Report on the activities of the Late Carboniferous – Permian – Early Triassic Nonmarine-Marine Correlation Working Group for 2016 and 2017

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The report for 2016 and 2017 highlights already published results obtained from recent studies in China, Russia, Germany, Czech Republic, Italy, France, Spain, Jordan, North America, Morocco and South Africa by the different regional working groups to draw attention to these publications.

Teams of the Nanjing Institute of Geology and Palaeontology, supported by colleagues from other institutions, published important new data on the correlation of continental and transitional continental-coastal marine sequences with the mass extinction level in the marine GSSP of the PTB in Meishan, South China, based on Shen et al. (2011). Zhang et al. (2016) concluded from the disappearance of the *Gigantopteris* megaflora, from microflora data as well as from a distinct negative $\delta^{13}C_{org}$ shift the position of the continental end-Permian mass extinction in the Kayitou Formation of South China, which should be of latest Changhsingian, rather than Triassic age. Partially based on the same sections (Guanbachong and Chahe) as well as some newly investigated sections, including paralic and shallow marine sections, Chu et al. (2016) state that the Kayitou Formation is of Permian-Triassic transitional age. Most important for long-distance interregional correlation, e.g. with Russia and Europe, is the proposal to use the *Euestheria gutta*-bearing conchostracan fauna and the *Pteria ussurica variabilis-Towapteria scythica-Eumorphotis venetiana* bivalve assemblage as markers of the Permian-Triassic transitional beds in continental-marine siliciclastic settings of South China (Chu et al., 2016, 2017 in press; Scholze et al., 2016, 2017a, b). In a recently accepted manuscript, Bourquin et al. (in press) state that the Chahe and Zhejue sections as reference sections of the continental Permian – Triassic transition must be handled with caution. Both sections have been strongly affected by polyphase deformations. Therefore, palaeoenvironmental reconstructions, the interpretation of geochemical trends and correlations to the marine sections at Meishan should be reconsidered. Newly sampled conchostracans from the Kayitou and Dongchuan formations of the Longmendong, Lubei, and Zhejue sections in South China are at present being investigated by a team from Freiberg, Nanjing and Yunan universities. The expected results in combination with data from Germany, European Russia, and Siberia will contribute to the more precise identification of the PTB in continental deposits.

Members of the working group from Germany, UK and China have published a multistratigraphic approach to pinpoint the Permian-Triassic boundary in continental deposits of Central Europe (Scholze et al., 2017b). The analysed samples were obtained from both classical key sections of the continuous and undisturbed Zechstein–Lower Buntsandstein transition in the Central European Basin of Germany. In combination with conchostracan biostratigraphy, investigations of isotope-chemostratigraphy ($\delta^{13}C_{org}$, $\delta^{13}C_{carb}$, $\delta^{18}O_{carb}$), major and trace element geochemistry, magnetostratigraphy, and palynology were carried out. In conclusion it is proposed to place the Permian-Triassic boundary in the lower part of the Upper Fulda Formation of the uppermost Zechstein Group, which is biostratigraphically confirmed by the first occurrence date of the Early Triassic *Euestheria gutta-Palaeolimnadiopsis vilujensis* conchostracan fauna, palynological data and magnetostratigraphy (Fig. 1). An interesting early Triassic conchostracan fauna, discovered by a Jordan-German team at the Dead Sea, was already reported in Permophiles 62/2015 and is meanwhile published in detail (Scholze et al., 2017a). The dominat genus *Rossolimnadiopsis* was previously recorded only from two localities in the Moscow syncline in Central Russia. In addition to Jordan, the genus has been identified in India and possibly in Germany. All these occurrences seem to be restricted to a narrow stratigraphic interval ranging from the late Permian to the Early Triassic.

The South African team of A. Götz published a first basin-wide correlation of marine black shales and coal deposits of the Main Karoo Basin based on palynostratigraphy and palynofacies analysis (Götz et al., in press). A major transgressive event ("Whitehill event") during the early Guadalupian (Roadian) is documented in the peak abundance of marine phytoplankton within the Whitehill shales of the southern Karoo Basin and glauconitic silt- and sandstones of correlative coal deposits of the north-eastern basin parts.

