$ (-5.91 ~ -12.08 %, mean: -8.17 %), with the pattern of variable $\delta^{13}C$ and relative constant $\delta^{18}O$, revealing strong meteoric diagenesis of the carbonates in the study area. We recognized six 3rd sequences, and 18 lowstand events in the Madiyi section. Compared to the shallow-water carbonate platform in Zongdi area (Guizhou province), the Madiyi's cyclothems are almost equal in the Moscovian, but obviously thinner in the Kasimovian to Gzhelian strata. And the absences of the *Protriticites* Zone and many typically elements of the *Triticites* Zone constrain a major sea-level fall within Kasimovian to Gzhelian in South China, which may be caused by the glacial maximum during the Pennsylvanian–Early Permian. The uncoverred paleokarst and high CIA values (range from 78–84) at the Madiyi section suggest that the climate of South China in the Pennsylvanian–Early Permian was generally humid rather than dry.

Evidence of intense floral interchange between South America and India during the Early Permian

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A scheme of correlation between the Permian floral succession of the Brazilian Paraná Basin and the Indian floral stages has been recently proposed by the working group of Indo-Brazilian cooperation project, as a start point for future investigations concerning paleobotany, paleogeography, and paleoclimatology. One of the first results indicated the existence of a strong correlation between the reported taxa in Brazil and India, particularly during the Early Permian (Asselian–Artinskian), which corresponds to records from the uppermost Itararé Group and the Rio Bonito Formation, in the Paraná Basin, and Talchir and Karharbari–Lower Barakar stages, in Indian basins. Therefore, the highest floral similarity between these two areas is recorded in this interval, assigned through the occurrence of many taxa in common. In generic level, beyond the *Glossopteris* and *Gangamopteris*, there is the sharing of about twenty other genera, i.e. *Paracalamites, Phyllotheca, Lelstotheca* (= *Annularia* in part), *Sphenophyllum*, *Giridia*, *Sphenopteris*, *Pecopteris*, *Neomariopteris* (including *Ponsotheca*), *Botrychiopsis*, *Psygmophyllum* (= *Notoangaridium* in part), *Rhabdotaenia*, *Arberia*, *Ottokaria*, *Plumsteadiella*, *Vertebraria*, *Cheirophyllum*, *Kawizophyllum*, *Palmatophyllites*, *Noeggerathiopsis* (= *Cordaites*), *Buriadia*, *Cordaicarpus, Samaropsis*. Furthermore, many species belonging to genera referred also occur in both areas. It should be noted that during this interval the climate was wet and favorable to the development of peat-forming environments, resulting in exuberant and diverse floras in the both areas. Therefore, comparable climatic and environmental conditions could satisfactorily explain the high level of floral similarity found during this interval. Towards the Late Permian, however, that two areas of Gondwana experienced situations environmentally and climatically quite different. While the depositional areas in India remained under the regime of humid climates favorable to the accumulation of peat, the region of the Paraná Basin went on to definitely be under a regime of seasonally humid to semi-arid climates, indicated by the presence of carbonates, red beds and eolian deposits. Consequently, Brazilian and Indian floras from this interval reflect these environmental and climatic differences, showing a large disparity in terms of taxonomic composition and diversity. Whilst the Indian floras continue to display a high diversity, floras in the Paraná Basin become impoverished, registering only a few plant groups at the end of the Permian, viz. glossopterids, equisetophytes and pteridophytes. Phytogeographically, it is inevitable to accept that there must have been a dispersal corridor through the Gondwana in the Early Permian times which allowed an intense floral exchange between these two areas.

Reevaluation of plant stratigraphic zonation from the Southern Paraná Basin

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In the 90s, it was proposed a preliminary plant stratigraphic zonation containing two assemblage zones for Lower Permian strata geographically restricted to Rio Grande do Sul, Southern Paraná Basin. The lowest zone, *Botrychiopsis plantiana* Assemblage Zone, was characterized by the first appearance of glossopterid elements and by the local abundance of the pteridophylls *Botrychiopsis plantiana* and / or *Phyllotheca*-like sphenophytes. This plant zone was originally divided into two units, the *Gangamopteris obovata* and *Phyllotheca indica* (= *P. australis*) Subzones. The uppermost, *Glossopteris / Rhodeopteridium* Assemblage Zone, was characterized by the abundance of species of genus Glossopteris and the occurrence of lycophytes (*Brasilodendron pedroanum*) and true ferns (*Pecopteris* sp., *Asterotheca* sp., *Sphenopteris* sp., *Neomariopteris* sp.). After more than twenties years, the information provided by several authors significantly modified the stratigraphic distribution and taxonomic composition of the mentioned zones, including: changes in the stratigraphic range of known plant zones, stratigraphic repositioning of previously known outcrops, establishment of stratigraphic correlations among the different outcrops fossiliferous, inclusion of new outcrops, revaluation of various taxa previously described, and addition of new taxa. From these results a new zonation proposal is presented for this portion of the Paraná Basin, redefining the previous zones in accordance to the criteria and recommendations indicated by the International Subcommission on Stratigraphic Classification (ISSC). The proposal of a formal scheme of zonation is of fundamental importance not only to systematize the floral succession this area but also so that we can establish a more precise correlation with the circum-neighboring depositional areas. The Early Permian flora from Rio Grande do Sul registers a number of key taxa found in Northern Argentina and India, as well consisting of a crucial area in understanding the evolution paleophytogeographic of Western Gondwana and its relation to areas located to the east, as Southern Africa and India.

Lower Permian fossils of the Sezym Formation (Kos'yu-Rogovaya Depression)

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The Sezym Formation is widespread on the western slope of the Polar Urals and in the southwestern Pay-Khoy. This formation is composed of mudstones, wackestones, packstones, peloid and cherty limestones, mixtites, siltstones, and fine-grained sandstones. Fossils are mainly included in the mudstones, wackestones, and packstones. The Asselian–Sakmarian Sezym Formation (thickness 8–14 m) underlies the Artinskian terrigenous deposits of the Gusinaya Formation. Deposits of the Sezym Formation overlie Middle Carboniferous wackestones of the Tsementnyj Zavod Formation with a stratigraphic unconformity. The Lower Permian fossils of the Sezym Formation are represented by bryozoans, echinoderms, brachiopods, gastropods, ostracodes, bivalves, foraminifers, sponges, ammonoids, trilobites, tetracorals, conodonts, radiolarians, and traces of ichnofossils. Apart from the above mentioned fossils, the microproblematic organism *Tubiphytes,* oncolite-like objects and microbial generations were found for the first time. Fenestral and branching bryozoans (40–45 % of fossils) are most common and they are represented by at least 4 genera. Echinoderms (20–25 %) are characterized by columnals and plates of echinoids. Brachiopods comprise about 10–15 % by content and comprise more than 25 species. Probably, the brachiopods inhabited a soft bottom, indicated by numerous fragments of their spines. The content of other fossils is 10–15 %. Most fossils are bioclasts, but whole shells of micro- and macrofauna were also found. The distribution of fossils is chaotic, without any sorting. Colonies of sponges of the order Tetraxonida were found in several sections of argillaceous limestones. This data is very important for paleoecology, since these sponges with isometric shapes are accumulated like lenses in which no traces of redeposition were revealed. Probably, some well-preserved colonies of bryozoans, whole shells of brachiopods, ostracods and small foraminifers and single cup-shaped tetracorals could also be preserved in situ. All fossils found are of the Asselian age. According to the data obtained, the Sezym Formation was deposited in open-marine conditions with relatively low hydrodynamics. A major part of the biogenic material was redeposited from shallower areas.

Bashkirian–Moscovian boundary on the Middle Urals: Foraminifers and corals in the Kremennoi and Mariinskyi Log sections

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Stratigraphy of the Bashkirian and Moscovian stages was developed based on the well-outcropped sections of the Moscow Basin and the Urals. Their historical stratotypes are situated in Bashkortostan and Moscow Basin. Ratification of the stages in the International Stratigraphic Scale demands the new definition of the stage boundaries. The marker of the Moscovian boundary is still under discussion. The Bashkirian–Moscovian boundary in the Moscow Basin is characterized by stratigraphic unconformity and continental sedimentation in the basal Bashkirian. Only a few localities with continued sedimentation are known up to now in the eastern part of the East-European Platform and western slope of the Urals. Traditionally the Lower Moscovian boundary is fixed at the base of the Verean Substage by the appearance of *Aljutovella aljutovica* Raus. The regional analogy of the Vereian Substage in the South Urals was regarded as the Solontzovian Regional Substage. In the complete sections the boundary interval is characterized by predominance of *Profusulinella* and *Depratina* and corresponds to the Depratina prisca Zone. The overlaying upper zone is Aljutovella aljutovica. The same succession was found in the boundary interval in the Askyn and Basu sections in the South Urals and Klyuch section (Iset' River) in the Central Urals. The Bashkirian-Moscowian interval was recently studied in the Kremennoi and Mariinskyi Log sections, situated on both sides of the Kos'va River in the vicinity of Gubakha Town (Perm District). Detailed measuring and bed-by-bed sampling provided lithological and microfacies characteristics, the new data on foraminifera distribution and allowed to recognize a few level with fasciculate coral colonies. The boundary between the Serpukhovian and Bashkirian studied in Mariinskyi Log quarry corresponds with unconformity embracing the upper part of the Serpukhovian and lower part of the Bashkirian. The lower part of firstly proposed Mariinskyi Formation includes two zones of the Russian standard zonation – Eostaffella pseudostruvei – E. postmosquensis и Pseudostaffella antique. This part in both sections is characterized by occurrences of *Heintzella* fasciculate colonies. The overlaying Profusulinella parva Zone is recognized in Kremennoi section only. The assemblage including representatives of Novella genus characterizes the upper part of the Mariinskyi Formation in the both sections. Besides *Novella* assemblage, the appearance of numerous *Profusulinella* is typical in the overlaying Elovka Formation. Bearing assemblage includes also *Profusulinella primitiva* Sosn., *P*. ex gr. *parva* (Lee et Chen). The first *Aljutovella* (A. conspecta Leont.) is fixed 9 m above the boundary of the Elovka Fm. After the overlaying barren interval (2.75 m) the Kremenskaya Fm. contains *Priscoidella priscoidea* Raus., *P. postaljutovica* (Saf.), dense *Depratina prisca* (Deprat), various *Pseudostaffella* and *Schubertella*, which are typical for the Kashirian of the stratotype region.

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Occurrence of xenacanthimorph sharks in the Carboniferous of Russia

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The Bransonelliformes are the most widely distributed xenacanthimorph sharks in the Carboniferous of Russia. Two species of the genus *Bransonella, B*. *nebraskensis* (Johnson) and *B*. *lingulata* Ivanov & Ginter, occur in many localities in European and Siberian Russia. Teeth of *B*. *nebraskensis* were known earlier, from the late Visean of the Kaluga Region and the Late Moscovian of the Moscow Region, East European Platform (EEP), the Late Visean of Nearpolar and South Urals, and the Early Visean of Kemerovo Region, Kuznetsk Basin, Siberia. *B*. *lingulata* is recorded in the Early Serpukhovian of the Moscow Region, EEP and the Early Visean of the Kuznetsk Basin.

New records of *B*. *nebraskensis* come from the Early Bashkirian of the Usolka and Belaya Rivers, the Early Moscovian of the Basu River, South Urals; the Tournaisian of Lekeyaga-42 drill core, and Varandey–Ad'zva structural zone of Timan–Pechora Province. Teeth of *B*. *lingulata* were found in the early Bashkirian of the Belaya River, South Urals. Both *Bransonella* species occur in one locality and stratigraphic level, in the Kuznetsk Basin. Thus, *B*. *nebraskensis* is distributed from the Tournaisian to the Late Moscovian, *B*. *lingulata* from the Early Visean to the Early Bashkirian. The *Bransonella* tooth found in the lowermost Tournaisian deposits of Medynskaya-5 drill core of Timan–Pechora Province can probably be assigned to an early form of the genus.

Xenacanthimorph fin spines were collected in Early Serpukhovian deposits of the Moscow Region, in the same two localities where *B*. *lingulata* was documented. These localities contain a very diverse chondrichthyan assemblage, but *B*. *lingulata* is the only xenacanthimorph taxon among numerous shark teeth. The spines resemble those of *Anodontacanthus* from the Carboniferous of England in shape and position of the ventrolaterally arranged denticles. Tentatively, they could be assigned to *Bransonella*.

The occurrence of remains belonging to Xenacanthiformes is very rare in the Russian territory. A taxon described as ?*Diplodoselache antiqua* Lebedev based on isolated teeth, scales, and fin spine was reported from the Lower Tournaisian of the Tula Region, EEP. The fin spine possesses characters different from typical xenacanthid spines but the teeth could be attributed to Diplodoselachidae. *Triodus teberdensis* Hampe & Ivanov was described as a representative of the family Xenacanthidae from the Moscovian of the Teberda River, Karachay-Cherkess Republic, Northern Caucasus. Another xenacanthid tooth, potentially belonging to *Xenacanthus*, was recently found in the Late Moscovian of Central-Khoreyver-3 drill core, Khoreyver Depression of Timan–Pechora Province. This discovery is the first typical xenacanthid from the East European Platform. There is no evidence for the Permian distribution of the Xenacanthimorpha in Russia, although the Early Permian chondrichthyan assemblages are taxonomically very diverse in the Urals.

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Latest Devonian–Early Carboniferous conodonts from the Altai-Sayan Folded Area

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New data on Late Devonian and Early Carboniferous conodonts from the western part of the Altai-Sayan Folded Area (ASFA) were recently obtained. The uppermost Famennian conodonts were found on the north-east margin of the Kuznetsk Basin. The red-coloured Podonino Formation (Nevsky and Yaya Sections) yielded a conodont assemblage with *Icriodus costatus* Thomas, *Polygnathus delicatulus* Ulrich et Bassler, *Polygnathus lenticularis* Gagiev, *Polygnathus parapetus* Druce, *Polygnathus symmetricus* E. R. Branson, *Pseudopolygnathus postinodosus* Rhodes, and *Siphonodella praesulcata* Sandberg. This assemblage characterizes the lower part of the Famennian *praesulcata* Zone. A very similar assemblage was recovered from the Topki Sequence. The presence of *Icriodus costatus* (Thomas) allows correlation of the Topki Sequence with the lower subzone of the *praesulcata* Zone. The Devonian–Carboniferous boundary interval contains rare *Bispathodus* and *Neopolygnathus* that have wide stratigraphic ranges from the Upper Devonian (Famennian) to Lower Carboniferous. Tournaisian conodonts were investigated from the north-east Salair sections. An assemblage including *Bispathodus aculeatus aculeatus* (Branson et Mehl), *Neopolygnathus communis* (Branson et Mehl), and *Clydagnathus darensis* Rhodes, Austin et Druce was recovered from the Lower Tournasian Taidon Horizon. The Late Tournaisian-Lower Viséan assemblages were found in a section along Artyshta Creek, near Artyshta Village. The lower part of the section yielded *Pseudopolygnathus multistriatus* Mehl et Thomas, *Neopolygnathus communis* (Branson et Mehl), *Clydagnathus darensis* Rhodes, Austin et Druce, and *Mestognathus groessensi* Belka characterizing the *typicus-isosticha* Zone. The middle part of the section is composed of layers and lenses of black cherts. Based on conodonts this chert interval correlates with the Upper Tournaisian, not older than the *typicus-isosticha* Zone. The upper part of the section contains the Viséan Assemblage including *Mestognathus beckmanni* Bischoff, *Cavusgnathus charactus* Rexroad, and *Taphrognathus varians* Branson & Mehl. *Mestognathus beckmanni* is the index-species for the eponymous Viséan conodont zone defined for the shallow-water facies. The records of *Taphrognathus varians* are confined to part of the oolitic limestones of the Mozzhykha Sequence. These oolitic limestones have a wide geographic distribution in Salair and are characterized by *Taphrognathus varians.* From limestones of the upper part of the Belovo Formation cropping out in the Gorlovo Basin the Viséan conodonts *Lochriea commutata* (Branson et Mehl) and new species of genus *Gnathodus*, probably related to *G. girtyi* Hass were identified for the first time. The analysis of the conodont distribution in the Upper Devonian and Lower Carboniferous sections of the western part of ASFA allowed the recognition of four conodont biostratigraphic markers, including (1) a diverse conodont assemblage of the Lower subzone of *praesulcata* Zone; (2) the second marker was defined in the Upper Tournaisian interval of chert sedimentation not older than the *typicus-isosticha* Zone; (3) Viséan marker bed of oolitic limestone in the Mozzhukha Formation showing the appearance of *Taphrognathus varians* Branson & Mehl., (4) The final stage of carbonate sedimentation in the Gorlovo Basin is dated as Middle Viséan based on conodonts of the *Gnathodus bilineatus* Zone.

A newly-recognized Permian vertebrate fauna from the Karoo Basin of South Africa and its implications for East African vertebrate biostratigraphy

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The Karoo Basin of South Africa yields an extremely rich sample of Permo-Triassic terrestrial vertebrates, preserved as part of a continuous record of sedimentation from the Middle Permian to Middle Triassic. Recent work by our research group has focused on resolving the confused taxonomy of Permo-Triassic Karoo therapsids, long obscured by a century of oversplitting. As a result of these revisions, we have been able to recognize a previously unknown vertebrate fauna restricted to the Camdeboo Municipality (the area containing the towns of Graaff-Reinet and Nieu Bethesda, Eastern Cape Province) and its immediate edges, which we term the "Camdeboo Local Fauna." This fauna is characterized by peak abundance of the widespread dicynodonts *Dicynodon* and *Oudenodon*, the therocephalian *Theriognathus*, the gorgonopsians *Aelurognathus* and *Cyonosaurus*, and the cynodont *Procynosuchus*. Additionally, this fauna also includes numerous 'endemic' taxa, known from no other localities in South Africa. These taxa include an array of dicynodonts (e.g., *Basilodon*, *Digalodon*, *Emydorhinus*, *Euptychognathus*, *Kitchinganomodon*, and *Pelanomodon*), rubidgeine gorgonopsians (e.g., *Dinogorgon*, *Rubidgea*, and *Clelandina*), and akidnognathid therocephalians (e.g., *Akidnognathus*, *Proalopecopsis*). The exposures in which this fauna occurs represent a limited time span, probably near the boundary between the *Cistecephalus* and *Dicynodon* Assemblage Zones. Intriguingly, ongoing field work in East Africa has revealed that several of the Camdeboo 'endemic' species also occur in Upper Permian deposits in Tanzania and Zambia. These East African faunas have also yielded an abundance of *Theriognathus*, *Procynosuchus*, *Oudenodon*, and *Dicynodon* specimens (although at least the latter is represented by a distinct species in East Africa). The recognition of this high degree of faunal overlap permits significantly finer cross-basinal correlations than were previously available for the East African faunas, and highlights the weaker degree of faunal differentiation between South and East African basins in the Permian than is present in the Triassic.

The microfacies of the Lower Pennsylvanian limestones in the Akobinka gas field at the Southern Uralian Foredeep

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Limestones of the lower part of the Bashkirian Stage (Krasnopolyanian and Severokeltmian Horizons) were studied at the depths more than 5000 m in several boreholes in the Akobinka gas field at the Southern Pre-Uralian Foredeep. They are light color oolitic and crinoidal-foraminifera limestones formed in open shallow shelf environment with water depths vary from 0 to 10 m. The coarse-grained oolitic grainstones cyclically intercalate with fine-grained oolitic and bioclastic packstones. The Bashkirian limestones are overlapped with a gap by dark color clayey-tuff-silt sediments of the Upper Carboniferous–Lower Permian (Asselian). The sediments of the upper part of the Bashkirian, Moscovian, Kasimovian and probably Gzhelian are absent. The main microfacies types are represented by sorted oolitic and bioclastic grainstones overpacked and normally packed. They belong to standard microfacies 15, belt 6 (after J. Wilson) formed in shoal environments in turbulent water. They are intercalated with fine-grained less well-sorted bioclastic and peloidal packstones and grainstones, standard microfacies 16, formed in shallow water ponds. The sequence was accumulated in the shoals or tidal bars of an open carbonate platform (at the boundary between the middle and inner parts of shelf) as shoal lime sand bodies.

Late Permian (Lopingian) plant mesofossils from the Eleonora locality, Vologda Region of Russia

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We present preliminary data about plant mesofossils from the Eleonora locality (Vologda Region, Russia). In 2011, M.A. Arefiev discovered a small clay lens containing mesofossils on the right bank of the Malaya Severnaya Dvina River near the Gorka Village of the Vologda Region and named it the Eleonora locality (Arefiev et al., 2014). Besides plant mesofossils were found ostracods, bivalves, fish scales and bones of tetrapods. Based on ostracod and fish assemblages, the deposits of the Eleonora locality was dated to the Late Permian (Lopingian), which corresponds to the top of the Vyatka Stage of Russian GSS (Arefiev et al., 2014). Arefiev and Yaroshenko (2015) published the first data on the palynological assemblage. The plant mesofossils include dispersed megaspores (about 100 specimens) and numerous fragmentary cuticles of gymnosperm and bryophyte leaves. The megaspore assemblage contains megaspores of *Erlansonisporites*? sp.; only one specimen of *Maiturisporites* sp. was found. Earlier, more or less representative, transitional Permian / Triassic megaspore assemblages were obtained from the Nedubrovian Member of the Vokhmian Formation at the Nedubrovo locality where megaspores were represented by species of the genera *Otynisporites* and *Maexisporites*. Recently, we have described more diverse megaspore assemblages from the Ryabinsk Member of the Vokhmian Formation at the Sholga locality, which have much in common with those from the Nedubrovo locality (Karasev, Turnau, 2015). Megaspores from older Vyatka deposits in the Moscow syneclise are represented by megaspores, which were found only in association with leaves of the lycopsid genus *Fasciostomia* (Gomankov, Meyen, 1986). Thus, the assemblage of megaspores from the Eleonora locality has no common taxa with megaspore assemblages known in the Late Permian and Early Triassic localities of the Moscow syneclise. Fragments of bryophyte leaves belong to the order *Protosphagnales* (M.S. Ignatov, 2015, pers. comm.). Most fragments of dispersed leaf cuticles of gymnosperms belong to pteridosperms of the family *Angaropeltaceae* of the genus *Aquestomia* Meyen. Less numerous are cuticles of peltasperm pteridosperms *Interpeltacutis conformis* Karasev, 2013. The presence of dispersed cuticles of the *Angaropeltaceae* and peltasperms is typical of both Late Permian and Early Triassic (Induan) deposits. Unlike frequently occurring cuticles, a large number of dispersed megaspores is not typical of Vyatka deposits. The recognized assemblages of megaspores at the top of the Vyatka Stage may indicate an increased diversity of lycopsids during that time; this trend probably continued during with the terminal Permian and Early Triassic of the Moscow syneclise. This work was supported by the grant from the President of the Russian Federation for Young scientists (MK-2369.2014.4) and Russian Foundation for Basic Research (15-04-09067).

Geochemical characteristics of organic matter in the rocks of the Ladeiny section (Perm Region)

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The rocks outcropping at the Ladeiny section, on the left bank of the Kosva River, present Viséan (Mikhailovian and Venevian regional substages of the Russian Scheme) and Serpukhovian stages of Carboniferous deposits. The outcrop is of interest not only because it contains the Visean–Serpukhovian boundary stages, but as a part of carbonaceous Viséan–Bashkirian oil and gas complex, one of the most oil productive in the Perm Region.

The predominantly bioclastic detrital bituminous Viséan limestones, according to the method of Rock-Eval, are mainly characterized by low values of the parameters of S_1 (<0,03 mg/g rock), S_2 (<0,3 mg/g rock) TPI (<0,27), not corresponding to the source rocks. TOC values up to 3.29 % are probably provided by bituminous substances. Tmax varies widely (361–610^{o}C) indicating the presence of both oil component and solid bitumens. An extremely low value HI (less than 30 mg/g TOC) corresponding to inertinite may indicate a high degree of oxidation of organic components. According to data of micro petrography brownish bituminous substances in micro fractures and intergranular space are widespread.

Detrital-slurry, micro and fine-grained, uneven bituminous and argillaceous Serpukhovian limestone (Kurmakovskaya Formation) have similar Rock-Eval results. According to the micro-petrography study, all samples studied are enriched with a brown, reddish-brown bituminous substance in the intergranular space and micro-fractures, and organic matter is of secondary importance. The concentration of chloroform bitumoids reaches 0.03 %; according to IR-spectroscopy, bitumoids are substantially enriched with oxygen and aromatic compounds, and rare paraffinic hydrocarbons, probably due to contamination.

The study indicates the presence in the rock outcrops of bitumens with modern composition and structure formed due to the rise of the oil-bearing horizons to the hypergenesis zone. Along with direct evaporation of light fractions and residual accumulation of asphalt-resinous substances, intense changes have been due to oxidation processes of different intensity. Source rocks have not been identified at rock outcrops. In connection with this conclusion, we can assume that the section is a part of the oil accumulation zone of the Domanik total petroleum system.

Fossil wood in Permian deposits of Volga–Ural Region as an indicator of their sedimentation conditions

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The formation and special features of sedimentary deposits that consist of fossilized wood remains are closely connected with the conditions of lithogenesis. Here we describe fossil woods from the Permian deposits of the Volga–Ural Region (Tatarstan).

Upper Permian deposits of the Volga–Ural Region represent molasses sediments consisting of siliciclastics brought from the growing Ural mountains. Their deposition is associated with a wide range of facies, from marine to continental, traditionally classified by geologists as many-coloured (alternation of red and grey-coloured bands) and red-coloured. Petrified wood occurrences are located in the groups of intermediate (many variegated) and continental facies (Belebeevo Formation red-coloured / krasnotsvety). The samples examined are from the east of Tatarstan, where wood remains can be found among fluvial sediment deposits of the Kazanian age. Fossil woods can differ in the character of mineralization: silicification and sulphidisation.

Silicified woods fragments from Kazan Tatarstan deposits are ochre-brown-coloured. They are almost completely replaced by quartz, opal and chalcedony, but retain a distinct pattern of the original plant tissue with annual layers. Different types of cellular elements are characterized by particular optical orientations of quartz grains, which indicate the selectivity of their replacement. The process of replacement of woods is driven by the deposition of dissolved silica from the alkaline waters of arid lithogenesis micronites, which begin to penetrate into the wood fragments at the early stages of diagenesis. Plant residues under these conditions act as local acidic geochemical barriers. According to the results of the electron paramagnetic resonance (EPR) research, the traces of organic matter preserved in the mineral matrix were recorded. The composition of carbon (δ13Corg) was determined in the samples of silicified wood. Based on the values obtained δ13Sorg (from -17 to -24), estimates of the paleoclimatic conditions of growth of higher plants and Permian sedimentation were refined.

Sulphidised wood fragments can be found in the sediments of transitional facies (from marine to continental) in copper ore occurrences. The petrified wood fragments appear to have conserved plant texture, substituted by ore units of black colour with smears and droplets of azurite and malachite on the surface.

They are composed of copper sulphide minerals: chalcocite and covellite, the formation of which is associated with the occurrence of anoxic conditions favorable for the development of sulphate-reducing bacteria.

To conclude, it should be noted that fossilized plant remains are of great importance for the reconstruction of conditions of lithogenesis.

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Coal deposits of the Volga–Ural Region: The formation conditions, composition and the prospects of the mining

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Significant untapped resources of coal are known in the east of the East European Platform (Kamsky Coal Basin). Coal deposits are associated with Devonian, Carboniferous and Permian sediments. Evolution of coal formation in the study area is connected with the changes in paleogeographic conditions. Because of this from time to time formed the landscapes, which were favorable for the formation of peat bogs. Coals of different ages differ greatly from each other in composition and quality. This is due to the changing of nature of the geographical landscapes and a different composition of the surrounding rocks.

Industrial coal resources are confined to the Carboniferous (Visean Stage) and Permian (Kazanian Stage) sediments. In the Permian sediments are several small deposits, which currently have no practical significance. Main prospects of coal may be associated with Visean coal deposits, which identified and estimated 95 deposits. Their shared resources and reserves exceed 3 billion tons.

In the current economic conditions the development of coal and raw material resources of the Kama Basin using traditional methods is unprofitable because of two reasons. Firstly, because of the difficult geological and mining conditions of occurrence of coal deposits. Secondly because of their considerable depth of 900–1400 m. In the future, work on the implementation of their development is possible in two main directions. First way involves more efficient technological using of coal with producing useful processing products. Second way is the development technologies of downhole production of coal resources.

Within the first way material composition of coals becomes very important. Coals characterize by low content of oxides of iron, magnesium and calcium. A relatively high content of silica and alumina imparts to coal ash high degree of whiteness, so they can be used as a coloring pigment. Certain categories of coal potential as water softeners, for making lignin-alkaline reagent, the production of liquid synthetic fuels, semi-coking products and carbon adsorbents. In Visean coals found elevated concentrations of trace elements and rare earth elements (REE), which may increase the value of the coal.

Second way involves the exploitation of coal fields by distance technology in-situ without extracting at the surface. Visean coals characterized by high-volatile substances and can be practiced by underground coal gasification methods (UCG). UCG can also be used to enhance oil recovery at mature fields. Shared resources of coal and coal-bearing rocks in the Visean deposits exceed 10 billion tons, which can be regarded as a source of coal bed methane.

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Turnover in aquatic ecosystems at the Permian–Triassic boundary: actinopterygians on top

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Although the end-Permian mass extinction event has long been regarded the most catastrophic biotic crisis of the Phanerozoic, until recently, only few reliable data existed concerning the extinction and recovery of aquatic vertebrates. Quantitative analyses performed in recent years allow us to better evaluate this faunistic turnover taxonomically as well as ecologically.

Chondrichthyan fishes were at the top of marine foodwebs during the Late Palaeozoic, and have competed with large semiaquatic tetrapods in the freshwater realm. Elevated extinction rates during the Late Permian and at the Permian–Triassic boundary not only concern some chondrichthyan lineages such as the Holocephali and Petalodontiformes, but also apply to large-bodied predatory forms. Lineages that survived and diversified in the Triassic, in contrast, mainly occupied lower trophic levels.

The trend is quite contrary for actinopterygians, which experienced a body size increase across the Middle Permian–Late Permian boundary, i.e. during the end-Guadalupian crisis. High extinction rates are balanced by the origination of new taxa, so that the ray-finned fishes may be considered the “winners” of the mass extinction. Large “palaeopterygians” such as *Birgeria* and *Saurichthys* were effective piscivores, and the latter genus was especially successful as it is found in nearly every fossil fish assemblage of the Early Triassic age, both marine and non-marine. A decline in saurichthyid diversity and palaeobiogeographic distribution, noted during the Triassic, may be correlated with the diversification of marine reptiles that became the dominant predators of the Mesozoic.

Microbial deposits in the Permian–Triassic boundary interval of the Slovenian Dinarides

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Investigating the Dinaridic branch of the western Palaeotethys, microbial type limestone and dolostone have been found in the Permian–Triassic boundary interval at three localities in Slovenia. In the previously studied Lukač section, where the P/T boundary has been identified, no microbial facies were found, but rather shallow subtidal and evaporite types of sedimentation occurred. A new discovery of microbial type sediments in the Slovenian Dinarides represents a rare occurrence of this significant facies at the end-Permian extinction event. Microbial deposits can be described as grey, tiny laminated stromatolites with thickness ranging between 1.6 to 2.2 m. They represent ramp deposits, possibly its mid-part. Conodonts and foraminifers in the section are being currently studied to document the exact position of the P–T boundary. The grey microbialite comformably overlies black Bellerophon limestone that contains a rich biota of dasycladacean algae, foraminifers, echinoderms, sponges, bivalves, gastropods, ostracods, brachiopods, bryozoans and conodonts forming small skeletal buildups or reworked bioclastic limestone with bioclasts, intraclasts and coated bioclasts. The most characteristic textural feature in the laminated stromatolite bindstone is an alternation of light (microsparitic) and dark (microbial) lamina couplets. In the light laminae homogenous microspar represents enhanced calcite precipitates due to significant changes in the marine biochemistry during the P–T interval. Isolated tests of *Hyperammina deformis* found in these laminae suggest stressful depositional conditions which may have promoted calcite precipitation. Microbial lamina may contain a significant amount of pyrite cubes and framboids. Several distinctive microfabrics that suggest precipitation within the microbial mat are recognized within the dark organic rich laminae: i) *microbial threads* consist of tiny micritic threads that can be continuous, dissected or wrinkled, often lying above light gray microcrystalline calcitic laminae and sometimes encompassing large macrospar crystals; ii) *sphere clusters* characterized by micrite-walled hollow spheres, sometimes scattered or forming continuous lamina that are considered to be coccoidal microbes preserved due to early mineralization; iii) *micrite clots* and *peloids* that are elongate, completely micritic forms or have only a dark micrite rim with macrocrystalline spar interiors, and iv) *sparitic microspheres* that have fairly round or ovoidal shapes, sharp dark edges and a macrocrystalline interior and, due to their spheric shape and dark outer rim, resemble ooids. We are not sure about the origin of the microbial threads that envelope the macrospar crystals and the formation of peloids and finally the microspheres. Peloids with a micrite rim and macrocrystallyne interior may represent reworked irregular knots of micrite threads encompassing spar crystals, whereas microspheres may represent further reworking, microbial coating and the forming of fairly rounded detrital objects.

An Early Triassic conodont sequence from Slovenia (Mokrice and Idrija-Žiri areas)

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The first recovery of the conodont *H. parvus* from Slovenia a few years ago highlights Slovenian for the Early Triassic conodont biostratigraphic study. Systematic sampling of the Mokrice section and five sections in the Idrija–Žiri area has resulted in the discovery of new species: *Platyvillosus corniger* sp. nov. and *Neospathodus planus* sp. nov. Based on these new species and other conodont elements obtained from these sections, a unique conodont sequence is proposed for the Slovenian Early Triassic. It composes of ten conodont zones that span from the Uppermost Dienerian (Upper Induan) to the Lower Spathian (Lower Olenekian). In ascending order, they are: *Eurygnathodus costatus* Zone, *Neospathodus planus* Zone, *Neospathodus robustus* Zone, *Foliella gardenae-Pachycladina obliqua* Zone, *Hadrodontina aequabilis* Zone *Platyvillosus corniger* Zone, *Platyvillosus regularis* Zone, *Triassospathodus hungaricus* Zone, *Triassospathodus symmetricus* Zone, *Neospathodus robustispinus* Zone. This conodont sequence is valuable for stratigraphic correlation within Central and South Europe, and it also promotes a better correlation between western and middle-eastern Tethys. A global comparison with conodonts indicates that the unique conodont sequence in Slovenia seems to have been more controlled by the ecological parameters of the epeiric ramp than by potential migration barriers. Multielement conodont apparatuses of *Triassospathodus hungaricus* and *Platyvillosus regularis* have been constructed based on conodont elements which are obtained from the Mokrice and Žiri-sortirnica 28 sections. Though S_2 element was not found, the apparatus indicates “*Spathognathodus*” *hungaricus* should be assigned to the genus *Triassospathodus.*

Diagenesis of an oil-water contact in a Lower Pennsylvanian carbonate reservoir: Constraints from cathodoluminescence microscopy and isotope geochemistry

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Methods of cathodeluminescence microscopy (CL) and isotope geochemistry for the first time were studied oil-saturated Lower Pennsylvanian carbonate reservoir rocks of the Volga–Ural Region. The diagenetic sequence of calcite cement formation was shown and connection was established of cement forming with the main parageneticaly events in the history of the basin. Detailed studying of a zone of oil-water contact showed that the calcites distinguished according to the CL analysis well grouped with data of stable isotopes of carbon and oxygen. The main difference have the calcites formed in early and shallow burial of diagenesis (Ca-1, Ca-2, Ca-3) and the calcites formed in the burial diagenesis conditions including influence of hydrocarbon migration and products of its oxidation (Ca-4, Ca-5). It was established that the zone of oil-water contact on a structure is non-uniform and there divided three subzones some different with cement sequence according to the CL data. Type of porosity differs in oil-saturated zones and oil water contact. In oil-saturated zones of lower part reservoir prevail intergrain type of porosity (mean value is 14 %). In oil-water contact type of porosity change and percent of porosity grows across section from upper part of oil-water contact (intergrain porosity; mean value is 7v8 %) to lower part of oil-water contact (cavernous porosity; mean value is 23–25 %).

The new data on Early Pennsylvanian deposits in the sections along the Kos'va River

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The mid-Carboniferous glaciation and frequent glacioeustatic oscillations in the Lower Pennsylvanian were mirrored by unstable sedimentation which caused gaps of various duration often marking the stratigraphic boundaries. This results in problems in the recognition of stage boundaries in the Urals. Sharp facies change in the transitional intervals or lack of index species of substages seems to be a consequence of the same factors. Two sections embracing the Bashkirian–Moscovian interval have been recently measured. They are located near the town of Gubakha (Perm Region). The first brief description of the Kremennaya section was published in 1972. Mariinskyi Log section was previously described in the local report only. The lower part of succession is considered as a lower member of the firstly proposed Mariinskyi Formation. It consists of algal and foraminiferal – algal grain – and packstones. A few levels with *Heintzella* corals are characteristic. The layer of tuffitic clay marks the upper boundary of subformation. This subformation is correlated with Kamennogorian and Akavasian RSs. The boundary between substages is determined by the appearance of the *Pseudostaffella antiqua*. The Kamennogorian RS bears transitional Serpukhovian / Bashkirian *Eostaffella postmosquensis acutiformis*, *E. pseudostruvei* only. The renovated fusulinid assemblage appears above the tuffitic clay in the upper subformation of Mariinskyi Fm. The scope of gap between members corresponds to the Askynbashian Substage. The Upper Mariinskyi SFM. is completed by detrital packstone, dolostone and mudstone. It includes species *Profusulinella* ex gr. *primitiva* which is typical for Tashastian RS. The boundary between Tashastian and Asatauian RS. provisionally distinguished by the appearance of *Novella* species. The interval of the Asatauian includes also for the first time found conodonts: *Declinognathodus marginodosus, Idiognathoides ouachitensis, Idiognathodus* sp., *Neognathodus* sp., that does not contradicts the Late Bashkirian age of the deposits. The overlaying Elovka Fm. is determined by increasing of the clastic material input and consists of the intercalation of shales and clayey limestone. The Lower Moscovian boundary is recognized in the Kremennaya section by the appearance of *Aljutovella conspecta* at 9 m above the base of the Elovka Fm. The *Idiognathodus aljutovensis* was also found at this level.