Members of the working group supported the Kazan Summer School GeoKazan 2016, held 25-30 July at the Institute of Geology and Petroleum Technologies, Kazan Federal University, Tatarstan. Participants and presenters from 10 countries (Russia, Germany, Italy, Spain, UK, Syria, South Africa, Bolivia, Ecuador, and USA) met in Kazan to discuss and learn about the Late Palaeozoic Energy Resources of European Russia, with a focus on stratigraphy, sedimentology, geochemistry, and organic facies. Scientists of the Kazan Institute of Geology and Petroleum Technologies and international collaboration partners from Germany (Andreas Brosig, Frank Scholze), Italy (Giovanna Della Porta), UK (Annette E. Götz) and the USA (Vladimir I. Davydov) presented a broad program to a group of international MSc and PhD students covering carbonate sedimentology, basin analysis, biostratigraphy and palynofacies, 3D modelling and GIS. A one day field trip to the Permian continental type sections of the Volga-Kama region led by Vladimir Silantiev completed the extensive program.

A principle task of the Nonmarine-Marine Correlation Working Group is the presentation and discussion of recent research developments of the regional teams at biennial stratigraphic meetings. In September 2017, the one week Second Kazan Golovkinsky Stratigraphic Meeting and the Fourth All-Russian Conference "Upper Palaeozoic of Russia - Upper Palaeozoic Earth systems: high-precision biostratigraphy, geochronology and petroleum resources" was attended by 92 scientists from 8 countries (Russia, Germany, UK, China, USA, Kyrgyzstan, India, Morocco). The presentations at the Golovkinsky Meeting showed the significant progress in studying the Permian and Triassic boundaries of marine and nonmarine deposits. Two workshops addressed the challenging task of the position of the Permian and Triassic boundaries in continental sections. Another two workshops focused on the stratigraphy of the marine Carboniferous of the Volga-Ural region, in particular conodont taxonomy and biostratigraphy as well as the Carboniferous stage boundaries in Russia. The Late Carboniferous-Permian-Early Triassic Nonmarine-Marine Correlation Working Group held a business meeting focussing on the middle Permian problem, i.e. on the so far missing detailed biostratigraphy and interregional correlation of continental late early Cisuralian and Guadalupian deposits. The first promising results to tackle this problem based on conchostracan biostratigraphy of the middle and late Permian continental reference sections of the Volga and Kama river regions were presented during the Golovkinsky Meeting by Zharinova et al. (2017) (see Fig. 1).