In the Mariinskyi Log section the thin-bedded clayey limestones and clays of the Elovka Fm. overlaps the brecciated limestone of the Mariinskyi Fm. The erosional surface of the top of the yellow massive dolostone is found in the 2 m below and is provisionally correlated with the base of formation. Both the upper part of the Mariinskyi Fm. and the lower part of the Elovka Fm. contain forams of the *Novella genus and conodonts: Idiognathoides ouachitensis, Idiognathodus aljutovensis*, *Neognathodus* cf. *atokaensis*. The conodont assamblage is characteristic for the Late Bashkirian–Early Moscovian. The assemblage of the Kashirian conodonts was found from upper part of the Elovka Fm.

Thus the new data suggests that (1) the Bashkirian Stage along the Kos'va River is incomplete; (2) the change of the carbonate type of sedimentation on carbonate-siliciclastic does not coincide with the lower boundary of the Moscovian, but occurred earlier at the end of Bashkirian.

Composition features of the Permian coals of the Pechora basin

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The Pechora Coal Basin is situated in the northwestern part of the Timan–Pechora oil and gas Province. A total of eight samples were collected in the northwestern part of the basin and analyzed using organic geochemical and organic petrological methods.

The aim of the present study is to interpret the depositional environment of the Permian coals of the Pechora Basin and estimate its generation potential. The recorded TOC (C_{om}) values range from 32.6 to 84 (%) based on this study. HI varies from 150 to 350 mg HC/g TOC and shows modest variations which imply a mixture of kerogen types (IV, III, III/II) of organic matter.

Petrographic studies were carried out to evaluate the evolutionary history of the coals analyzed. The macerals and the lithotypes provide evidence on the nature of the plant community, the intensity and duration of humification, and the depositional environment.

In the studied samples, vitrinite is the dominant maceral group, followed by inertinite and liptinite. These coal samples also contain a considerable amount of mineral matter (5–40 %). Inertodetrinite, fusinite, semifusinite and macrinite are the dominant inertinite macerals (10–45 %) in the analyzed coal samples. Gelinite, vitrodetrinite, telocollinite and telinite are the most common vitrinite macerals (45–90 %) whilst sporinite, liptodetrinite and cutinite are the most common liptinite macerals (5–40 %). Alginite (6–9 %) has been observed in the studied samples, confirming the presence of a limnic depositional setting.

It is known that type II kerogen is composed mainly of liptinite macerals with considerable amounts of vitrinite macerals. On the other hand, type III kerogen is composed mainly of vitrinite macerals with considerable amounts of inertinites. Type IV kerogen often found in the studied coals samples is composed mainly of inertinite macerals. For a long time the question has been asked: can Permian coals that are often interbedded with shales be a source of oil hydrocarbons, or is such coal only recognized as a source of gas?

The studied Permian coals with high liptinite contents (up to 40 %), high chloroform extracts (0.24–1.41 %) and hydrocarbon yields (2–18.5 %) indicate that they have already generated and expelled hydrocarbons. The mean vitrinite reflectance of 0.85–1 % values support that these samples are thermally mature for final hydrocarbon generation. HI values of 200 mg HC/g TOC have been proposed as the minimum values for liquid hydrocarbon expulsion from coals, and the studied coals of the Pechora area often have higher HI. The measured higher hydrogen indices of the analyzed coal samples in this study, ranging from 225 to 350 mg HC/g TOC with considerable amounts of liptinite (e.g., cutinite, sporinite, alginite, resinite, etc.) corresponds to the generation potential both for gaseous and liquid hydrocarbons. The liquid hydrocarbon potential in the studied coals is most likely attributed to the high contents of liptinitic macerals, particularly alginite.

According to some researchers, peat formation in wet conditions is characterized by high TPI and high GI, while peat formed in dry conditions gives a low GI and low TPI. The identified low GI (0.23–90) with low to moderate TPI (0.15–2.3) of the studied coals suggest their origin in intermittently dry forest swamps. However, the higher GI (up to 90) of some of the studied coals suggest their origin in a frequently changing peat-swamp depositional setting, followed by the formation of banded coal in most of the Pechora Basin.

Coals with higher HI have a limited distribution. However the study reveals that the coals from the northwestern part of the Pechora Basin have good quality source potential for liquid hydrocarbon generation, but in small quantities.

Regional stratotype of Global Permian Stages boundaries in Russia

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In regions with different facial and geological development, detailed interregional correlation requires reliable determination of the positions of the ISC stage boundaries beyond the approved stratotype sections. This involves selection and substantiation of regional stratotype sections and points (RSSP) of global stage boundaries in the most complete and well-studied sequences of major geological regions in Russia.

For determining the RSSP, as well as for determining the GSSP, one should use biozonal markers of the orthostratigraphic faunal groups most widely developed in the region, in conjunction with global and regional event-stratigraphic levels and additional paleomagnetic, geochronological and isotopic levels. Tracing of the ISC stage boundaries of the Permian after selected or mutually replaceable markers using all stratigraphic methods in facially different sections provides additional criteria for boundary correlation in a lateral series of facies and in various depositional and paleobiogeographic environments beyond the global stratotype. Selection of RSSP provides a wider use of the ISC and development of a single stratigraphic space.

The stratotype of the lower boundary of the Permian system was ratified in 1998. The GSSP of the lower boundary of the Permian system or Asselian stage was identified in Northern Kazakhstan. The Usolka section, located on the right bank of the Usolka River east of Krasnousolsk, is selected as the Asselian RSSP in Russia. It is proposed to define the Artinskian RSSP in the same section. The Sakmarian RSSP is defined in Kondurovka section, located on the right bank of the Sakmara River, in the southern Urals. The Kungurian RSSP, if it is not accepted at the rank of GSSP, should be the Mechetlino section located on the right bank of the Yuryuzan River, Republic of Bashkortostan. Identification of stage boundaries of the Guadalupian and Lopingian series in Russia, where conodonts are practically absent, is extremely difficult.

The recognition of some boundaries of ISC stages in specific sections of Russia is only possible if global paleomagnetic and isotopic events are used. Utilization of the globally traceable paleomagnetic event of the Kiaman-Illawarra hyperzone succession enables the lower boundary of the Capitanian ISC stage to be defined in the continental facies of the EEP in Monastyrsky ravine sections on the right bank of the Volga River, in the Orenburg Region. The lower boundary of the ISC Lopingian series and Wuchiapingian stage was defined as a result of the identified succession of R2P and N2P magnetozones near the base of the Guadalupian and Lopingian series in America and the base of the Vyatkian stage in northern EEP. A continuous PTB section and the absence of a regional gap on PTB have been proved. The RSSP of the Global PTB can also be established in some sections of the East-European Platform.

New data on the fauna and flora of the Upper Paleozoic deposits in the north of the Siberian Platform (Anabar–Khatanga saddle)

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Since July 2013, OAO Polyarnaya GRE has drilled the core hole AKh-1 at the left bank of the Khatanga Bay within the Anabar–Khatanga petroleum Province.

Within the studied Permian section there is a clearly traced upper part of the Tustakh. Within the siltstone interlayers there are fossil flora prints. V.E. Sivchikov insisted that the stratigraphic position of the assemblage points at the middle part of the Burgukli Horizon in the Cisurals series of the Permian System. Besides, he correlated it with plant remains of the Efremov Formation in the Western Taymyr. As for fauna, at a depth of 972.5 m there are scattered fragments of poorly-preserved arenaceous foraminifera. A.V. Zvereva has defined the non-marine bivalve *Naiadites* cf. *angustus* Bet., which occurs in the Burgukli Formation of the Tunguska Basin.

Above the Tustakh Formation there is a transgressive-regressive age-rank stage with a thickness of 539 m, which is referred to as the Lower Kozhevnikovskaya Formation. Marine fine-grained siltstones correspond to the maximum of the Kungurian transgression. A wide foraminifer assemblage occurs there, represented by the large shells *Hyperammina borealis* Gerke, *Saccammina arctica* Gerke, *Hyperamminoides proteus* Cush. et Wat., *Ammodiscus septentrionalis* Gerke,, *Cornuspira megaspharica* Gerke, *Protonodosaria proceraformis Gerke, Protonodosaria praecursor* Gerke. The assemblage can be correlated with the “arenaceous foraminifera” horizon identified by A.A. Gerke in the Lower Kozhevnikovskaya Formation deposits in the Nordvik Region. The marine bivalve assemblage of *Phestia* cf. *flexuosa* (Lutkevich et Lobanova), *Nuculopsis* vel *Phestia* sp. indet. indicates the Kungurian age of the hosting rocks. The non-marine bivalves there are represented by *Mrassiella magniforma* Rag. There are also pteridophyte spores prevailing over gymnosperms pollen, dominants are spiny spores and cordaite pollen grains. The spectra pertain to the Late Early Permian Epoch.

The Upper Kozhevnikov Formation overlies erosively the Lower Kozhevnikov Formation at the 213th meter. The analyzed part of the formation characterized the maximum of the extensive Kazanian transgression stage. The assemblage defined within the interval includes *Jakutoproductus* sp., *Cancrinella bajkurica* Ustritsky, *Strophalosia* cf. *sibirica* Licharew, *Licharewia* cf. *schrenski* (Keys.) brachiopods, which is typical of the Baikur Formation within the Middle Permian Kazanian Stage. There are also foraminifera characteristic of the Middle Permian deposits of the northeastern Siberian Platform. The study of spore-pollen assemblages revealed that the spectra are characterized by pteridophyte spores prevailing over gymnosperms pollen. Thus, the defined spectra are somewhat similar to the palynocomplexes of the Pelyatka Formation of the Tunguska Basin as well as those of the Upper Kozhevnikovskaya Formation of Nordvik.

Brachiopods of the *Delepinea lebedevi–Ovatia markovskii* Zone in the carbonates of the eastern slope of the South and Middle Urals

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In the Early Viséan, the deposition of marine carbonates in the basins of the eastern slope of the South and Middle Urals occurred in the small, isolated Gusikha and Rezh carbonate platforms. The deposits of the Gusikha Platform crop out in the continuous "Nizhnyaya Gusikha" section (the Nizhnyaya Gusikha River, to the north of the village of Maxim Gorky). Limestones of the Rezh Platform are exposed in a several tectonic blocks in the vicinity of the villages of Pokrovskoe, Mironovo, and Sokharevo. The deposits and fossils of these platforms were studied in the 1960s–1980s by N.P. Malakhova. Z.G. Simonova (Popova), M.V. Postoyalko, L.M. Donakova, I.M. Garan, and the present author. The results of these studies are summarized in the officially adopted stratigraphic scheme of the East Uralian Subregion. According to the this scheme, the Lower Viséan Substage is subdivided into the Obruchevian, Burlian, and Ustgrekhovian horizons containing the *Eoparastaffella simplex – Globoendothyra ukrainica, Eoparastaffella subglobosa – Uralodiscus primaevus,* and *Plectogyranopsis paraconvexa – Uralodiscus rotundus* foraminiferal zones and the *Delepinea lebedevi – Ovatia markovskii* brachiopod zone. Brachiopods are one of the most widespread early Viséan groups. The assemblage of the Obruchevian Horizon is dominated by the index species and small *Composita* sp. The "Nizhnyaya Gusikha" section contains abundant *Delepinea comoides* (Sow.), and the section near the village of Pokrovskoe contains *Actinoconchus adepressiorus* (Ein.). In total, the assemblage of the South Urals includes six species and five genera, while that of the Middle Urals includes five species and five genera. The assemblage of the Burlian Horizon contains most species continuing from the Obruchevian Horizon. The "Nizhnyaya Gusikha" section contains four species and four genera, and shows the first appearance of *Davidsonina* sp. The assemblage of the Rzhev Platform is composed of five species and four genera, but all taxa, except for *Composita* sp., are infrequently found in the section. The assemblage of the Ustgrekhovian Horizon is similar to that of the Burlian Horizon, but is much more diverse (12 species and 11 genera in the Middle Urals, and 9 species and 9 genera in the South Urals). *Ovatia markovskii* and *Composita* continue being dominant, while *Delepinea lebedevi* (Middle Urals) and *Delepinea comoides* (South Urals) are common. Isolated *Schizophoria resupinata* (Mart.), *Schuchertella fascifera* (Tornq.), *Schellwienella crenistria* (Phill.), *Avonia* sp., *Echinoconchus punctatus* (Sow.), *Unispirifer* aff. *smirnovi* (Gar.) appear in the Middle Urals, while *Eumetria* sp., *Bruntonathyris tomiensis* (Besn.), and *Linoprotonia probus* (Rot.) appear in the South Urals, increasing the diversity of the assemblage. The brachiopod associations found in the Early Viséan in the Rzhev and Gusikha carbonate platforms, which were located at a considerable distance from one another, are characterized by a low taxonomic diversity, and similar assemblages to the synchronous horizons.

Taxonomic composition of the Upper Visean and Serpukhovian foraminifers of the Verkhnaya Kardailovka section, South Urals, Russia

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Changes in the taxonomic composition of foraminifers in the condensed carbonate part of the section in the interval of the *Lochriea mononodosa, L. nodosa, L. ziegleri, Gn. bollandensis* conodont zones and transitional beds to the *Declinognathodus noduliferus* zone are discussed. The distribution of foraminifers and their taxonomic diversity to a large extent depend on the facies. The total thickness of the marked part of the section is 57 m. An assemblage of the *Paraarchaediscus koktjubensis* Zone in association with conodonts of the *Gnathodus texanus* Zone is found at the base of the marked section (0-2 m). No foraminifers are found in the interval 2-17.3 m in the tuffaceous siltstone and mudstone. The impoverished *Mediocris-Endostaffella* biofacies appears from 17.3 m and is recognized at the levels of microbioclastic packstone and wackestones (*L. mononodosa, L. nodosa* zones). The assemblages studied have characteristically small-sized foraminifers and are dominated by eurifacial, stratigraphically widespread species. The assemblage is represented by 17 species of two-chambered long-ranging foraminifers (known beginning from the late Devonian) and continuing the entire early Carboniferous: *Eotuberitina, Bituberitina, Earlandia*; of the order Archaediscida: *Pseudoammodiscus, Paraarchaediscus, Archaediscus*, *Asteroarchaediscus, Neoarchaediscus, Howchinia;* of the order Endothyrida, families Endostaffellidae – *Endostaffella, Mediocris* and Endothyridae – *Endothyra, Rectoendothyra, Planoendothyra, Omphalotis;* occasional Haplophragmellidae. In the overlying horizon (interval 19.65 – 20 m, *L. ziegler*i zone), composed mainly of mudstones and wackestones, the number of foraminifers and their diversity depleted. Only *Earlandia* spp. and *Monotaxinoides* sp. are identified at this level. An impoverished euryfacial assemblage similar to the assemblage with *E. asymmetrica*, with several additional species of Archaediscida – *Eolasiodiscus muradymicus* (21-22 m), *Neoarchaediscus postrugosus* (33 m) are traced in the section. From the level of the appearance of grainstones (36.8 m, *Gn. bollandensis* Zone), the assemblage becomes more diverse. The number of species of foraminifers increases up to 40 because of the increased diversity of Endothyridae, Eostaffellidae, Archaediscida, and the appearance of the superfamily Tetrataxoidea and the order Palaeotextulariida. This is an increase in foraminiferal diversity, as the composition shows species re-appearing after the Viséan. Of species that appeared in the Serpukhovian Stage, *Janischewskina* sp., a few species of *Eostaffellina* and *Biseriella* are worth mentioning. The most diverse specific composition of the foraminiferal assemblages is associated with the Upper Serpukhovian bryozoan-crinoid limestones with ammonoids of the upper part of the *Fayettevillea-Delepinoceras* Genozone. The number of species increased to 50. The new species of the genus *Monotaxinoides* first appeared at this level.

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Bashkirian bioherms along the Khudolaz River near Sibai, eastern slope of the South Urals, Russia

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Several mound-shaped Bashkirian bioherms are exposed in a structurally complex fault sheet along the Khudolaz River southeast of Sibai and nearby village of Kalinino. The mounds lie within the Syuranian regional substage and extend southward along the east bank of the Khudolaz River from the large quarry in upper Visean to upper Serpukhovian limestone at Kalinino to the village of Novo-Pokrovka. Because of structural complications and characteristics of the present-day erosion surfaces, the bioherms are not exposed as three-dimensional convex-up buildups. Instead, only the core facies of most bioherms are well exposed across the undulatory two-dimensional low-relief erosion surfaces characteristic of the region but some gully exposures show flanking facies and contacts with the foundation and capping deposits. The mounds are recognizable as bioherms by their very thick bedded thrombolitic internal fabric and by presence of syndepositional submarine cements. Immediately south of the Kalinino quarry, the biohermal lithofacies are well displayed along the steep north side of the Solyonyi Gully at its confluence with the Khudolaz River. The mound exposed in the gully is large and elongate parallel to the depositional strike, extending southward for about 1 km along the east bank of the Khudolaz River but the mounds to the south appear to be somewhat smaller. Along the Solyonyi Gully, which runs perpendicular to the depositional strike of the large northern bioherm, and along another gully, the thrombolitic deposits locally display brachiopods, tabulate corals, and cephalopods. More than 10 brachiopod species occur but the genus *Phricodothyris* prevails with up to 50 shells collected at some localities. Beds and lenses of lime grainstone are locally present in the bioherms and commonly contain the encrusting foraminifer *Tolypammina* sp., and the eostaffellid genera *Eostaffella* and *Semistaffella*, and archaediscids. The foraminifers date the buildups to the Syuranian regional substage of the Bashkirian Stage. Bioherms resembling those along the Khudolaz occur to the northeast along the Bolshoi Kizil River but are of Akavassian (Bashkirian) age. Early Bashkirian reefs on the eastern slope of the South Urals record widespread reef development before the Uralian orogeny.

Isotope geochemistry ($\delta^{13}C$, $\delta^{18}O$), lithology and origin of carbonate deposits of the Bashkirian Stage of the southwestern Urals (Askyn River, Bashkortostan)

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Significant global geological, paleoclimatic and biotic events occurred at the Carboniferous. That led to changes in the conditions of sedimentation and manifested in the lithological features of sedimentary rocks as well carbon and oxygen isotopic composition of carbonates. The $\delta^{13}C$ and $\delta^{18}O$ values in the Carboniferous rocks show considerable variation. The most important of these is a positive trend in the $\delta^{13}C$ values at the Mississippian–Pennsylvanian transition. This trend observed in the deposits of North America, Europe, China and others. Positive $\delta^{13}C$ and $\delta^{18}O$ excurse of carbonates in the basins of western and eastern Laurasia, Gondwana and Paleotethys were correlated with Carboniferous glaciation, decrease of sea level, drawdown of atmospheric CO_2, mass extinction and global increase in organic carbon burial. Positive isotope shift on the Mississippian–Pennsylvanian boundary is also observed in the sediments of Russian Platform.

Continuous sections of carbonate rocks of different intervals of the Devonian and Carboniferous situated on the western slope of the Southern Urals (Bashkortostan). We studied the most complete section of sediments from the Serpukhovian Stage of the Lower Carboniferous (C_1s) to the Bashkirian and Moscovian stages of the Upper Carboniferous (C_2m), along the Askyn River (left tributary of the Inzer River). The sequence in that location is parastratotype for the Bashkirian Stage of the Southern Urals (south-western part of the mid-upper-paleozoic Ural paleo ocean) and consist of interstratification limestones of different lithological types: micro grained (micritic-microbial; L_1), detrital (L_2), biomorphic (L_3), oolitic (L_4) and their transitional varieties. Dolomites (D) present also.

The $\delta^{13}C$ and $\delta^{18}O$ values in the studied carbonate rocks vary over a wide range: from -3.0 to 4.1 ‰ (PDB) and from -24.7 to 30.0 ‰ (SMOW), accordingly. They are distributed irregularly in the sequence, with numerous negative and positive excursions. In the lower layers of the Pennsylvanian (at the boundary of layers 6 and 7), there is a positive shift $\delta^{13}C$ (from -3.0 to 2.1 ‰) and $\delta^{18}O$ (from 24.8 to 30.0 ‰). Isotope excursion coincides with the global events: glaciation of Gondwana, decrease of sea-levels and mass extinction of biota.

The C_2b–C_2m carbonate rocks were formed in shallow-marine environments. Small-scale C- and O-isotope variations in the sequence of the Bashkirian and the Moscowian Stages due apparently, regional and local factors: climatic (temperature) changes, biological productivity of basin, desalination of sea water, transgressions and regressions. Negative $\delta^{13}C$ excursions show an increase of the role of oxidized organic carbon, and positive – increased bio-productivity and burial C_{org}. The $\delta^{18}O$ variations reflect periods of humid climate, desalination and ingressions of marine waters.

In general, there is not a distinct dependence of the $\delta^{13}C$ and $\delta^{18}O$ from the lithological type-rock. But, politaxonic and biomorphic detrital limestones of the Upper Bashkirian Substage characterized by more positive isotope values.

Crinoid diversity in the Carboniferous of Transbaikalia

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Crinoids of Eastern Transbaikalia are among the most important components of the Carboniferous marine biota. The remains of their stems are very widely used for local biostratigraphy. The systematic composition of the Carboniferous crinoid stems of Transbaikalia constitutes 50 species from 23 genera. The first Carboniferous species appeared in the Famennian. A sharp renewal of the taxonomic composition of the crinoid faunas is associated with this time. The Kotikha Horizon contains the Platycrinites? subtuberosus Biozone, which is transitional from the Devonian to the Carboniferous and yields massive collections in Transbaikalia. The crinoid assemblage has a mixed composition and is represented by the co-occurrence of Devonian and Carboniferous species. Most of the typical Devonian genera disappeared. Genera widely distributed in the Lower Carboniferous occur for the first time. Representatives of the family Platycrinidae are characteristic of the Carboniferous deposits of many Russian regions: Platycrinites? subtuberosus Stukalina, Pl.? donicus Kurilenko, Pl.? gazimuricus Kurilenko among others are most widespread. Besides Platycrinidae the typical assemblage is composed of Carboniferous genera: Bicostulatocrinus, Pentaridica, Floricyclus and Ungulicrinus. Devonian crinoids are represented by Anthinocrinus, Asperocrinus and Amurocrinus. Sections containing this Biozone are characterized by the Upper Famennian bryozoan fauna and brachiopods of the Sphenospira julii – Spinocarinifera nigra Zone. In the territory of the Mongol – Okhotsk fold belt a gradual transition from Devonian to Carboniferous sediments was defined

Permian ammonoids of the Okhotsk Region, Northeast Asia

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In the Permian of the Okhotsk Region it is now possible to allocate three ammonoid levels: *Tenkensis* beds, *Paragastrioceras–Baraioceras* beds, *Harkeri* beds.

The oldest ammonoid level in the Okhotsk Region is known in the lower part of the Upper Rodionovoi Subformation in the Ayan-Yuryakh zone. This level includes *Neopronorites tenkensis* Kutygin which is characterized by morphological features intermediate between *N. skvorzovi* (Tchernow) and *N. permicus* (Tchernow). Taking into account the stages of migration of ammonoids from the Ural Basin in the Verkhoyansk-Okhotsk seas, the occurrence of *N. tenkensis* in the Ayan-Yuryakh zone is related to the formation of the Mysovsky ammonoid association, which is characteristic of the upper part of the Echijan Horizon of the Verkhoyansk Region, corresponding to the Upper Artinskian.

The second level is represented by Kungurian goniatites of the terminal phylogenetic line of the Paragastrioceratidae. The *Paragastrioceras–Baraioceras* beds allocated in the Nonkichan Formation of the Niutian zone and characterized by *Baraioceras subwandageense* (Popow) and *Paragastrioceras* sp. nov. (="*Paragastrioceras jossae jossae"* Popow non (Verneuil)). *Baraioceras subwandageense* is morphologically very similar to the Kungurian species *Baraioceras stepanovi* Andrianov from the Tumarian Regional Horizon of the Western Verkhoyansk Region. *Paragastrioceras* sp. nov. is a transitional species between late representatives of *Paragastrioceras (P. kungurense)* and *Baraioceras subwandageense.* We have attributed the *Paragastrioceras–Baraioceras* beds to the middle ("pre-Ufimian") part of the Kungurian.

The third ammonoid level is selected at the upper part of the Middle Beglyi Subformation of the Khuren zone and at the Lower Pionerskii Subformation of the Ayan-Yuryakh zone. At this level *Sverdrupites harkeri* (Ruzhencev) and *Pseudosverdrupites budnikovi* Kutygin are found, which are associated with the Roadian of the Middle Permian. These species are the main elements of the ammonoid association of the *Harkeri* zone, which is allocated in the lower part of the Delenzhian Horizon of the Verkhoyansk Region and in the Russko-Omolonian Horizon of the Omolon Region.

Type section of the Sakmarian–Artinskian boundary in the Verkhoyansk Region

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The Sakmarian–Artinskian boundary in the Verkhoyansk Region is located within the Echian Horizon. The lower part of the Echian Horizon is composed mainly of clay deposits, formed during a major transgression. Biotic crisis in development of invertebrates is associated with a maximum of this transgression (Late Sakmarian–Early Artinskian). Representatives of ammonoids *Andrianovia* disappeared and areas of brachiopods *Jakutoproductus* were significantly reduced at that time. A little earlier, first bivalves of *Aphanaia* genus appeared in the Verkhoyansk Regions. Extensive Arkachanian ammonoid association at the base of the Artinskian was replaced by Endybalian association, which was taxonomically depleted and spread very locally. Type section with the Sakmarian–Artinskian boundary is in the Kuranakh subzone of the Western Verkhoyansk Region (the upper reaches of the Tumara River, mouth of the Dielenzha River). The boundary between the Khorokytian and Echian Formations with a total thickness of more than 480 m are opened here. Asselian-Early Sakmarian invertebrates is found in shallow marine siltstones of the Khorokytian Formation, represented by brachiopods *Jakutoproductus* ex gr. *verkhoyanicus*, *J.* cf. *crassus* and bivalves *Astartella permocarbonica*. This invertebrate association is typical for the *Verkhoyanicus* zone and *Mezhvilki* beds of the Khorokytian Horizon. The base of the Echian Formation contains shell rocks with brachiopods *Jakutoproductus insignis*, which characterize brachiopod zone of the same name and the *Subsimense* beds of the Upper Sakmarian. Goniatite *Uraloceras omolonense* are found at the level of 93 m above the base of the Echian Formation at the 3-meter interbed of medium-grained sandstone found, being the basic element of the Ogonerian association in the Omolon region, that characterizes the upper part of the Ogonerian Horizon. Together with goniatite in this interbed, *Aphanaia kletzi* Biakov also was found, which is the oldest species of the *Inoceramus*-like bivalves in Northeast Asia. At 121 m above the base of the Echian Formation, brachiopods *Jakutoproductus* aff. *terechovi* occur, which apparently characterize the *Terechovi* zone. Early Artinskian invertebrate association was found in the 10-30 cm interbed of calcareous sandstone, 150 m above the base of the Echian Formation, being the basis of the Member IV. *Neoshumardites triceps hyperboreus*, *Uraloproductus stuckenbergianus*, *Overtonia cristato-tuberkulata*, *Camerisma* aff. *pentameroides*, *Schrenkiella* sp. nov., *Spirelytha magna*, *Tiramnia yakutica*, *Anidathus* cf. burgaliensis, *Rhynoleichus* aff. *etschiensis*, *Kolymopecten* cf. *mutabilis, Hyperamminoides proteus, Hyperammina borealis, Nodosaria incelebrata* and other invertebrates are found at this level. From the above it follows that in the section of the Lower Permian mouth of the Dielendzha River Sakmarian–Artinskian boundary is fixed by goniatite genus *Neoshumardites* and it coincides with the boundary of Members III and IV, located at the level of 146 m above the base of the Echian Formation. This is the only section in the Verkhoyansk Region, where the discussed boundary on ammonoids is clearly established.

Biostratigraphic subdivision of the Lower–Middle Permian of the Kolyma–Omolon Region based on ammonoids

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In the Lower–Middle Permian of the Kolyma-Omolon Region, four ammonoid associations are identified: Kyrian, Ogonerian, Dzhigdalinian and Omolonian. The most ancient is the Kyrian association, which is found in the lower part of the Ogoniorian Horizon. The constituent elements of this association are *Kolymoglaphyrites lazarevi* and *Uraloceras margaritae*. Such *lazarevi* beds found in the Kyrian association correlated with the *mezhvilki* beds of the Verkhoyansk Region, and correspond to the lower part of the Sakmarian. Ammonoids of the Ogonerian association in which *Uraloceras omolonense* dominate are found in the upper part of the Ogonerian Horizon. To determine the Pre-*triceps* age of this association, finds of *Neoshumardites munugudzhensis* and *N. nassichuki* are important. In the Ogonerian association there is also a goniatite with a bisinusoidal transverse ornamentation – *Bulunites gracilis*. The *Omolonense* beds are correlated with the same biostratigraphic unit of the Verkhoyansk Region and relate to the uppermost part of the Sakmarian. Above these beds lies the Koargychanian Horizon of the Artinskian in which no ammonoids have been found. The range of the Vodopadnyan subassociation of the Dzhigdalinian ammonoid association extended into the lower part of the Khalalinian Horizon: this includes *Tumaroceras? kashirzevi*, *T.?* sp. nov., *Paragastrioceras* sp. nov. and *Neouddenites* aff. *caurus*. The *Kashirzevi* beds in the Kolyma–Omolon and Verkhoyansk Regions are isochronous and are referred to the lower part of the Kungurian. Ammonoids were collected in the middle part of the Khalalinian Horizon of the Zyrianka River Basin which were described by V.N. Andrianov as *Epijuresanites musalitini* and *E. kolymaensis*. We include these goniatites in the Ozernyan subassociation of the Dzhigdalinian association of the middle part of the Kungurian. The species *E. musalitini* is known in the Tumarinian Horizon of the Verkhoyansk Region, where the *Musalitini* beds, that overlap the *Kashirzevi* beds, are described. In the upper part of the Khalalinian Horizon in the Kolyma-Omolon Region, as in the upper part of the Tumarian Horizon in the Verkhoyansk Region, no ammonoids are known. The Omolonian ammonoid association is established in the Russko-Omolonian Horizon, and is the most widespread. This association includes *Sverdrupites harkeri*, *Pseudosverdrupites budnikovi, Anuites kosynskyi* and characterizes the *Harkeri* beds of the Roadian. Similar ammonoid beds are distinguished in the lower part of the Delenzhinian Horizon in the Verkhoyansk Region. A find of *Sverdrupites amundseni* in the Middle Permian of the Western Koryak is also of interest. In the Western Verkhoyansk Region this species is known above the *S. harkeri* level. The review indicates that the lowermost Permian ammonoid associations in the Kolyma–Omolon and Verkhoyansk regions are discrete. A hiatus is observed in the Artinskian of the Kolyma–Omolon Region. After the Kashirzevi (lower part of the Kungurian) beds, the Verkhoyansk and Kolyma–Omolon ammonoid scales become identical.

Magnetic and chemical studies of Permian sections in the Volga Region

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This paper presents the results of the study of an internationally important site: the section of the Permian System's Urzhumian Stage in the "Cheremushka" gorge. The outcrop is located on the right bank of the Volga River (about 10 km west of Kazan). It has local, regional and planetary correlation features and also evidence of different geographical scale events

The main objective of the research is the deep study of sediments using magnetic and chemical investigations. Measurements of magnetic susceptibility were made for 600 samples on MS2 Bartington. On the basis of the data obtained, samples were identified for study on the coercive spectrometer (CS) and for differential thermomagnetic analysis (DTMA). CS and DTMA were used to identifying magnetic minerals, which can be presented by terrestrial (authigenic and allogenic minerals, volcanic ash etc.) and extraterrestrial matter. The presence of cosmic and volcanic dust is a sign indicator for determination of the age of sediments and the sedimentation rate. The XRF spectrometer was used for chemical investigations of samples. Chemistry of carbonates and clastic rocks includes the analysis of chemical elements, compounds, and petrochemical (lithogeochemical) modules for the interpretation of the genesis of the lithotypes. For the review of the geochemistry of stable isotopes of carbon (oxygen) we used IRMS. The main objective was to determine the nature of the isotope fractionation issues, to address issues of stratigraphy and paleogeography.

The measurements have shown the variability of both parameters (magnetic and chemical) in the section. It gives us opportunity to see small changes in sedimentation and recognize the factors that influence to the process.

Late Permian invertebrate ichnoassemblages from the uppermost part of the Ikakern Formation of the Argana Basin (Western High Atlas, Morocco)

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During recent years, Morocco is becoming a more and more important place for vertebrate and invertebrate ichnology by the discovery of numerous Late Paleozoic and Early Mesozoic footprint assemblages in continental red-beds. The findings come from uppermost part of the up to 1800 m thick red-bed Ikakern Formation (Tourbihine Member, T2). The Tourbihine Member consists of a variety of clastic sedimentary rocks ranging from conglomerates to mudstones, which are arranged in cycles of 5–20 m thickness. Each cycle consists of thin lenticular to wedge shaped conglomerates or conglomeratic sandstones grading laterally and vertically into thick tabular sandstones, siltstones, and mudstones. Coarser units decrease in abundance and thickness towards the top of the succession suggesting a tendency of equiplanation of the local relief.

The Tourbihine Member (T2) yielded diverse invertebrate traces, including the ichnogenra Arenicolites, Paleohelcura, *Spongeliomorpha*, *Striatichnium* and Scoyenia, which co-occur with tetrapod footprints assigned to the ichnogenra *Bratchichnus-Limnopus* and *Dimetropus, Hyloidichnus.* We note the first description of a new ichnotaxon *Paleohelcura ichnosp. nov.* and the first occurrence of the ichnogenus *Dimetropus* in the Argana Basin. The red-bed cycles of the Tourbihine Member are interpreted as channel and floodplain deposits of low and high sinuosity meandering streams. Rarity of mudcracks in the Tourbihine Member probably indicating that overbank areas were frequently water-saturated or shallowly inundated with water. Due to their abundance, diversity, and excellent preservation in the Moroccan red-beds ichnofossils seem to be of particular interest for understanding the Late Palaeozoic to Early Mesozoic terrestrial ecosystems.

Kasimov Quarry – the key section of the Moscovian–Kasimovian transition in the east of the Moscow Basin

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New criteria for definition of stage boundaries in the International Stratigraphic Scale require detailed study of the boundary deposits in the various regions. The proposal to define the Kasimovian boundary by the FAD of *Idiognathodus sagittalis* and its probable future confirmation will lead to substantial changes in the regional stratigraphy. It will lead to re-assignment of some traditional Kasimovian units. The traditional boundary at the base of the *Streptognathodus subexcelsus* Zone coincides with a regional inconformity. It is outcropped in the neostratotypes of the Myachkovian Substage and the Kasimovian Stage – Domodedovo and Afanasievo sections respectively, and the section studied.

The Kasimov quarry (Oka–Tsna swell) is located on the left bank of the Oka River 8 km upstream of the town of Kasimov. The section comprises rhythmic alternation of carbonate deposits and clay. Lots of paleokarst and erosion surfaces mark formation boundaries. The Kasimov quarry section embraces the upper part of the Korobcheevo Fm., Domodedovo Fm., and Peski Fm. of the Moscovian and Suvorovo and Voskresensk fms. of the Lower Kasimovian in its traditional range. The fusulinid and conodont occurrences allow recognition of the typical faunal assemblages comparable with those from the Domodedovo and Afanasievo sections of the Moscow Basin.

The upper part of Korobcheevo Fm. is represented by fusulinid grain and packstones and is characterized by the abundant fusulinids *Ozawainella mosquensis, Fusulina rauserae, Fusulinella bocki, and* the conodonts *Neognathodus inaequalis*, *Idiognathodus* ex gr. *delicatus* and the rugose coral *Bothrophyllum conicum conicum.*

The boundary of the Domodedovo Fm. is marked by the appearance of the new transgressive cycle mirrored in the deposition of coarse grainstone with wavy interbedded surfaces. The first appearance of *Neognathodus roundyi* is in the lower part of the Domodedovo Fm. The interval of occurrence combines by intercalation of the green clay and fusulinids-crinoid grain-packstones containing small fragments of *Tubiphytes*. Many *Bothrophyllum* solitary rugose corals occurred at the base of limestone in this interval. The most characteristic is *B. robusta*. The fusulinid assemblage includes *Fusulina* ex gr. *cylindrica*, *Fusulinella bocki*, *Bradyina* cf. *pseudonautiliformis*, *Ozawainella angulata,* etc.

The overlaying Peski Fm. is separated by unconformity. The following Suvorovo Fm., earlier considered as Kasimovian, begins with basal carbonate breccia bearing clay lenses. Clay contains abundant ostracods and pebbles of underlying limestone. The FAD of *Streptognathodus subexcelsus* is typically at the base of the formation. The limestone contains *Ozawainella nikitowkensis, Fusulinella* ex gr. *myachkovensis.* The overlaying Voskresensk Fm. is represented by red and green clay and bears *Swadelina makhlinae* 2 m above the base, and the first *Protriticites* sp. in the uppermost outcropped part of the formation.

Recent advances on the study of Chinese Permian tetrapod faunas

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Permian tetrapod fossils are widely distributed and have long been used to correlate continental deposits. Previously the Chinese record of Permian tetrapod fossils is much less extensive than that of Russian and South Africa. Recent works have greatly increased the diversity of tetrapod of this period in China and provided better correlation with the faunas from other region.

The Dashankou fauna is the most important discovery. It is dominated by therapsids such as *Sinophoneus yumenensis, Biseridens qilianicus* and *Raranimus dashankouensis,* it also includes *Anakarnacops petrolicus* (Temnospondyli); *Ingentidens corridoricus* and *Phratochronis qilianensis* (Anthracosauria); *Belebey chengi* and *Gansurhinus qingtoushanensis* (Captorhinomorpha). It also includes undescribed dissophoid. It is one of the oldest therapsid fauna and can be correlated to the *Parabradysaurus silantjevi* Assemblage Zone of Russia and the *Eodicynodon* Assemblage Zone of South Africa.

The Jiyuan fauna is dominated by the pareiasaur *Honania complicidentata* and comprises three chroniosuchian species, one cynodont species and possibly one gorgonopsian. It is roughly correlated to the *Proelginia permiana* Assemblage Zone of Russia and the *Cistecephalus* Assemblage Zone of South Africa. It also produced the youngest diadectomorph *Alveusdectes fenestralis*, which is approximately 16 my younger than any other diadectomorph.

The Daqingshan fauna was discovered from the Naobaogou Formation in 1980s, only two species were formally known: *Daqinshanodon limbus* (Dicynodontia) and *Gansurhinus qingtoushanensis* (Captorhinomorpha). Two burrows were collected from this formation and they could be produced by the dicynodont slightly smaller than *Lystrosaurus*. Recent work shows this fauna includes at least two parareptile species, one captorhinomorph species, three therocephalian species, and four dicynodont species. The dicynodonts can be referred to Cryptodontia or Dicynontidea. Based on the therapsid fossils, this fauna should be no older than *Tropistoma* Assemblage Zone of South Africa, much younger than the age indicated by *Gansurhinus.* More work is needed to establish the correlation of this fauna.

Short-time palaeoenvironmental impact on the *in-situ* vegetation of an early Permian forest ecosystem (Chemnitz, SE-Germany)

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Palaeoenvironmental studies on ancient terrestrial ecosystems make a large contribution to our understanding on the evolution of individual habitats in the Earth history. The fossil forest of Chemnitz (Leukersdorf Formation, Chemnitz Basin) represents a unique early Permian (Sakmarian) forest ecosystem that was buried instantaneously by pyroclastic deposits of an explosive volcanic event, 291 Ma ago. Recently, it was proofed to be a three-dimensionally preserved T^0 assemblage consisting of mainly arboreal plants, silicified and still rooting at their places of growth. Diverse animals such as reptiles, amphibians, arthropods and gastropods complement the fossil record of the ancient living community. Although an equator-near palaeogeographic position is assumed, sedimentological and geochemical studies on the palaeosol provide evidence for a seasonal, semi-humid climate with an estimated palaeoprecipitation in a range of 800–1,100 mm/a. Promoted by site-specific hydrologic conditions, indicated by a near-surface groundwater calcrete, the diverse plant community of mainly hygrophilous elements developed on a mineral substrate of alluvial red beds. Seasonal fluctuations affected growth of long-lived woody plants like calamitaleans and cordaitaleans, which is recorded in rhythmic growth ring-like tissue density variations in the secondary xylem. Characterised by a gradual decrease of cell size and an increase of cell wall thickness these so called “false rings” are most probably the result of seasonal droughts. In addition, distinct event zones show severe damage on the trees caused by phases of particular environmental stress. Our data suggest diverse short-time environmental perturbations and offers for the first time the possibility to assess the fourth dimension in an early Permian *in-situ* forest ecosystem. Once established as a correlation tool between single plants or plant groups of the habitat, growth ring analysis can provide information on plant synecology, age-composition, structure and development of the former forest.

Biostratigraphy and brachiopods of the Carboniferous–Permian boundary deposits of the Kubalakh section (lower reaches of the Lena River)

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The Upper Paleozoic deposits of the lower reaches of the Lena River have previously been studied by A.A. Mezhvilk, A.S. Kashirzew, R.V. Solomina, M.D. Bulgakova, O.I. Bogush, O.V. Yuferev, V.N. Andrianov, B.S. Abramov and others. However, the conclusions of these researchers have serious contradictions concerning stratigraphic division of the Upper Paleozoic deposits and definition of the boundary between the Carboniferous and Permian.

The boundary between Carboniferous and Permian deposits in the lower reaches of the Lena River is represented by the Kubalakh and Tuora-Sis Formations, which are still not biostratigraphically divided. In 2010, we studied the type section of the Kubalakh and Tuora-Sis Formations (Kubalakh section). During the study, extensive paleontological material was collected. The studied formations are composed of interbedded siltstones and sandstones. The Lower Kubalakh Subformation is poor in fossils. In the Middle Kubalakh Subformation, a succession of species of the genus *Jakutoproductus* is identified. In the subformation, *J.* aff. *monstrosus*, previously known only in the Kolyma–Omolon Region, is found for the first time in the Northern Verkhoyansk Region, as well as the new *Jakutoproductus* sp. nov. According to our research, the Lower and Medium Kubalakh Subformations belong to the Upper Carboniferous. The boundary of the Middle and Upper Kubalakh Subformations is hidden by the mouth of Kubalakh Creek. The Carboniferous–Permian boundary is similarly unexposed.

The brachiopods *Jakutoproductus crassus* and *J. verkhoyanicus* are found in the Upper Kubalakh Subformation, characterizing the lower part of the *Verkhoyanicus* zone and belonging to the Asselian. The brachiopod *J. verkhoyanicus* and ammonoid *Bulunites mezhvilki* are found in the lower part of the Tuora-Sis Formation; they are typical of the *Verkhoyanicus* zone and *Mezhvilki* beds of the Khorokytian Regional Horizon (Upper Asselian?–Lower Sakmarian). At this level, a new species of the *Jakutoproductus lenensis* Makoshin group is identified, which we also found in the Orulgan Ridge and the Western Verkhoyansk Region. The ammonoid *Uraloceras subsimense* and the brachiopods *Jakutoproductus insignis* are found in the middle part of the Tuora-Sis Formation, characterizing the lower part of the Echian Horizon (Upper Sakmarian, *Subsimense* and *Insignis* beds). The species *J. terechovi* is identified at the top of the Tuora-Sis Formation, which we found earlier in the Echian Horizon of the Western Verkhoyansk Region above the *Insignis* beds. A dorsal valve of *J.* cf. *rugosus* and the bivalves *Pyramus* aff. *nelliae* and *Phestia* aff. *undosa* are found in the uppermost part of the Tuora-Sis Formation. The Tuora-Sis Formation is overlapped by the sandstone of the lower part of the Sakhaian Formation (Artinskian), where the bivalve *Aphanaia* sp. is found.

The Lower Carboniferous phosphorites in the Moscow Basin

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The phosphorites studied belong to the Tulian Horizon of the Viséan (Lower Carboniferous or Middle Mississippian) and were found in the Bogoroditsk quarry. The Tulian Horizon is one of the most complex in structure, since it is composed of various facies and due to the different nature of the lower and upper parts of the stratification.

In the stratotype sections (near Tula), this horizon is composed of alternating layers of clay and limestone with marine fauna, with subordinate interbedded sands, silts, and coals. The lower alluvial-coal-bearing part of the section has an erosional contact with the underlying deposits, and lies mainly in the paleovalleys, being absent in the inter-valley spaces. The upper part is represented mainly by marine formations (lagoons and shallow-marine silt, clay and limestone) and lies transgressively on a relatively level surface after filling the paleovalleys. Phosphorite nodules occur in the clay bed of the Bogoroditskaya Formation. Dark grey-green calcareous clay up to 2.5 m thick, which contains remains of brachiopods, bryozoans, bivalves and plants, as well as concretions of siderite (5–10 cm) and phosphorite (1–3 cm), overlies the light gray and finely detrital limestone with many fossils, up to 1.8 m thick. The phosphorite concretions are black, sometimes glossy and very dense, covered with a light gray crust, mostly elongated elliptical or pear-shaped, less commonly spherical and rarely larger than 3 cm, with a content of P_20_5 up to 29.21 %. The depositional environments of phosphorite sediments are very similar to those of the Jurassic: sandy sediments of deltas transgressively replaced up the section by sand and clay deposits of brackish lagoons, bays, and finally, shallow marine clays containing phosphorites with interbedded limestones. Similar phosphorites were found in the Culm Basin (Tournaisian to Viséan) of the Holy Cross (Poland), Moravia (Czech Republic) and Rhenish Mountains (Germany).

Sequence Stratigraphy as a tool for paleogeographic reconstructions of the Permian in the south of the Barents Sea

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The Permian deposits are widely spread over the Eastern European Platform and proved to be productive in the Pechora oil and gas basin and its offshore continuation. Several oil and gas fields were discovered in the Asselian-Sakmarian carbonate and Upper Permian siliciclastic reservoirs. Very strong heterogeneity of Permian deposits and significant changes in Permian Stratigraphic scale were the reason for application of Sequence Stratigraphy as an additional criterion for correlation and environmental reconstructions.The current study was based on 2D–3D seismic and well data in offshore and adjacent onshore areas. 13 wells with minor coring penetrate Permian deposits within considered offshore area. As a result of the study three complex sequences and their bounding surfaces have been defined in the offshore part: the Asselian–Artiscian (Lower Artiscian?), Kungurian (including former Ufimian) and Mid-Upper Permian (former Kazanian–Tatarian). The base of the Permian characterized by relatively conformable boundary with minor zones of hiatus or subaeral erosion (within onshore area) is regarded as third order sequence boundary. Asselian-Sakmarian deposits composed of warm water carbonates are referred to as lowstand (LST) and transgressive (TST) system tracts. They embrace the sections of three depositional types: bioherms; relatively condensed shaly carbonates and slope carbonate turbidites. Within the Barents Sea seismically identified anomalies of “reef” type and interpreted as isolated carbonate platforms that rim shelf edge, and patch-reefs and pinnacles confined to different structural zones of inner shelf. The top of the Asselian-Sakmarian is expressed as downlap maximum flooding surface. It marks depositional and climatic changes to Artiscian cold water siliciclastics, carbonates and spiculites as well as landward shift of deep water facies and shelf edge. The Artiscian is regarded as highstand system tract (HST). The top of the Artiscian is also characterized as downlapping surface and is interpreted as maximum flooding surface coinciding with sequence boundary. The Kungurian to Upper Permian terrigenous succession is represented by series of prograding clinoforms composed of coarsening and shallowing upward units. It could be subdivided into two complex sequences with very clear seismically identified sequence boundary between them. It is confined approximately to the base of Mid-Permian interval (the top of former Ufimian Stage). Sigmoid clinoforms in the landward parts display subparralel high amplitude reflectors, interpreted as interbedding of sandy and shaly beds with coals in the uppermost part. 3D data as well as log and core data reveal gradual change from distal offshore facies to nearshore bar-delta complex and coastal plain non-marine deposits. The top of the Permian is characterized by strong erosional truncation that suggests from about tens to about 800 m of erosion within offshore and even more onshore areas. As a whole application of Sequence Stratigraphy for the study of the Permian provided regional paleogeographic reconstructions in time and space indicating positions of shelf edges, shore lines, slopes and most favorable locations of reservoirs.

Biogeography of the Permian marine basins of Mongolia

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During the Permian, there were two different marine basins in Mongolia: the epicontinental Khangai-Khentei Basin (Boreal) in the north-eastern and central parts of the country and the South-Mongolian Basin (Tethyan) in the south-east. The benthic fauna of both basins includes brachiopods, bryozoans, and bivalves. The South-Mongolian Basin was part of the Ussurian Province of the northern Tethys margin, near the Siberian (or Angarida) and Katasian plates. A characteristic feature of the basin was a sharp change in the biota over time. Carbonates (often accretionary) of the Aguylskian Asselian–Sakmarian Horizon mainly contain foraminifers (about 30 genera) which were widespread in subtropical offshore seas. The first indications of a cold water transgression were recorded at the end of the Artinskian and in the Kungurian. The maximum transgression was in the Kazanian. Artinskian and Kungurian siliciclastics of the Khovsgold Horizon contain a Boreal-Tethyan fauna. An analysis of the brachiopod assemblage shows that of 27 species of 22 genera, 7 species are new and endemic, 6 species are associated with Tethyan beds of the same age, 6 are associated with the Eastern Arctic Subrealm, and 8 with the Western Arctic Subarea. This supports the hypothesis about possible directions of faunal migrations from the Western-Arctic (or Euro-Canadian) Subrealm, past the Kazakhstanian block (separated from the Siberian Platform) and further, between Katasia and Angarida, through South Mongolia and the Ussurian Province of Tethys. The brachiopod assemblage (17 genera, 24 species) of the Tsaganulskian (Kazanian–Urzhumian) Horizon correlates with the maximum of the boreal transgression. The percentage of endemics increased (11 new species), and the number of species known from the same age deposits of Tethys (Southern Primorski Territory, Dzhisu-Khongor) raised (9) and only two species in common with the Western and Eastern Arctic subrealms were found. Deposits of the Solonokerkian Horizon spread as a narrow strip along the border with China. The brachiopod assemblage is represented by 19 species and 19 genera. Three species are new; others occur in the synchronous beds of Tethys. This shows that the routes of migration toward the Western Arctic basins were closed and the coldwater transgression of the Boreal Basin had ceased. The Khangai-Khentei Boreal Basin was on the southern margin of the Mongol–Transbaikalian Province of Taimyr–Kolymian (or Eastern Arctic) Subrealm of the Biarmian Realm. Based on long term collecting and analysis of the benthic faunal assemblage, sedimentary deposits were shown to have been formed as a result of two marine transgressions. The deposits of the Sakmarian–Artinskian transgression form a 200 km stretch of siliciclastics in the North-Gobian Region of Central Mongolia. It is most probable that the transgression spread in a submeridional direction from the Tchironian cave of Transbaikalia along the north-east slopes of the Khetei Ridge (the same route as for the Early Carboniferous transgression). The faunal assemblages of the Alatsagian Horizon resemble those of the Zhinkhoshinian Horizon of Transbaikalia, the Egyiskian Horizon of the Verkhoyansk Region, the Ogonerskian regional stage of the Kolymo–Omolon Basin, and the Gengenaobao Formation of North-East China. The deposits of the Late Permian Kazanian–Urzhumian transgression are traced in a nearly latitudinal stretch 1000 km from the north-east boundaries of Mongolia to the central part of the country. Changes in the direction of the transgression were probably connected with tectonic dislocations at the contact of the Siberian and Katasian plates in southern Mongolia. Five brachiopod zones are established in the Late Permian. Four of them (of the Kazanian–Urzhumian time) in conformity with the development of the transgression, are included in Tzaganmetian Horizon and are correlated with the assemblages of the Tzaganulskian Horizon of the South-Mongolian Basin, the Onulonian Horizon of the Kolyma-Omolon Basin, the Antinskian Horizon and, partly, the Sosutcheiskian Horizon of Transbaikalia. A small marine basin at the last stage of the transgression in the northeast contains the Binderian (Northdvinsk) faunal assemblage. It correlates with the lower part of the Solonkerkian Horizon of the South-Mongolian Basin, with the upper part of the Sosutcheiskian Horizon of Transbaikalia, and with the Gizhiginian Horizon of the Kolyma–Omolon Basin. The Permian deposits of the warm South-Mongolian The Tethyan Basin contains 68 species and 41 genera of brachiopods. An assemblage of the same age, from the Khangai-Khentei Boreal Basin is half the size (22 genera, 43 species).

Upper Kazanian Substage (Middle Permian) gastropod assemblages of the Eastern European Platform

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The taxonomic structure of the Upper Kazanian gastropod assemblages is unique. All genera are marine, but with a conspicuous lack of Euomphalidae, Microdomatidae, Trachyspiridae and few other families. Of 68 recorded species, only 9 are known from outside of the basin, thus suggesting 85.5 % of assemblage is endemic. The relationship between families / genera / species is 23/36/68, the ratio of the number of species to the number of genera is 1.8. Six genera are monotypic and endemic, formed, in part, by foetalization with a rather high rate of speciation. The majority of studied species show a high degree of polymorphism. Observed characteristics suggest a potentially mixed mesohaline basin. Periodic connections with the open marine basin are correlated with biotic invasion events, recorded in the discrete distribution of some gastropod groups and changes in diversity. Differences in the species composition and / or pronounced changes in the types and degree of polymorphism are especially notable in the supralittoral, shallow flats (analog of modern day *Strombus* flats), closed and semi-closed lagoons and reef facies. Reef and shallow flats facies have the maximum diversity. With an almost equal ratio of all recorded species in these facies (44/48), and 26 common species, the number of index habitat-specific forms is high (16/19). Only a few scattered species characteristic of reef facies were recorded from the oryctocoenoses of the “podluzhnik” strata of the shallow flats. The distribution suggests that bioherm mounds were forming during the entire Late Kazanian. Supralittoral facies contain only two characteristic species. Oryctocoenoses of lagoonal facies do not contain any index-species, but can be differentiated by their generally low diversity with large numbers of a dominant species – *Baylea vjatkensis*, where it reaches a peak in its variability. Formation of these lagoons is attributed to the final stages of basin development. These lagoons formed very rapidly, within an nsufficient time frame for the origin of new species. A shift in abiotic factors, in this case, did not result in variability that significantly departed from the “morphologic norm” of the species. Polymorphism of individual species appears to be controlled by facies. For example, the exceptionally polymorphic species *Baylea vjatkensis* and *Arribazona lata* do not show any variability within reef facies. On the other hand, the species *Eirlysia scalare*, *Biarmeaspira striata* and *Juvenispira esaulovae,* which are restricted to the reef facies, show a wide range of variability.

Apparently, changing salinity of the paleobasin was not the main factor in the formation of the taxonomic structure and evolution of the Upper Kazanian Substage gastropod assemblages. What might have been more important was the increase in the sulfate content and in calcium cations, together with a reduction in chlorine ions and potassium, analogous to the Caspian and Aral seas of today. This hypothesis supports an idea on the semi-closed nature of the Kazan paleobasin. Hyperhaline, euhaline, mixohaline, and possibly, even brackish and freshwater environments existed in different parts of the basin simultaneously. The hydrological conditions were, at the very least, controlled by opening and closure of northern straits, changes in depth, and changes in the fresh water input from the direction of the Ural Mountains.

Pennsylvanian microbial carbonate platforms of the Cantabrian Zone (NW Spain): New outcrop analogs for the subsurface reservoirs of the Pricaspian Basin

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A wide spectrum of high-relief and steep-fronted microbial-dominated carbonate platforms nucleated nearly synchronously during Early Bashkirian times in the foreland basin of Cantabrian Zone (NW Spain), which developed in the eastern embayment of the Palaeotethys Ocean during the collision between Laurentia and Gondwana. Nowadays, these carbonate platforms can be investigated along numerous nearly vertically-rotated thrust sheets providing good seismic-scale transects across the foreland basin infill. Detailed geological mapping and available biostratigraphic data allow investigating outcrop platform size, growth styles, evolution based on stratal patterns and age of platform drowning. This study reveals that the stacking patterns, growth styles and evolution of these carbonate platforms vary depending on their location within the foreland basin, which controlled the rates of accommodation, terrigenous input and, most probably, seawater chemistry and trophic levels.

Close to the foredeep of the basin, carbonate platforms consisted of isolated depositional systems of moderate size (from a few kilometres up to a few tens of kilometres in width, and 500–1500 m in thickness) buried by orogen-derived siliciclastic sediments during the Late Bashkirian to Early Moscovian. In most of the cases, these carbonate systems show aggradational growth styles and limited progradation of the foreland-oriented platform margin. Due to their dimensions and growth styles, they could be considered good outcrop analogues of the subsurface reservoirs of the Pricaspian Basin (e.g., Tengiz, Korolev, Karachaganak).

In contrast, the Sierra del Cuera-Picos de Europa Platform, developed in the most distal realms of the foreland basin, grew free of siliciclastic input until the Late Moscovian–Early Kasimovian. This hundred-kilometer wide carbonate system, which covered an area of 12,000 km^2, most probably resulted from the lateral amalgamation of initially isolated build-ups. A number of seismic-scale cross sections show remarkable progradation of its orogen-ward oriented margin.

Carboniferous conodonts of the Melekes Depression

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The Melekes Depression is a tectonic element of the western part of the Volga–Ural anticline. With many tectonic forms, the Paleozoic structural stage of the anticline is associated with the oil fields of the Republic of Tatarstan. The purpose of the work was to study the conodonts from the Groznenskaya 1192 borehole, Melekes Depression. Electron and light microscopy were used to study color changes in conodonts and the internal structure of individual conodont elements, and to analyze the growth stage of platform, blade and bar conodonts. The stratigraphic distribution of conodonts in the Lower Carboniferous sediments in the Melekes Depression was studied. At a depth of 1235 m, numerous conodonts *Neopolygnathus communis* Branson et Mehl were found, but at a depth of 1226.4 m, conodonts were represented by single specimens of *Pseudopolygnathus triangularis* Branson et Mehl. Above, in the range 1226.4–1213.95 m, only bar elements of the conodont apparatus were found, and these evolved slowly and are stratigraphically uninformative. Overall, the complex is typical of the Gumerovian–Malevian horizons of the Carboniferous Tournaisian Stage (*sulcata-duplicata* zone).

On the origin of the Severodvinian beds in the Permian reference section on the Sukhona River based on ostracods and ichthyofauna

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Sediment accumulation in the Severodvinian went on for several million years. During that period, the sedimentological settings changed repeatedly – from the continental to the shallow-water marine environment. Existence of a major epicontinental basin in this area at that time has been previously mentioned by Z.A. Yanochkina, E.A. Molostovsky and others. Their conclusions were based primarily on the rock lithology and facies. The data below provide evidence of periodic sea ingressions into the northern areas of European Russia in the Severodvinian, based on data from ostracods and ichthyofauna.

Ostracods are the most frequent fossils in these beds. They are represented by the fresh-water Darwinulocopina and brackish-water Cytherocopina (*Sinusuella, Permiana, Clinocypris*). *Bairdia sukhonica* Molostovskaya is a typically marine ostracod species from the lower part of the Poldarsa Formation (Babye-Belaya and Mikulino). Species of the genus are common in the Kazanian marine beds of the Russian Platform. The presence of *Bairdia* in the Severodvinian beds in the Sukhona River Region is a direct indication of a short-term ingression of the northern sea into the study area.

Earlier analyses of the fish communities combined with the data on lithology, facies and sedimentation environment have allowed M.G. Minikh and A.V. Minikh to show a number of paleogeographic aspects of the ichthyofauna. The presence of the brackish-water deep-bodied *Platysomus* and *Kargalichthys*, as well as of *Xenosynechodus* sharks among cartilaginous fishes, in the Severodvinian beds, is of particular interest. These fishes sporadically occur in the Permian reference section in the Sukhona River, inclusive of the Severodvinian Sukhona Formation and the lower part of the Poldarsa Formation (Mikulino, Babye-Belaya, Poldarsa, and Navoloky), frequently alongside ostracods; they are unknown from the upward part of the section.

The presence of coccolithophorids in the Sukhona Formation (the Poldarsa Formation has not been studied in this context), which are preserved as separate coccospheres and calcareous coccolith tests that are of great rock-forming importance, is noteworthy. Among the fish finds from the coccolith limestones in the upper part of the Middle Permian Urzhumian Stage from the southeast of the East European Platform, numerous remains of *Platysomus*, *Kargalichthys*, various algophages, shark skeletons, teeth and scales have been confirmed.

Periodic sea ingressions in the Middle Permian Urzhumian and Early Severodvinian south of the study area – towards the vicinity of Kazan – have been previously mentioned in a publication by G.A. Krinari. His observations were based on lithological-mineralogical data. We believe that new facts will eventually emerge to confirm the presence of marine facies in certain spans of the Severodvinian.

Crinoid assemblages and the Moscovian–Kasimovian boundary in the Upper Carboniferous of the Moscow Region

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Traditionally crinoids considered to be a parastratigraphic group. However, in some cases the analysis of crinoid assemblages especially the sequence of their change could provide additional information for the stratigraphists. Previously five different crinoid assemblages were proposed in the Upper Carboniferous deposits of the Moscow Region and Oka–Tsna Swell. These assemblages are usually associated with certain stratigraphic intervals, reflecting the stages of the benthic community development in the Carboniferous of the Moscow Basin. However, Myachkovian crinoid assemblage continued to exist on the Moscovian–Kasimovian boundary. The dominant crinoids in this community are cladids (*Cromyocrinus simplex*, *Dicromyocrinus ornatus*, *Hydriocrinus pusillus*, *Mooreocrinus geminatus*, *Moscovicrinus multiplex*, *Pegocrinus bijugus*) and rare flexibles (*Synerocrinus incurvus*) and camerates (platycrinitids and acrocrinids). A significant change of the crinoid assemblage occurred in the Khamovnichean Stage. The taxonomic composition of this assemblage has recently been studied in details. This assemblage is characterized by the absence of nearly all dominant species from the previous community as well as by the appearance and widespread distribution of new crinoid species and genera (*Parasciadiocrinus lancetospinosus*, *Trautscholdicrinus miloradowitschi*, *Neotaxocrinus arendti*, etc.). Some of these new taxa could be originated or evolved from migrants from Midcontinent of the USA. The appearance of such a clearly defined crinoid assemblage is well correlated with the proposed lower boundary of the Kasimovian Stage inside the Neverovo Formation by the appearance of conodont *Idiognathodus sagittalis*.

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Late Devonian–Early Carboniferous on the Western Ural: Isotope Geochemistry ($\delta^{13}C$, $\delta^{18}O$) and palaeoecological events

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At the end of the Devonian and in the Early Carboniferous occurred global geological (tectonic and magmatic), paleoclimate (glaciation, aridization) and biotic (mass extinctions) events. They are established in many regions of the world, and manifested in lithological features, as well in the carbon and oxygen isotopic composition ($\delta^{13}C$, $\delta^{18}O$) of carbonate rocks. The anoxic Kelwasser Events (upper and lower) at the end of Frasnian and Hangenberg Event at the Devonian–Carboniferous boundary were the most important. The traces of these events were noted in the studied carbonate rocks on the Rezh River of the eastern slope of the Middle Urals.

The studied sequence composed by limestone's of the Upper Devonian (Frasnian tops and Famennian) and the Lower Carboniferous (lower horizons of the Mississippian), which were formed on an isolated carbonate (Rezhevskaya) platform situated in the marginal sea of the Paleozoic Ural Ocean. Famennian complex represented by shallow and deep-sea limestone's, with variable composition and different amounts of macro- and microfauna. Layers at the top consists of limestone's with numerous foraminifera of the groups of *Quasiendothyra (Quasiendothyra) konensis (Leb.)* and *Q. (Eoquasiendothyra) bella corpulenta Post*., which completely disappears on the Devonian–Carboniferous boundary. The lower horizons of the Mississippian composed by dark bituminous limestones with numerous shells of gastropods, brachiopods; thin-walled small segments of crinoids there are also. Stratigraphic subdivisions were performed mainly on foraminifera because conodonts are absent in the Famennian and Mississippian limestones.

Carbon and oxygen isotope composition in the Devonian carbonates relatively constant ($\delta^{13}C$=1…2 ‰, PDB; $\delta^{18}O$=24…26 ‰, SMOW). Positive $\delta^{13}C$ isotope shifts are observed near the Frasnian and Famennian (Upper Kelwasser Event), and at the Devonian–Carboniferous boundary (Hangenberg Event). The lower part of the Mississippian is characterized by a noticeable variation of the isotopic composition of carbon and oxygen: $\delta^{13}C$ of 2…2.5 ‰ at the Pershinskij Horizon (corresponding conodont zone *isosticha*), and up to 6.9 ‰ – at the top of Kizelovskij Horizon (corresponding conodont zone *typicus*); and $\delta^{18}O$ here range from 24 to 27 ‰. Light oxygen isotopic composition is noted in the middle of the Pershinskij Horizon ($\delta^{18}O$ = 20 ... 22 ‰).

Positive $\delta^{13}C$ excursions near the Devonian–Carboniferous boundary are established in many regions of the globe, including the east of the Russian Platform. Shifts could be due to changes in the depth of the sea and the climate caused by alternating glacial and interglacial episodes in the Gondwana. Traces of these episodes were identified in Europe, Siberia, China and North America. Variations $\delta^{13}C$ and $\delta^{18}O$ in carbonates of the Eastern Urals likely were connected mainly with the changes of sea level and glaciations. Global tectonic and magmatic activity, including trap magmatism and rifting on the Siberian Platform apparently are not the cause of the observed isotope trends.

Principles of the ostracod-based boundary definition of Permian non-marine strata

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Non-marine ostracods have been used as for dating and correlating the Late Permian biota over the vast areas of continental deposits in the Russian Plate and the Cis-Uralian marginal trough. Bed-by-bed ostracod sampling from numerous sections allowed recognition of stages of their morphological evolution at various taxonomic ranks. The ostracod succession is used to characterize zones and zonal boundaries in the General Stratigraphic Scale (GSS) of Russia. Ostracods studied are represented by the two suborders: *Cytherocopina* and Darwinulacopina. The representatives of *Cytherocopina* are restricted to fairly narrow ecological niches; they sporadically occur within sections and are informative for paleogeographic reconstructions. The *Darwinulocopina* ostracods are numerous and ecologically tolerant. At present, their taxonomy has been updated, and the evolution and phylogeny have been studied. Almost uninterrupted geochronological series are available for all the superfamilies of the suborder: *Darwinulacea* Brady et Norman, 1889; *Suchonellacea* Mishina, 1972 and *Darwinuloidacea* Molostovskaja, 1979. Joint analysis of the stages in ostracod development and of the Earth’s magnetic field polarity confirmed that principal events in the ostracod evolutionary history corresponded to the boundaries of stratigraphic units in the East of European Russia. The strata studied are dated and characterized by assemblages of simultaneously existing ostracods: those completing their evolution, persisting and newly emerging taxa. The ranks of ostracod taxa correspond to the ranks of geologic units containing the assemblages: ostracod families define series, genera define stages, and species define substages and smaller units. Boundaries of stratigraphic units are determined based on critical moments in the ostracod evolution indicating geological events. The lower boundary of the Biarmian Series is still questionable due to the uncertain status of the Ufimian Stage in the GSS. The boundary between the Biarmian and the Tatarian Series is marked by a change in the *Darwinulacea* superfamily: the family *Paleodarwinulidae* is replaced by *Suchonellinidae*. The boundary between the Urzhumian and the Severodvinian Stages is defined at the level where the genus *Paleodarwinula* is replaced with *Suchonellina*. The boundary between the Severodvinian and the Vyatkian Stages corresponds to the change from *Prasuchonella* to *Suchonella*. Evolution in ostracods, as in all other groups, was driven by endogenic factors. Its correlation with the impact of the geologic environment in many ways explains the heterochrony of critical moments in the evolution of different superfamilies of the same suborder. Some discordance in the response of ostracods to the environment compared to other groups of organisms is expected and is considered natural.

Carboniferous–Permian development of the East Gondwana Interior Rift: a west Australian perspective

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Carboniferous–Permian remnants of the 6000-km-long East Gondwana Interior Rift system are preserved in Antarctica, East India, Australia, Timor and various terranes now in South-East Asia. Australia's western margin contains some of the least structurally complicated of these within the Perth, Southern Carnarvon, Canning and Bonaparte basins. Fragments scattered through South-East Asia commenced separating from the main part of Gondwana in the Mid-Permian apart from most of Timor that is still part of the Australian plate. Whereas the dispersed fragments of the interior rift have been subjected to multiple deformations in the Mesozoic and Cenozoic, the more southerly intracratonic parts of the rift are little deformed. Unfortunately that setting, and its high-latitude at the time, inhibited the spread of cosmopolitan faunas. While there were influxes of marine, likely warmer-water, faunas from Tethys in parts of the Tournaisian, Visean and Sakmarian to Changhsingian, there are variations in their diversity and distribution between basins, undoubtedly due to latitudinal and climatic factors. Regional correlation, therefore, is largely reliant on endemic palynomorphs and climatic signatures. At present the chronostratigraphic reliability of microfossils is difficult to assess due to the limitations of associated marine faunas and the scarcity of horizons suitable for isotopic dating. Additionally, the dichotomy between data from drill holes and outcrop in Australia is exacerbated by the paucity of macrofaunas in the former and intense post-Permian oxidisation having destroyed palynomorphs in the latter.

In the Tournaisian–Mid-Visean deposition was dominantly shallow marine but reached only into the Carnarvon, Canning and Bonaparte basins. By the Late Visean sedimentation largely contracted into central troughs as fluvial deposition became dominant, but extended slightly further south into the northern Perth Basin. With the abrupt spread of ice across Gondwana, sedimentation appears to have ceased in West Australia – Timor, perhaps for most of the Bashkirian–Moscovian. Gzhelian carbonates in Timor were possibly deposited coeval with the onset of glaciogenic deposits in mainland Australia, which were followed by the southern extension of an interior seaway that formed a major Early–Mid-Permian depocentre along the eastern margin of the rift. Glacial conditions eased late in the Sakmarian, as a regional marine incursion extended into this seaway, but by the Mid-Permian the seaway contracted to the north. The youngest Permian (Roadian) marine faunas in the northern Perth Basin were likely spread via a connection west of the earlier interior seaway, but warm-marine influences, albeit sporadic, extended into the Canning and Bonaparte basins in the Lopingian. The north-western blocks and Timor by then lay within Tethys or along its margin. Even though deposition in the southern end of the Perth Basin and basins in Antarctica were completely non-marine throughout the Permian episodic marine influences in the Permian of East India suggest the East Gondwana Interior Rift contained a number of marine seaways no longer preserved.

At the end of the Permian deposition in West Australia contracted to the west and north-west, and major depocentres formed along the present-day North West Shelf. These depocentres formed during Mesozoic rifting along north to north-easterly axes that further dispersed various Gondwanan terranes throughout South-East Asia.

Loess-paleosol series in the reference section of the Middle–Upper Permian of the Monastery Ravine (Kazan Volga Region, Russia)

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In this work, we studied the red paleosols and host rocks from the reference section of the Urzhumian and Severodvinian stages in the Monastery Ravine using field definition, grain size analysis, optical microscopy, XRD and X-ray fluorescence. Red siltstones and mudstones dominate in this section, comprising up to 62 % of the total thickness. By the lithofacies, these rocks are of two types: a) laminated and b) massive. Laminated siltstones have distinct thin bands with rhythmic alternation of presumably silty and presumably muddy laminae. Rocks locally contain ostracod shells and mudcracks. Along the strike of the layers, laminated siltstones form a regular succession: (1) subhorizontal fine laminated rock, (2) irregular undulating laminated rock, (3) rock with broken and subhorizontal sloping lamination and (4) breccias. Usually, gleyzation spots and pedogenic transformation in these rocks are absent. Such a sequence indicates the short subaerial exposure of sediments without deep soil formation.

Massive siltstones have no lamination and are often complicated by paleosol processes. Both types of siltstones are quartzose greywackes with carbonate-clayey cement, lithoclasts make up to 20–25 % and are represented by quartzites. Clay minerals in the studied rocks are illite and smectite, carbonate matter is calcite in the upper part of the section and dolomite in the lower one. The predominant fraction of these rocks is silt (58–82 %). Massive rocks are slightly more homogeneous (C_u – 4.5) than laminated rocks (C_u – 5.3) and have mainly subangular silt grains; laminated rocks have subrounded silt grains.

This section includes more than twenty paleosol levels, most of them occurring in the upper part of the Urzhumian (~ Wordian) and in the Severodvinian (~ Capitanian) stages. The main genetic types of paleosols are calcic gleysols and gleyed vertisols, they are marked by *in situ* roots, slickensides, carbonate nodules, gleyed spots and other pedofeatures. The average thickness of paleosols 0.7–1.5 m, host rocks are mostly red siltstones. A vertical geochemical profile through the paleosols revealed constant values of TiO_2/ZrO_2 ratio (21–22) and chemical index of alteration, CIA (68). If soil formation occurred after the sediment accumulation, CIA would increase upward in the paleosol profile. Hence, this may be evidence of simultaneous pedogenesis and aeolian silt accumulation.

Thus, the settings of laminated siltstone formation are interpreted as periodically drained ephemeral lakes or “mudflat” environments. Massive siltstones formed in subaerial environments of flat plains flooded in wet seasons, with eolian dust influx and pedogenesis. These processes, replacing each other in time, occurred in a semi-arid climate with contrasting seasonal precipitation, as evidenced by the red rocks, carbonate cement and carbonate nodules in paleosols, desiccation cracks and other signs.

The composition and properties of reservoir sandstones of the Ufimian Stage in the east of Tatarstan in connection with their bituminiferous

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Significant resources are confined to Permian bitumen deposits in Tatarstan, located in the east of the East European Platform. Resources of Permian bitumens exceed the already-known oil reserves in the Devonian and Carboniferous sediments, but due to some geological reason their exploration is not possible without using high-tech methods.

Natural bitumen deposits in Tatarstan are confined to Permian sediments, which are associated with deposits of the Ufimian and Kazanian stages. Bitumen deposits associated with terrigenous clastic rocks with high reservoir properties. We examined samples of bitumen-containing rocks of the Sheshminskiy Horizon of the Ufimian Stage. Most researchers agree on the continental and coastal-marine origin of clastic rock strata of the Ufimian Stage. Bitumen saturated sands and sandstones are mainly small-, at least – medium-grained, polymictic. In mineral composition sandstones are graywacke group. Among them are subgreywacke and greywacke-crystal-litoclastic species, which differ in the composition of clastic material. At the mineral composition of sand and sandstones quartz is prevail, less meet albite, calcite, chlorite and pyrite. At all sandstones are also found numerous fragments of magmatic (intrusive and extrusive) rocks, femic (pyroxene, amphibole) and accessory (magnetite, zircon and others.) minerals. Such composition of the rocks due to the receipt of clastic material from intensively destroyed in the Permian age of the Ural Mountains. The detrital material is insufficient sorted, indicating that the brevity of his transfer. Angular fragments increases the intergranular space and, as a consequence, high reservoir properties of rocks. As a result of NMR (nuclear magnetic resonance) studies determined that the bitumen content is directly dependent on the porosity of the sample. The cement in the sandstones have clay-carbonate, sometimes carbonate composition. The nature and composition of the cement has a significant influence on the permeability of rocks for petroleum substances. According to EPR (electron paramagnetic resonance) investigations it found that at investigated sandstones there are 2 types of organic matter – oil and coal. Oil substance has the nature of migration and, most likely, due to the inflow from deeper horizons. Organic matter of coal has syngenetic origin and represents the remains of vegetation (algae) is deposited with the primary precipitation. Vanadium is a characteristic element of the Permian bitumens, as well as for the Devonian and Carboniferous oils. The presence of vanadium in the bituminous material in the form of vanadyl ion was confirmed by EPR. The presence of vanadyl ion is a sign of high viscosity oils.

The results indicate the relationship of the rocks bitumen deposits with terms of their formations and may be used during the exploration and development of these fields.