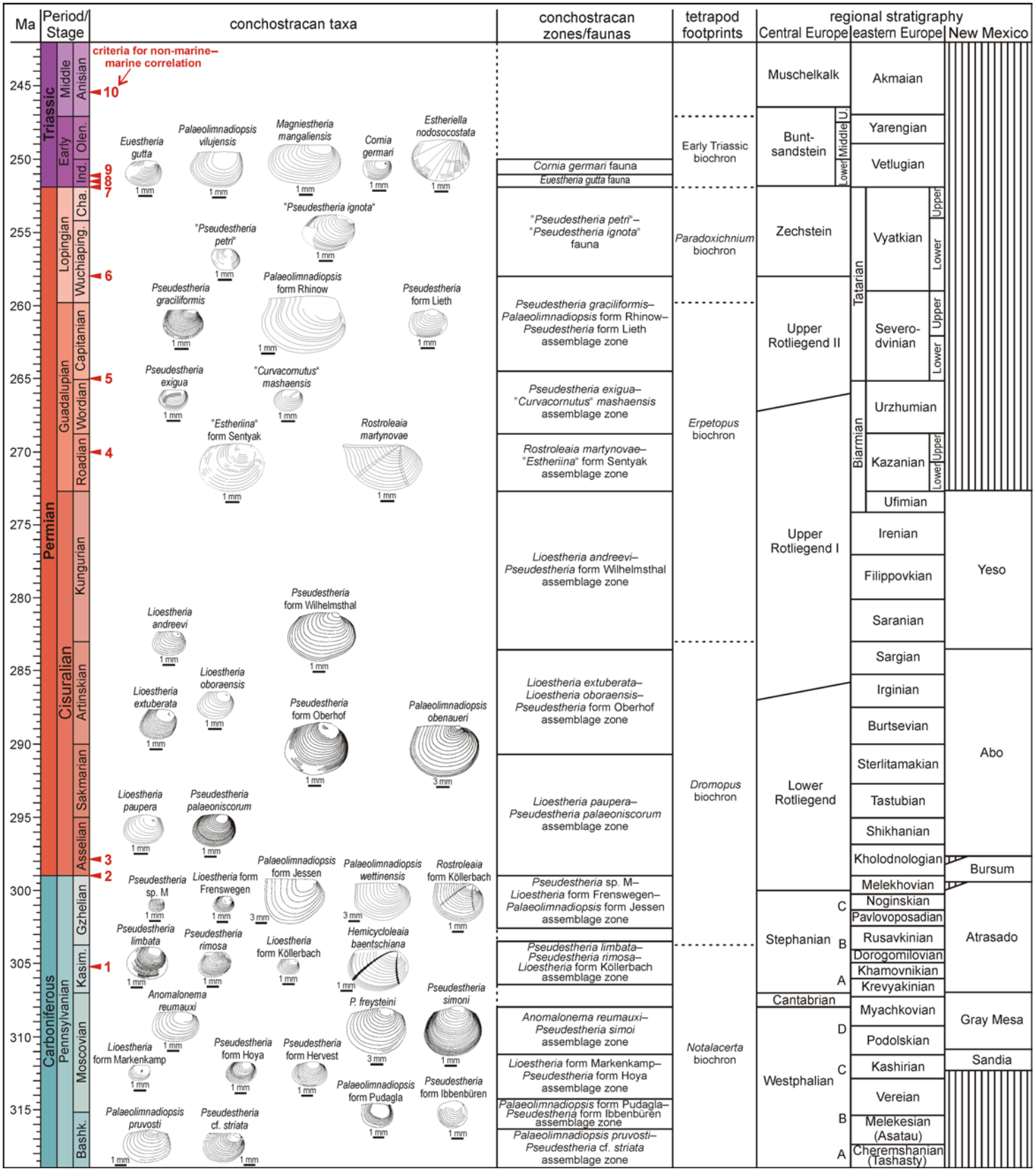
Ma
Period/ Stage
conchostracan taxa
conchostracan zones/faunas
tetrapod footprints
regional stratigraphy
Central Europe
eastern Europe
New Mexico
criteria for non-marine–marine correlation
Triassic
Permian
Carboniferous
Pennsylvanian
Early
Middle
Olen.
Ind.
Anisian
Cha.
Lopingian
Wuchiaping.
Guadalupian
Capitanian
Wordian
Roadian
Cisuralian
Kungurian
Artinskian
Sakmarian
Asselian
Gzhelian
Kasim.
Moscovian
Bashk.
245
250
255
260
265
270
275
280
285
290
295
300
305
310
315
Euestheria gutta
Palaeolimnadiopsis vilujensis
Magniestheria mangaliensis
Cornia germari
Estheriella nodosocostata
"Pseudestheria ignota"
"Pseudestheria petri"
Pseudestheria graciliformis
Palaeolimnadiopsis form Rhinow
Pseudestheria form Lieth
Pseudestheria exigua
"Curvacornutus" mashaensis
"Estheriina" form Sentyak
Rostroleaia martynovae
Lioestheria andreevi
Pseudestheria form Wilhelmsthal
Lioestheria oboraensis
Lioestheria extuberata
Pseudestheria form Oberhof
Palaeolimnadiopsis obenaueri
Lioestheria paupera
Pseudestheria palaeoniscorum
Pseudestheria sp. M
Lioestheria form Frenswegen
Palaeolimnadiopsis form Jessen
Palaeolimnadiopsis wettinensis
Rostroleaia form Köllerbach
Pseudestheria limbata
Pseudestheria rimosa
Lioestheria form Köllerbach
Hemicycloleaia baentschiana
Anomalonema reumauxi
P. freysteini
Pseudestheria simoni
Lioestheria form Markenkamp
Pseudestheria form Hoya
Pseudestheria form Hervest
Palaeolimnadiopsis form Pudagla
Pseudestheria form Ibbenbüren
Palaeolimnadiopsis pruvosti
Pseudestheria cf. striata
1 mm
3 mm
10
9
8
7
6
5
4
3
2
1
Cornia germari fauna
Euestheria gutta fauna
"Pseudestheria petri"– "Pseudestheria ignota" fauna
Pseudestheria graciliformis– Palaeolimnadiopsis form Rhinow– Pseudestheria form Lieth assemblage zone
Pseudestheria exigua– "Curvacornutus" mashaensis assemblage zone
Rostroleaia martynovae– "Estheriina" form Sentyak assemblage zone
Lioestheria andreevi– Pseudestheria form Wilhelmsthal assemblage zone
Lioestheria extuberata– Lioestheria oboraensis– Pseudestheria form Oberhof assemblage zone
Lioestheria paupera– Pseudestheria palaeoniscorum assemblage zone
Pseudestheria sp. M– Lioestheria form Frenswegen– Palaeolimnadiopsis form Jessen assemblage zone
Pseudestheria limbata– Pseudestheria rimosa– Lioestheria form Köllerbach assemblage zone
Anomalonema reumauxi– Pseudestheria simoi assemblage zone
Lioestheria form Markenkamp– Pseudestheria form Hoya assemblage zone
Palaeolimnadiopsis form Pudagla– Pseudestheria form Ibbenbüren assemblage zone
Palaeolimnadiopsis pruvosti– Pseudestheria cf. striata assemblage zone
Early Triassic biochron
Paradoxichnium biochron
Erpetopus biochron
Dromopus biochron
Notalacerta biochron
Muschelkalk
Bunt-sandstein
Upper
Middle
Lower
Zechstein
Upper Rotliegend II
Upper Rotliegend I
Lower Rotliegend
Stephanian
C
B
A
Cantabrian
Westphalian
D
C
B
A
Akmaian
Yarengian
Vetlugian
Tatarian
Vyatkian
Severo-dvinian
Biarmian
Urzhumian
Kazanian
Ufimian
Irenian
Filippovkian
Saranian
Sargian
Irginian
Burtsevian
Sterlitamakian
Tastubian
Shikhanian
Kholodnologian
Melekhovian
Noginskian
Pavlovoposadian
Rusavkinian
Dorogomilovian
Khamovnikian
Krevyakinian
Myachkovian
Podolskian
Kashirian
Vereian
Melekesian (Asatau)
Cheremshanian (Tashasty)
Yeso
Abo
Bursum
Atrasado
Gray Mesa
Sandia