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Lithology and foraminifers from the Visean–Serpukhovian boundary beds in the Zhanakorgan deep-water section in Big Karatau (Southern Kazakhstan)

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Serpukhovian sections in the Big Karatau Mountains of Kazakhstan are well exposed and contain an excellent fossil record; consequently, they can be used as reference sections for the Viséan–Serpukhovian boundary. The best-studied boundary successions in the northwestern part of the Big Karatau are in the Zhanakurgan, Aktobe, Akuyuk, Zhertansay, and Ushozen sections. These important sections, however, require comprehensive restudy to more adequately document their lithofacies and biostratigraphy, especially that of the foraminifers and conodonts. The information presented herein documents the preliminary results of that reevaluation.

Finding a suitable index to define the GSSP at the Viséan–Serpukhovian boundary and locating a suitable section for that GSSP are two of the principle research objectives of the SCCS. The Task Group has been assigned by the International Commission of Stratigraphy to establish a GSSP for the Viséan–Serpukhovian boundary. For boundary definition, the task group plans to use the first evolutionary appearance of the conodont *Lochriea ziegleri* Nemirovskaya, 1994 in the lineage *Lochriea nodosa –Lochriea ziegleri.*

Locating the upper boundary of the Viséan Stage in Kazakhstan and elsewhere using foraminifers and many other taxa remains problematic. In the Franco-Belgian Basin, that boundary is drawn at the base of foraminiferal zone Cf7, at the base of the ammonoid E1 Zone in the British Isles, and in Russia at the base of the *Pseudoendothyra globosa–Neoarchaediscus parvus* foraminiferal Zone.

In the type area of the Serpukhovian, the base of the stage was placed at the base of the Tarusian regional substage near the appearances of *Neoarchaediscus postrugosus*, *Eolasiodiscus donbassicus*, and *Janischewskina delicata* but that position cannot be correlated with deeper-water successions using foraminifers. It was previously thought that the appearances of *N. postrugosus*, *E. donbassicus* and *J. delicata* coincided approximately with the FAD of the conodont *Lochriea ziegleri* but it was recently shown that *L. ziegleri* appears slightly lower within the underlying Venevian regional substage therefore, the task of finding a better foraminiferal marker for the base of the Serpukhovian remains.

The Upper Viséan beds in the Zhanakorgan section include lime wackestone interbedded with coarse-grained turbidites. The grainstone contains the foraminifers *Bradyina rotula*, *Archaediscus chernoussovensis*, *Asteroarchaediscus baschkiricus*, *Asteroarchaediscus* sp.

The lower 80 m of strata in the Serpukhovian portion of the Zhanakorgan section comprise lime grainstone interbedded with lime wackestone. In the upper part of the interval, the grainstone contains algae and foraminifera: *Archaesphaera grandis, Janischewskina minuscularia*, *Janischewskina delicata*, *Janischewskina typical*, *Neoarchaediscus cf. parvus* and *Rugosoarchaediscus* sp.

Flourishing microbial community during the Early Permian paleoclimatic transition on the Mid-Panthalassan Akiyoshi atoll (SW Japan)

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The Carboniferous–Permian Akiyoshi Limestone, SW Japan was formed as an oceanic atoll upon a hot-spot volcanic edifice in the tropical Mid-Panthalassa. This limestone has recorded a long-term biotic succession of reef communities during the Late Paleozoic time. The drill-core observation reveals that microbialites including large oncoids (up to 14 cm) are abundant in the Artinskian (Lower Permian) section of this limestone. The microbialites consist mainly of a tubular microproblematicum, girvanellid cyanobacterial filaments, microbial micrite crusts, and pore-filling sparry calcite cements. They are surrounded by intraclastic-bioclastic grainstone / rudstone, indicative of moderate- to slightly high-energy, shallow subtidal conditions. The microbial community was the primary boundstone-forming organisms on the Akiyoshi atoll during this time. It represents a transitional stage in a Mid-Panthalassan reef succession between a cooler-water autotrophic *Palaeoaplysina*-microencruster community in the Gzhelian–Asselian and a warmer-water heterotrophic calcareous sponge-microencruster community in the Middle Permian. The flourishing Mid-Panthalassan microbial community during the Late Early Permian is probably related to enhanced alkalinity, increasing nutrient levels, elevated sea-surface temperatures, and the absence of major reef-building metazoans, which resulted from Gondwanan deglaciation, climatic changes, and a pulse of active volcanism.

A comparative study of the preservation of brachipods from the former Shan-Thai and the Indochina microplates in Thailand

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Brachiopods have been found abundantly in many Permian carbonate sequences of Thailand. The characteristics of their preservation vary: occurring individually, as aggregations or distributed within the beds. These fossils are prominently found both in the former Shan-Thai and the Indochina microplates of Thailand and the Southeast Asia Subcontinent / Sunda Block. The preservation of these fossils indicates that they have been exposed to different stages and degrees of taphonomic alteration. In this study, we compared the biostratinomic indicia, articulation, fragmentation, breaching, encrustation, boring and shell color of the brachiopod specimens collected from the above two microplates. For the degree of taphonomic alteration, the brachiopods from the Shan-Thai showed 15 to 20 % more alteration than those from Indochina. The majority of the fossils from the Shan-Thai are larger in size and predominantly altered by chemical processes as indicated by the color of their shell, while those from Indochina are smaller and mostly altered by physical processes as indicated by fragmentation and breaching of fossil shells. Field observation and petrographic evidence of the host rocks suggested that the brachiopods from the Shan-Thai were deposited in wackestone and packstone containing an abundance of other fossils; crinoids, bryozoans and corals, whereas those from Indochina were deposited in shale. It is preliminarily concluded that the brachiopod fossils of the Shan-Thai were relatively autochthonous and deposited in the vicinity of the coral zone of the shallow marine environment, but those of Indochina were probably allochtonous and had been transported for much greater distances, possibly in storm events, and deposited on an inner shelf of the Permian Sea.

Soyana flora as a mirror of plant life in the middle of the Permian period

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Many Permian sections have been recognized and studied in the Russian Platform by several generations of paleontologists and stratigraphers, and these sections still provide new important data about the organic world in the Permian Period. Special attention of experts was paid to the Iva–Gora locality, which is situated at the middle reaches on the right bank of the Soyana River in the Arkhangelsk Region, 50 km upstream from the village of Soyana.

A floral assemblage from the Iva–Gora locality includes lycopodiopsids, sphenophytes, ferns, peltasperms (order Peltaspermales, families Peltaspermaceae and Angaropeltaceae), conifers, and vojnovskyans (order Vojnovskyales).

The Iva–Gora locality was discovered by M.B. Edemsky in 1926. The Permian sections on the Soyana and Kuloi rivers were studied in detail by J.D. Zekkel in 1935. The outstanding Russian paleobotanist Zalessky in 1937 published the first descriptions of fossil plants from the Iva–Gora locality: *Pecopteris attenta* Zalessky, *P. spiculosa* Zalessky, *P. conserrata* Zalessky, *Odontopteris sojanaeana* Zalessky, and *Meristophyllum sojanaeanum* Zalessky. I.A. Ignatiev and S.V. Naugolnykh (2001) published general information on the Iva-Gora flora in a broad review of Kazanian floras of Eurasia.

The present study is based on the collection of fossil plants, which is provided to the author by V.N. Kuleshov (Geological Institute, Russian Academy of Sciences). The collection includes more than 70 compressed and impressed plant remains. The epidermal structure of ferns of the Iva–Gora flora was studied under the Stereoscan 600 SEM in the Geological Institute of the Russian Academy of Sciences.

The Iva–Gora flora contains numerous leaf whorls and leafy shoots of *Annularia* aff. *carinata* Gutbier. The ferns *Pecopteris* ex gr. *leptophylla* Bunbury are also very common. The material studied includes phylloids and sporophylls of heterosporous lycopodiopsids, which are probably taxonomically close to the heterosporous isoetalean lycopodiopsid *Signacularia* Zalessky, which is characteristic of the Kazanian deposits of the Russian Platform and adjacent areas. Among gymnosperms from the Iva–Gora locality there are peltasperms represented by leaves of the callipterid morphological group, family Peltaspermaceae, which were described by Zalessky (1937, p. 98, text-figs. 74, 75) as "*Odontopteris*" *sojanaeana@* Zalessky, These leaves according to the modern nomenclature should be assigned to the species @*Permocallipteris wangenheimii@* (Fischer) Naugolnykh. In addition to the callipterids, the Iva–Gora locality has yielded of leaves of angaropeltians of the genus *Praephylladoderma* Naugolnykh (family Angaropeltaceae, order Peltaspermales). Leafy shoots of conifers also occur in the Iva–Gora locality; but exact taxonomic position of these forms remains uncertain. The Iva-Gora Floral assemblage includes leaves of *Rufloria (Alatorufloria)* S. Meyen, *Entsovia* S. Meyen, bracts of *Nephropsis* Zalessky, and scale-like leaves (cataphylls) of the genus *Lepeophyllum* Zalessky, which I regard as belonging to gymnosperms of the class Vojnovskyopsida (Naugolnykh, 2010). Some seeds with a well-developed apical wing also belong to this group.

Conodont biostratigraphy of the Moscovian Stage of the Donets Basin, Ukraine

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Diverse Pennsylvanian conodont faunas of the Donets Basin comprise almost all genera and species known from contemporaneous deposits of the other areas. Declinognathodus and Idiognathoides species dominate in the Bashkirian. Neognathodus also occurs. Idiognathodus and “Streptognathodus” entries were recorded at Mid-Bashkirian. New genera Diplognathodus and Mesogondolella as well as the new species of Neognathodus and Idiognathodus appeared in the Early Moscovian although the latest species of Declinognathodus and Idiognathoides were most common that time. Upwards the section Idiognathodus prevail. From the Mid-Moscovian tup to its end Swadelina species dominated. Neognathodus last occurrence was not found above the limestone $N_{2.}$

The Bashkirian conodont zonation was established in the Donets Basin decades ago but the Moscovian one is just several years old. Seven conodont zones were erected in the Bashkirian and the same number of zones in the Moscovian.

The attention is paid here on the Moscovian conodont biostratigraphy of the Donets Basin and its correlation to the stratotype. Seven Moscovian conodont zones are in ascending order: Declinognathodus donetzianus, Neognathodus atokaensis – “Str” transitivus, Idiognathodus izvaricus, Swadelina dissecta, Sw. concinna, Sw. sp. 1, Neognathodus inaequalis – Sw. sp. 2 and Sw. subexcelsa.

The Bashkirian–Moscovian boundary deposits were studied in the most complete reference sections of Donbas for many years. Two conodont zones Declinognathodus marginodosus and Decl. donetzianus, were erected and later studied in several new sections. The Bashkirian–Moscovian boundary was defined by the entry of Decl. donetzianus, which evolutionary appearance was recorded at the top of the limestone K_1. Above the upper boundary of the Decl. donetzianus Zone the Idiognathoides taxa gradually became extinct. The entry of “Streptognathodus” transitivus and Neognathodus atokaensis marked the base of the next zone named by these species. Conodont association of the overlying part of the Lower Moscovian – Id. izvaricus Zone – is taxonomically rather poor, consists mostly of Neognathodus and Idiognathodus species. Id. izvaricus prevails.

The evolutionary appearances of a number of Swadelina species were used to zone the Upper Moscovian in Donbas. They are in ascending order: Swadelina dissecta, Sw. concinna, Sw. sp. 1, Neognathodus inaequalis – Sw. sp. 2 and Sw. subexcelsa zones. The marker for the Moscovian–Kasimovian boundary still is under question. Subadult specimens of Idiognathodus sagittalis were found in limestone N_5^1 together with the new conodonts, younger than the Moscovian.

A diverse Roadian (Guadalupian, Middle Permian) microfauna from the Guadalupe Mountains, West Texas, USA

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A diverse Roadian microfaunal assemblage is present in various lithofacies of about 6 m of limestone beds exposed at a small quarry on Texas Highway 62/180 approximately 3 km north-east of its junction with Texas Highway 54, Culberson County, Guadalupe Mountains, West Texas. These strata were long considered as Bone Spring Limestone of Leonardian (Early Permian) age and in recent years have been assigned to the Roadian (Middle Permian) based on the presence of the ammonoid species *Paraceltites elegans*. At the present day, these strata are assigned to the Williams Ranch Member of the Cutoff Formation of the Roadian based on the presence of the conodont-marker species *Jinogondolella nankingensis*. Recently, the section has been restudied and resampled in an attempt to integrate the biostratigraphic data obtained for conodonts, foraminifers, radiolarians, ostracodes, and vertebrates. Besides these groups of microfauna there are also scolecodonts and holothurian sclerites present. Conodonts are represented by *Jinogondolella nankingensis* with its three morphotypes, and elements of *Sweetina*. Various elements of the apparatus of *Hindeodus wordensis* are also present, representing the earliest occurrence of this species in the Delaware Basin. The presence of the slender morphotype of *J. nankingensis,* common to the Phosphoria Formation, is the first reported from West Texas. Small foraminifers are represented by species of agglutinated and calcareous genera such as *Ammobaculites*, rare "*Textularia*", *Calcitornella*, *Calcivertella*, *Multidiscus*, *Pseudoammodiscus*, *Hemigordius*, *Nodosaria*, rare *Tristix*, *Lingulonodosaria*, *Ichthyolaria*, rare *Howchinella*, *Globivalvulina*, and *Tetrataxis*. Fusulinaceans are represented by rare broken tests of the genus *Parafusulina*, and abundant smaller forms of the species *Ozawainella delawarensis*. The locality is especially important for radiolarian biostratigraphy because several important West Texas Permian radiolarian species were first described from this site by Nazarov and Ormiston, and Cornell and Simpson, many years ago. The radiolarian assemblage is very diverse and represented by 32 species, among which are the stratigraphically important species: *Albaillella foremanae*, *Pseudoalbaillella cornelli*, *P*. *scalprata*, *P*. *cona*, *Polyedroentactinia centrata*, *Wuyia endocarpa*, *Copicyntra simulens*, *Latentifistula patagilaterala*, *Quinqueremis robusta* and *Polyfistula leonardia*. The vertebrate assemblage includes the remains of very diverse chondrichthyans, common actinopterigyans and very rare tetrapods. The chondrichthyans are represented by isolated teeth of *Stethacanthulus decorus*, *Stethacanthus*, *Glikmanius* cf. *G. occidentalis*, *Isacrodus marthae*, *Adamantina foliacea, Polyacrodus*, *Cooleyella amazonensis*, *C.* sp. nov., various scales and denticles. The actinopterigyans contain the skull bones and scales of haplolepid and elonichthyid *Alilepis* sp. nov.

Early Kazanian fauna of the Nemda River Basin (Volga–Vyatka Region), Russia

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The presence of bioherms or "reefs" in the Kazanian deposits of the Nemda River Basin was first described by Solodukho in 1954. He divided the Kazanian strata into lower and upper parts based on lithology and faunal content with the bioherms considered to occur in the lower part. The authors investigated sections of Kazanian strata in the Kremeshki, Chimbulat and Popovtsevo quarries. Bioherms were found only in the first two named quarries and are composed of crinoid and bryozoan remains, and also contain gastropods, ammonoids, foraminifers, brachiopods and rare rugose corals. The encompassing deposits are represented by lagoonal lithofacies with shallow water brachiopods, bivalves, abundant foraminifers, conodonts, and rare ammonoids. Foraminifers from the bioherms and encompassing rocks are represented by almost the same species such as *Pseudoammodiscus megasphaericus*, *P. microsphaericus*, *Hemigordius discoides*, *Polarisella elabugae*, *Nodosaria noinskyi*, and *Geinitzina spandeli*, which are typical for the lower part of the Kazanian. Ammonoids are found in the bioherm of the Kremeshki quarry and represented by *Sverdrupites amundseni, S. harkeri, Biarmiceras esaulovae, B. kremeshkense, Medlicottia postorbignyana.* According to Leonova and Shilovsky, the first two species are known in the Roadian of many regions. Conodonts have been found in the Kremeshki and Chimbulat quarries in the lagoonal lithofacies and include species *Sweetina triticum* and *Kamagnathus khalimbadzhae*, which are characteristic for the lower part of the Kazanian of the Volga–Kama area, and the first one occurs in the *Jinogondolella nankingensis* zone of the Roadian of North America. Brachiopods are present in bioherms and encompassing deposits, but differ by their species composition. The species *Globiella hemisphaerium*, *Cancrinella ledjensis*, *Terrakea hemisphaeroidalis*, *Odontospirifer subcristatus*, *Bajtugania netschajevi* are found in the bioherms, whereas in the encompassing deposits the species *Cancrinella cancrini*, *Aulosteges wangenheimi*, *Cleiothyridina pectinifera*, *Stenocisma superstens, Odontospirifer subclatratus* are present. The main difference of the brachiopod assemblages in the bioherms is in the complete absence of the Licharewiidae (genera *Licharewia* and *Tumarinia*), and thin costate spiriferids. Rugose corals are found in the reefal facies of the Kremeshki quarry and are represented by species *Paracaninia variabilis* known from younger deposits in the Arctic. Only foraminifers have been found in the lower part of the section in the Popovtsevo quarry suggesting a very restricted marine environment. They are represented by species typical for the lower part of the Kazanian of the Volga–Kama Region such as *P. megasphaericus*, *P. microsphaericus*, *Nodosinelloides netschajewi*, *Nodosaria hexagona*, *N. noinskyi*, *N. farcimeniformis*, *Pseudonodosaria nodosariaeformis*, *P. lata*, *Ichthyolaria longissima*, and *G. spandeli*.

Late Viséan–Serpukhovian deep-water fossil assemblages on the eastern slope of the South Urals (Verkhnyaya Kardailovka)

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In the eastern slope of the South Urals, deep-water condensed carbonate facies with abundant Late Viséan–Early Serpukhovian ammonoid occurrences have for a long time been known in the basin of the Ural River, opposite the village of Verkhnyaya Kardailovka. In this section, the Viséan–Serpukhovian beds are represented by deep-water condensed carbonates. Two types of microfacies are dominant: finely microbioclastic wackestones with large bioclasts and microbioclastic-intraclastic wackestones. Some parts of the section, including the Viséan–Serpukhovian boundary interval, contain abundant faunal occurrences (diverse ammonoids, crinoids, trilobites, solitary rugoses, holothurians, foraminifers, and ostracods).

Ammonoid assemblages are very abundant and found in multiple levels. Four ammonoids genozones (*Goniatites, Hypergoniatites-Ferganoceras, Uralopronorites-Cravenoceras, and Fayettevillea-Delepinoceras*) are recognized in this section. The Viséan–Serpukhovian boundary recognized by the FAD of the conodont *Lochriea ziegleri* lies within the *Hypergoniatites-Ferganoceras* Genozone and is controlled by ammonoid occurrences below and above. Calcareous microfossils are mostly represented by thin-shelled ostracods, whereas foraminifers are less abundant, small and not diverse. Three foraminiferal zones in the Serpukhovian and the beds with *Endostaffella asymmetrica* in the Upper Viséan are recognized. The Serpukhovian species *Eolasiodiscus muradymicus* is found 1.5 m above the FAD of *L. ziegleri*. The conodont assemblages are dominated by deep-water *Gnathodus bilineatus* group, and diverse *Lochriea* with *Vogelgnathus* at some levels. The shallow-water genera *Cavusgnathus* and *Mestognathus* are completely absent. The $\delta\ ^{18}O$ data in conodont apatite demonstrate a cooling episode at the Viséan–Serpukhovian transition (19.0–20.0 m). The deep water corals in the Viséan–Serpukhovian boundary deposits ("*Cyathaxonia*" facies) are not numerous (in total 25 specimens were collected in 2009–2015). They are represented by *Sochkineophyllum*? sp., *Amplexizaphrentis* sp., *Rotiphyllum* sp., *Rhopalolasma bradbournense* (Wilmore) and *Caninia* sp. sensu Hudson, 1943. Previously *Rh. bradbournense* (Wilmore) was recorded from the Upper Asbian–uppermost Lower Brigantian (Morocco, Poland, Germany, and England). Most of the corals were found in the Upper Viséan part of the section. The Upper Serpukhovian beds in the mud-mound facies contain *Cladochonus* sp. and *Calophyllum* sp.Thin sections sometimes contain bryozoans. Other microfossils include crinoidal columnals, holothurian sclerites, agglutinated foraminifera (*Hyperammina*) and spheroids with spines, previously identified as radiolarians and fish teeth. Mandibular crowns of crustaceans found in many samples are very similar to those of *Angustidontus*. In addition, the microfossil assemblages contain casts of small gastropod shells and fragments of phosphate shells of lingulid brachiopods.The study is supported by the Russian Foundation for Basic Research, projects 14-05-00774,15-05-06393, 15-05-00214 and Kazan Federal University (Russian Government Program of Competitive Growth of Kazan Federal University).

Early Viséan ammonoid assemblages in the Middle Tian-Shan Naryn Zone, and their correlation with the conodont and foraminiferal framework

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The Lower Viséan beds in the Naryn Zone of the Middle Tian-Shan contain ammonoids of the *Fascipericyclus-Ammonellipsites* and *Bollandites-Bollandoceras* genozones found in the Dzhapryk and Karakiya formations, in association with conodonts and foraminifers. The base of this *Fascipericyclus-Ammonellipsites* genozone approximately correlates with the base of the *Merocanites–Ammonellipsites* Genozone of the Russian scale, and *Fascipericyclus-Merocanites* Genozone of the combined scale of Europe and North Africa, whereas the upper boundary coincides with the base of the *Bollandites–Bollandoceras* Genozone.

The lower boundary of the *Fascipericyclus-Ammonellipsites* Genozone lies within the Upper Tournaisian, so part of this genozone is certainly Tournaisian, which is confirmed by ammonoids found in association with the conodonts *G. bulbosus, P. praebeckmanni, S. anchoralis, and P. pseudosemiglaber*. However, many occurrences of this ammonoid genozone are certainly Viséan, including in the Naryn Region, where ammonoids *Fascipericyclus, Ammonellipsites, and Dzhaprakoceras* are found within the conodont *texanus* Zone, which is similar to the situation in Central Kazakhstan. The *Fascipericyclus-Ammonellipsites* Genozone can rarely be reliably subdivided into the Tournaisian and Viséan parts because of the lack of the boundary *foraminiferal markers* in the ammonoid-bearing successions. Attempts to subdivide this genozone based on stages in ammonoid evolution, irrespective of the Tournaisian–Viséan boundary, also need further substantiation. The "*Fascipericyclus*" (F) and "*Ammonellipsites*" (A) subzones recognized in the Naryn Region were difficult to correlate because they were very rarely found in the same sections, and were originally recognized based on the percentage content of species, rather than on their first appearance levels. The Naryn sections give a unique opportunity to trace the evolutionary changes in the ammonoid assemblages, and correlate the ammonoid distribution with conodonts and foraminiferal zones. The F-A assemblages in the Korgon I–III and On-Archa II–III sections, contain *Neopericyclus, Helicocyclus, Dzhaprakoceras, Merocanites* and *Ammonellipsites djaprakense*.The F2-A1 assemblages characterized by *Helicocyclus tianshanicus*, *Dzhaprakoceras sonkulica* and the first *Ammonellipsites*, are found in the foraminiferal *Omphalotis paraturkestanica* Zone, whereas the A2-A3 assemblages with the highly developed pericyclids *Ammonellipsites nikitini*, *A. kochi*, *A. multicostatus,* and *Michiganites asiaticus* correlate with the *Tetrataxis kiselica-Pseudotaxis eominima* foraminiferal Zone. The overlying *Bollandites–Bollandoceras* Genozone includes ?*Bollandites librovitchi* found at the base of the Karakiya Formation in association with the conodonts of the *texanus* Zone and foraminifers of the *Pseudotaxis eominima*-*Tetrataxis kiselica* Zone. The study is supported by the Russian Foundation for Basic Research, project 14-05-00774 and Kazan Federal University (Russian Government Program of Competitive Growth of Kazan Federal University).

Stable isotopes of carbon and oxygen in the Middle Permian carbonate rocks within the reference sections of the Volga Region, Russia

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Data on stable isotopes of carbon and oxygen of the Permian carbonate rocks play an important role to create chemostratigraphic frame of the Permian formations. The stable isotopes records reflect changes in chemical composition of carbonate rocks in dependence on regional and global factors in history of the Permian period. Variations of the stable isotopes across the Middle Permian rocks open significant stratigraphic boundaries and paleoenvironmental aspects.

New processing techniques for estimation of reservoir properties of carbonate rocks

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Carbonate rocks contain more than 60 % of the world's hydrocarbon reservoirs. They have a reservoir composition that is more complex than in clastic rocks. Carbonate rocks contain interconnected and unconnected pores. There are 3D cylindrical core samples to estimate porosity. They are expensive and time-consuming, e.g. measurement of interconnected porosity by liquid injection porosimetry. This technique can only evaluate connected pores because the injected fluid cannot get to the unconnected pores. An alternative to this method is a digital image processing technique which estimates porosity from thin section images. The estimates of porosity in digital method give the total porosity in a 2D image of the section. These estimates are useful to project what part of the porosity can be considered as perspective to become interconnected under intensification processes during development.

The new Cluster Image processing technique is considered as a cost-effective alternative direct digital method for estimation of 2D-porosity from thin sections images of carbonate rocks on example of core samples picked out from carbonate reservoir rocks of the Carboniferous age. The Java program 'Cluster Image' was created especially to process thin sections of carbonate rock to estimate its porosity on an image of any format and with a color contrast between the mineral part and the pores under polarized light.

Carboniferous microfossils from the southern Char Belt, East Kazakhstan

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Accretionary complexes in the southern part of Char Belt in East Kazakhstan are composed of volcanic rocks associated with oceanic cherts and carbonates formed at the closing stage of the Paleo-Asian Ocean that resulted from collision of Kazakhstan and Siberian continents. Sedimentary sequences contain Late Devonian–Early Carboniferous microfossils including radiolarians and conodonts.

Late Paleozoic volcanic-sedimentary sequences are represented mainly by carbonates (bioclastic limestones and dolomites) and terrigenous-siliceous rocks (tuffs, tuffaceous sandstones, siltstones, siliceous mudstones, cherts) and occur as olistolites and separate blocks within volcanics.

From the Karabaev Formation outcrop, north-west of Charsk Village, microfossils were recovered by chemical preparation of red, grey and green-grey cherts. Radiolarian assemblage contain *Trilonche* cf. *vetusta* Hinde, *Tr. echinata* Hinde, *Tr. davidi* (Hinde), *Stygmosphaerostylus* sp., *Archocyrtium* cf. *reidelli* Deflandre, *Ar.* cf. *ormistoni* Cheng, *Ar.* sp., *Duplexia* sp. Won and *Helioentactinia* sp. Age of strata is dated as Tournaisian (Mississippian) by found with them conodonts *Siphonodella* cf. *bella* Kononova et Migdisova and *Polygnathus* sp. characteristic for *duplicata* Zone.

The Verochar Formation is cropped out near Igorevka Village, on the east of Charsk Village. After chemical preparation of grey cherts radiolarians together with conodonts were recovered. The Radiolarian Assemblage includes typical for Tournasian *Albaillella* cf. *paradoxa* Deflandre, *Albaillela* sp. and *Polyentactinia* sp. age of bearing strata is also controlled by presence of *Gnathodus* cf. *punctatus* (Cooper) characteristic for *Siphonodella isosticha*–Upper *S. crenulata* – lower *typicus* zones of the Tournaisian Stage.

Upper Devonian (Famennian) radiolarian assemblage found from cherts on the south-east and north-west of Charsk Village were also revealed along with conodonts. Radiolarians are dominated by *Trilonche, Astroentactinia*, *Archocyrtium* and *Stygmosphaerostylus with* conodonts of *rhomboidea*–Lower *marginifera* zones.

Contribution to IGCP 592.

Foraminiferal fauna of some Carboniferous–Permian blocks from the Mersin Mélange (Central Taurus, Southern Turkey): A correlation with carbonate successions in adjacent Tauride tectonic units

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The Mersin Complex from Southern Turkey is composed of two different tectonic units as; the Mersin Mélange, and the ophiolitic series with a metamorphic sole. The Mersin Mélange is composed of blocks of various origins with different stratigraphic ranges within a Late Cretaceous matrix. The foraminiferal contents of three limestone blocks of the Carboniferous and Permian age from the Mersin Mélange have been studied to evaluate their origin, to determine their total stratigraphic range and to correlate them with autochthonous successions in the adjacent Tauride units.

The Keven Block, one of the well-exposed outcrops in the study area, is represented by a typical transgressive sequence of 12 m total thickness. Thirteen samples have been studied throughout the section for their fossil content. Some clasts from the basal part of the Keven Block include *Nonpseudofusulina karapetovi* and *Pseudofusulinoides* ex gr. *postpusillus* assemblage. *Rugosofusulina stabilis*, *Grovesella staffelloides*, *Schubertella paramelonica*, *Spireitlina conspecta* and *Hemidiscus carnicus* are the main constituents of the overlying part. The age of the clasts and overlying succession in the block is the Early Permian.

The other block, Keven-1 block, is composed of a 2 m thick carbonate succession. One of the two samples taken from the upper part of the block is very productive for the foraminiferal fauna and comprises mainly Bashkirian (probably Early Bashkirian) fusulinid assemblage as *Varistaffella ziganica* and *Plectostaffella varvariensis.*

The Cingeypinarı block is about 64 m in thickness and mainly composed of a carbonate-sandstone alternation with a carbonate-dominated basal part. The base and the mainly carbonaceous parts of the block include rich but poorly preserved fusulinid (*Pseudofusulinoides*? spp.) assemblage. The overlying units are rich in small foraminifera represented by *Hemigordius permicus beitepicus*, *Nodosinelloides pinardae* and *Neohemigordius*? sp. The determined fossil assemblage in this block indicates that its age is limited to the Early Permian.

The Early Permian fossil assemblage of the studied blocks within the Mersin Mélange correlate with the coeval ones within the carbonate successions of the Aladağ Unit and its equivalents of the Tauride-Anatolide Platform or with those within the limestone blocks of the Karakaya Complex and the autochthonous cover of the Variscan basement of the Sakarya Composite Terrane in NW Turkey.

Considering the faunal and floral assemblages, the source areas of the blocks may have been located relatively close to each other and were positioned on the same paleo-latitude. This may further suggest the presence of a common Early Permian carbonate platform on the Tauride and Sakarya terranes and the derivation of the limestone blocks in the Mersin Mélange from this platform. This study was funded by TUBITAK 112Y370.

Frasnian plant assemblages of North Timan (Russia)

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Distribution of the fossil plants through the Frasnian deposits (the Upper Devonian) of the North Timan was examined. Five plant assemblages were defined. First two assemblages characterize the Lower Frasnian deposits. The lowermost one of the Vyuchejskij Formation is mainly represented by imprints of the fern fronds of genera *Rhacophyton, Flabellofolium*, *Meristopteris*, and *Dimeripteris.* Also leaf remains of archaeopteridean genera *Svalbardia* and *Archaeopteris*, a single stem of lycopsids (*Knorria* sp.) were observed here. Next plant assemblage from the Grubyj Ruchej Formation differs from the previous one by first appearance of sphenopsids (genera *Pseudobornia* and *Sphenophyllum*). Also lycopsids (*Kossoviella, Lepidodendropsis* and *Knorria*), ferns (*Rhacophyton*, *Flabellofolium*, *Meristopteris, Aphlebiopteris, Dimeripteris, Pietzschia* and *Calamophyton)* and archaeopterids (*Svalbardia* and *Archaeopteris*) are more variable.

The Middle Frasnian deposits are characterized by the plant assemblage of the Rassokha Formation. The assemblage consists of 14 taxa. Like in the previous assemblage archaeopteridaleans (*Svaldardia* and *Archaeopteris*) and ferns (*Rhacophyton*, *Aphlebiopteris, Dimeripteris* and *Pteridorachis*) were abundant while lycopsids (*Kossoviella* и *Knorria)* and sphenophytes (*Sphenophyllum)* were rarely met.

Two plant assemblages of the Ust'bezmoshitsa and Kamenka Formations characterize the Upper Frasnian deposits. The Ust'bezmoshitsa plant assemblage is the richest Late Devonian plant assemblage (29 taxa) of North Timan. Lycopsids are most various and represented by four genera (*Gutzeitia*, *Kossoviella*, *Ludovatia* and *Kosychia).* Among the sphenopsids two species of *Pseudobornia* were found. Archaeopteridean plants are represented by three genera: *Archaeopteris, Svalbardia* and *Eddya.* Probable aneurophytalean *Timanophyton* was also observed. There are a lot of frond imprints of ferns (*Pseudosporochnus, Aphlebiopteris, Cephalopteris, Flabellofolium, Dimeripteris*, and *Rhacophyton*). Besides the higher plants, remains of phaeophytes (*Caudophyton fasciolus*) are observed. The latest Frasnian assemblage of the Kamenka Formation is represented by only stem fragments of *Lepidodendropsis, Knorria*, *Pseudobornia, Archaeopteris*, *Heterangium* and *Pteridorachis*. The Kamenka plant assemblage is much poorer in comparison with the Ust'bezmoshitsa Assemblage. This work is supported by the Russian Foundation for Basic Research, project no. 15-04-09067.

On the taxonomy of some representatives of the subfamily Fusulininae Moeller, 1878

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Representatives of the subfamily Fusulininae Moeller, 1878 are widely distributed in the transition of the Moscovian / Kasimovian deposits in the Carboniferous, they are especially typical for the upper part of the Moscovian.

The genus *Fusulina* Fischer de Waldheim, 1829 was established over 170 years ago and during that time it was repeatedly the subject of subdivision. Some genera which were raised from the genus *Fusulina*, were once considered junior synonyms, such as *Beedeina* Galloway, 1933 *Pseudotriticites* Putrja, 1940 and *Qusifusulinoides* Rauser et Rosovskaya, 1959. At present these genera are considered independent taxa. The subfamily Fusulininae also includes the genera *Bartramella* Verville, Thomson & Lokke, 1956 and *Kamaina* Solovieva, 1996. In modern taxonomy the genus *Beedeina* Galloway, 1933 is not only considered a separate genus, but is also placed in a separate subfamily Beedeininae Solovieva, 1996.

The genus *Kamaina* Solovieva, 1996 is separated from *Fusulina* Fischer de Waldheim, 1829 but is close to it. The following features are found in both genera: the shape of the test is elongate – fusiform or subcylindrical with rounded – sharpened axial ends and a large proloculus. As well as the four-layered wall which includes an outer thin tectorium, a tectum, a diaphanotheca and an internal thin tectorium; the fine pores in the outer volutions; the inconstant chomata in early ontogeny, and replaced by pseudochomata in the outer volutions or sometimes absent; the axial fillings in the form of seals of the axial ends, sometimes in the middle region or absent.

The differences between these genera are: The genus *Fusulina* Fischer de Waldheim, 1829 is characterized by a smooth surface of the test; septal folds usually frequent, medium-high or high, straight; the arches in the septal-section are round, angular, triangular, narrow and high; a moderate number of septa (upto 150); the aperture is narrow or moderate, with a permanent position on the volutions. Dimensions: length 4.0 – 6.0 mm, diameter 0.9 – 2.1 mm, number of volutions 4–5, rarely 6. L: D = 3.3 – 4.8.

The genus *Kamaina* Solovieva, 1996, is characterized by the uneven sometimes wavy surface of the shell; the septa with are frequent, high and irregular folding; the arches in the septal-section are usually narrow and high, angular, rounded, trapezoidal, rounded-rectangular, triangular and irregular and a wide zone of medium or coarse cellular plexus. The number of septa is in excess of 160 septa. The aperture is very narrow, with a non-permanent position on the volutions. Dimensions: length 3.5 – 7.0 mm, diameter 1.1 – 2.1 mm, number of volutions 4.5 – 5. L: D = 2.8 – 3.4, rarely up to 3.8: 1.

Sensitivity of the Late Permian climate to radiative forcing changes: A study of biome and phytogeographic patterns

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During the Late Paleozoic, the climate transitioned from an icehouse to an ice-free hothouse by the Early Triassic. The flora and fauna on Pangea underwent a remarkable reorganization during this period. The largest loss of biodiversity within the terrestrial realm coincided with the eruption of the Siberian Flood Basalts and culminated in the largest mass extinction of the Paleozoic. Recent studies support extreme volcanism and magma intrusion into coal beds may have led to increased emissions of greenhouse, sulfur and other gases into the atmosphere. To assist with the determination of the overall global climatic conditions that may have contributed to the Permian–Triassic extinction, the combining of climate model simulations with mapping of phytogeographic patterns and climate sensitive sediments could be an valuable method to assess rapid climate change during this period.

In this study, sensitivity experiments conducted with the National Center for Atmospheric Research's (NCAR) Community Climate System Model v. 3 (CCSM3), a fully-coupled comprehensive Earth system model, were performed with variations in atmospheric CO_2 concentrations to reflect the conditions of the Middle Permian and the Latest Permian. Model simulations featured 4 x and 12.7 x the pre-industrial atmospheric CO_2 concentrations to emulate the Middle and Late Permian climatic conditions, respectively. The response of climate-sensitive sediments and biomes to a carbon pulse exceeding 4800 PgC into the atmosphere was assessed to better understand the environmental changes that occurred during the Middle Permian–Early Triassic transition.

The 4 x CO_2 and 12.7 x CO_2 biome simulations were in reasonable agreement with lithological and paleofloral data from the Middle Permian and Late Permian, respectively. A cold bias in the high latitudes was present in both sensitivity experiments; however, the bias was significantly reduced from previous climate model studies performed with general circulation models (GCMs). Cathaysian paleobotany records were in excellent agreement with both the Middle and Late Permian biome simulations. Comparison of the 12.7 x CO_2 simulation with Early Triassic lithological and paleobotany data plotted outside of the normal biome categories suggestive that temperatures were significantly higher during this time. Sensitivity experimental results implied that the extreme temperature increases during the Middle and Late Permian, coupled with change in precipitation patterns, likely caused an expansion of inner-continental deserts and contributed to the mass extinction of much of the fauna and flora as suggested by the modeling results and phytogeographic patterns.