Fig. 1. Outline of a late Carboniferous (Bashkirian) to early Triassic (Induan) conchostracan biostratigraphy combined with pinpoints for non-marine–marine correlation (marked by red numbers). The ranges of the conchostracan assemblage zones are based on two or more index species (Schneider and Scholze, 2016). Instead of species designations, for some of the here shown conchostracans a open taxonomy is used. Instead of zones, the latest Permian and early Triassic intervals are preliminary defined as "faunas". Key to the non-marine–marine correlation: **(1)** co-occurrences of the insect-zone species *Syscioblatta allegheniensis* and the conodonts *Idiognathodus corrugatus* and *I. cherryvalensis*, Kinney Brick quarry, Atrasado Formation, New Mexico (Lucas et al., 2011); **(2)** 299 ± 3.2 Ma SHRIMP U-Pb age, upper Siebigerode Formation; Saale Basin, Germany (Schneider & Scholze, 2016); **(3)** correlation of the *Sysciophlebia ilfeldensis–Spiloblattina weissigensis* insect zone and the *Streptognathodus nevaensis* conodont zone, Bursum Formation, New Mexico (e.g., Lucas et al., 2013; Schneider & Scholze, 2016); **(4)** occurrences of conchostracans and the conodont *Kamagnathus khalimbadzhae* in the Sentyak section, Tatarstan, early Kazanian (Silantiev et al., 2015); **(5)** palaeomagnetic Illawarra Reversal at ~265 Ma (e.g., Menning & Bachtadse, 2012); **(6)** occurrence of the conodont *Mesogondolella britannica* in the Kupferschiefer equivalent, basal Zechstein Group (Legler & Schneider, 2008); **(7)** marine and continental early Triassic occurrences of the amphibian *Tupilakosaurus* (e.g., Nielsen, 1954; Shishkin et al., 2000; Sennikov & Golubev, 2012; Scholze et al., 2015); **(8)** occurrences *Euestheria gutta* in marine-continental sections of South China, Kayitou Formation, Early Triassic (e.g., Chu et al., 2013) or transitional latest Permian–earliest Triassic (e.g., Zhang et al., 2016); **(9)** co-occurrence of the conchostracan *Magniestheria mangaliensis* and marine bivalves in northern China, Sunjiagou Formation, early Triassic (Liu & He, 2000); **(10)** occurrences of the conodont *Nicoraella germanica* in the middle and upper part of the Lower Wellenkalk Horizon, Jena Formation, Lower Muschelkalk Subgroup, Bithynian, early Anisian (e.g., Kozur, 1999). The conchostracan data of Central Europe were obtained from Malzahn (1957), Martens (1983), Goretzki (2003), Schneider & Scholze (2016, and literature cited therein), and Scholze et al. (2016, 2017); preliminary middle Permian conchostracan data of the East European Platform from Novozhilov (1952), Silantiev et al. (2015), and Zharinova (2017a,b); tetrapod footprint ichnostratigraphy from Voigt & Lucas (2016); regional stratigraphic subdivisions for Central Europe, eastern Europe, and New Mexico from Schneider et al. (2014) and Schneider & Scholze (2016).