On the systematic position of the genus *Chivatschella* Zavodowsky, 1968 (Rhynchonellida, Brachiopoda)

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In the latest edition of the Treatise on Invertebrate Paleontology the status “nomen dubium” was assigned to the genus *Chivatschella* Zavodowsky, 1968. It was noted by N.M. Savage that the material is inadequate for description of a new genus. This genus was described from the Chivatschoyskaya Formation of the Upper Permian of Northeast Asia. The type species is *C. orotschensis* Zavodowsky, 1968. The species is described based on limited material: five ventral and six dorsal valves. Two photos of the opposite valves were published. Images of the internal shell structures are absent. The type specimens stored in CNIGR museum (St. Petersburg) (collection number 8234) were studied to determine the characteristics of the internal shell structure. The specimens were investigated using X-ray micro-CT Skyscan 1172. Microtomography options: U = 100 kV, I = 100 mA, rotation – 180°, rotation step – 0.7°, resolution – 29.67 μm. Only two type specimens, ventral (holotype) and dorsal valves, were found. Duplicate material is absent. The author of the genus indicated in the description that in the ventral valve there are short, parallel dental plates close to the shell wall, and in the dorsal valve there is a long median septum, which can be traced in the first third of the shell length. Other details of the internal shell structure are not described. V.M. Zavodovsky included this genus in the family Wellerellidae, but by using micro-CT study additional features of the shell structure could be identified. Dental plates in the umbo of the ventral valve are combined to form a spondylium. Closer to the top of the umbo they are fused into a single plate. Closer to the anterior margin they form a spondylium with a high base. A thickened low median septum is in the dorsal valve. It already formed a deep septalium at the top of the umbo. No cardinal process was found. Thus, based on these data, the genus *Chivatschella* should be included to the superfamily Stenoscismatoidea, family Psilocamaridae, subfamily Psilocamarinae. This study was supported by the Russian Foundation for Basic Research, project No. 13-05-00459.

Conodont and vertebrate assemblages from the Early Carboniferous section of the Malaya Usa River (Polar Urals, Russia)

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Conodont and vertebrate assemblages from the carbonate marine deposits cropping out in the middle stream of the Malaya Usa River are studied for the first time. Previously these beds were correlated with the Upper Devonian based on of rare foraminifera and rugosa remains. The following conodont taxa have been determined: *Siphonodella sandbergi* Klapper, *Si. cooperi* Hass, *Si. duplicata* (Branson et Mehl), *Si. carinthiaca* Schönlaub, *Si.* aff. *semichatovae* Kononova et Lipnyagov, *Si. obsoleta* Hass, *Si. quadruplicata* (Branson et Mehl), *Si. crenulata* (Cooper), *Bispathodus aculeatus aculeatus* (Branson et Mehl), *Bi. stabilis* (Branson et Mehl), *Pseudopolygnathus dentilineatus* Branson, *Polygnathus parapetus* Druce, *Po.* cf. *bischoffi* Rhodes et al. These assemblages characterize the *sandbergi–quadruplicata* SC Zones and allow correlation of the studied section with the middle part of the Tournaisian Stage including the level of Lower Alum Shale Event. The fish remains are represented by teeth of *Thrinacodus* cf. *ferox* (Turner), *T.* sp., *Protacrodus* sp., Elasmobranchii gen. indet., Ctenacanth-type scales, fin spines and scales of *Acanthodes* sp., indeterminate actinopterygian teeth and scales. Such assemblages occur in the uppermost Famennian–Tournaisian deposits of the Timan–Pechora Region. Thus new data on the conodont and vertebrate association specify the stratigraphic range of the Malaya Usa section.

Lithogeochemical features of Carboniferous deposits in the Southern Verkhoyansk Region (Republic of Sakha (Yakutia), Russia)

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High-carbonaceous sediments were intensively accumulated in coastal-deltaic settings and deep-sea fan settings in the Middle–Late Carboniferous time in the territory of the Southern Verkhoyansk Region. During this period, a large amount of terrigenous material, which was accumulated as thick series of multicomponent bioclastic-mineral system, was coming to the sedimentary basin. The deposits were formed in various sedimentary environments from sand-silt deposits of grain flow to deep-sea terrigenous-siliceous and carbonate deposits. The average value of Ce/Ce* is 1.3 which corresponds to coastal continental settings. The high ratios LREE/HREE (medial value 23.12±4.15) and (La/Yb)n (median value 15,44±4,06) suggest an important role for magmatic rocks of acid composition in the provenance of terrigenous material. The lack of a strongly pronounced europium anomaly (Eu/Eu*) is typical of the studied rocks; values of this anomaly vary within 0.52–0.77, which indicates predominance of Precambrian crystalline rocks in washout areas.

Periodic changes in sea level, high rates of sediment burial, and its saturation with C_{org} affected redox (oxidative-reductive) conditions of the bottom waters, existing at the time of sedimentary series formation. This is indicated by a number of markers. The V/(V+Ni) ratio, ranging from 0.65 to 0.7, is typical of the sediments being formed in moderately oxygen-free conditions, whereas increased values of the same parameters (up to 1.0) suggest an anoxic environment. The Upper Carboniferous rocks have median value of V/(V+Ni) 0.75±0.04, at min=0.67 and max=0.84. A weakly expressed negative Ce-anomaly is registered at lower levels, indicating reductive conditions and sea-level rise. Thus, anoxic settings were replaced by dysoxic and oxic settings favorable for authigenic mineralization and saturation of terrigenous deposits with ore components.

A change in the geodynamic regime in the Late Mesozoic time was the reason for large-scale manifestation of metagenic changes in sedimentary series with large-scale development of regeneration-granulation blastasy and formation of strike-slip fault – cataclastic, cataclastic-segregation and segregation-banded structures of the stream. The distributive provinces of these structures are controlled by regional faults and mark the zone of mobilization of ore components (gold, arsenic, iron, lead, etc.) into fluid flow, their further migration and deposition on new geochemical barriers, and participate in the hydrothermal-metamorphic and stratigraphic gold-quartz mineralization.

Evolution of *Palaeoaplysina* Krotov, 1888 (hydroids): Structural changes of the channel system

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Palaeoaplysina fossils are widely distributed in the Upper Pennsylvanian and Lower Permian carbonate deposits of the Northern Hemisphere. The systematic position of *Palaeoaplysina* is still debated. Our studies indicated the hydrozoan nature of these fossils. The author has studied Pennsylvanian–Lower Permian carbonate deposits of the western slope of the Northern Urals for a long time (2005–2015). Many samples of different ages (from the Moscovian to Asselian) have palaeoaplysinid fossils, and their investigation showed increasing complexity of the channel system during this time.

Moscovian. The first palaeoaplysinids occurred in the Upper Moscovian deposits. They had the simplest construction. We can see one horizontal channel (HC) with simple vertical channels (VC). These palaeoaplysinids were recently described as *Eopalaeoaplysina* Anderson and Beauchamp, 2014.

Kasimovian palaeoaplysinids had a more complicated construction. The HC has a multileveled structure, and VC is simply bifurcated. VC are divided into two or three branches, and were perpendicular to HC.

Gzhelian. HC also has a multilayered structure. VC are located at various angles to HC, and gradually flatten and form new HC levels. VC bifurcation is relatively simple.

Asselian palaeoaplysinids have the most complex construction. These specimens are characterized by three zones of the channel system. *Zone A*. Basal zone of the plate has straight, rarely connecting horizontal and vertical channels. *Zone B*. This is a portion of the plate with strongly branching horizontal and vertical channels. *Zone C*. This is the terminal portion of the plate (about 0.1–0.2 mm) with intensely branching vertical channels. The horizontal channels in this part of the skeleton resemble a reticulum completely covering the plate.

Thus, the channel systems of palaeoaplysinids changed over time. Evolutionary changes in these hydroids are characterized by increasingly complicated internal structures. The determination and description of new genera and species must be based on the construction of the channel system.

Additional data on brachiopod recovery after end-Permian mass extinction: Evidence from the Olenekian brachiopods of Kamenushka sections, South Primorye

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Middle Olenekian ammonoids in South Primorye (e.g., *Inyoceras*, *Yvesgalleticeras*, *Tirolites, Koninckitoides, Bajarunia, Albanites, Nordophiceratoides, Palaeophyllites*) are characteristically accompanied by articulated brachiopods, abundant in both the shallow-water facies of the Early Spathian age (Schmidt Suite in southern part of South Primorye) and the recently discovered deeper facies of the Middle Spathian age (Middle Kamenushka Suite in the Kamenushka River Basin, northern part of South Primorye). We focus in this paper on taxonomic composition of middle Olenekian brachiopods from the Kamenushka River Basin. The Middle Kamenushka Suite is characterised by rhynchonellid (*e.g., Piarorhynchella* sp. nov.), spiriferinid, terebratulid (e.g., "*Fletcherithyris*" *margaritovi* (Bittner), ?*Heterelasma* sp. nov.) and athyridid (*Hustedtiella planicosta* Dagys) brachiopods. New data provide an important evidence for recovery reconstruction, connected with end-Permian mass extinction. Among brachiopod families crossed the P–T boundary about 16 ones, including about 10 subfamilies (e.g., Pontisiinae, Spirigerellinae,Punctospirellinae, Hustediinae, Dielasmatinae, Misoliinae) have been reported till now. The finding of the *Heterelasma*? sp. nov. in the middle part of the Kamenushka Suite allow to suppose that Cryptonellinae also survived the end-Permian mass extinction. Another finding (?*Tetrarhynchia* sp.) demonstrates apparently that the family Tetrarhynchiidae had longer stratigraphical distribution than it was considered till now.

A proposal for a Devonian–Carboniferous boundary based on the Hangenberg extinction event, as suggested by the transition in the Namur–Dinant Basin (Southern Belgium)

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In most sections worldwide, difficulties are encountered for the recognition of the Devonian–Carboniferous (D–C) boundary on the basis of the conodonts, as the current guides (*Siphonodella praesulcata, S. sulcata*) usually are not discovered, and that no phylogenic lineage in other fossils seems to be useful. Therefore a new way of dating has to be sought. The uppermost Famennian and lowermost Tournaisian succession of Southern Belgium consists of a relatively thick series of shallow water siliciclastic evolved to carbonate deposits. This thick series permits a good understanding of the Famennian and Tournaisian transition and of the crisis affecting the marine ecosystems at the D–C boundary, better than sections in deeper, usually condensed, facies. In the Namur–Dinant Basin, the Hangenberg Black Shale Event is not well marked because its anoxic facies, probably never spreads, or only exceptionally, into the shallow-water environments, and carbonate facies rich in benthic fossils continued to develop during its development in other areas. Contrarily, the following Hangenberg Sandstone Event, which reflects a strong sea-level drop, is easily recognizable and traceable from the Aachen (Germany) to the Dinant areas. It sharply overlies levels with numerous Strunian brachiopods, rugose corals, stromatoporoids and foraminifera. Only reworked Strunian marine fauna are recorded in the sandstone bed and therefore the extinction event occurred between it and the underlain deposits.

Therefore, in the Namur–Dinant Basin, the extinction event perfectly fits the sudden sea-level drop reflected by the deposition of sandstone or more or less sandy limestone, but not the development of black shale facies, as usually observed in deeper water settings and absent here.

Moreover, the patterns of deposition before and after the event are identical and made of carbonate-shale cycles corresponding to precession orbitally forced sequences (20 KA). Therefore, the strong sea-level drop and the extinction may be related to a single very short event, probably corresponding to an unusual ice-age event, and neither in sequence with the rest of the deposits nor to a major sequence boundary as suggested by some authors. The same pattern for the D–C extinction event can be observed in other countries, such as in South China.

The diachronic Hangenberg Black Shale (corresponding to the whole of the Middle *praesulcata* Zone or only to a thin bed of short duration) caused only local, but not definitive, extinctions, as was also the case with the diachronic development of the Upper Frasnian dysoxic–anoxic Matagne Black Shale, whose range spans the interval of the Early *rhenana* Zone to the *linguiformis* Zone, and caused local extinctions before the end Frasnian Upper Kelwasser Event.

Therefore, taking the base of the short duration extinction event corresponding to the base of the Kellwasser sandstone event could be a good marker for the D–C boundary because it can be traced easily everywhere.

The orbitally forced sequences of the Lower Tournaisian (Hastarian Substage) of Belgium: Climate reconstruction and time calibration

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The deposits of the Tournaisian in Belgium and adjacent areas are controled by orbitally forced sequences corresponding to two cycles: precession cycles of short duration ('sixth-order') and excentricity cycles of long duration ('third-order' sequences). No other cycles were recognized. These cycles were investigated and counted for the Lower Tournaisian (Hastarian Substage).

The Lower Tournaisian precession cycles vary from alternations of shale and calcareous shale to alternations of calcshale and limestone, and to limestone bed dominated. Their thicknesses vary from about 0.2 m to 1 m, and are strongly influenced both by the sediment production and the compaction in the argillaceous levels and pression dissolution in the limestone levels. The distribution of their sedimentary nature follows the evolution of the third-order sequences recognized in the lower Tournaisian. Thus, truncations at the top of the precession cycles, indicating emersion-transgressive surfaces, can occur during the low-stand and the falling-stage system tracts of the third-order sequences, whereas they are not marked during the transgressive and high-stand system tracts.

That suggests relatively low eustatic variations, i.e. low ice formation and melt, at the scale of the precession sequences, but higher ones at the scale of the excentricity sequences, i.e. higher ice formation and melt, as evidenced by the lateral variation in the geometry and bathymetry of the laters. Apparently without influence of obliquity, 40 Ka, and excentricity, 100 and 400 Ka, cycles. That climatic pattern is similar for the Upper Tournaisian (Ivorian Substage).

The Lower Tournaisian overlaps three third-order sequences: the uppermost part of sequence 1 (most of that sequence is latest Famennian), sequence 2, and the lower part of the sequence 3 (the rest of the sequence is the Late Tournaisian). These sequences are separated by transgressive erosion surfaces. The precession cycles for the Lower Tournaisian are about 17 and 20.2 Ka for their duration (18.6 Ka as a rough average) and the third-order excentricity cycles are 2.4 Ma. Therefore the 93 precession sequences recognized in the third-order sequence 2 could represent 1.73 Ma, suggesting that the erosion surface marking the sequence boundary between sequence 1 and 2, or 2 and 3, could correspond to a gap as long as about 0.67 Ma, if a similar number of precession sequences in both sequences 1 and 3 is considered.

So, considering the duration of the 31 precession sequences in the Lower Tournaisian part of the third-order sequence 1, i.e. 0.577 Ma, + 0.67 Ma, + 1.73 Ma, + 0.67 Ma, + 31 sequences in the Hastarian part of the third-order sequence 3, i.e. 0.577 Ma, we obtain 4.224 Ma as a possible duration for the Lower Tournaisian Hastarian Substage.

The counting of orbitally forced sequences in the Upper Tournaisian (Ivorian Substage) possibly could contribute to a better calibration of the Tournaisian Stage.

Paleotectonic development during Permian period : An implication of REE and precious metals in Madina Regency, North Sumatra, Indonesia

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During Late Paleozoic era, tectonic movements had its place in all over the Pangaea. Later Permian period, in Eastern Gondwana, an active convergence process was generated between Eurasia Plate and Australia Plate where is standing along Southern Sumatra until now. Further petrographic analysis of the basaltic samples also shows the most possible geological setting of Sumatra where those samples were formed in the island arc and the other granitic samples have the active continental margin characteristic. Besides petrographic analysis, study of some trace element and REE literatures gives additional information about the magma type and its source. Nowadays, most of various precious metals and REE (Rare Earth Element) deposit in Madina Regency are found as the result of this paleotectonic movement in Late Paleozoic era.

The Permian Flora of the Pechora Cisuralia and its researchers

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Interest in the plants of the Permian of north-eastern European Russia began with the first geological studies in this region at the end of the 19th century. The first records of this flora were by Schmalhausen (1879).The next stage, from the beginning of the 1920s, was marked by the research of A.A. Chernov and his team in Pai-Khoy,in the Pechora Basin and Pechora and Cisuralia (1921–1933). All of the paleobotanical material was transferred to M.D. Zalessky, who studied these collections for 25 years (1913–1938). He developed detailed phytostratigraphic schemes correlating the coal-bearing series of the Pechora Cisuralia and the Pai-Khoy Range with the Kuznetsk Basin and the Middle Urals. He recognized the major types of the Pechora flora and monographically described more than 100 species of plants. From the time of the discovery of coal deposits (1930s), the main focus was on the paleontology, stratigraphy and correlation of Permian deposits (ca. 8.5 km thick). K.G. Voinovsky-Kriger (1894–1979) was the originator of these studies.At different times, N.A. Shvedov (1939–1941); M.F. Neuburg (1944–1962); S.V. Meyen (1966–1984); L.A. Fefilova (1966-1990) and S.V. Naugolnykh (1992–2014) studied the Permian flora of Pechora Cisuralia. However, it was specialists from Vorkuta who systematically studied the fossil plants and emphasized their stratigraphic and correlative potential. These studies were initiated by Kh.R. Dombrovskaya (1942–1984) and continued by S.K. Pukhonto, G.G. Manaeva and others.The results were used for stratigraphic schemes, establishing the synonymy of coal beds, and correlations with other regions. Permian deposits were mainly represented by continental deposits. Each stratigraphic subdivision has its floristic characterization. **Asselian Stage** – conifers and seeds of gymnosperms. **Sakmarian Stage** – Euramerican taxa. **Artinskian Stage** – close connection with Euramerican floras (up to 60 % shared genera and up to 30 % of species in common). **Kungurian Stage** – high taxonomic diversity, loss of connection with the Euramerican flora. The Bardian Assemblage is represented by conifers, ginkgoaleans, pteridosperms, peltasperms pteridosperms, equisetopsids, seeds of gymnosperms, etc .**Ufimian Stage** – the Solikamian Horizon in the stratotype is represented by lycopodiophytes (*Viatcheslavia vorcutensis*), ferns, cordaites, etc (*Intia, Kosjunia, Syrjagia*).The Sheshmian Horizon – ferns, pteridosperms, seeds of gymnosperms, in the north – new species of Vojnovskyales. **The Kazanian Stage** is subdivided into two substages. It contains numerous phylladoderms, pteridosperms, *Signacularia*, and W*attia*, characteristic of the Roadian deposits. **The Urzhumian Stage** has the same assemblage, but impoverished. **The Severodvinian and Vyatkian stages** have a similar *Tatarina* flora (*Pursongia, Tatarina, Aequistomia, Peltaspermum*, and *Quadrocladus*).

New perspectives on the candidate sections for the GSSP of the base of the global Gzhelian Stage in South China

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Idiognathodus simulator (Ellison, 1941) has been selected as the index taxon for the base of the global Gzhelian Stage, but its evolutionary origin remains unresolved. Conodont successions across the Kasimovian–Gzhelian (K–G) boundary interval have been investigated in detail at the Naqing and Narao sections in southern Guizhou Province, South China. Extremely rich conodont faunas were obtained from new collections from both sections. The conodont faunas are abundant and highly diverse through the K–G boundary interval in the Naqing section. *I. simulator* and related forms first appear in sample LDC 255.55~255.75m and range about 3 m upwards. The interval between 254 m to 255.55 m, which was previously regarded as a barren interval, contains numerous small elements that may be transitional in the lineage from *I. eudoraensis* to an unnamed species, then to *I. simulator*. The Narao section also contains abundant and diverse conodont specimens across the K/G boundary interval. Here, *I. simulator* first occurs at 229.61 m and ranges about 4 m upwards.

The *I. simulator* group is composed of several morphospecies that can be diagnosed using a few simple characters, as supported by landmark-based geometric morphometric analyses of collections from the Heebner Shale in Midcontinent North America, the type level of the species. This morphometric classification system can also be applied to conodonts across the K–G boundary interval in the Naqing and Narao sections. Additional information on the sedimentology, stable-isotope geochemical trends and fusuline faunas across the K–G boundary interval in these sections permits thorough characterization of potential levels for the placement of the base of the Gzhelian in South China. Thus, they are important for selecting the GSSP of the relevant boundary.

The Late Paleozoic basement of the West Siberian Plate

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The basement of the West Siberian Plate was uncovered by the Yangi–Yugan parametric well. There two geodynamic rock complexes are distinguished. Low complex is composed of intra ocean island arc's magmatites. It is combined with upper complex through Zone of mélange tectonically. The upper volcanic complex is a building of hotspot type, which is formed on an oceanic crust in the Early Carboniferous. That hotspot had stopped its activity at the Visean age. Carbonate and carbonaceous shale deposits were formed on the submersible denudation surface of the plateau. They were dated after algae and forams as deposits from the Early Carboniferous (Visean) to the Middle Carboniferous (Bashkirian) age. These data are consistent with isotopic dating of zircon for rock mass overlying Melange Zone. It was obtained for three concordant dates in the interval 337–352 million years (Tournasian–Visean age). In the carbonaceous shale deposits, which are covering the Yangi–Yugan Plateau, there are no clastic quartz grains. This fact indicates the existence of a vast ocean space around the plateau in the Visean. Thus, in contrast to previous views, it is proved the absence of blocks of Precambrian continental crust in oceanic space forming the basement of Western Siberia.

The earliest *Rugosofusulina* (Foraminifera) and their correlative potential

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The genus *Rugosofusulina* was described by D.M. Rauser-Chernousova in 1937 with type species *Fusulina prisca* Ehrenberg. Its distribution in the geological record spans the interval from the Late Carboniferous to the Early Permian. The earliest *Rugosofusulina* are of interest in connection with the characterization of the Kasimovian–Gzhelian boundary deposits. We have studied the highest Kasimovian deposits of the North Timan. *Rauserites* q*uasiarcticus*–*Triticites acutus* fusulinid Zone was recognized there. Species of *Quasifusulina* and *Rugosofusulina* dominate this assemblage. Numerous primitive *Rugosofusulina* ex gr. *prisca* (*R. ovoidea* Bensh, *R. exi*qu*a* Remizova, *R. pleiomorpha* Remizova) characterize the base of this zone. They are associated with weakly folded *Triticites* (*T. explanatus* Remizova, *T. simplex* Schellwien, *T. incomptus* Remizova and others). Additionally the presence of the original *Triticites (?)* with subsphaerical shells (*T. globoides* Z. Mikhailova and *T. tumefactus* Remizova) is inetersting. This Timan assemblage is similar to the *Rugosofusulina flexuosa* Zone assemblage described from north Greenland by V. I. Davydov. He considered this zone to be of the Early Gzhelian age. However, poorly preserved specimens of *Rauserites* have been recorded from the *Rugosofusulina flexuosa* Zone*.* Moreover, the nominate species, *Rugosofusulina flexuosa,* was described by S.E. Rosovskaya from the Carboniferous C3B beds (i.e., the Upper Kasimovian). Based on the nearly identical specific compositions of *Rugosofusulina* assemblages in northern Timan and north Greenland, we consider their correlation to be established. Since the age of the Timan Assemblage has been determined to be Late Kasimovian based on associated species of *Triticites* and *Rauserites*, we suggest the age of the *Rugosofusulina flexuosa* Zone in north Greenland is Late Kasimovian, too. The characteristic assemblage of primitive *Rugosofusulina* is very significant for correlation of the Upper Kasimovian strata, especially in the Arctic Province. The first appearance of this genus is dated as Late Kasimovian in many regions (Northern Timan, Timan–Pechora Basin, Urals, Precaspian, and Central Asia).

Current status of the International Carboniferous Time Scale

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The Carboniferous comprises the Mississippian and Pennsylvanian subsystems and Tournaisian, Viséan, Serpukhovian, Bashkirian, Moscovian, Kasimovian and Gzhelian stages in ascending order. GSSPs define the base (358.9 Ma; co-incident with Mississippian-Devonian [D–C] boundary) and top of the Carboniferous (298.9 Ma; co-incident with Pennsylvanian-Permian boundary). Bases of the Tournaisian, Viséan (346.7 Ma) and Bashkirian (323.2 Ma; co-incident with base of Pennsylvanian) are fixed by GSSPs, but the Devonian–Tournaisian boundary (defined by FAD of conodont *Siphonodella sulcata* in slope carbonates at La Serre, France) is being contested. The Subcommission on Carboniferous Stratigraphy (SCCS) is diligently searching for a more suitable index for the D–C boundary and another stratotype section for its GSSP. The FAD of foraminifer *Eoparastaffella simplex* defines the Tournaisian–Viséan boundary GSSP in the Chinese Pengchong section (carbonate turbidites). The basal Pennsylvanian GSSP, defined by the FAD of conodont *Declinognathodus noduliferus* s.l., lies in neritic carbonates at Arrow Canyon, Nevada, U.S.A. The FAD of conodont *Streptognathodus isolatus* defines the Gzhelian–Permian boundary GSSP in the Aidaralash section (shallow-shelf deposits), Kazakhstan. Formal proposals for indices to define the bases of the Serpukhovian, Moscovian, and Kasimovian stages have not been presented but should be prepared shortly because suitable taxa have been selected for most of these boundaries. The FAD of the conodont *Lochriea ziegleri* has been selected as a potential index for the base of the Serpukhovian (330.9 Ma). Carbonate-basin and slope successions in China and the Southern Urals of Russia are being intensively investigated for basal Serpukhovian GSSP candidates. Several conodonts have been proposed as indices for the basal Moscovian GSSP (315.2 Ma) but only FADs of *Diplognathodus ellesmerensis,* and *Declinognathodus donetzianus* have received substantial support from SCCS task-group members. Using the FAD of *D. ellesmerensis* for boundary definition, SCCS members are investigating several turbiditic carbonate sections in Guizhou province, China for potential basal Moscovian GSSP candidates. Of those sections, the Naqing section appears to have the best potential. FADs of the conodonts *Idiognathodus turbatus* and *Idiognathodus sagittalis* are considered to have the best potential for fixing the basal Kasimovian GSSP but a new option, the first occurrence of *Idiognathodus heckeli* in the lineage *Idiognathodus swadei–I. heckeli–I. turbatus*, is being considered. Carbonate slope deposits in the Naqing section of south China are being intensively studied and the FADs of *I. turbatus* and *I. heckeli* located. Documentation of the lineage containing *I. heckeli* in the Naqing section makes it a good potential candidate section for the basal Kasimovian GSSP. The FAD of the conodont *Idiognathodus simulator* s.s. has been ratified as the definition for the base of the Gzhelian (ca. 303.7 Ma). Slope successions in China and the Urals are being investigated for basal Gzhelian GSSP candidate sections. In sections containing ratified GSSPs and in sections being investigated for potential GSSP candidates, a multi-disciplinary approach is being used to facilitate global correlations.

Stratigraphy, sedimentology and inorganic geochemistry of the Late Famennian to Early Tournaisian Exshaw Formation, Canadian Rockies

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The Subcommission on Carboniferous Stratigraphy is searching for a better marker for the Devonian–Carboniferous (D–C) boundary GSSP than the present index, the FAD of *Siphonodella sulcata*. One potential marker being considered is the positive $\delta^{13}C$ excursion at the base of the late Famennian Hangenberg event at ≈ 359.5 Ma. The Exshaw Formation, spanning the D–C boundary at 358.9 Ma, is being studied because of its economic significance and to determine if the Hangenberg event is readily identifiable in southwestern Canada. The Exshaw is a thin (mainly < 20 m), widespread hydrocarbon source-rock unit constituting a second-order transgressive-regressive sequence that includes the underlying the Upper Costigan Member of the Famennian Palliser Formation and is overlain by transgressive black shale of the Tournaisian Banff Formation. Toward the east, the Exshaw and lower Banff pass into the Bakken Formation, a major conventional and unconventional oil producer in the Williston Basin. The Exshaw, deposited on the cratonic platform and in Prophet Trough, comprises a transgressive sharp-based black-shale member gradationally overlain by a regressive member dominated by silty carbonates grading into siltstone and sandstone. Because of lithofacies changes and unconformities, boundaries of the Exshaw and its members are highly diachronous. Conodonts and U-Pb radiometric data indicate the D–C boundary lies in the black-shale member at the Exshaw stratotype on Jura Creek near Canmore and in nearby sections. In the Canmore area, the black shale member, containing a lower non-calcareous shale unit with Famennian conodonts and an upper calcareous unit with Tournaisian conodonts, extends from the Famennian Middle to Upper *expansa* conodont zones into the lower Tournaisian *duplicata* to *sandbergi* zones. The non-calcareous shale unit is high in organic carbon, decreasing upward from 5.4 % at its base to 4.2 % near its top in the thermally over-mature (dry gas zone) Jura Creek section. In the calcareous shale unit, carbon decreases upward from 3.0 % to 1.3 %. At Jura Creek, the shale member is expected to contain the prominent positive $\delta^{13}C_{org}$ excursion of the Hangenberg event, widely recognized in Europe at the base of the Middle *praesulcata* Zone. However, $\delta^{13}C_{org}$ values gradually become more negative upward in the shale member, ranging from -27.9 ‰ $\delta^{13}C$ (V-PDB) at the base to -29.1 ‰ $\delta^{13}C$ at the top with only a minor excursion (+0.5 ‰) slightly below the top of the non-calcareous black-shale, the approximate D–C boundary position. Many sections of the non-calcareous shale unit contain beds of arkose and alkaline trachyte and trachyandesite tuffs that are of late Famennian age as indicated by U-Pb radiometric dates (363.4 to 358.9 Ma) and conodonts within the Middle *expansa* to *praesulcata* zones. Tuffs resembling those of the black-shale unit occur in the Exshaw siltstone member and black-shale of the lower Banff. The Famennian pyroclastics are alkaline and comagmatic with subalkaline (calc-alkaline) granites in the pericratonic Kootenay terrane that were intruded in a continental arc setting along the northwest margin of North America. Geochemically they do not closely resemble those intrusives and other known comagmatic intrusives in western Canada. The Exshaw black shale is anomalously rich in base metals including Ni, Zn, Mo, with values decreasing upward from the basal sandstone, which contains up to 9 % sphalerite and 2 % vaesite (NiS_2).

Volcanic ash and deep-water carbonates in Verkhnyaya Kardailovka section, South Urals, Russia: A candidate for the basal Serpukhovian GSSP

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The Verkhnyaya Kardailovka section is one of the best candidates for the GSSP at the base of the Serpukhovian. For boundary definition, the first appearance of the conodont *Lochriea ziegleri* in the lineage *Lochriea nodosa–L. ziegleri* is used. *L. ziegleri* appears in the Venevian regional substage of the Moscow Basin somewhat below the base of the Serpukhovian as defined by its lectostratotype by Serpukhov. In the Kardailovka section, the FAD of *L. ziegleri* lies within the *Hypergoniatites–Ferganoceras* ammonoid genozone. The boundary succession at Kardailovka comprises unnamed formations A to C, in ascending order, with the boundary lying in C. Upper formation A is grainstone, B is dominated by turbiditic volcanoclastics, and C comprises laminated to nodular deep-water limestone. Before 2010, the stylonodular limestone containing the boundary in formation C was well exposed but only 3 m of Viséan strata cropped out immediately below. Recent trenching exposed another 10 m of underlying Viséan carbonates in formation C and older Viséan volcanoclastics and tuffaceous shale to mudstone in formation B. The contact between formation B and underlying crinoidal lime grainstone in formation A, representing the Middle Viséan Zhukovian (Tulian) regional substage, was also excavated. The boundary succession, situated in the Magnitogorsk tectonic zone above the Devonian Magnitogorsk arc and Mississippian magmatic and sedimentary rift succession, was deposited in the Ural Ocean west of the Kazakhstanian continent. In formation B, turbiditic, well-indurated, Viséan siltstone and sandstone tuffs (feldspathic litharenite to arkose) are interbedded with bentonitic volcanic ash and smectite- and palygorskite-bearing shale and mudstone recording marked deepening after deposition of the neritic middle Viséan grainstone of formation A and subsequent subaerial exposure. The lower 4.02 m of overlying upper Visean and Serpukhovian formation C is dominated by hemipelagic, laminated lime wackestone to mudstone containing a pelagic grain association with radiolarians and cephalopods. The overlying 5.8 m of strata in lower formation C, including those in the boundary interval, are dominated by are deep-water stylonodular lime wackestone and packstone containing a pelagic radiolarian- and cephalopod-bearing grain association and elements of a heterozoan benthonic grain association dominated by crinoid debris. Lower formation C, deposited in a sediment-starved basin, contains several volcanic ash layers and one lying 1.5 m below the boundary gave a U–Pb date of $^{206}Pb/^{238}U$ of 333.87+/-0.08 Ma. Higher in the Serpukhovian, widely separated crinoidal turbidites occur and a carbonate mound shows: a massive ammonoid-rich core facies, flanking facies, and crinoidal capping facies.

New Data on Middle Permian Conulariids (Samara Region)

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In the Permian deposits of the Samara Region, conulariids (Conulatae) are occasionally encountered along with the remains of better-known fossil fauna, such as brachiopods, bryozoans and corals. They have been discussed in publications, but remain poorly studied and poorly known. The nature and mode of life of conulariids have not been completely ascertained. They are treated as the subclass Conulata, class Scyphozoa, phylum Cnidaria. However, there is another viewpoint linking them to pteropod molluscs. They are shaped like a tetrahedral conelet or a pyramidion. The thinnest chitin skeleton (periderm) is reinforced with calcium phosphate. There are longitudinal grooves in the corners and on the edges. The latter are covered with straight or chevron-like transverse grooves and fine openwork patterns.

As for their mode of life, conulariids have been treated as both benthic and planktonic organisms. Some of them had tentacles and swam like jellyfish, while others were attached to the ground, as indicated by some sort of accretion heels. Perhaps, this is indicative of the alternation of medusoid (sexual) and polypoid (asexual) generations, which is characteristic of Cnidaria.

During our 2014 field-work, we succeeded in assembling a representative collection of fossils from two sections of the Lower Kazanian Substage of the Middle Permian. One section is located near the Rezyapkino Village, the other is in a Baytugan quarry. Within the laminated limestone, brachiopods, bryozoans, corals, bivalves and conulariids have been found. Of the latter, the majority of specimens represent flattened prints, which is unsurprising considering the thin flexible wall of the skeleton. Neither a volumetric specimen nor a cross-sectional sample demonstrating four-rayed symmetry have been discovered. In the Baytugan quarry, some limestone plates were found that contained conulariids randomly scattered on the bedding surface. Their cone dimensions are commonly 8–10 cm.

One of these plates contained conulariids in an unusual, previously unknown position. Four conulariid cones were arranged as a rosette, tapering cones were directed centrally, nearly approaching each other, and probably accreting. Unfortunately, the central part of the cones is missing. Almost half of the rosette is preserved, consisting of four conulariids. In the complete sample, there should have been nine or ten. It may be suggested that during their lifetime (*inter vivos*) these conulariids settled on the seabed, "growing up" from a common center, most likely, being attached to any couch (a disk?). This indicates not only a benthic mode of life, but also a colonial one. This is the first time a discovery of this kind has been made. Until now, a only solitary conulariids have been found, with disks for attachment to the bottom. This finding sheds new light on the mode of life of benthic conulariids, among which individuals were apparently naturally grouped into colonies.

The Permian–Triassic boundary in Western Tethys: stratigraphic and paleontological record from the Catalan Pyrenees (NE Spain)

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A continental Upper Carboniferous–Permian and Lower–Middle Triassic (Buntsandstein) succession up to 2000 m thick of predominantly reddish siltstones, sandstones and conglomerates with subordinate volcanic and volcaniclastic rocks, wonderfully crops out in the southern border of the Pyrenean Axial Zone and is preserved in a series of small sub-basins. Recent field-work focused in the Middle–Upper Permian and Lower–Middle Triassic deposits of the Catalan Pyrenees (Gramós Basin) provided new stratigraphic information and new paleontological discoveries, among which tetrapod footprints, vertebrate fauna and palynomorphs.

The aim of this research is to better constrain the Permian–Triassic boundary in this area on the basis of a revision of the stratigraphic framework and the paleontological record, a detailed facies analysis and on the new (bio)chronologic data.

The Upper Paleozoic paleontological record remains are poor but a single vertebra attributed to a large amniote was found in the uppermost unit of the Permian Sequence (Upper Red Unit). This is the first amniote body fossil found in the Middle–Upper Permian of the Iberian Peninsula.

Concerning the ichnoassemblages, the Buntsandstein deposits yield a rich association of Triassic tracks, dominated by *Rhynchosauroides* (up to four morphotypes), and in lesser way chirotheriids. The ichnospecies in most cases could not be assessed with confidence due to the lack of diagnostic features. Anyway, the presence of potential *Rhynchosauroides* cf. *schochardti*, as well as *Prorotodactylus-Rotodactylus*, suggests a late Early Triassic–Early Middle Triassic age.

In the Buntsandstein facies, also some small bone fragments probably of the early tetrapods Stereospondyls were found, representing the first direct remains of the Pyrenees. They enlarge the faunal association from the ecosystem, as no temnospondylian footprints were yet found. The presence in the Buntsandstein basal beds of a sporomorph assemblage with different types of lycopod spores as *Endosporites papillatus* and *Densoisporites nejburgii*, as well as other bisaccate pollen type as *Voltziaceaesporites heteromorpha*, and various taeniate bisaccate pollen as *Lunatisporites* or *Protohaploxipinus*, allow to ascribe this association to a late Olenekian age.

Finally, the comparison of the Pyrenean bio-stratigraphigical data with nearing Permian and Triassic basins (i.e., from Spanish Cantabrian Mountains, Northern Italy, Northern Morocco, Southern France and Sardinia) shed light not only on the transition from Permian to Triassic periods, but also on the paleobiogeography of the Western peri-Tethian domain.

The Lower Permian continental basins of the Southern Alps (Italy) revisited: Palaeoenvironments, fossil record and correlation at the Western Paleoeuropean scale

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In the Southern Alps the late Cisuralian cycle 1, or lower tectono-stratigraphic unit (TSU1), lies unconformably over the Variscan crystalline basement and ranges up to a maximum thickness of more than 2,000 m. It starts with polygenic conglomerates, interbedded with sandstones and finer-grained clastics (Basal Conglomerate, Ponte Gardena Conglomerate) but mainly consists of calc-alkaline acidic to intermediate volcanic rocks (namely Cabianca volcanite, Lower Quartz Porphyrs, Auccia Volcanics and Atheshian Volcanic Group), and fluvio-lacustrine continental deposits (such as Pizzo del Diavolo, Collio, Tregiovo fms. and Dosso dei Galli Cgls.), both infilling intramontane fault-bounded, transtensional subsiding basins, isolated from each other by metamorphic and igneous structural paleo-highs.

Many studies have dealt with the stratigraphic and paleotectonic reconstruction of such sedimentary basins which are, from W to the E: the Orobic, Collio, Tione and Monte Luco-Tregiovo basins. Otherwise, a few research was devoted to deepen the knowledge on their terrestrial environments as well as the interrelations of which with their vertebrate/invertebrate ichnological record.