The activities of the Czech team focused on re-evaluation of lithostratigraphy of the Late Palaeozoic continental basins of the Bohemian Massif, a segment of the central European Variscides, which now forms the principal part of the Czech Republic (Opluštil et al., 2016a,b, 2017, a,b) . The continental basins archive rich fossil and climatic records, the full understanding of which, however, is possible only when high-resolution stratigraphy is established. So-far only biostratigraphic data were used as a chronostratigraphic tool. Therefore, numerous intercalated acid volcanic ash beds were sampled for high-precision radioisotopic dating in the framework of projects of the Grant Agency of the Czech Republic P210-11-1431 (Climatic archives recorded in the Late Palaeozoic basins of the Bohemian Massif: proxies for reconstruction of climatic changes) and P210-12-2053 (High-resolution floristic changes as a response to climatic dynamics during the Late Palaeozoic ice age recorded in the basins of the Bohemian Massif). About 18 U-Pb CA-IDTIMS high-precision ages obtained from single zircon crystals separated from volcanic ash beds and ignimbrites allowed improvement of the stratigraphy of the basins in central and western Bohemia (=central and western Czech Republic) and in the Sudetic area in the NE part of the country (Fig. 2). Although most radioisotopic data are located in the Carboniferous part of the succession, several U-Pb ages were obtained from Cisuralian strata. The data were used for constraining the ages of lithostratigraphic units in different basins and their correlation to global stages. Detailed correlation of individual basins via a dense borehole network allowed the establishment of an integrated time-calibrated lithostratigraphical model for the entire 10 000 km^2 size complex of the continental basins in both areas. In addition, radioisotopic ages allowed for calibration of some macrofloral biozones of Wagner and Álvarez-Vázquez (2010) as well as of amphibian (Werneburg and Schneider, 2006), blattoid insect (Schneider and Werneburg, 2012) and local fish biozones and, in turn, their correlation to global stages. Current research focuses on floral diversity, vegetation patterns and their changes throughout Pennsylvanian and Cisuralian time. Part of this research deals with high-resolution macrofloral biostratigraphy (Fig. 2) from the Pennsylvanian to Cisuralian in the Intra-Sudetic and the Boskovice basins (Opluštil et al., 2016a,b, 2017a,b; Martinek et al., 2017).

Fundamental new data on the correlation of the Carboniferous-Permian boundary in continental basins with the marine stratotype as well as for the numerical age calibration of non-marine biozones have been published by a French-US team (Pellenard et al., 2017). CA-ID-TIMS U–Pb ages are obtained from ashfall deposits, recorded within lacustrine to swamp deposits of the Igornay and Muse formations in the Autun Basin of the French Massif Central. The middle part of the Igornay Formation is dated at 299.9 ± 0.38 Ma, the Lally oil-shale bed is dated at 298.91 ± 0.08 Ma and the upper part of the Muse oil-shale bed is dated between 298.05 ± 0.19 and 298.57 ± 0.16 Ma. The Muse Formation is the stratum typicum of *Apateon dracyi*, a zone-species of the *Apateon dracyi* - *Melanerpeton sembachense* amphibian zone (Schneider and Werneburg, 2012). Additionally, *Sysciophlebia balteata,* a zone species of the insect zonation of Schneider and Werneburg (2012) probably occurs in the same formation. The isotopic ages of the Muse Formation allow for the first time the calibration of both biozonations in this level with the marine Standard Global Chronostratigraphic Scale. The applicability of the Autunian as a regional West-European stage has been long discussed because of the lack of a definition of its base (e.g. Broutin et al., 1999). The new isotopic ages in combination with future improvements to the biostratigraphic data it seems possible to propose Autunian as a reliable West European regional stage. After Pellenard et al. (2017) caution must be paid in the application of the definition of the range of the West European regional stages after Wagner and

Álvarez-Vázquez (2010): based on the new French isotopic ages of the Autunian flora it is no longer acceptable to consider the middle and late Autunian as terminal substages of the Pennsylvanian.

An astonishing amount of work has been done by an Italian-Spanish research group lead by A. Ronchi, J. López-Gómez and others within the Spanish Ministerio de Economía y Competitividad project "Continent-ocean relationship in the crisis and recovery of the ecosystems in the western margin of the Tethys during the Permian-Triassic transition". Data collection was focused on Permian to Early/Middle Triassic continental deposits of the Catalan Pyrenees in NE Spain, the Balearic Island of Majorca in eastern Spain, the island of Sardinia as well as the Dolomites region of western and northern Italy, respectively. A report on the results was already given in Permophiles 63 and published in detail in PPP (Mujal et al. 2016a, b). Vertebrate remains from red bed units of the youngest Permian strata below the 1st order P/T unconformity in the Catalan Pyrenees were ascribed to the middle Permian. The discovery of Early Triassic tetrapod tracks as well as the reconsideration of palynological data allowed dating of the overlaying Buntsandstein red-beds as Olenekian (Spathian?). Interesting in this context is the discovery of an assumed continuous Permian-Triassic red bed section at the Coll de Terres in the Catalan Pyrenees by a team of Barcelona University (Mujal et al., 2017). Uninterrupted continental P-T sections were hitherto unknown in the Mediterranean region (= peri-Tethyan domain of Southern Europe and Northern Africa in Bourquin et al., 2011). The uppermost Permian strata at Coll de Terres yield a relatively diverse ichnoassemblage dominated by tetrapod footprints and arthropod traces. *Dicynodontipus*-like tetrapod tracks are used to assign a late Permian age to the strata immediately below the Buntsandstein facies (Mujal et al., 2017).

Gaggero et al. (2017) published new isotopic ages of latest Carboniferous to early Permian volcanic rocks of the southern Variscides in Sardinia. One of them, the 295 ± 3.5 Ma U-Pb (Zr) age of the Punta Guardiola dacite in the Perdasdefogu basin, though not very precise, is in relatively good agreement with the supposed Sakmarian age (based on the temnospondyl amphibians *Melanerpeton eisfeldi*, *Apateon kontheri* and *Apateon flagrifer*: Werneburg et al., 2007) of the underlying Rio sa Luda Formation.

Significant progress has been made in tetrapod ichnostratigraphy. Based on the study of approximately 20,000 Palaeozoic tetrapod footprints from more than 120 public and private collections on five continents, Voigt and Lucas (2017) propose a subdivision of the Permian into three tetrapod footprint biochrons (comp. Fig. 1): (1) *Dromopus* – latest Carboniferous (approximately Gzhelian) to

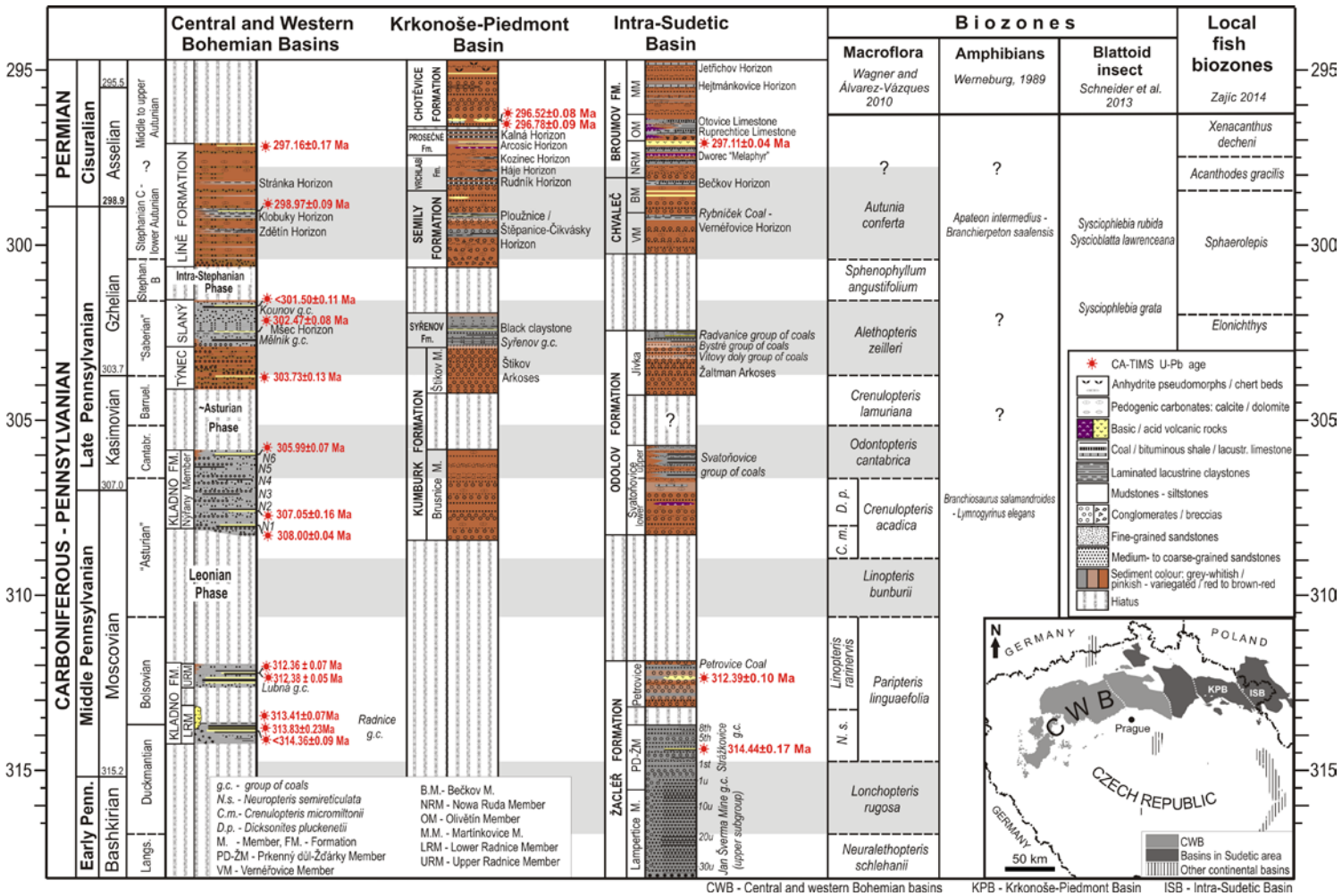

Fig. 2. Chronostratigraphic correlation of the lithostratigraphic units in the Late Palaeozoic continental basins of the Czech Republic. Based on data from Opluštil et al., 2016a, b.

late early Permian (approximately Artinskian); (2) *Erpetopus* – late early Permian (approximately Kungurian) to late middle Permian (approximately Capitanian); and (3) *Paradoxichnium* – late Permian (Wuchiapingian and Changhsingian). This conservative biochronology has potential to become refined to almost stage-level resolution by near-future comprehensive analyses, especially of Permian captorhinomorph and therapsid footprints. An international group of vertebrate ichnologists lead by Lorenzo Marchetti, Sebastian Voigt and Hendrik Klein, also focused on tetrapod ichnology at the Permian-Triassic transition exemplified by their recent comprehensive revision of the famous Val Gardena Sandstone vertebrate ichnoassemblage of the Dolomites region in northern Italy (Marchetti et al., 2017). The Val Gardena Sandstone, which interfingers with shallow marine deposits of the Bellerophon Formation, is considered to be of Lopingian age, most likely representing just part of the Wuchiapingian (Kustatscher et al., 2017). The tetrapod ichnoassemblage of the Val Gardena Sandstone includes 10 out of 12 tetrapod ichnogenera hitherto known from Lopingian deposits worldwide and thus constitutes a key for the understanding of the *Paradoxichnium* biochron.