The final aims of our study are: i) revise and make insights on the depositional, palaeoenvironmental and climatic evolution of these basins (mainly on the Orobic and Collio) through an integration of palaeontological data and facies analysis; and ii) the regional correlation of key stratigraphic successions to other coeval ones in the Western peri-Thethys, particularly on the basis of their ichnofauna associations.

The opportunity to study material from different localities, with considerations on the relative proportion between ichnotaxa, footprint preservation and detailed facies analysis, permitted some palaeoecological and palaeoenvironmental inferences.

With respect to previous studies, different tetrapod ichnoassociations were identified in the different basin-fill and lists the following taxa: *Batrachichnus*, *Limnopus*, *Amphisauropus, Erpetopus, Varanopus, Hyloidichnus, Dromopus*, corresponding to temnospondyl amphibian, seymouriamorph reptiliomorph, captorhinomorph and diapsid reptile trackmakers. This ichnofauna is characterized by the prevalence and diversity of eureptile footprints, indicative of a late Cisuralian age in the low-latitude panorama of Pangaea. The relative proportion of the taxa suggests also a facies-controlled ichnoassociation, suggesting different life habits of the trackmakers.

Initial analyses regarding the invertebrate trace fossil association, highlighted an unexpected diversity and the prevalence of arthropod tracks and surface grazing trails, indicative of alternating Mermia and Scoyenia ichnofacies.

Some uncertainties, and new possibilities, for a graphostatistical method of element analysis (in coals)

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This report attempts to clarify the patterns of generation of methane (and carbon dioxide and humidity) in the process of peat and coal formation. Methane is especially interesting in this regard, as it greatly complicates coal mining. There is much evidence to assume that the process of coalification is accompanied by an increase of the carbon content (and a decrease in the hydrogen and oxygen content), resulting from the cleavage of methane, carbon dioxide and water. Before solving the problem of coalification fluid generation during metamorphism, it is necessary to clarify the range of allowable values for the whole range of metamorphism from peat to superanthracite. The complexity is faced by classification on the basis of their element composition (the inversion of gas generation capacity with carbon dioxide to methane is an especially interesting area). In this regard the evolution of coal organic matter is shown from a new angle. The metamorphism of organic matter and formation of coalification fluids (not just methane) should be considered as two sides of a single and indivisible process. Petrographic composition, gradation of metamorphism and oxidation of organic matter determine the chemical nature of peat and coal, but they do not give information about caking. The change of the Leifman–Vassoevich coefficient indicates parameters that characterize the sintering behavior of the coal seam. Graphostatistical analysis shows the very simple but, nevertheless, important information that in the Krevelen coordinates (or Leifman–Vassoevich coefficient) the volatile products of peat – and coalification are represented by straight lines. If the substance of CCHHOO loses water (despite the fact that the atomic ratio H/C=y and O/C=x), dehydration would be a straight line H2O=2x + (h-2o)/c, i.e. straight lines, with constant slope equal to 2. These straight lines, corresponding to the dehydration of coal, pass through the characteristic area coinciding with the main technological (caking) properties of coal. Thus, the Krevelen and Leifman–Vassoevich diagrams clearly demonstrate that the graphostatistical straight lines of fluid are at ыthe same time the parameter of inversion of the gas generation potential of coals.

Carboniferous–Permian Ocean Plate Stratigraphy of Central and East Asia: A key for reconstructing the history of Pacific-type orogens

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Ocean Plate Stratigraphy (OPS) implies a regular succession of igneous and sedimentary rocks of the oceanic lithosphere, which were, respectively, erupted and deposited on the sea floor as the underlying oceanic basement traveled from the mid-oceanic ridge to the subduction zone. During oceanic subduction, OPS units are incorporated into accretionary complexes (ACs) of Pacific-type (P-type) orogens. A typical OPS succession includes (i) pelagic chert often associated with MORBs; (ii) hemipelagic siliceous shale, greywacke and mudstone; and (ii) trench turbidites. Five types of OPS, which formed at different distances from the trench and detached along the decollements at variable depths, were recognized in ACs of Japan, which is a world type locality of P-type orogens. Type 1 consists of turbidite and shales and may form over the younger oceanic crust and detach from a shallow decollement. Type 2 includes turbidite, shales, and chert; Type 3 includes the same sedimentary rocks as Type 2 plus MORBs and Type 4 additionally includes gabbros. Type 5 OPS is special as it forms on oceanic islands / seamounts and includes OIBs capped by carbonates, epiclastic slope facies and foothill shale and chert. Type 5 OPS is typically indicative of mature oceanic plates moving over hot spots related to mantle plumes.

The oceanic subduction formed numerous P-type orogens and ACs of Central and East Asia. The Carboniferous–Permian (C–P) OPS units are of special importance as they record the final stages of the Paleo–Asian Ocean (PAO), which once separated Siberia, Kazakhstan, Tarim and North China, and the early stages of the Pacific Ocean (PO), which subduction under East Asia started back to 300 Ma and is still continuing. The C–P OPS units of Central Asia are hosted by ACs of East Kazakhstan (Types 4, 5), Junggar (Type 4) and Inner Mongolia (Types 4, 5) formed during the closure of the PAO. The age of OPS is typically constrained by microfossils, e.g., the Char limestones contain Mississipian conodonts.

The C–P evolution of the PO formed the Khabarovsk and Samarka ACs of the Russian Far East and their probable analogues in SW Japan, Akiyoshi and Mino-Tamba ACs, respectively. The Akiyoshi OPS includes a large reef limestone sequence, the Pennsylvanian-Permian age of which was constrained by mollusks, corals, fusulinids, and conodonts. The Mino-Tamba limestones and cherts contain Pennsylvanian–Guadalupian fusulinids and Cisuralian radiolarians, respectively. The PO ACs of Japan host OPS Types 2 and 5 suggesting subduction of at least two oceanic plates.

Thus, the model of OPS allows the full history of the oceanic plate to be traced from its “birth” at mid ocean ridges to its “death” at subduction zones and to reconstruct (i) relative ages of oceanic plate and ACs; (ii) subduction polarity; (iii) tectonic setting; (iv) volcanism settings. Ignoring the model of OPS may result in wrong interpretation of even seemingly coherent sediments hosted by ACs. Therefore, study of relationships between magmatic and sedimentary OPS is a reliable method for understanding the present structure and past history of ACs and P-type orogens.

The C–P OPS of Asia is of key importance as it recorded a period of global tectonic reconstruction: collision of major cratons of Asia, i.e. Siberian, Kazakhstan, Tarim and North China, formation of the Central Asian Orogenic Belt and amalgamation of Laurasia, the future core of the Asian continent. Contribution to IGCP 592.

Lithology of Pennsylvanian skeletal mounds, Shchuger River, Subpolar Urals

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In the Shchuger River Basin, the bioherm deposits occur in the Moscovian–Kasimovian outcrop of the “Verhnie vorota”. Their thickness is 89 m. The bioherm structure includes biocementolites (terminology from Antoshkina, 2008), grainstones, microbialites, mudstones and rudstone. *Biocementolites* are limestones with rich encrusted structures. Morphologically, they comprise massive bodies of complex construction that combine parts of different limestones, but with an apparent predominance of biocementolites. The main structural components of this type of limestone are brachiopods, bryozoans and remains of phylloidal algae. In the composition of the rocks, there are *Tubiphytes* and thin bacterial films around bioclasts and fragments of algae *Anchicodium* and *Ivanovia*. The *grainstones* are primarily composed of the large and coarse bioclastic sediment. The size of the organic components typically ranges from 0.5 to 3 mm. Depending on the composition of the bioclasts these lithofacies are divided into crinoidal, bryozoan-crinoidal, brachiopod-bryozoan-crinoidal and bryozoan types. The *microbialite* consists of assemblages of microbial lumps and clots. These rocks are composed of a small proportion of microbioclastic material (10 %) and a single colony of *Tubiphytes*. The cement of the lump-clots areas is a fine-grained sparite, and encrusting calcite around *Tubiphytes*. The *mudstones* are composed of cryptocrystalline calcite with a small admixture of quartz silt and small grains of pyrite (3 %). This facies is characterized by horizontal lamination and massive structure. Sometimes there are ill-defined textures of trace-fossils.

The *rudites* are divided into small-fragmental breccias and bio-lithoclastic gravelite. The first of them consists of small (<5 cm) weakly rounded fragments of laminated mudstones, bioclast-microbial limestones and phylloid-algal biocementolites. Bio-lithoclastic gravelite is formed by approximately equal amounts of angular fragments of biocementolites (1–2 cm) and mainly crinoid bioclasts of the same size. Two bioherms can be recognized in the studied section. The first, 14 m thick, with “patchwork” texture, was formed at the end of the Podolskian (Moscovian Stage).

Crosswise and along the strike the alternation of areas (1.5–2 m) having different coloring and structural features are observed. There are fields of phylloid-algal biocementolites, levels of mud and rudites. This buildup conforms to the type of phylloid-algal skeletal mounds. The second Moscovian–Kasimovian buildup is also a skeletal mound. In our interpretation, it belongs to the algal-bryozoan type. This buildup has a similar texture, but greater thickness — 32 m. The base of the mound was formed by the phylloid-algal limestones, and the rest is composed of the algal-bryozoan biocementolites.

Late Palaeozoic biodiversity and palaeoclimatic significance of the coal forming flora of Singrauli Coalfield, Son-Mahanadi Basin, India

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Permian Gondwana deposits of Singrauli Coalfield constitute an important part of Son-Mahanadi master Basin of Peninsular India. This coalfield embodies the last deposits of the Gondwana sedimentation and has distinction of having the thickest coal seam (Jhingurdah seam – 130 m) in India. The coal measures are restricted to the Barakar (Artinskian–Kungurian), and Raniganj (Lopingian) formations. With the exception of two preliminary studies, the coalfield has never been investigated for the macrofloral aspects. Recent studies have yielded diverse assemblage comprising of dispersed leaves, branched axes and significant record of spore tetrads in the palynoassemblage recovered from different lithologies of Barakar Formation and leaves and in-situ preserved roots from Raniganj Formation. In the present paper an attempt has been made to systematically analyze and depict the palaeofloristics, evolutionary trends, and their palaeoenvironmental significance in the Singrauli basin. Complete megafloral assemblage consists of five genera with 26 species representing four orders viz., Equisetales (*Paracalamites*), Cordaitales (*Euryphyllum*), Cycadales (*Macrotaeniopteris*) and Glossopteridales (*Glossopteris* and *Vertebraria*). The order Glossopteridales is highly diversified with 23 taxa and the genus *Glossopteris* with 22 species dominates the flora. Most of the megafossils are found preserved in the grey shales and mudstones. Preserved *Glossopteris* leaves in the Raniganj assemblage exhibit microphyllous nature, mostly intact and are found in thick mats with little matrix that can be attributed to physiological response to semi-arid conditions prevailing in the area during Lopingian or edaphic factors. Such non-congenial climatic conditions did not allow the Glossopterids to blossom as is evidenced by the fact that the entire flora is completely devoid of fructifications. The absence of the groups Lycopodiales, Sphenophyllales, Filicales, Ginkgoales and Coniferales in the assemblage indicate that this palaeogeographic region might not be adequately cool and humid to facilitate the growth of these shade loving under storied plants. Exceptionally well preserved *in-situ Vertebraria* roots (20 to 45 cms in height), penetrating through the sedimentary layers are also recorded from the thinly laminated siltstone horizon near to the carbonaceous shale and mud stone bed accommodating the dispersed fossil leaf assemblage. The attitudes of the *Vertebraria* roots in relation to the sedimentary layers demonstrate that the roots were preserved at their original place of growth. The findings of *in-situ* roots with other macrofloral elements indicate both autochthonous as well as allochthonous preservation at the same place. In addition, the first record of dispersed naked spore tetrads from Lower Barakar strata (Artinskian) has led to envisage the factors responsible for the formation of spore tetrads and their correlation with extreme cold climatic conditions.

Late Carboniferous to Early Triassic non-marine–marine correlation – ideas, tasks, perspectives

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The Carboniferous, Permian, and Triassic time scales based on marine rocks and fossils are well defined and of global utility. The opposite is the case for nonmarine deposits of this time frame. Caused by the Carboniferous–Permian glaciation, the Hercynian orogeny, and plate tectonics a huge number of mixed marine-continental and especially of pure continental basins from tens to thousands of square kilometres in size emerged. Apart from economic importance (coals, hydrocarbons, salt, fire clay, etc.) those basins record the interplay between extrinsic and intrinsic processes, i.e. from orbital cycles and climate to volcano tectonics and sedimentation as well as the evolution of biota and environment, including the most severe mass extinctions in earth's history. During last decades a variety of bio- and chronostratigraphic methods has been developed and successfully applied in order to correlate continental deposits locally (intra-basinal) and regionally (inter-basinal).

Intercontinental correlations and especially correlations with the Global Marine Standard Time Scale are still at an early stage. To overcome this disappointing situation, in agreement between the International Subcommissions on C, P and T Stratigraphy a Non-marine–Marine Working Group was established. Following the example of Menning et al. (2006) Devonian–Carboniferous–Permian Correlation Chart 2003, a "Pennsylvanian–Permian–Early Triassic Non-marine–Marine Correlation Chart" should be compiled by this working group. Geoscientists from all continents are requested to provide contributions covering any stratigraphic tool. Included basins should be characterised by their geotectonic and palaeogeographic position, lithostratigraphical subdivisions, depositional environments, paleoclimate information, resources, and of course the tie points for inter-basinal and global correlation. A first call for cooperation in this working group was published in Permophiles 60, 2014, a more detailed one with instructions and an example of the description of a specific basin with all required data will follow in Permophiles 61, 2015. First results will be presented during the ICCP 2015 in Kazan.

Two Late Palaeozoic fossil-Lagerstaetten compared – inland lake, Souss Basin (Kasimovian, Morocco) and coastal plain ponds, Carrizo Arroyo (Early Permian, New Mexico)

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In contrast to the highly diverse earliest Pennsylvanian (Bashkirian) marine insect fossil-Lagerstaetten of Ningxia, China, and Hagen-Vorhalle, Germany, Middle Pennsylvanian to Early Permian insect sites are worldwide dominated by cockroachoids. Most of them are situated in the roof shales and interbeds of coal seams (e.g., Mazon Creek, Writhlington, Commentry, Wettin, Kuznetsk, etc.). Exceptions are the Artinskian Obora pond locality in Czech, the Kungurian lacustrine Wellington shales of North America, and Chekarda in Russia, with higher diversities. Two new fossil-Lagerstaetten may change this picture: the earliest Permian Carrizo Arroyo site in New Mexico, investigated during the last decade, and the newly discovered Late Pennsylvanian fossil sites of the Souss Basin, Morocco. Both of them offer, besides insects and plant fossils, a relatively wide spectrum of other invertebrates and vertebrates. Both do not belong to coal-forming peat environments, and share some similarities, but differ from one another considerably in their depositional environments. This raises some basic issues ranging from taphonomic biases to the habitat preferences of Late Palaeozoic arthropods in general. Carrizo Arroyo is interpreted as coastal plain deposits on a very shallow shelf during repeated trans- and regressions. Transgression built up carbonate ramps that, during the following regressions, were subaerially exposed and eroded. Fossiliferous greenish-greyish mudstone-siltstone-sandstone sequences were deposited in a very low-gradient depositional environment as overbank deposits of an anastomosing system. Beds with large plant leaves and fronds originated during falling flood. The insect beds were formed in ponds on floodplains at the very end of a flooding event, when the finest material started to settle down in quiet water. Ponds must have existed for weeks, if they contain only conchostracans and monurans, to complete their life cycle. If freshwater bivalves occur, a standing time of these ponds of several months could be assumed. Eurypterids of all ontogenetic stages are common. Fish and tetrapod remains are rare in the sequence. The dominance of conifers points to a dry hinterland of a coast with a maritime climate. The fossiliferous formations of the Souss basin consist of gray, alluvial plain sediments with fluvial sandstones, lacustrine black shales and (locally) decimeter-thick coal seams. The depositional environment is interpreted as an extensive low relief braid plain with lakes and ponds. Common load casts indicate event-like sediment shedding. This is well supported by storm flood ponds filled with large conifer twigs. Desiccation cracks are rare; stigmarian roots and thin dirty coal seams point in places to high ground water levels. Terrestrial and aquatic insects are very common in the black, clayey tops of centimeter-thick, silty, upward fining successions. Fishes are very rare. Tetrapod tracks are common. The flora consists of a mix of hygrophilous and meso- to xerophilous elements (conifer dominance), indicating wet stands in a generally semihumid environment with dry, well-drained hinterlands.

Late Palaeozoic wet red beds – dry red beds: How to distinguish them

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Long term field studies of Pangean Late Palaeozoic deposits suggest that there are two types of continental red beds: wet and dry ones. Wet red beds are characterized by the following litho- and biofacies markers, which can be observed in fine-grained overbank deposits of alluvial plains and floodplains:

1. Planar to weakly flaser bedded red-brown to red, sandy or clayey siltstones with abundant burrows of *Scoyenia* and / or *Planolites.*

2. Bed-scale pedogenic overprinting by *in situ* micro-brecciation (mm- to cm-scale), pedogenic slickensides and colour mottling (vertisols).

3. In places, mm-thick, mainly horizontally arranged and branched root systems.

4. Calcic soils of different maturity, ranging from mm- to dm-sized calcareous nodules and rhizoconcretions up to massive, plugged calcrete horizons.

5. Rarely, dm-thick lacustrine micritic limestones with ostracods, gastropods, characeans and, in places, isolated vertebrate remains (fishes, temnospondyls).

6. Channel sandstones and conglomerates that may be leached to bright reddish and whitish-greenish because of paleo-groundwater flow.

7. Desiccation cracks (cm-sized), raindrop imprints, microbially induced sedimentary structures.

Wet red beds are indicative of semihumid to semiarid climates with seasonal wet and dry conditions. Evaporation is higher than precipitation, allowing the formation of calcic soils. Seasonal high groundwater levels allowed for sparse vegetation, which is merely documented by the root structures. The flora was dominated by conifers, but “wet spots” with elevated and stable groundwater levels can contain diverse, hygrophilous floras. In the paleo-equatorial belt, these kind of red beds were first widespread in the Westphalian D after the Westphalian C/D wet phase A (Schneider et al., 2006; Roscher & Schneider, 2006) and can be observed in all the succeeding dry phases up to the intensive aridization during the late Early Permian, when they are increasingly replaced by dry playa red beds.

Dry red beds are characterized by the following litho- and biofacies markers, which are observable in fine-grained deposits of braided plains and floodplains:

1. Red, horizontally bedded to laminated silt- and claystones with rare or no invertebrate burrows; partially mass occurrences of arthropod tracks, freshwater jellyfish, conchostracans and triopsids; microbially induced sedimentary structures are common.

2. Bed-scale pedogenic overprinting by in situ micro-brecciation (mm- to cm-scale), pedogenic slickensides and common dm- to m-scale pseudanticlines.

3. Haloturbated mudstones, patchy sand-fabric, gypcretes, evaporites and residual horizons of evaporites, gypsum and halite pseudomorphs.

4. Eolianites ranging from sand flats to dune sands; ideally rounded coarse sand grains arranged in single-grain caviar-sand laminae or interspersed in other clastics.

5. Common and often stacked desiccation cracks, in places meter-long mega-desiccation cracks; common raindrop imprints; water level marks in pond or pool deposits.

New data on conchostracans from the Zechstein and Lower Buntsandstein in Germany used for biostratigraphic correlations with continental Permian–Triassic boundary sections in Russia and China

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Conchostracans (Crustacea: Spinicaudata) play a crucial role in biostratigraphic correlations of continental Permian–Triassic transitional sections. The Late Permian conchostracan record in the Zechstein basin of Germany is rather poor, due to extreme palaeoenvironmental conditions of a sabkha facies in alternation with hypersaline marine deposits. So far, new findings of conchostracans from the Zechstein Group are restricted to the upper Fulda Formation in the Caaschwitz key-section in central Germany and taxonomical determined as *Palaeolimnadiopsis*. The conchostracan fauna of the overlying Buntsandstein Group is currently reinvestigated by studying collection material from a former drill site at Billeben in Central Germany. The preliminary results indicate occurrences of *Euestheria*, *Cornia*, *Estheriella* and *Magniestheria* in the Buntsandstein interval of the Billeben drill core. In order of correlating the sections in Central Germany with the Permian–Triassic boundary of the international stratigraphic scale, respective taxa are used for comparison with new collected conchostracans in both pure continental and mixed marine-continental Permian–Triassic boundary sections in Central Russia, Southern China and North-Western China. In particular, occurrences of certain species such as *Euestheria gutta* in Germany, China and Russia demonstrate their wide palaeogeographical distribution on Northern Pangaea. This indicates the high value of conchostracans for correlating continental Permian–Triassic boundary sections.

The position of the Permian–Triassic boundary in continental sections of Northern Pangaea: First results from a non-marine–marine correlation project

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Correlating the Permian–Triassic boundary in continental and mixed continental–marine profiles in Germany, Poland, Hungary, Russia and China is currently a research project at the Geological Institute of the Technical University Bergakademie Freiberg. The studied sections represent different palaeoclimatic and geotectonic settings on the northern hemisphere of Pangea. The aims of the project are both establishing a fine-scale multistratigraphic framework and the reconstructions of local to global geologic processes related to the end-Permian mass extinction.

In Central Germany the lithostratigraphic Zechstein and Buntsandstein Groups have been studied for conchostracan biostratigraphy and C_{org}-, C_{carb}-, O_{carb}-isotopes. For the first time, the Nelben section and a core from a drill site at Caaschwitz were analysed for major- / trace-elements. New measurements of palaeomagnetics were carried out in a current key-section at an active quarry at Caaschwitz. A prominent change in the sedimentary facies as well as a shift in C_{org}-isotopes and the first occurrence of the conchostracan *Palaeolimnadiopsis vilujensis* were recorded in the upper Fulda Formation of the Zechstein Group, which are associated with a gradually lithofacies change from a decrease in palaeosoils (vertisol) to an increasingly developed lacustrine facies consisting of clay- to sandstones with internal lenticular and flaser bedding.

In Hungary two mixed continental / marine Late Permian to Early Triassic sections were studied: a railway cut at Balatonfüred and the Vadvirag road cut in Balatonalmádi. Both sections expose the alluvial Balaton Red Sandstone (Balatonfelvidék Formation) overlain by yellowish green, flaser and lenticular bedded silt- to sandstones (Nádaskút Dolomite Member) of a coastal plain facies. At their top the sections consist of oolitic sand-, lime- and dolostones. Both sections have been sampled for palaeomagnetic measurements. The complete section at Balatonfüred was analysed for isotopes, major- / trace-elements and micropalaeontology, while a bed-by-bed profile documentation proofed an absence of conchostracans.

In Central Russia continental deposits from the Obnora and Vokhma Formations in ravine sections near Vyazniki and Gorokhovets provide a continuous Late Permian to Early Triassic profile. The new recorded conchostracan fauna consist of *Cornia germari*, *Magniestheria mangaliensis*, *Euestheria gutta*, *Palaeolimnadiopsis vilujensis* and *Rossolimnadiopsis* sp. in the respective Early Triassic section intervals. The fauna suggests biostratigraphic correlations with the conchostracans in Central Germany. A similar faunal composition was also preliminary recorded in northwest China during recent field campaigns in the continental Permian–Triassic boundary sections at Dalongkou and Tarlong. Moreover, *Euestheria gutta* was also new sampled from key-sections in South China, which are directly correlated with the marine Permian–Triassic boundary. In result, the first new data indicate the importance of conchostracan biostratigraphy for correlating continental Permian–Triassic boundary sections.

Replacement of the dominant groups of tetrapods at the turn of the Permian and Triassic

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Several diverse and stratigraphically successive faunas and floras are known from the Middle Permian to Middle Triassic of Eastern Europe. The unique Permian and Triassic tetrapod materials from Russia are very important for resolving of the problem of the appearance and basal divergence of the archosaurs and replacement of therapsids by diapsids as the most important component of ecological crisis at the Paleozoic–Mesozoic boundary on land.

The unique and diverse biotic complex of Terminal Permian, including vertebrates, invertebrates and plants, was discovered in vicinity of Vyazniki Town (Vladimir Region, Central Russia) and in several other localities. Vyazniki terrestrial community demonstrate the transitional character between the Permian and Triassic ones, and represent the last, so far unknown stage of the global ecological crisis of continental biota on the PTB. The presence of the earliest all over the world Late Permian archosaurs in the Vyazniki fauna is the most important. A new basal archosaurian carnivores – *Archosaurus rossicus*, coming from the subdominant diapsid-anapsid community, increased in size and became the top predator in the first thecodontian-dicynodontian dominant community at the Vyazniki time only after the extinction of previous top carnivores – gorgonopians. After disappearing of huge pareiasaurs among the most common herbivores in Vyazniki community we known dicynodontids, medium-sized elgiinid parareptiles are rare. The aquatic Vyazniki community with most common brachyopoid temnospondyls, seymouriamorph parareptiles and chroniosuchian anthracosaurs is more conservative, similar to the previous Sokolki Assemblage.

In Western Europe (Italy) are known basal archosaur footprints (*Chirotherium*) in Terminal Permian deposits. This means that there archosaurs probably replaced gorponopians before PTB.

In South Africa Terminal Permian tetrapod community we don’t know basal archosaurs. But first lystrosaurs appeared before BTB and co-existed with the last dicynodontids and last gorponopians. Pareiasaurs disappeared some time before PTB. Archosaurs replaced gorponopians only on PTB.

Replacement of the dominant groups of the tetrapod at the turn Paleozoic and Mesozoic was associated with global ecological crisis and occurred gradually and in stages, not competitive, but alternatively, with endemic peculiarities on different continents.

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Marine productivity changes during the Permian–Triassic boundary crisis and Early Triassic recovery

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The Permian–Triassic boundary mass extinction coincided with major changes in the composition of marine plankton communities, e.g., a large increase in bacterio- plankton, yet little is known about concurrent changes in primary productivity. Earlier studies have inferred both decreased and increased productivity in marine ecosystems following the end-Permian crisis. Here, we assess secular and regional patterns of productivity variation during the crisis through an analysis of the burial fluxes of three elemental proxies: total organic carbon (TOC), phosphorus (P), and biogenic barium (Ba_{bio}). Primary productivity rates appear to have increased from the pre-crisis Late Permian through the Early Triassic in many parts of the world, although the South China craton is unusual in exhibiting a pronounced decline at that time. Most of the 14 Permian–Triassic study sections show concurrent increases in sediment bulk accumulation rates, suggesting two possible influences on marine productivity: (1) more intense chemical weathering on land, resulting in an increased riverine flux of nutrients that stimulated marine productivity, and (2) higher fluxes of particulate detrital sediment to continental shelves, enhancing the preservation of organic matter in marine sediments. An additional factor may have been intensified recycling of bacterioplankton-derived organic matter in the ocean-surface layer, reducing the export flux rather than primary productivity *per se*. The ecosystem stresses imposed by elevated fluxes of nutrients and particulate sediment, as well as by locally reduced export fluxes of organic matter, may have been important factors in the ~2- to 5-million-year-long delay in the recovery of Early Triassic marine ecosystems.

Permian GSSPs: Progress and problems

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Six GSSPs in the Permian have been defined, three remain to be defined. Although great efforts have been made, no consensus for the remaining GSSPs has been reached so far. The most important point to understand a GSSP is that the boundary at a stratotype is defined at the level of a single stratigraphical signal, that is the FAD of the index taxon. However, accurate chronocorrelation actually requires the evaluation of multiple, varied stratigraphic signals (e.g., the lowest occurrence of a specific taxon, an isotopic negative excursion, a high-precision date, a palaeomagnetic reversal, distinct sea-level change, etc.) rather than relying solely on a single signal, such as that on which the level of the GSSP was placed. This is because all the first occurrences for any taxon are diachronous in different sections. It is plausible to select the index taxa with short ranges and to have more additional signals to define a GSSP.

Currently, we face problems in the Cisuralian potential GSSP candidates. The Sakmarian-base candidate at Usolka is relatively better than others because quite a few high-precision dates and high-resolution isotope chemostratigraphical profile are available in addition to the conodont lineages. However, it is not consistent for the conodont lineage we should choose. The Artinskian-base GSSP at Dalny Tulkas is not very ideal. It needs to be investigated in more detail if the lineage of the defined species *Sweetognathus* aff. *whitei* is present or not. Isotope chemostratigraphy is not reliable at the section because the rocks contain low carbonates and high organic materials, and suffered substantial diagenesis. The correlation and taxonomy of the defined species is still controversial. It is not clear whether the first occurrence of the defined species at the Dalny Tulkas section represents the FAD of the species or not. The Kungurian-base candidate at Mechetlino sections is defined by the FAD of *Neostreptognathodus pnevi* only, no other signal is available.

In addition, the three defined GSSPs of the Guadalupian Series in Texas, USA need more investigations and data to support their definitions and correlation value. Little progress has been made for the base of the Permian System since it was defined at Aidaralash, Kazakhstan in 1998.

Fusulinid study with the assistance from geometric morphometrics

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Test of fusulinids, one of most important Carboniferous and Permian fossil foraminifera, keeps the developmental record during their lifespan, and therefore is not only essential for their taxonomy, but also a proxy access to their probable lifestyle.

Most morphological characters, including size, shape, inner structures, of the fusulinid test could be digitized, and further, the changes concerning these characters through the successive whorl stages during their lifespan could be quantified by a variety of geometric morphometric methods, to reveal not only the potential allometric development, but also the indications concerning their palaeobiology, palaeoecology and palaeobiogeography.

An example of ontogenetic form change of Permian pseudoschwagerine and schwagerine genera has been studied through this procedure. Significant developmental life stages were recognized with regard to the size and shape change of their tests, and the adult spherical stage of pseudoschwagerine genera probably benefit their dispersal. The patterns of ontogenetic shape trajectory among different genera are distinct from each other, indicating distinguish developmental histories and meanwhile clarifying the ambiguous taxonomic classification.

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Revision of the Carboniferous–Early Permian succession based on the new lithostratigraphic data in the western edge of the Central Iran Microcontinent

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Despite various studies on the Carboniferous–Early Permian successions in Central Iran, definitions of the Carboniferous–Early Permian strata in the weastern edge of Central Iran (Sanandaj-Sirjan Block) were based on insufficient lithostratigraphic data. Even more, in the latter case, by taking the superficial lithological similarities and neglecting obvious differences into account, several lithostratigraphic names (*e.g.,* Shishtu, Sardar, Ghaleh and Absheni formations), originally defined in palaeogeographically remote areas, have been erroneously applied. All does not yet permit to discuss a detailed and further regional developments in paleogeography and basin analysis. The purpose of this study is revision of the lithostratigraphic subdivisions and biostratigraphic features of the Carboniferous–Early Permian deposits in the localities of the Sanandaj-Sirjan Block including Tang-e-Darchaleh, Asadabad and Banarizeh transects.

Older deposits (unnamed formation, Tournaisian–Late Serpukhovian), Asadabad Formation (informal and new formation, Late Serpukhovian–Mosscovian) and Vazhnan Formation (emended definition, Latest Gzhelian–Asselian) with the limited outcrops are considered as the lithostratigraphic subdivisions of the Carboniferous–Early Permian succession in the Sanandaj-Sirjan Block, their stratigraphic features has not so far been investigated exactly. This interval is composed of the siliciclastic and carbonate rocks together with frequent bioclast fragments and types of the sedimentary structures. Field investigations reveal that the lower boundary of the older deposits is not exposed or most likely faulted and its upper boundary is marked by the basal conglomerate-sandstone of the upper Asadabad Formation. Vazhnan Formation overlying the Asadabad Formation is distinguished with basal conglomerate-sandstone and the distinct eroded surface at the base and top of this stratigraphic interval.

Permian non-marine bivalve zonation of the East European Platform and its correlative capacity

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New finds and revision of available collections of nonmarine bivalves provided grounds for development of a zonal scale for terrestrial sequences of the Permian System based on species of the genus *Palaeomutela* Amalitzky, 1891, which are characterized by regular changes in the structure of the shell hinge. The scale includes two parallel zonal successions that are based on the stratigraphic distribution and evolutionary trends of two morphological lineages of the genus. The zonal succession, based on development of the *P. umbonata* group (which inhabited mobile waters and silt substrates) includes 11 range zones: *stegocephalum, ovatiformis, umbonata, quadriangularis, krotowi, wohrmani, numerosa, ulemensis, keyserlingi, curiosa, golubevi*. The zonal succession, based on development of the *P. castor* group (which inhabited calm waters and clayey substrates) includes eight range zones: *larae, castor, olgae, doratioformis, marposadica, fischeri, obunca, amalitzkyi*. The proposed zonal units are correlated with zonations based on ostracod, fish, and tetrapod fossils.

In addition, several marking intervals characterized by the presence of specific genera are proposed. A generalized correlation scheme of the Middle and Upper Permian successions of Euramerica, Angarida and Gondwana based on non-marine bivalves, is proposed.

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The Permian non-marine bivalve genus *Palaeanodonta* Amalitzky, 1895 and its position in the modern system of Bivalvia

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Bivalve mollusks assigned to the genus *Palaeanodonta* Amalitzky, 1895 include more than 30 species and are widespread in the Permian malacofaunas of Eurasia and Gondwana. The history of the establishment of *Palaeanodonta* Amalitzky, 1895 and the change in the author's views on the composition (characterization) of the genus and its type species are considered. The relationship between *Palaeanodonta* and *Naiadites* Dawson, 1860 originally considered as its senior synonym, are analyzed. The comparison of *Palaeanodonta* with the externally similar genus *Anthraconaia* Trueman et Weir, 1946 is given. The presence of such features as the outer opistodetic ligament, reduced pseudotaxodont hinge, and comarginal and radial crossed-lamellar microstructure of the shells, led to the conclusion that the type species of this genus *Unio castor* Eichwald, 1860 and the closely related species *P. longissima* (Netschajew) and *P. rhomboidea* (Netschajew), as well as the species belonging to the *Palaeanodonta fischeri* (Amal.) group (*P. subcastor* (Amal.), *P. okensis* (Amal.), *P. parallela* (Amal.), *P. obunca* (Netschajew), *P. amalitzkyi* Silantiev) and also to the group *Palaeanodonta dubia* (Amal.) (*P. umbonata* (Amal.), *P. sibirzevi* (Amal.), *P. indeterminata* (Amal.), *P. monstrum* (Amal.) should be assigned to the genus *Palaeomutela* Amalitzky, 1892. These species can be united by the reduced pseudotaxodont hinge, characterized by a narrow hinge plate with a few small teeth, not exceeding 10 in number, and in some cases completely absent. This feature is the basis for establishing the subgenus *Palaeanodonta* Amalitzky, 1895 within the genus *Palaeomutela* Amalitzky, 1892. The genus and subgenus diagnosis and their species composition are given.

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Systematics of non-marine bivalve mollusks from the Indian Gondwana Coal Measures (Damuda Group, Permian, India)

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This work is the first systematic description of non-marine bivalves from the Permian deposits of the Indian Gondwana Coal Measures.

Six new genera, *Gondwanaiadites, Bakulia, Gangamya, Raniganjelia, Gondwanadontella,* and *Indonellina*, and 13 new species are described. The new taxa are assigned to four families: Prokopievskiidae, Anadontellidae, Naiaditidae, and Senderzoniellidae. A review of the morphological characters used in the study of Indian bivalves represented only by external or composite casts and imprints of the shells is given. The position of the Indian non-marine bivalve fauna in the modern system of Bivalvia is discussed. An analysis of the stratigraphic distribution of non-marine bivalves shows their potential for the correlation of coal seams. The possible reasons for the morphological similarity of Indian non-marine bivalves with non-marine bivalves from the Permian successions of Angarida are discussed.

A probable Middle Permian age is proposed for the Indian fauna.

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The flora and dispersed cuticles from the coal seams in the Jan Pit of the Šverma Coal Mine in Žacléř (Bashkirian, Intrasudetic Basin, Czech Republic)

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The recent state of knowledge of stratigraphy of the Intrasudetic Basin is result of nearly 200 years of palaeobotanical research. Here, The flora and cuticles from the Lampertice Member of the Jan Pit of the Šverma Mine in Žacléř is evaluated. The Jan Pit was constructed during 1959–1964 and all results remained in unpublished reports and palynological samples from 46 coal seams were unmacerated. Nowadays, these samples were macerated for dispersed cuticles to learn the floral assemblages of coal seams. The Lampertice Member contains 56 coal seams; 24 of them belong to the lower group of coals and 32 belong to the upper group of coals. The strata of the Lampertice Member can be divided into 5 units: Extinction of *Mariopteris glabra* (17^{th} lower coal seam) defines the end of Namurian; extinction of *Neuralethopteris schlehanii* (20^{th} upper coal seam) defines the end of the Langsettian; the first occurrence of *Lonchopteris* determines beginning of the Upper Langsettian and the first occurrence of *Linopteris neuropteroides* defines the Upper Duckmantian. The Namurian strata are poor on flora and only 19 natural species was distinguished (e.g. *Mariopteris glabra, Pecopteris aspera, Alloiopteris similis*). The Langsettian and Duckmantian strata are more diversified and diversity increases up from 47 to 63 natural species per unit and there are in total 106 natural species per Lampertice Member. The typical Langsettian-Duckmantian species are: *Lepidodendron aculeatum, L. obovatum, Sigillaria elegans, Asterophyllites grandis, Sphenophyllum amplum, S. cuneifolium, Alloiopteris essinghii, Sphenopteris flexuosissima, Mariopteris muricata, Alethopteris decurrens, A. urophylla, Paripteris gigantea. Mariopteris muricata, Neuralethopteris schlehanii* (Langsettian), *Paripteris gigantea* (Duckmantian) belong among the most common species.

Cuticles were studied from 4 coal samples. Two coal samples came from the Langsettian age. Cuticular spectrum is difficult to evaluate. Cordaitaleans, otherwise difficult determinable, are the only discernible group in cuticular spectra in Žacléř. These assemblages contain cuticles of *Cordaites schatzlarensis* and maybe one undescribed species. Other found cuticles do not have stomata, therefore their identification is difficult. Their cells are principally polygonal, randomly oriented or tetragonal, oriented in one direction. They can be thin- or thick-walled, with or without papillae. The polygonal types come probably from seed integuments; the tetragonal types from stems or rachises. Some cuticles bear trichome bases and resembles to some *Sphenopteris* cuticles. The assemblages of the Duckmantian coals are similar. Cordaitaleans are reptesented by two natural species et least. *Cordaites schatzlarensis* continues from the Langsettian. The second species is very similar to *Cordaites borassifolius* and is represented by artificial species *Cordaabaxicutis borassifolioides, C. papilloborassifolius* and *Cordaadaxicutis krajewskae.* Other cuticles are without stomata with polygonal or tetragonal cells. A cuticle belonging probably to *Sphenopteris* is known as *Silesiacutis prosenchymatica* in the artificial system of dispersed cuticles.