A remarkable tetrapod ichnofossil assemblage of supposed late Guadalupian (Capitanian) to early Lopingian (Wuchiapingian) age was recently discovered in an active crushed stone quarry near Mammendorf, Saxony Anhalt (Buchwitz et al., 2017). This part of northern Germany was once situated at the southern border of the huge north-central European Southern Permian Basin and yields tetrapod tracks of at least five different morphotypes: *Erpetopus*, cf. *Procolophonichnium*, cf. *Dicynodontipus*, cf. *Paradoxichnium* and aff. *Pachypes*. Ongoing study has the potential to turn the Mammendorf locality into one of the most important mid/late-Permian (ichno-)fossil sites in Central Europe as well as a reference for the biostratigraphy of dry playa red beds of this specific stratigraphic interval.

Starting in the last decade, the Moroccan late Palaeozoic to Mesozoic deposits have been the object of enhanced palaeontological and sedimentological research carried out by a Moroccan-German team. Recent fossil exploration of the Souss Basin in the Western High Atlas Mountains led to the discovery of tetrapod footprints assigned to the plexus *Batrachichnus*, *Limnopus*, *Dimetropus*, and *Ichniotherium* (Lagnaoui et al., 2017). This moderately diverse tetrapod footprint assemblage is important because it is the second-oldest record of tetrapod footprints from Africa and only the second record of the well-known ichnogenus *Ichniotherium* from outside of North America and Europe. Publications on extensive collections of fossil insects, conchostracans, and a newly discovered temnospondyl amphibian skeleton of this basin are in preparation.

To promote the application of ichnofossils not only for environmental analysis but also for biostratigraphy, the 2nd International Conference of Continental Ichnology (ICCI 2017) was held in South Africa, Nuy Valley (Western Cape Winelands). The conference was organised by Emese Bordy and her post-graduate students from the Sedimentology–Palaeontology Group at the University of Cape Town (UCT), and was attended by 50 international delegates from Canada, USA, Uruguay, Argentina, France, Germany, Sweden, Switzerland, Russia, Spain, UK, Italy, Poland, South Africa and Lesotho. One third of the delegates were postgraduate students, and about one quarter of them were international students. The delegates presented research that focused on investigating various ichnofossils such as burrows, nests, tracks and trails. The conference was followed by an ichnological and geological field trip across the Permian to Lower Jurassic of the main Karoo Basin from the 1st to 8th of October 2017, which showcased some of the best ichnological outcrops in South Africa and Lesotho.