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Development of the *Glossopteris* flora and its end Permian demise in the Tatapani–Ramkola Coalfield, Son-Mahanadi basin, India

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The Tatapani–Ramkola Coalfield is located in the Sarguja District of Chhattisgarh State in Central India, between latitude 23°30’: 23°55' and longitude 83°00’: 83°40'. From a palaeobotanical aspect, the area is significant as it exhibits a complete Permian–Triassic Sequence and yields a considerable amount of plant macrofossils and microspores. Barring a few studies, the macrofloras of this coalfield have never been investigated thoroughly. Recent extensive investigations carried out at thirteen different localities belonging to the Barakar (Artinskian–Kungurian), Raniganj (Lopingian) and Panchet (Anisian) formations in this coalfield have resulted in a large cache of plant fossils. The complete flora includes 16 fossil-genera and 55 fossil-species representing 7 orders viz., Equisetales (*Paracalamites*, *Schizoneura* and *Tatapania*), Sphenophyllales (*Trizygia*), Filicales (*Neomariopteris*, *Dizeugotheca* and *Lepidopteris*), Ginkgoales (*Glossophyllum*), Cycadales (*Pseudoctenis*), Corystospermales (*Dicroidium* and *Umkomasia*) and Glossopteridales (*Gangamopteris*, *Glossopteris*, *Eretmonia*, *Partha*, *Cistella* and *Vertebraria*). Plant fossils from nine localities represent typical *Glossopteris* floras of the Permian age with *Glossopteris* as the dominant genus (31 species), whereas Early Triassic floral elements recorded from three locations, are characterised by the presence of *Glossopteris senii* and *G. gopadensis* (marker species for the Triassic System) along with the marker genus *Dicroidium* (4 species). Three floristic assemblages identified on the basis of the macrofloras are the Lower Permian Barakar assemblage with 25 taxa, the Upper Permian Raniganj assemblage with 33 taxa, and the Lower Triassic Panchet assemblage having 22 taxa. The Barakar Formation has a moderate diversity of *Glossopteris* (15 species), which rises to 24 species in the Raniganj Formation. *Glossopteris* is also represented in the Panchet Formation (12 species). The Permian–Triassic transition in the Tatapani–Ramkola Basin is marked by a gradual change in the taxonomic composition of the Raniganj floristic assemblages, with a decline in diversity, although with some typically Permian taxa (e.g. *Paracalamites*, *Schizoneura*, *Dizeugotheca*, *Glossopteris*, *Vertebraria*) continuing up to the Permian–Triassic boundary. At the system boundary, the *Glossopteris* species typical of the Raniganj Formation (i.e. *G. stenoneura* and *G. stricta*) disappear. The Lower Triassic Panchet Formation sees the appearance of elements such as *Dicroidium* and other related pteridosperm groups. It is inferred that plant life was only transformed and evolved near the Permian–Triassic boundary in this basin, rather than been the subject of a comprehensive taxonomic turnover.

New data on phylogenetic relationships of ammonoids evolved after the end-Permian mass extinction: Evidence from the inner shell structure of some Olenekian ammonoids from South Primorye

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It is known that the largest ammonoid groups, Paraceltitina and Otoceratina, survived the P–T boundary, but died out at the very beginning of the Induan (Griesbachian time). They seem to be ancestral groups for the common Olenekian suborders Meekoceratina and Proptychitina, respectively. The inner shell structure of some representatives of these ammonoid lineages, *Inyoceras, Anasibirites, Yvesgalleticeras* (Meekoceratina) and *Koninckitoides* (Proptychitina) has been investigated in detail. In *Inyoceras,* the initial chamber (protoconch) is globe-shaped, up to 0.45 mm in diameter, caecum is globular (up to 0.069 mm in diameter), with a short (about 0.043 mm) so-called prosiphon (fixator); the living chamber of the ammonitella is short (α = 260-280^{o}); the siphuncle is ventral at all ontogenetic stages studied; the septal necks are retrochoanitic, replaced by modified retrochoanitic (A and B) ones. In *Anasibirites* (two species), the protoconch is large (up to 0.63 mm in diameter); the caecum is globular (up to 0.079 mm in diameter), with a short (about 0.042 mm) fixator; the living chamber of the ammonitella is short (α = 243-282^{o}); the siphuncle has intermediate location between the subcentral and subventral positions at the earliest ontogenetic stage; the type of septal necks like in *Inyoceras*. In *Yvesgalleticeras,* the protoconch diameter is up to 0.42 mm; the caecum is globular (up to 0.080 mm in diameter), with a short (about 0.040 mm) fixator; the living chamber of the ammonitella is short (α = 270^{o}); the siphuncle position and type of the septal necks like in *Anasibirites.* In *Koninckitoides,* the protoconch is globe-shaped, up to 0.40 mm in diameter, caecum globular (up to 0.108 mm in diameter), with a longer (about 0.12? mm) fixator; the living chamber of the ammonitella is short (α = 246-290^{o}); the siphuncle is characterized by its ventral location at all investigated ontogenetic stages; the septal necks are retrochoanitic, replaced by modified retrochoanitic (A) ones. Our data show that *Anasibirites* and *Yvesgalleticeras,* as well as *Timoceras,* are very similar in their inner shell structure to *Sibirites,* which allows us to consider them to be representatives of a single family (Sibiritidae), though some recent workers consider them to be representatives of the families Prionitidae (*Anasibirites*), Columbitidae (*Yvesgalleticeras*) and Olenikitidae (*Timoceras*). If our assumption that *Inyoceras* belongs to the family Xenoceltidae is correct, ammonoid evolution in the lineage Xenoceltidae-Sibiritidae proceeded along the path of deviation in position of a siphuncle in the earliest ontogenetic stage. There was, however, a more significant early Olenekian deviation in the Xenoceltidae–Olenikitidae lineage. *Koninckitoides,* in contrary, is characterized by a ventral position of the siphuncle at the earliest ontogenetic stage, which is common for otoceratid ammonoids. However, both retrochoanitic and modified retrochoanitic septal necks and smaller protoconch have been recognized in it, like in *Arctoceras* (in *Otoceras,* retrochoanitic type of septal necks is common for all ontogenetic stages). New data illustrate the rapid diversification of the family Sibiritidae started at late Smithian time, but not later as it is usually considered, and somewhat more conservative development of proptychitid ammonoids.

A hypothesis for archaeabacterian hydrocarbon biosynthesis in sulphidian hydrothermal vent

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Theoretical development and wide experience in geothermal research in the oil fields of the Volga Region, Northern Caucasus, Ukraine, Belarus, Central Asia and Kamchatka (Neprimerov N.N., Nikolaev, S.A., E.I. Sinyavskiy, G.V. Sonin, A.V. Khodyreva, E.J., Khristoforova N.N., etc.) given the new materials, which clearly indicate the existence of vertical migration of fluids in sedimentary cover. Based on experience and discoveries in marine geology, the authors offer to scientific community –the thermal-bacterial hypothesis of oil origin.

New thermal-bacterial hypothesis is based on the following facts: clear paragenetic relationship between the Cheleken, Baku and the Tatar oil with sulfide telethermal mineralization; the relationship of oil fields with hydrochemical and geothermal anomalies around structures with vertical movement of fluids; component differentiation of hydrocarbons and epigenetic changes of the molecules of oil in the shale in the presence of sulphate-reducing bacteria. We should add the discovering chemolithoautotrophic bacteria (from the group of the oldest high-temperature sulfide and methane of archaebacteria) related to modern hydrothermal activity “black” and “white smokers” and oily suspensions of oil films containing traces of subsurface microbiota.

We assume that it is a relict bacteria primary anaerobic biota of the Earth (relict endobiota), at unusually high temperatures (over 200 degrees) and pressures (hundreds of atmospheres), are able to synthesize unusual “oil-like” organic matter. They may be responsible for the genesis of at least one-third of the oil fractions having a boiling point of from 225 to 300 degrees Celsius and rotating the plane of polarization to the left. Abiogenic chemosynthesis creates a racemic mixture of L and D isomers, but only living organisms synthesize the levorotatory isomers.

Bitumen in brachiopod shells and shell beds from the Brigantian (Visean, Mississippian) Eyam Limestone Formation

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As in other carbonate platforms with Mississippi Valley-type mineralization, the Derbyshire platform is well-known for the occurrence of hydrocarbons within hydrothermal mineral veins; here we also describe bitumen associated with brachiopod shells and shell beds in exposures of the Brigantian (Visean, Mississippian) Eyam Limestone Formation near Monyash in Derbyshire, UK. This is the stratigraphically highest carbonate unit of the platform; and to the east of the localities it is overlain directly by argillaceous facies including the Bowland Shale Formation, which is the UK's most prospective shale unit and a proven source rock for conventional hydrocarbons in the UK Midlands.

The bitumen is distributed within large gigantoproductid shells which occur in dense assemblages forming thick (2 m) and laterally persistent shell beds (likely over tens of km^2). Despite their general good preservation, the shells are locally affected by silicification in the form of quartz crystals which mostly replace prismatic calcite. The internal cavity between the valves is partly filled by sediment, and the residual intraparticle porosity by coarse blocky equant to drusy calcite cements. Locally the residual porosity is filled by bitumen, which is also locally infiltrated in the rock matrix. We recognized the following diagenetic evolution: 1) Intraparticle brachiopod primary cavity filled by sediment; 2) Late primary cavities filled by blocky calcite; 3) Shell silicification possibly by hydrothermal fluids; 4) Precipitation of equant calcite cement in fractures and residual primary porosity; 5) Oil migration into residual porosity in the shell cavity and in the matrix; 6) Pressure solution and stylolite formation.

Samples analysed by pyrolysis gas chromatography (PYGC) suggest that the bitumen came from a source whose composition is similar to that of the Bowland Shale Formation, confirming an origin suggested by previous studies. Only the Edale Gulf shale basin to the north of the platform was mature for oil and gas and may have been the source of hydrocarbons and the mineralizing solutions. It has been suggested that flow paths were governed by the dolomitised carbonate platform margin, but the apparent abundance of bitumen within shell beds suggests that they may also have been hydrocarbon fluid flow pathways, because of their heightened porosity and permeability.

The gigantoproductid shell beds allow primary and diagenetic conditions to be compared and to determine if there is evidence for a close relationship between included bitumen and diagenetic growth.

Thymospora (Wilson & Venkatachala) Alpern & Doubinger, 1973: Unusually early occurrences of spores in the Pennsylvanian of NW Turkey (earlier than in the standard stratigraphic models)

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The earliest occurrences of species and undefined forms of the Late Palaeozoic stratigraphic marker and monolete spore-genus *Thymospora* (Wilson and Venkatachala) Alpern and Doubinger, 1973 are reviewed. Occurrences of *Thymospora* spp., earlier than in the standard stratigraphic models, have recently been found in NW Turkey in Lower Moscovian deposits. From the literature, there are (worldwide) three other regions where similar early occurrences are known of such spores. Palaeogeographically, these regions were situated near the equator (e.g. NW Turkey), up to approx. 30° N. The specimens from NW Turkey do not fall within the species circumscription of *Thymospora thiessenii* (Kosanke) Wilson and Venkatachala, 1963. *T. thiessenii* is, together with other *Thymospora* species, considered as indicative of the (standard) OT-Miospore Zone; and the base of the OT-Zone is correlated with younger Moscovian deposits. By acknowledging that *Thymospora* spp. can already appear in Early Moscovian deposits, misleading age interpretations can be avoided (as well as subsequent statements regarding stratigraphic correlation). The age dating for the lower Moscovian coal-bearing sequence of NW Turkey has been based on "Marine–Non-marine Correlation", using the established spore, conodont, and foraminifer biostratigraphy of the mid-continent of North America.

Macrofloral and palynological biostratigraphy of the Pennsylvanian coal-bearing sequence in the Zonguldak–Amasra Coalfield, NW Turkey

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The palaeobotany and palynology of the coal-bearing sequence of the Zonguldak–Amasra Coalfield in NW Turkey is currently being revised. Traditionally the sequence has been interpreted as spanning more or less continuously much of the lower and middle Pennsylvanian series, but the new data is suggesting that there are major stratigraphical gaps. The sequence here is comparable with the coal-bearing sequences of the Dobrudzha Coalfield (NE Bulgaria) and with the Upper Silesia Coalfield (Poland and Czech Republic), and together they represent an eastern extension of the coal swamps of the Variscan Foreland.

Content and composition of deeply sorbet hydrocarbon gases in coals of the Donbass and degree of coal metamorphism

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Investigations of the content and composition of deeply sorbet hydrocarbon gases in coals, there petrographic composition and degree of coal metamorphism in deep levels of the Donbass are very relevant now in connection with problems of increasing coal mining output, development of gas resources in this region and safety of coal mine works.

Deeply sorbet hydrocarbon gases derived from coals of the Donbass coal basin were investigated by the method of thermal degassing in helium atmosphere at 200ºC temperature. These hydrocarbons are found out to be substantially enriched of heavy hydrocarbon (the sum C_2+C_6 is up to 99 total amounts %). High amount of residual hydrocarbons is 45–74 cm^3/kg in fat and cook coals. High content of heavy hydrocarbon in deeply sorbet or residual hydrocarbons increases fire and explosion danger in coal mines.

We have investigated detailed the coal samples from upper and down parts of the coal seam l_1 (suite C_2^6 of Moscow stage) in 12th Western conveyor drift in A.F. Zasyadko mine. This coal mine is located in Donetzko-Makeevsk region on the south branch of Kalmius–Torezk Depression in the Vetkovsk structure. This region is characterized by complete tectonic and complete folds of subhorizontal and sub meridional directions. Strata composed with sedimentary complex of the Middle and Upper Carboniferous, covered with Quaternary and partly Paleogene sediments. Thickness of coal seam l_1 changes from 0.7 to 2.1 m. There is one rock interlayer in this coal seam. Thickness of coal seam is not stable. Coal seam l_1 has very complicated structure with parting and pinching-out.

Standard microscopic methods of coal petrography with magnification 90–600^X in plane polarized transmitted and reflected light were used for detailed examination of the coals.

Coals of the seam are humic. Macerals of vitrinite group are prevalent. They are represented by stringy or lumpy attritus and fragments of vitrinite. There are also fragments of telinite of different forms and sizes, with clear contours or gradual transition into collinite. They are colored orange, red-orange and brown-red. Macerals of inertinite group are present with lens and lenslike fragments of semifusain, fusain, attrite and desmit-inertinite and rarely – micrinite, sclerotinite and exinite. In liptinite group there are macro- and microexinite, rarely – cutinite and resinite. Their color changes from dark orange to light brown. Minerals are represented by pyrite, quartz, kaolinite, carbonates. Mineral components occur in collinite or fill sells in structure coal macerals. Ratio of telinite and collinite macerals (Vt_t/Vt_c) equals 0.14–0.84. The degree of metamorphism is at the stage of fat and cook coals. Vitrinite reflectance is 0.99–1.15 % in oil immersion (R_0). Such degree of metamorphism coals could have been reached in conditions of regional metamorphism at depths of 5 km with paleogeothermic gradient equal 31^0C/km.

Palynostratigraphy of the Upper Tournaisian–Visean terrigenous deposits of Permian Prikamie (Volga–Ural oil-and-gas province)

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The territory of Permian Prikamie is located in the north-east of the Volga–Ural oil-and-gas province. The results of extensive research of palynological terrigenous deposits of the Lower Carboniferous (Early and Middle Mississippian) have been given. Description of miospore assemblages and stratigraphic distributions of the basic miospore taxa allowed the recognition of eight palynozones: Upper Tournaisian (Kosvian Horizon) – two paynozones *Tuberculispora exigua-Triquitrites batillatus* (lower), *Monilospora variomarginata-Euryzonotriletes macrodiscus* (upper); in the Viséan – six paynozones; Radaevian Horizon: *Knoxisporites multiplicabilis-Murospora aurita* (lower), *Monilospora culta-Lycospora pusilla* (middle*), Gorgonispora appendices-Cincturasporites canaliculatus* (upper); Bobrikovian Horizon: *Knoxisporites literatus-Auroraspora rugosiuscula* (lower); *Vallatisporites variabilis-Camarozonotriletes granulosus* (upper); Tulian Horizon – *Cingulizonates bialatus-Granulatisporites piroformis.* The names of the palynozones are derived from the names of the index taxa. First index species prevails in the whole assemblage; the second one appears for the first time at the lower boundary zone.

Also, the analysis of stratigraphic distribution of taxa miospore is given. The author offers criteria for determining the position of the lower boundary of the Viséan in the Permian Prikamie area according to miospores. Within these deposits the lower boundary of the Viséan should be drawn at the bottom of the Radaevian Horizon. The palynozones of Permian Prikamie with Lower Carboniferous units and foraminiferal zones of Russia.

Permian foraminiferans of the Usolka River

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The Usolka River geological section is located in the Gafury District (in the southern Uralian Foredeep) and is the parastratotype of some subdivisions and boundaries of the Permian System, displaying the stages. The Asselian–Artinskian interval contains a large assemblage of small foraminifers of hundreds of specimens and dozens of calcareous and agglutinated species.

The assemblage includes five orders: Astrorhizida (family Psammosphaeridae), Hyperamminida (families Hyperamminidae, Hippocrepinidae), Ammodiscida (families Ammodiscidae, Tolypamminidae, Calcivertellidae), Endothyrida (family Endothyridae), Nodosariida (family Nodosariidae), and 10 genera: *Saccammina*, *Hyperammina*, *Kechenotiske, Hyperamminoides, Turritellella, Tolypammina, Trepeilopsis, Endothyra, Protonodosaria, Nodosaria*, represented by taxa previously described from the Biarmian Realm (Taimyr–Kolyma and East European Regions) (e.g., *Hyperammina borealis* Gerke, *Hyperamminoides proteus* Gerke) and some new species, e.g., of the genus *Turrittellella*. This allowed the recognition of beds with foraminifers that can be traced in the Biarmian realm.

Beds with ***Nodosaria shikhanica*** are recognized in the lower part of the Shikhanian Horizon (Asselian) and contain an assemblage of 13 species of *Hyperammina*, *Tolypammina,* and *Nodosaria* (the last genus dominating with four new species). This assemblage correlates with that of the basal beds of the Sezima formation in the Pechora Basin, Shikhanian Horizon in the Denisov–Moreyu Zone, Paren Horizon of Northeastern Russia. The correlation is based on several species in common, including the index species *Nodosaria shikhanica* Lip., which suggests Asselian age. Beds with ***Hyperammina borealis***, represented by several dozen specimens, are recognized in the lower part of the Tastubian Horizon (Sakmarian). The assemblage contains two species of *Saccammina,* several species of *Hyperammina* (including three new); two new species of the genus *Nodosaria* and the genera *Protodonodosaria* and *Endothyra* (one new species each). This assemblage is similar to the assemblages of the Pechora Province (of the upper part of the Nelynyashor Formation (Chernyshev Range) and middle part of the Sezima Formation (Northern Pechora Zone)), also containing *Hyperammina borealis* Gerke. It correlates with the assemblages of the Taimyr–Kolyma Subregion: the Tustakh Formation contains a large assemblage of agglutinated species, including the shared species *Hyperammina borealis* Gerke*, H. subtilensis* Voron*.,* and *H. borealis delicatula* Voron*. Saccammina ampulla* (Crespin), abundantly represented at this level, is also found in the Sakmarian of Australia (new South Wales and Western Australia) and Tasmania.

Beds with ***Kechenotiske hadzeli*** are recognized in the lower part of the Artinskian (Irginian Horizon). The assemblage includes the agglutinated genera *Saccammina, Kechenotiske* and *Turrittellella,* two dozen specimens including some new species: one of S*accammina,* one of *Kechenotiske* and two of *Turrittellella.* This assemblage contains the index species *Saccammina arctica* Gerke, which first appears in the Artinskian and is readily recognized in the synchronous beds of the East European Subregion. It has also been recorded in the Chernyshev Formation of the Chernyshev Range and in the Kosyu Formation of the Kosyu–Rogov Basin (Artinskian). The species *Kechenotiske hadzeli* (Crespin) is widespread in the Biarmian Realm, in the northern regions of the Pechora Province (Belkov Formation of the Kosyu–Rogov Basin) and in the Kosyu Formation of the Chernyshev Range (Artinskian), and is widespread in the Artinskian of Australia (Queensland and Western Australia).

Permian Foraminifera of Spitzbergen (Starostin Formation)

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The Permian deposits of Spitzbergen are very interesting, as they contain uninterrupted carbonate successions representing a link between the basins of the Canadian Arctic Archipelago and those of the East European and Taimyr–Kolyma subregions. Twelve foraminifera-based assemblages are recognized in the Carboniferous and Permian beds of Spitzbergen. Of these, assemblages VIII–XII correspond to the Permian.

Material was collected in the stratotype region (Western Spitzbergen) in the basal and middle parts of the Starostin Formation (material was donated by T.A. Grunt who worked in Spitzbergen on the invitation of the Norwegian Polar Institute). The age of the formation is debatable and is dated from Artinskian to Kazanian. Assemblage X is recognized in the Spirifer Limestone at the base of the Starostin Formation. It is represented mainly by agglutinated shells, of which *Hyperammina borealis* Gerke and *Saccannina arctica* Gerke are essential as they are characteristic of the Lower Permian. The beds contain a rich assemblage of *Globivalvulina,* including *Globivalvulina* ex gr. *shikhanensis* Moroz., characteristic of the Lower Kungurian, and also *Orthovertella eximia* Suchov, indicating the Filippovian Horizon of the Kungurian Stage. The interval with assemblage X should be assigned to the Filippovian Horizon. Assemblage XI contains abundant material in the most complete state of preservation. Light grey cherty limestones contain calcareous and agglutinated shells of about 30 species. These are representatives of the orders Astrorhizida (Psammosphaeridae), Hyperamminida (Hyperamminidae, Hippocrepinidae), Earlandiida (Earlandiidae), Ammodiscida Ammodiscidae, Tolypamminidae, Pseudolituotubidae), Endothyrida (Endothyridae), Ataxophragmiida (*Globivalvulina*), Cornuspirida (Pseudocornuspiridae), Nodosariida (Nodosariidae), genera *Saccammina*, *Hyperammina*, *Hyperamminoides, Erlandia, Glomospira, Ammovertella, Tolypammina, Palaeonubecularia, Endothyra, Endothyranella, Orthovertella, Nodosaria, Rectoglandulina,* and *Geinetzina.* The assemblage contains the rarely found *Earlandia minuta* (Cushman et Waters), indicative of the Lower Permian, *Saccammina arctica* Gerke and *Hyperamminoides* ex gr. *elegans* (Cushman et Waters). There are many skein-shaped taxa, including *Glomospira compressiformis* Igon., characteristic of the Irenian Horizon and *Palaeonubecularia uniserialis* Reitl., known from the Kungurian (Kyrtadi Formation) of the Pechora Province. Nodosariida, *Nodosaria, Rectoglandulina,* and *Geinetzina* are present. *Nodosaria ustritskii* Sossip. occurs in the Upper Kungurian, whereas *Ichthyolaria semiovalis* Zol. and *I. partita* Zol. Are index species of the Irenian Horizon. At the same time, *Nodosaria krotowi* Tscherd. (Kazanian) is a new, younger element. Assemblage XI contains about 10 species of Foraminifera, recognized in the Irenian Horizon of the Permian Urals and its equivalents, which correlated the middle part of the Starostin Formation with the Irenian Horizon.

Kasimovian–Gzhelian transition, Usolka section, Southern Urals, Russia: new data

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The Usolka section is located on the right bank of the Usolka River (the northeastern margin of the city of Krasnousolsk, the Bashkortostan Republic of Russia). The Kasimovian–Gzhelian boundary beds there are predominantly mixed carbonate-siliciclastic succession with frequent volcanic ash beds. Chernykh et al. (2006) proposed the Usolka section as a potential candidate for establishing a GSSP for the base of the Gzhelian Stage (Chernykh et al., 2006; Davydov et al., 2008). There have been some concerns about the precise position of the boundary and particularly the first appearance datum (FAD) of the index species of conodont *Streptognathodus simulator* within the proposed GSSP (Villa et al., 2008; 2009).

To confirm the precise position of the FAD of S. simulator in Usolka section we collected additional conodont samples, re-measured and described the section during field seasons in 2012–2014. We studied conodonts and ammonoidea in the Kasimovian- Gzhelian boundary interval of the Usolka section.

In the Usolka section, the boundary interval covering the upper part of the Dorogomilovian Horizon of the Kasimovian Stage and the lower part of the Dobryatinian Horizon of the Gzhelian Stage is characterized by diverse conodonts. Deposits of the Kasimovian Stage have yielded a conodont assemblage characteristic of the Streptognathodus firmus Zone, which includes the following taxa: *Idiognathodus excedus* Chernykh, *I. magnificus* Stauffer and Plummer, *Idiognathodus toretzianus* Kozitskaya, *Streptognathodus crassus* Chernykh, *S. firmus* Kozitskaya, *S. gracilis* Stauffer and Plummer, *S. pawhuskaensis* Harris and Hollingsworth, *S. praenuntius* Chernykh and *S. zethus* Chernykh and Reshetkova. Here also were found the ammonoids of the genus Eoasianites (family Gastrioceratidae), Somoholites (family Somoholitidae) and Glaphyrites (family Goniatitidae). In the lower part of the Gzhelian Stage enclosed conodonts typical for the Streptognathodus simulator Zone: *Idiognathodus toretzianus* Kozitskaya, *I. undatus* Chernykh, *I. aff. verus* Chernykh, *Streptognathodus aff. auritus* Chernykh, *S. crassus* Chernykh, *S. dolioliformis* Chernykh, *S. gracilis* Stauffer and Plummer, *S. simulator* Ellison.

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Rapid carbonate depositional changes following the Permian–Triassic mass extinction: Sedimentary evidence from South China

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Various environmental changes were associated with the Permian–Triassic mass extinction at 252.2 Ma. Diverse unusual sediments and depositional phenomena have been uncovered as responses to environmental and biotic changes. Lithological and detailed conodont biostratigraphic correlations within six Permian–Triassic boundary sections in South China indicate rapid fluctuations in carbonate deposition.

It’s clear that the boundary limestones cap the uppermost Permian deposits from onshore to offshore. Here, these limestone beds are designated the Permian–Triassic boundary cap limestones (PTBCLs). Besides the occurrences of PTBCLs, no carbonate deposits has been found within the studied sections during the *Clarkina meishanensis* zone. Thus, the spatial and temporal variation of carbonate deposits during the P–Tr transition can be summed up as 4 phases (Fig. 9): Phase 1) Pre-extinction, *Clarkina yini* zone and earlier, carbonates only occurred on the platform and slope; Phase 2) at *Clarkina meishanensis* zone, the onset of the extinction interval, carbonates rarely occurred; Phase 3) *Hindeodus changixngensis* zone to *Hindeodus parvus* zone, medium-massive bedded carbonates were deposited from onshore to offshore settings; Phase 4) *Isarcicella staeschei* zone and later, carbonates disappeared from the neritic clastic facies and were enriched in mud and thin bedded in other facies.

Although availability of skeletal carbonate was significantly reduced during the mass extinction, the increase in carbonate deposition did not behave the same way. The presented rapid carbonate depositional changes suggest that diverse environmental changes played key roles in the carbonate deposition of the Permian–Triassic mass extinction and onset of its aftermath. The enhanced terrestrial input, abnormal ocean circulation and various geobiological processes could have contributed to carbonate saturation fluctuations. The rapid carbonate deposition changes reveal that various geochemical and geobiological processes took over regular biomineralization and carbonate deposition due to the low O_2 and high CO_2, responding to the large volcanic eruptions.

Bryozoan diversity at the Devonian-Carboniferous boundary in Eurasia

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The Upper Famennian–Lower Tournaisian bryozoans are described from several regions of Eurasia. These regions fall into two groups based on systematic diversity, common taxa and the degree of endemism. Belgium, Armenia, Azerbaijan, and the South Urals is referred to as the "western" group and China, Mongolia, Eastern Transbaikalia, the south of Western Siberia, and Kazakhstan as the "eastern" group. The "western" regions contain a few taxa in the Late Famennian–Early Tournaisian (3–16 species, 5–12 genera), and show high endemism (70–100 % at species level and 20–22 % at genus level). In contrast, many taxa are known from the "eastern" regions (30–80 species and 10–30 genera), and the proportion of the endemic taxa is small (30–60 % at the species level, 7–10 % at the generic level).

The Hangenberg event only slightly affected Eurasian bryozoans. The change in the generic composition suggests an increase in appearances during Late Famennian in the "western" regions. At the species level, the number of appearances and extinctions is the same. During the early Tournaisian there were more appearances than extinctions at both levels. The change in generic composition suggests an increase in extinctions during the Late Famennian in the "eastern" regions. Appearances prevail at the species level. During the Early Carboniferous, more species and genera appeared than became extinct.

In total, species appearances were equal to extinctions in the Late Famennian. The number of appearances of new genera is higher than the number of extinctions of genera in regions with low bryozoan diversity. In regions with high diversity there were more extinctions than appearances. During the Early Carboniferous more species and genera taxa originated than became extinct. This is the same for genera, but a difference is observed in the evolutionary trends in the poorly studied regions.

Synchronous parallelism of four-layered wall in Early Moscovian fusuline evolution: Example from the Donets Basin, Ukraine

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In the fusuline evolutionary history, development of four-layered spirothecal wall denotes an important renovation event on the shell architecture. It occurred in the Pennsylvanian–Late Carboniferous in conjunction with their increasing test-size. The genus *Fusulinella*, derived from its potential ancestral genus *Profusulinella*, is considered as the first fusiform taxon that developed this type of spirothecal structure. These two genera consist of a phyletic continuum, referred to as the *Profusulinella-Fusulinella* evolutionary transition, which shows successive structural changes from the three-layered wall to the four-layered one. Their evolutionary dynamics is still debatable, but it is suggested that the transition occurred almost synchronously in several independent *Profusulinella* root-stocks in some, paleobiogeographically distinct Carboniferous basins.

We investigated the Karaguz section located at about 15 km south of Lugansk in Eastern Ukraine, to understand Early Moscovian fusuline biostratigraphy and faunal succession. In this section, Lower Moscovian paralic–shallow marine strata are continuously exposed, cyclically intervening foraminifer-rich limestone beds from K_2 to M_1. Three independent lineages, showing evolutionary changes from the profusulinellid-type three-layered wall to fusulinellid-type four-layered one, were recognized. They are the *Aljutovella postaljutovica–Citronites*? sp. lineage, the *Profusulinella pseudorhomboides–Kanmeraia subpulchra* lineage, and the *Profusulinella constans–Fusulinella schubertelloides* lineage. In these evolutionary transitions, species having unquestionable four-layered walls appear in limestones K8, L1, and L5, respectively. Thus, the development of this type of wall structure occurred almost simultaneously in these three lineages, probably during the Early Kashirian. This would be a good example of synchronous parallelism.

Shell microstructure in the Permian non-marine bivalves: Application for systematics

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Non-marine bivalves are widespread in continental biota of the Carboniferous and Permian comprising several dozen of genera and more than hundreds species. First non-marine bivalves invaded into non-marine realm at the end of the Devonian and then rapidly adapted to various continental water bodies of the Upper Paleozoic. Thus, this is one of a few non-marine groups of Upper Paleozoic suitable for interregional correlation and development of zonal stratigraphical charts. Due to many co-occurrences, it is possible to control the age of fossil bivalve assemblages on the base of vertebrate fauna. At the same time, the use of non-marine bivalves for biostratigraphy is restricted by a small number of taxonomic characters of shell morphology combined with a wide range of variation. The schematic generic and species diagnoses and unreasonably wide stratigraphic range of some taxa result in considerable difficulties encountered in the use of bivalves for biostratigraphy of the Upper Paleozoic continental beds.

The microstructure of shell layers is one of the major characters used in modern taxonomy of fossil Bivalvia at the generic and higher levels. The rank of the character is based on the complex mechanism of the formation of shell. Shells of bivalves are multilayer, composed of crystallites of calcium carbonate embedded in organic matter. The shell of each taxon displays unique structural characters dependent on its evolutionary development. The organic matrix synthesized by the animal is a framework, where nucleation, orientation, and growth of inorganic crystals occur. As the shell is fossilized, the preservation of the matrix determines the possibility of preservation of the primary structure. In bivalves, the shell is composed completely of aragonite or of aragonite and calcite. It is evident that original structure is present in the shell retaining the primary matter. Transition of aragonite into calcite and recrystallization of the primary calcite either retains the initial structure of layers or change it to a greater or lesser extent up to complete transformation.

The purpose of the present study is substantiation of microstructural shell features of the Permian bivalve genera *Palaeomutela* Amalitzky, 1892, *Oligodontella* Gusev, 1963, *Palaeanodonta* Amalitzky, 1895, *Opokiella* Plotnikov, 1949, *Prilukiella* Plotnikov, 1945, *Concinella* Betekhtina, 1966, *Anadontella* Betekhtina 1987 as a character of family or generic rank. New microstructural data are the base of revision of family and generic diagnosis, and, hence, improvement of their biostratigraphic value and correlation potential.

Microstructural characters of non-marine bivalves are equally reliably recognized by optical and scanning microscopes in both primary aragonitic shells and shells in which aragonite is replaced by pelitic calcite. Calcareous sparitic recrystallization of shells, which disrupts their structure, is rarely observed and easily diagnosed.

The analysis of microstructural characters of non-marine bivalves has shown that the sequence of shell layers and their structural characteristics are identical in each family or genera and independent of the development of the dental apparatus.

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Revision of the Late Permian non-marine bivalve genus *Verneuilunio* Starobogatov, 1987

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The genus *Verneuilunio* (type species *Naiadites verneuili*) was established by Yaroslav I. Starobogatov from within the genus *Palaeanodonta* Amalitzky based on differences in the structure of the hinge margin, based on the literature evidence. Both genera had been included in the family Palaeanodontidae. The authors of this presentation revised Amalitsky's collection and concluded that the original diagnosis of the genus *Palaeanodonta* contains several inaccuracies. These complicated both identification and higher taxonomy of *Verneuilunio*. We present a revised diagnosis of the genus *Verneuilunio* and a detailed description of the type species. The genus *Verneuilunio* was assigned to the family Naiaditidae based on the duplivincular and slightly amphidetic ligament. In this feature, *Verneuilunio* differs from other unio-like Late Permian non-marine bivalve genera such as *Palaeomutela*, *Palaeanodonta*, *Oligodontella* and *Opokiella,* which often occur in the same strata. *Verneuilunio* resembles some Late Carboniferous "atypical" unio-like species of *Anthraconaia* Trueman et Weir. Statistical analysis of the biometric parameters of *Verneuilunio verneuili* and its most similar species *Anthraconaia pruvosti* reveals statistically significant differences in the degree of elongation of the posterior end of the shell. Recently, *Verneuilunio* has been shown to be widespread in the Early Severodvinian of the central part of the East European Platform.

Pore and sorption characteristics of Westphalian shale deposits in the Campine Basin

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Present-day research in unconventional hydrocarbon systems is strongly focussed on shale gas present in marine black shales. Similar research on other organic rich deposits is very limited. This study focuses on the lacustrine and riverine shale deposits of the Westphalian coal-bearing sequence in the Campine Basin (NE Belgium). These differ from their marine counterparts in type of organic matter and diagenetic processes, and reduced lateral continuity. Earlier work showed that these shale deposits do have a potential to generate natural gas and condensates. Reservoir characteristics, being porosity and sorption capacity, and factors influencing them, were examined by means of subcritical nitrogen adsorption (BET), high-pressure methane sorption, Rock-Eval pyrolysis and quantitative X-Ray diffraction with Rietveld refinement.

The selected samples are in general clay-rich, with mostly illite as dominant mineral, and mainly situated within the oil window. The total organic content (TOC) is promising, with an average value of 5.44 % and samples that can measure up 10 %, even 20 % of organic matter in the sediment. N_2 subcritical gas adsorption shows a strong correlation between the amount of illite in the sample and the micropore volume and surface area. In contrast, a similar relationship was not found for total organic carbon (TOC). In fact, calculated surface energy values show that these decrease with increasing TOC, thus indicating a very weak interaction between nitrogen and the organic matter. This means that if micropores are present in the organic matter, that these cannot be detected by N_2 subcritical gas adsorption.

High-pressure experiments with CH_4 provide contrasting results. The methane excess sorption values at 15 MPa increase with higher TOC values, but there is no correlation with illite content. The positive correlation with TOC suggests that there indeed is a pore system present in the organic matter. This apparent contradiction seems to confirm the weak interaction between nitrogen and the organic matter in at least these samples.

Another hypothesis for this discrepancy that needs to be considered is the presence of condensates blocking the pore areas for nitrogen sorption at low temperatures. Additional sampling and other methods, such as subcritical gas adsorption with CO_2 and helium pycnometry will be conducted to study the pore characteristics of the organic matter.

Overall from these results it can be concluded that illite content is at least one of the parameters that defines the micro and mesoporosity of the sediment. Further research steps are needed to verify that micropores are also present in organic matter, and, if so, why it is not being revealed by subcritical N_2 adsorption.

On the Tournaisian–Viséan boundary in the Muhanovo–Erohovsky Basin (Kama–Kinel trough system)

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There is no unified view among researchers on the boundary between the Tournaisian and Viséan stages within the Kama–Kinel trough system.

In the Volga–Ural oil and gas bearing province, the Kama–Kinel system of troughs is filled with Upper Devonian–Lower Carboniferous deposits produced in a starved sedimentary basin. These include the Muhanovo–Erohovsky and Ust-Cheremshansky troughs located in the Samara Region. The basins are rimmed by a thick succession of Famennian–Tournaisian carbonates produced by flux from organic buildups and are filled with Lower Carboniferous siliciclastics.

Since the time when the Malinovskaya Series was first recognized, the Tournaisian and Viséan boundary level boundary has been placed at various stratigraphic levels.

The Kosvian deposits in the Muhanovo–Erohovskiy Basin of the Samara Region contain argillites, with interbeds of aleurolites, sandstones and alternations of carbonate rocks. The Radaevian deposits are characterized by the presence of alternations of sandstones, siltstones, and argillites with alternations of carbonate rocks.

In the axial zone of the Mukhanovo–Erokhovsky Basin, the Viséan foraminiferal fauna was identified from the former Dmitrievskaya Series. According to the modern stratigraphic interpretations, the Dmitrievskaya Series corresponds to the lower part of Bobrikovian Horizon and the upper part of Radaevian Horizon. Identification of the Tournaisian foraminiferal fauna in the Kosvian deposits and the Viséan foraminiferal fauna in the carbonate beds in the Radaevian Horizon, allows the Kosvian Horizon to be assigned to the Tournaisian Stage.

New evidence of plant–insect interactions in the Carboniferous and Permian of Russia and Mongolia

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Fossil evidence of interactions between arthropods and plants has attracted much attention over the last few years. Paleozoic fossils are of particular interest here: they are much rarer than Mesozoic or Cenozoic ones and could provide important information on the paleoecology and the biology of extinct taxa, and could indirectly contribute to solving some problems that exist in our notions of the early evolution and co-evolution of insects and plants. Brief information on new finds of biodamage of fossil plants from Russia and Mongolia are provided below.

Kamensk-Shakhtinsky, Rostov Oblast (upper Bashkirian, Carboniferous): probably the earliest known endophytic ovipositions with pseudolinear allocation of eggs have been found on the stems of pterydosperms (?); three forms of biodamage of unclear origin on plant stems and leaves.

Izykh, Khakassia (Kasimovian to Lower Gzhelian (?), Carboniferous): marginal feeding traces with visible overgrowth of tissues along the margin have been found on leaves of *Cordaites* and *Rufloria*; endophytic ovipositions, with both arcuate and pseudolinear structure; leaf galls of the *Paleogallus zherikhini* type. Damaged seeds have also been found.

In two Upper Permian localities of South Mongolia (Yaman Us and Noyon), pseudolinear and chaotic endophytic ovipositions of very small eggs have been found, as well as sporadic marginal feeding traces on leaves.

New biodamage of plants has also been found in some Permian fossil sites in Russia: in Trans-Uralia (Lower Permian), a giant endophytic oviposition on an equisetophyte stem; in the Pechora Basin (Upper Permian), linear endophytic ovipositions on leaves of *Phylladoderma*; the latest materials collected in the extremely rich Isady fossil site (Upper Permian) contain a number of new forms of biodamage on peltasperm leaves.

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Geodynamic environments of early Carboniferous volcanogenic complexe formation of Eastern interterrane segment of the Urals Paleozoic orogen

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Interterrane segment of the Urals Paleozoic orogen is distinguished along the eastern periphery of the Middle Urals. It is formed by accretion of the Adui-Murzinka, Reftinsk and Krasnogvardeisk terrains of the ancient continental crust. In the inner part of this structure volcanogenic rocks of basalt-andesite-dacite-rhiolite complex of the Early Carboniferous age (C_1bk) occur. The complex is presented by a complicated lava association of basalts, andesibasalts, andesites, andesidacites, dacites, rhiodacites, as well as tuffs and tuffites, tuff-coconglomerates, tuff-sandstones, tuff-aleurolites and tuff-aleuropelites. In the composition of the complex's tuffs and lavas andesites predominate, basalts are present in subordinated quantity. The volcanites along the whole segment length form extended stripes among heterofacial sedimentary rocks of the Upper Devonian and carbonate-terrigenous sediments, in which interbeds of calcareous sandstones there is the foraminifera fauna of Upper Visean. In the East they are replaced by coal-bearing rocks.

The basalts are known in the segment northern part, where they form short flows and overlap thitknesses of shell and massive limestones, as well as tuffogenic-sedimentary deposits containing the Famennian stage fauna in limestone interbeds.

The main part of the complex's volcanic sections, located to the South, is composed of the andesite lavas. According to their structure, the presence of pyroclastic rocks volcanic paleo-structures were reconstructed and the planned centres of volcanic eruption were anticipated. Andesites on phenocryst composition are pyroxene-plagioclase. Their structure is porphyry. The plagioclase phenocrysts are presented by zonal andesite. On their geochemical parameters the andesites are responsible for the formation of active continental margins.

The complex's subvolcanic rocks are presented by numerous dolerite dikes. These are the elongated oriented in north-eastern direction bodies of 0.5–1.5 m thick. Their age is accepted as Carboniferous, younger than the Zhukovsky Horizon (C_1v_2z) on the base of finds in limestones of rare brachipods. Dolerites possess geochemical features of intraplate entities.

The formation of early Carboniferous volcanic rocks of the segment reportedly occurred within the active continental margin. A distinctive feature is that its role in the Early Carboniferous time has been played by compositional structures formed by the accretion of continental terrains in different parts of eastern periphery of the Urals orogene.

Palaeobotanical evidence of wildfires in the Lopingian of Junggar Basin, Northwestern China

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It is now widely accepted that fusain represents fossil charcoal, which has been produced by wildfires during past episodes of the Earth's history. Most detailed reports on late Palaeozoic charcoal from northern hemisphere came from Westphalian and pre–Westphalian deposits. Fewer investigations have demonstrated that evidence for palaeo–wildfires can be found in many Permian deposits. So far fossil charcoal has been reported from the Lopingian low latitudes (palaeotropics) of Cathaysia, Euramerica and Northern Gondwana, and high latitudes of southern Gondwana. Knowledge about Lopingian wildfires in the mid–latitudes only comes from coal deposits by inertinite because there is no fossil charcoal has been found from clastic sediments. Here is presented an anatomical analysis of charcoal originating from Wuchiapingian and Changhsingian terrestrial deposits of Junggar Basin, northwestern China. The anatomical diversity of charred wood is higher than that of the permineralised woods from the Lopingian that has been described previously. The coniferous charred wood may have been derived from an extrabasinal forest, perhaps from upland environment deep within the hinterland, according to results of modern taphonomic research. The growth ring within the charred wood implies that these plants may have grown under a seasonally subhumid climate. The presence of charcoal indicates that these vegetation may have experienced more or less regular wildfires during the Lopingian in the mid-latitudes of Pangaea.

Invasion of Angaran and Euramerican floras to Cathaysia in Latest Permian: A peltasperm-dominated flora with cuticular preservation from the Nanshan Region, Western China

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The Sino-Swedish "Scientific expedition to the North-western provinces of China under the leadership of Dr. Sven Hedin" from 1927 to 1935 is well known. The scientific conclusion from this expedition that the Angaran flora is, on the whole, younger than the Cathaysian flora, based on material from the Nanshan section in Gansu received broad international attention. However, subsequent reinvestigations of the Nanshan section and other nearby sections by Chinese geologists and palaeobotanists indicated that this statement was arguable. As a whole, Angaran and Cathaysian floras are now considered to be roughly of the same age. Unfortunately, none of the previously described plant fossils yielded cuticles; information on the epidermal structure is essential for reliable identifications of the plant taxa and comparisons of the Nanshan flora with typical Angaran floras.

An extensive collection of fossil plants with cuticle recently brought together from the Sunan Formation of Dashankou, Yumen (uppermost Permian, western China) clearly indicates that the dominant taxa are Angaran and Euramerican. Except for *Lobatannularia* sp., this flora does not contain any other typical Cathaysian elements. This flora is clearly dominated by callipterids, *Tatarina* (*Pursongia*) *elegans* and *Peltaspermum nanshanense*. A critical reexamination of the Late Paleozoic floras from the Nanshan region shows that Angaran and Euramerican elements became locally dominant during the Latest Permian and replaced the typical Cathaysian flora in this region. This may be ascribed to the northward movement of the North China Block to a higher-latitude with different palaeoclimatic conditions, more suitable for typical Angaran and Euramerican elements.

The Pennsylvanian *Neognathodus* conodont fauna in the Naqing Section, Guizhou, South China

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The carbonate Naqing section (slope facies) located in the southern Guizhou Province, South China, contains abundant conodonts belonging to all genera known from the Pennsylvanian of the other areas. These are *Declinognathodus*, *Idiognathoides*, *Neognathodus*, *Idiognathodus*, "*Streptognathodus*", *Neolochriea*, *Diplognathodus*, *Mesogondolella* and *Gondolella*. Among them, *Neognathodus* species display sufficient interspecific diversity during the Bashkirian and Early Moscovian. Preliminary study enables to identify the following taxa, in ascending order they are: *N. symmetricus*, *N.* aff. *bassleri*, *N. askynensis*, *N.* aff. *atokaensis*, *N. kanumai*, *N. uralicus* and *N. atokaensis*. Meanwhile, several new morphotypes found in this almost continuous section may be significant for the discovery of the potential lineages and interregional correlations.

New progress on the study of the Visean–Serpukhovian boundary in South China

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A synthetic study on biostratigraphy, sedimentology and geochemistry of the Upper Visean to Serpukhovian succession in South China is being undertaken in order to comprehensively understand the evolutionary change of the biota and global correlation around the Visean–Serpukhovian boundary. The studied sections include the following: the Naqing, Narao, Luokun, Dianzishang and Yashui sections, among of which the former three are relatively deep water (slope) facies and the last is shallow water (platform) facies.

Abundant P1 elements of conodont *Lochriea* species, which have a wide morphological variability throughout the Upper Visean–Lower Serpukhovian boundary interval in the Naqing section, are recently restudied. Two lineages are herewith proposed: 1) noded *Lochriea* species, such as *L. mononodosa–L. nodosa–L. ziegleri, L. senckenbergica* and *L. multinodosa*, and 2) ridged *Lochriea* species such as *L. monocostata–L. costata–L. cruciformis*. The numerous and very variable species of *Lochriea* across the V–S boundary in the Naqing section, South China are sorted out for the first time, and the possibilities for their derivation are discussed.

In addition, detailed conodont biostratigraphy across the V–S boundary intervals in the Luokun section and the Narao section have also been studied based on a bed-by-bed sampling during 2013–2014. Abundant foraminifers have been found in the Dianzishang and Yashui sections around the V/S boundary interval. Several volcanic ash beds have been collected from the Naqing section and wait for dating. A preliminary chemostratigraphic study shows that a negative carbon isotope excursion exits shortly above the FAD of conodont *Lochriea ziegleri* in all the Naqing, Narao and Luokun sections, which might be used for the global correlation.

Palaeoenvironmental and palaeoclimatic reconstruction of the Witbank coal deposits (Karoo Basin, South Africa)

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Coal deposits are important palaeoclimate archives and the use of palynofacies is a crucial tool in the understanding of past climate and environmental change. Sporomorph assemblages act as proxies for their parent plant communities which are in turn controlled by environmental and climatic conditions. Furthermore, particulate organic matter behaves in much the same way as sedimentary particles do during transport, giving us another tool to interpret the depositional environment and transport mechanisms.

The Late Carboniferous to Middle Jurassic Main Karoo Basin features the most economically important coal deposits in South Africa. The development of coal swamps on the north-east coast of the Ecca Sea during Permian times, as well as the climate and environments associated with them can be interpreted using palynomorphs. The fluvio-deltaic deposits of the No. 2 Coal Seam in the Witbank Coalfield have been particularly useful for interpreting at a high resolution the switch between icehouse to greenhouse conditions of post-glacial Gondwana. This coal seam is split into a Lower Coal Seam and an Upper Coal Seam by a sandstone marker bed and samples were studied from all three horizons.

Palaeoenvironmental interpretations based on palynofacies analysis from multiple localities suggest a proximal swamp-dominated setting but local-scale differences have been observed. The palynofacies analysed from the sandstone marker layer agrees with the sedimentological evidence of a river-dominated phase.

Vegetation patterns inferred from the sporomorph assemblages in the Lower Coal Seam include an upland community of monosaccate pollen-producing conifers, which give way to bisaccate-producing gymnospermous vegetation in the Upper Coal Seam. The lowland vegetation is interpreted as featuring monolete and trilete spore-producing groups such as ferns and horsetails common in peat-forming wetland environments.

The change in the sporomorph assemblage from the Lower Coal Seam to the Upper Coal Seam appears to indicate a shift from cold to cool-temperate climate. This regional signature of climate amelioration would have occurred as glaciers continued to recede as Gondwana moved further away from the South Pole during the Permian.

Clay mineralogy of marine sediments across the Permian–Triassic boundary in South China

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The Earth experienced the most severe biotic crisis during the Permian–Triassic transition. Despite decades of efforts to explore the real causes of this crisis, no consensus has been reached. Increasing evidence has shown that the end-Permian biotic crisis and associated deterioration of both marine and terrestrial environments were actually long, protracted processes that began before the very end of the Permian, which were accompanied by mineralogical and geochemical changes. Thus, insight into the understanding of the geological processes during the Permian-Triassic transition can be obtained by examining mineralogical changes. Clay minerals have been proved good indicator of environmental changes, while they are sensitive to both syn-depositional and burial diagenesis. So far, rare (and of low-resolution) clay mineralogical studies have been conducted during this critical transition time. This study reports preliminary clay mineralogy of the Permian–Triassic strata from four marine sections (Dongpan, Xinmin, Ganxi and Shangsi) outcropping in South China.

While showing various proportions, illite and illite-smectite mixed layers (I/S) are the most ubiquitous clay species both in the Permian and Triassic strata, although I/S generally decreases prominently in the Triassic when illite either increases or stays relatively unchanged. The estimation of the proportion of illite in I/S mixed-layers (% Illite) from K-bentonites intercalated in the sedimentary series is used to evaluate the intensity of diagenesis. % illite shows values of 70–80 for Shangsi, 85–95 for Xinmin, >90 for Ganxi, and 40–50 (R0) and 70–80 (R1) for Dongpan, indicating significant influence of thermal diagenesis, especially in Xinmin and Ganxi sections. Chloritic clay minerals (chlorite, chlorite-smectite and chlorite-vermiculite mixed-layers) constitutes respectively a dominant and a subordinate part in Xinmin and Dongpan sections (both belong to the southwestern deep basin of the Yangtze platform) probably due to the proximity to basaltic source(s) assuming parent smectitic minerals. In Shangsi and Ganxi sections (both in the northern marginal basin of the Yangtze Platform), they start to appear as a subordinate component up-section only when sea-level drops prominently in the Latest Permian where significant amount of detrital materials was introduced into the basin. The occurrence of vermiculite, though present in only a few samples in Dongpan and Shangsi sections, clearly coincides with the Latest Permian sea-level drop. While diagenetic influence of chloritic minerals may be significant, the emergence of vermiculite may represent the combined effects of rapid and large terrestrial influx into the sedimentary basin due to collapse of terrestrial ecosystem and a change of climate to much drier conditions. Discrimination between the two, however, is difficult, given the data we obtained.

New bio- and lithostratigraphy data for the Early Carboniferous of Northern Kharaulakh (Arctic Yakutia, Lena River)

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A working group from IPGG SB RAS carried out a complex lithological-biostratigraphic investigation of the reference Carboniferous–Permian section ("South" section) of North Kharaulakh, located between the mouth of the Taba-Bastakh-Yurege River and that of the Kysam River on the right bank of the Lena River and stretching more than 10 km. Stratotypes of almost all local and regional stratigraphic units can be observed in the section. Detailed lithological-biostratigraphic studies were made for the Lower Carboniferous interval – the Bastakh, Atyrgakh and Tiksi formations. The Bastakh Formation in its lower part is composed of terrigenous-carbonate strata (about 50 m thick) with poor fossils. The upper part of the formation (about 120 m thick) consists of bioclastic carbonates; carbon-bearing siliceous-carbonate sequences characterize descending carbonate platform environments. The late Tournaisian conodont assemblage *Pseudopolygnathus multistriatus* M. et Th., *Neopolygnathus communis* (Br. et M.), *Bispathodus aculeatus* (Br. et M.), *Mestognathus praebeckmanni* Sand. et al., and *Gnathodus* sp., as well as the brachiopods *Prospira settedabanica* (Abr.) and *Spirifer subgrandis* Rot. were found there. The overlaying Atyrdakh Formation is about 290 m thick and is composed at the base of relatively deep-water slowly accumulated clayey-siliceous, carbonic-clayey-silty strata. The upper part of the formation consists mainly of silty-sandy strata with rare incised channels filled with coarse-grained sediments. Fauna is very rare: at the base of the formation the brachiopods *"Lingula"* and *Orbiculoidea* were recovered, in the upper part – endemic species of the brachiopods *Neospirifer*, *Syringothyris* and some others. The Tiksi Formation is 970 m thick and is composed of distal silty-clayey turbidites with rare channels filled with sandy material. The lower part of the formation (480 m thick) lacks any fossils. In the middle part of the formation, 480–560 m from the base, the ammonoid *Goniatites* cf. *americanus* Gordon was recovered, dating the strata as the *Beyrichoceras–Goniatites* Genozone characterizing the middle part of the Viséan. In the interval 590–675 m from the base of the Tiksi Formation, a diverse brachiopod assemblage was found. It consists mainly of Verkhoyansk Region endemics with rare *Torynifer* cf. *evagoratus* Besn., *Buxtonia scabriculoides* (Paeck.) and *Orulgania* cf. *gunbiana* Kotl., allowing this part of the section to be conditionally assigned to the Viséan. 110 m from the top of the formation, the ammonoid *Neoglyphioceras septentrionale* Andr. was identified. At the same locality, the first appearance of the brachiopod *Balakhonia* was observed, and 20 m upward the nautiloid *Diodoceras* was recovered. The fossils found allow us to propose that the upper part of the Tiksi Formation (110 m thick) could be assigned to the Serpukhovian Stage. The Tiksi Formation, overlain by sandstones of the Tugasir Formation, yielded Upper Bashkirian Orulganitidae.

High-resolution Lopingian conodont biostratigraphy at the Shangsi section of Sichuan Province, South China

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Three GSSPs in the Lopingian Series have been precisely defined by conodonts in South China based on continuous marine sequences. However, a continuous Lopingian conodont succession established based on a single section is still absent. The Shangsi Section in Sichuan Province was formerly selected as one of the candidate sections for the GSSP of Permian–Triassic boundary (PTB) and has been studied for more than three decades. The Permian sequence consists of continuous carbonate-dominated facies and is lithostratigraphically divided into six formations. They are respectively the Maping, Chihsia, Maokou, Wuchiaping, Talung and Feixianguan formations in ascending order. The conodont fauna in the Lopingian was poorly documented from the Wuchiaping to Talung fromations in contrast to the PTB interval in the base part of Feixianguan Formation. Two hundred and fifty conodont samples were collected and processed from the upper part of the Maokou Fromation to the lower part of the Feixianguan Formation in about 100 m thick strata at the section in this study, of which 125 are productive. Eleven conodont zones are recognized. They are, in ascending order, *Clarkina dukouensis*, *C. asymmetrica*, *C. liangshanensis*, *C. transcaucasica*, *C. orientalis*, *C. wangi*, *C. subcarinata*, *C. changxingensis*, *C. yini*, *C. meishanensis* and *Hindeodus changxingensis* zones. Lopingian conodont biostratigraphic framework is established at the Shangsi section and is correlated with the Wuchiapingian conodont biostratigraphic framework at the Penglaitan and Dukou sections and the Changhsingian conodont biostratigraphic framework at the Meishan sections.

Late Viséan and Serpukhovian ostracod assemblages in the Paleouralian and Moscow marine basins

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Two ostracod assemblages, indicative of relatively deep-water and shallow facies are recognized in the Upper Viséan and Serpukhovian of the South Urals. In the late Viséan, the Bairdiidae–Paraparchitidae –Rectonariidae ostracod community existed in the relatively deep-water regions of the marine basin, also inhabited by ammonoids and other deep-water organisms (Verkhnyaya Kardailovka, Kiya, Sholak-Sai, Dombar Hills, etc.). At the same time, the Bairdiidae–Paraparchitidae ostracod community inhabited the nearby open shallow sea with abundant algae and foraminifers (Bolshoi Kizil). In the Early Serpukhovian the relatively deep-water regions of the South Uralian marine basin were inhabited by the Rectonariidae–Bairdiidae–Bairdiocyprididae community (Verkhnyaya Kardailovka, Kiya, Sholak-Sai, Dombar Hills, etc.). At the same time, the shallow sea of Bolshoi Kizil with abundant brachiopod banks, and algal and coral mounds, continued to host a community of ostracods similar to that of the Late Viséan, but with the more diverse specific composition of *Bairdia*. In the Late Serpukhovian, the relatively deep zones were inhabited by a community of Rectonariidae–Bairdiidae–Healdiidae–Paraparchitida, whereas the Late Serpukhovian mounds (Bolshoi Kizil) were inhabited by Paraparchitidae and Bairdiidae (of which Paraparchitidae were the more diverse and abundant). In the Russian Platform (northwestern regions of the Moscow Basin, Msta River), the Late Viséan clastic and carbonate sedimentation basins were inhabited by the Bairdiidae–Paraparchitidae–Amphisitiidae–Cavellinidae community, whereas the southern margin of the Moscow Basin (Novogurovo Quarry) was inhabited by the Bairdiidae–Paraparchitidae–Cavellinidae assemblage. At the beginning of the Early Serpukhovian (Tarusian), the shallow Moscow Basin (Rovnoe locality) was inhabited by the Bairdiidae ostracod community, which was later replaced by the Paraparchitidae community. The southern margin of the Moscow Basin (Novogurovo Quarry) was at that time dominated by the Bairdiidae community which was, in the Steshevian, replaced by the Amphisitiidae–Cavellinidae community. A similar community existed at that time in the southeastern regions of the Russian Platform (Borehole 20 of the Peschanaya Field). Thus the Upper Viséan ostracod assemblage of the South Urals is similar to that of the Russian Platform, whereas the Serpukhovian Assemblage is shown to be endemic by to the presence of Rectonariidae.

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Carbon and nitrogen isotope record of Induan–Olenekian sequences in South Primorye and conditions for ammonoid and brachiopod recovery after Late Permian mass extinction

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Carbon and nitrogen isotope ratios in Lower Triassic sediments in Russian Far East were measured in detail for the first time on the basis of 207 samples, collected from the Abrek section. A couple negative carbon isotope excursions are present in the Olenekian Zhitkov Fm. We explain carbon isotope shifts mainly with variations of ratio terrigenous versus marine organic matter and connect the predominance of marine organic matter in investigated sediments (the negative excursions) with the beginning of transgressions. Higher $\delta^{15}N$ values have been discovered in the lower part of the Zhitkov Fm., lower values in the lower part of the Induan Lazurnaya Fm. and the upper part of the Zhitkov Fm. This shift, seemingly independent from the origin of organic matter might reflect a change of the N-cycle in both organic matter reservoirs, or a pronounced shift in one of it, probably the marine organic matter (possibly connected with microbial blooms, perhaps as a result of palaeotemperature changes). The intervals of the negative carbon isotope excursions mentioned above are found to be associated with the transgressive facies and the related biotic change (or change in fraction of organic matter reservoir). The known isotopic palaeotemperatures, calculated from the Early Triassic aragonite preserved cephalopods and apatite-bearing fossils without any specific correction, seem to be partially unrealistically high (about 31.5–43 and 29–45^{o}C, respectively). The question concerning the interpretation of anomalously light $\delta^{18}O$ signatures still remains debatable. They are preserved in both the aragonite preserved cephalopod shells from the Lower Triassic Olenek River basin and the upper Anisian in Taimyr and the apatite fossils from the Lower Triassic of South China, Pakistan and Iran. Three versions are proposed for an explanation of this mystery: (1) Early Triassic was a time of extreme warmth existing in both the low and higher palaeolatitudes; (2) it was a time of the almost global low salinity of ocean water; (3) alternatively, the results discussed above enable also recognition of marine basins having a strongly pronounced low salinity during Early Mesozoic time only in the Boreal realm, but overestimated palaeotemperature values calculated from Early Triassic apatite fossils seem to be an artifact because of some reasons (e.g., minor diagenesis and / or local change in the oxygen isotope composition of marine waters under influence of a lower dilution with freshwater). The latter seems to be preferable. We assume that earliest Mesozoic ammonoids, as well as brachiopods and conodonts, inhabited some northern high latitude marine basins, were appreciably low salinity tolerant organisms, but those from low and middle palaeolatitudes apparently the high temperature tolerant ones. The presumed early Smithian transgressions in South Primorye were periods of favourable conditions for the recovery of ammonoids after end-Permian mass-extinction. However, Early Triassic brachiopods got somewhat more favourable conditions only during the following transgression, starting in the Spathian.

The genus *Quasiendothyra* as the basis for the zonal subdivision of the Famennian and for definition of the Devonian–Carboniferous boundary in the Volga–Urals and Peri-Caspian regions

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The genus *Quasiendothyra* (Foraminifera) plays a dominant role in the detailed stratification of the Middle-Upper Famennian deposits. These foraminifers were widespread in the Famennian basins of Eurasia, making them especially valuable for remote correlations. *Quasiendothyra* evolved rapidly and layers with foraminifera are allocated by different researchers from 2 to 9 zones and subzones in the Volga–Urals and the Caspian subregions. The following zones can be traced most clearly and are most stable in different facies sediments of these subregions: *Quasiendothyra bella*, *Q. communis, Q. kobeitusana*.

The *Quasiendothyra bella* zone is characterized by the appearance of the index species and the development of a variety of *Septaglomospiranella* (*S. primaeva primaeva* (Raus.), *S. primaeva kasakhstanica* (Raus.), *S. compressa* Lip.) and *Septatournayella rauserae* Lip. The instability of morphological features of species markers, the affinity with the ancestral form *Septaglomospiranella* and similarities with the primitive *Q. communis* lead this zone sometimes being combined with the *S. primaeva* zone, as the *S. primaeva–Q. bella* zone, or regarded as the lower part of the *Q. communis* zone.

The *Quasiendothyra communis* zone is determined by the appearance of the index species and is characterized by intense intraspecific diversity and increased speciation of the genus *Quasiendothyra*, allowing it to be split into *Q. communis communis, Q. communis regularis* and *Q. radiata* subzones. A typical complex includes, in addition to the listed species, *Septaglomospiranella primaeva* (Raus.), *Septatournayella rauserae* Lip., and *Quasiendothyra bella* (N.Tchern.) passing from the underlying zone.

The *Quasiendothyra kobeitusana* zone is diagnosed by the appearance and wide distribution of the index-species. It is characterized by passing from the underlying zones of various *Quasiendothyra* of the *Q. communis* groups, *Septaglomospiranella* and *Septatournayella*. In the upper part of the zone the large inflated *Q. dentata* (Durk.) and the bimorphic foraminiferan *Klubovella konensis* (Leb.) with the shell straightening in late ontogeny, appear. This is the basis for the subdivision of this zone into 2 subzones: *Q. kobeitusana kobeitusana* and *Q. dentata–K. konensis.*

A sharp decrease in taxonomic diversity and reduction in the number of *Quasiendothyra* define the Devonian–Carboniferous boundary. Above the boundary only sporadic *Quasiendothyra* sp. are found in the sections of the Volga–Urals subregion. Thus, the disappearance of *Quasiendothyra* occurs near the Devonian–Carboniferous boundary. In the Volga–Urals and Peri-Caspian regions, foraminiferans of this group can serve as an additional biostratigraphic marker for the D–C boundary.

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The microspherules from the P–T boundary layers in South China: Not an evidence for an extraterrestrial impact event

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Over 60 samples from 35 Permian–Triassic boundary event layers in 12 sections in China were collected and analysed for searching microspherules to study possible evidence of extraterrestrial impact or volcanic eruptions. Detailed SEM observations of surface and internal structures and chemical analyses indicate that the microspherules from the PTB beds are of multiple origins. Among them, most of iron and magnetite-silicate microspherules are modern fly ashes rather than of volcanic origin or impact event. The pyrite microspherules and framboidal pyrite are of depositional or / and diagenetic origins. The calcareous microspherules and the hollow organic microspherules are of biological origin.

Based on a study of microspherules from the P–T boundary beds in South China, no evidence supports that microspherules from the PTB beds in South China are of impact origin. No accompanying minerals with impact planar deformation features were found so far in the PTB beds in South China.

Early Permian deglaciation and subsequent palaeobiogeographic changes in Northern Tibet

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The Lhasa and South Qiangtang blocks were located at the Gondwanan margin during the Earliest Permian. The Early Permian deposits in both blocks were affected by the Late Paleozoic glaciations, which were represented by widespread glacio-marine diamictites and drop-stone structures. The deglaciation and subsequent climatic warming seem to have been synchronous in both the Lhasa and South Qiangtang blocks, which were characterized by the appearance of carbonates with diverse marine faunas. However, the fusulinids began to occur in the South Qiangtang as early as the Artinskian and they were represented by Peri-Gondwanan elements. The subsequent Kungurian faunas in the South Qiangtang Block were composed of many warm water brachiopods and fusulinids such as *Cancellina, Parafusulina* and the bi-polar fusulinid genus *Monodiexodina*. By contrast, the Artinskian and Kungurian strata in the Lhasa Block were dominated by cool-water brachiopods, the conodont *Vjalovognathus* and non-dissepimental solitary corals. The warm-water fusulinids, foraminifers and compound-corals occurred as late as the Roadian. The Lhasa Block was apparently late in the advent of warm-water faunas compared with the South Qiangtang Block. This difference, combined with different geochemistry of the Permian basalt in both blocks, may reflect their different paleogeographic positions.

Sequence stratigraphy of the Upper Paleozoic deposits in the Pechora Sea

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Upper Paleozoic deposits of the Pechora Sea are forming the Ramp complex. Evidences of different scale sea level changes are observed in their structure. Twelve sequences of the third order were identified within the Upper Paleozoic section. Development and sequence types were controlled by different ratios of carbonate sedimentation rates and the accommodation space. The Lower Carboniferous section mainly composed of high stand system tract deposits. The Lower Permian Sequence consists of three system tracts. The algal and Palaeoaplysina-dominated buildups are associated with the lower system tract.

Late Paleozoic carbonate buildups of the Southern Norwegian Barents Sea – a new target for hydrocarbon exploration

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Upper Paleozoic deposits of the Norwegian sector of the Barents Sea are considered as one of the promising target with significant hydrocarbon resource potential. The reservoir potential of this interval is associated with warm-water carbonate buildups of the Gipsdalen (Orn Formation) and with cool-water carbonate buildups of the Bjarmeland (Polarrev Formation) groups. Reservoir properties are controlled by numerous lenticular and linear trends of Palaeoaplysina and Bryozoan-dominated buildups. The sedimentological model is based on the results of comprehensive seismic and well data interpretation that formed the basis for leads and prospects identification of top-priority search of hydrocarbon accumulations.

Investigation of lithotypes of carbonate rocks from the Upper Tournaisian in the south-east of Tatarstan

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The efficiency of engineering of the field development system depends on the knowledge of the lithological and petrophysical features of component of the oil field reservoir. It requires studying the pore void space structure of lithology matrix and characteristics of the fine component that fills the pore channels.

Alekseevskoe oil field is located in the south-east of Tatarstan. Tectonically the study area coincides with the join area between South-Tatar arch (STA) and Sernovodskaya–Abdulinsky aulacogene. The Upper Tournaisian consists of the Kizelovskian and Cherepetian horizons, which are oil-saturated in Alekseevskoe oil field.

Lithological composition of the deposits is represented by light gray, patchy oil-saturated, biomorphic, bioclastic-detrital interlayers, brown, oil-saturated, patchy high oil-saturated, cryptocrystalline, porous and cavernous limestone which is partly brecciated. There are also low sloping numerous steaks of argillaceous carbonaceous material.

Based on the analysis of microscopic investigation of the high variety of carbonates have been distinguished: (1) lumpy; (2) clot-detrital; (3) slurry- detrital; (4) clot- foraminiferal.

The first two lithotypes of carbonate rocks are reservoir, the following two are non-reservoir.

Kizelovskaya Horizon is mainly consists of lumpy limestones including fine-grained calcite nuggets, with scarce shell of foraminifera as admixture, floral and rare faunal detritus.Clot-detrital limestone contains the flabbily sorted mainly algal detritus and fine-grained calcite clots. The structure of pore range/field is much more complicated than in lumpy difference of limestone. Pores are small intra-formational, bunch to bunch, canals are narrower, longer, more tortuous.

Thickness of rocks according to morphological features and genesis reservoirs are of pore and mixed types. In the Kizelovskian Horizon the pore type of reservoir is spread. The Cherepetian rocks are characterized by pore cavernous and pore fissure types of voids.

Studied lithotypes of carbonate rocks of the Alekseevskoe reservoir is characterized by high enough value of reservoir features. Positive results of the study of present collectors will be recommended for effective and expedient maintenance.

Kazanian (Mid Permian) depositional environments on the Eastern Russian Platform: New lithological data and facies analysis

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Mineral composition of carbonate rocks of the Lower and Upper Kazanian (Mid Permian) of the Petchischi Region (Eastern Russian Platform) was investigated by X-Ray powder diffraction, ICP spectroscopy and optical microscopy.

The Lower Kazanian deposits in studied area are presented predominantly by dolomites of mixed waters with changing terrigenous component and the lack of gypsum-bearing layers in the succession. The terminal Lower Kazanian layers consist of unsaturated biomicritic dolomites with incompletely dolomitized remains of macro- and microfauna.

The Upper Kazanian succession includes the cyclic recurrence of mixed water dolomites and evaporitic dolomites. Regular alternation of gypsum-bearing dolomite, clayey dolomites, and dolomites containing fossils is a consequence of depositional environment changing from sabkha (with gypsum-bearing dolomites) to shoaling transgression (with mixed water dolomites).

On the results of provided analysis of facies spatial and temporal distribution, petrographic studies of the Kazanian carbonate rocks and in accordance with synopsis of standard facies belts, two marine facies can be distinguished on the Eastern Russian Platform: peritidal shallow flat and continental sabkha. The peritidal shallow flat was connected with an open sea northward. Due to arid climate, low water circulation, and shallow sea (up to 10–30 m) pure biomicrite dolomite and lime mud were deposited here. Shallow-water biota periodically inhabited this part of the sea: mostly brachiopods, bivalves, conodonts, foraminifera, ostracods, crinoids, bryozoans and algae. These organisms adapted to exist in a narrow range of environmental conditions reconstructed in the Early Kazanian. Sabkha stretched southward to the Northern Caspian Basin. It is represented by pure micrite dolomite and lime mud with organisms adapted to exist in a wide range of environmental conditions, including increased salinity. The depth was very shallow (up to 10 m), temperature of water could increase dramatically which could lead to intensification of salt formation on the one hand, and to a complete drainage on the other. Marine and silisiclastic facies are combined in the depositional model.

Discovered bentonite-bearing component in marls and bentonite clays are evidence of volcanic activity in the Urals in the Kazanian Stage and periodically intensive discharge of the ash clouds onto the basin of sedimentation.

Chronostratigraphic scheme with a regional sea-level curve first proposed for the Eastern Russian Platform. Regional sea-level after rapid rise at the beginning of the Kazanian (Roadian) began long smooth fall synchronous to the global sea-level trend untill the Vjatkian (Wuchiapingian).

Late Paleozoic non-marine bivalves of the Norilsk Region

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A.B. Gurevich's collection of non-marine bivalves (n-MB) collected in 1988 in the Norilsk area was re-discovered at the end of 2014. Early and middle Permian n-MB were recoignized from imprints in the borehole core of four wells in the carbonaceous mudstones by specialists from the A.P. Karpinsky Russian Geological Research Institute. These included: KP-6 Well. Interval 530.70–532.30 m (Schmidt formation (Lower Pelyatka subhorizon)) – *Mrassiella* (?) s*triata* Khalf., *M. magniforma* Rag., *Kinerkaella balakhonskiensis* (Rag.), *K. elongata* Khalf., and *Yavorskiella* sp. Interval 494.40–494.60 m (Schmidt formation (Lower Pelyatka subhorizon)) – fragments of larger shells of n-MB. Interval 189.00–195.70 m (Kayerkan formation (Upper Pelyatka subhorizon)) – *Anthraconaia* sp.

NP-49 Well. Interval 1095.50–1103.90 m (Talnah formation (Lower Pelyatka subhorizon)) – *Mrassiella magniforma* Rag., *Kinerkaella* cf. *balakhonskiensis* (Rag.), Group 'M', two incomplete imprints of large shells. *Conhostraca*. Interval 927.05–980.00 m (Schmidt formation (Lower Pelyatka subhorizon)) – part of a shell.

NP-1 Well. Interval 1323.00–1323.50 m (Daldykan formation (Upper Burgukli subhorizon)) – juvenile and adult shells of *Kinerkaella* sp. and *Mrassiella magniforma* Rag., *Anthraconauta* cf. *lanceolata* (Rag.) (juvenile), *Angorodon rotundata* Khalf., Group «M» (*Mrassiella*-like shells, *Kinerkaella*-like shells, and *Angorodon*-like shells), and imprints of large poorly preserved shells.

OP Well. Interval 1911.40–1916.10 m (Daldykan formation (Upper Burgukli subhorizon)) – incomplete prints shells n-MB.

The stratigraphic position of n-MB Upper Paleozoic assemblages in the Tunguska basin is usually determined by correlation with the fauna of the Kuznetsk Basin, as most species were originally established in the Kuznetsk Basin. In general, the assemblages from the above n-MB wells are similar to those from "Alykaeva" The fauna of the Kuznetsk Basin comes from the Upper Carboniferous and Lower Permian. In the Kuznetsk Basin L.L. Khalfin recognized two Aykaeva faunas, separated by an interval (observed recurrence). In the Norilsk area the taxa studied appear in the Talnah time and continue to exist until the Schmidt time.

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- universal testing machines of Walter+Bai AG company /Switzerland/;
- high-frequency testing systems of RUMUL AG company /Switzerland/.

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Компания «АджиТек» с 2008г. является официальным партнёром Российского представительства компании *Keysight Technologies*. Наша компания активно ведет работу в Приволжском и Уральском федеральных округах, осуществляет ряд проектов в области оборонно-промышленного, аэрокосмического и нефтепромышленного комплексов, а так же сотрудничает с федеральными институтами и университетами.

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В городах Казань, Ижевск, Екатеринбург работают официальные представительства компании «АджиТек», осуществляющие поставку, полный комплекс работ по поверке, калибровке, гарантийному и послегарантийному ремонту оборудования *Keysight Technologies*.

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