A North American-European team of the New Mexico Museum of Natural History gives a comprehensive summary on the Carboniferous-Permian transition in Socorro County, New Mexico (Lucas, DiMichele and Krainer, eds., 2017). The results of 20+ years of field, laboratory and museum research on the Pennsylvanian-Permian rocks and fossils of Socorro County were documented. Lithostratigraphy, sedimentary petrography, microfacies analysis and sedimentological interpretation as well as diverse paleontological studies (fossil plants, calcareous microfossils, conodonts, fossil insects, tetrapod footprints, coprolites and fossil fishes) are presented. The Pennsylvanian strata of this area are a complex succession of sedimentary rocks of marine and nonmarine origin deposited during the Middle-Late Pennsylvanian. The co-occurrence of marine zone fossils (fusulinids, conodonts) with non-marine guide fossils (insects) allows for the improved calibration of the nonmarine biostratigraphy to the Standard Global Chronostratigraphic Scale (Schneider et al., 2017). Based on almost 500 tetrapod track specimens, assigned to the ichnogenera *Amphisauropus, Batrachichnus*, *Dimetropus*, *Dromopus*, *Erpetopus*, *Hyloidichnus*, *Ichniotherium*, *Limnopus*, *Tambachichnium* and *Varanopus*, Voigt and Lucas (2017) demonstrate the turnover from the *Dromopus* biochron to the *Erpetopus* biochron in early Permian red beds.

A comprehensive overlook on the state of the art of Permian marine and non-marine biostratigraphy was compiled by 15 authors in Lucas and Shen (eds., 2016; to be fully published in February, 2018): The Permian Timescale. This and the present report show that further development of the Late Palaeozoic and Early Mesozoic chronostratigraphic scale should focus on GSSP selection for the remaining, undefined marine stage bases, and further correlation of the nonmarine late Carboniferous – Permian – early Triassic deposits to the chronostratigraphic scale with all available biostratigraphic tools in combination with radioisotopic, magnetostratigraphic and chemostratigraphic methods for cross correlation and calibration.

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http://kpfu.ru/portal/docs/F1616694132/2017.Golovkinsky_2017.Abstract.Volume._zip.pdf

https://sites.google.com/site/icci2017conference/home/2017-abstract-book

Report of the Chinese, Italian, Iranian working group: The Permian-Triassic boundary sections of Abadeh revisited

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At the end of November 2017, a research group composed of a Chinese party with S.Z. Shen, H. Zhang, and Y.C. Zhang, an Italian party with L. Angiolini and G. Crippa and an Iranian party with M. Ghorbani, M. Ghorbani and M. Ovissi, visited the section of Abadeh in the Hambast Valley, near Abarqu in Central Iran (Fig. 1).

During the field trip, we sampled in great details for conodonts, foraminifers, brachiopods and geochemistry the sedimentary succession comprising the Upper Permian Abadeh and Hambast formations and the Lower Triassic Elikah Formation (Figs 2-3). The main goals were:

1) to establish a refined conodont and foraminifer biozonation for the Changhsingian of central Iran through a very detailed sampling and a direct comparison and correlation with the biozonation of Djulfa (NW Iran) and South China. Besides this the focus of the field work was to perform a very detailed geochemical analysis of bulk rock samples, conodont apatite and brachiopod calcite;

2) to study the brachiopod evolution approaching the Permian-Triassic boundary, focusing on the palaeocology and functional morphology of the fauna and the possible change in brachiopod biomineralization and geochemistry which are among the best tools to reconstruct the chemical condition of the oceans in this critical time interval (e.g. Garbelli et al., 2007; Jurikova et al., this Permophiles issue).

3) to study the geochemistry of the bulk rock at the PTB.

The Abadeh section is well known to Permian specialists around the world from the detailed study published by Taraz et al. (1981), which is still quite modern in contents and methodology and the more recent researches on the conodonts faunas (Shen and Mei, 2010).

However, there are still open problems mainly related to the conodont taxonomy and succession (Kozur, 2004, 2005; Shen and Mei, 2010) and the position of the Guadalupian-Lopingian boundary in the upper part of the Abadeh Formation, which, due to the scarcity of conodonts and the occurrence of non-resolutive foraminifer biozones, is tentatively placed at about 8 m below the top of the formation based on the geochemical record (Liu et al., 2013) and the necessity to sample both the PTB boundary and GLB intervals in still greater details (sample strategy with spatial resolution of 10 cm in some intervals).

With this in mind, we reached the section which crops out in very good conditions and in a very beautiful landscapes at about 20 minutes walk from the car, and since the first day (November, 24th), Shuzhong Shen was able to find the exact position on the section and on the PTB where he took a photo in 2009 (Fig. 4): as

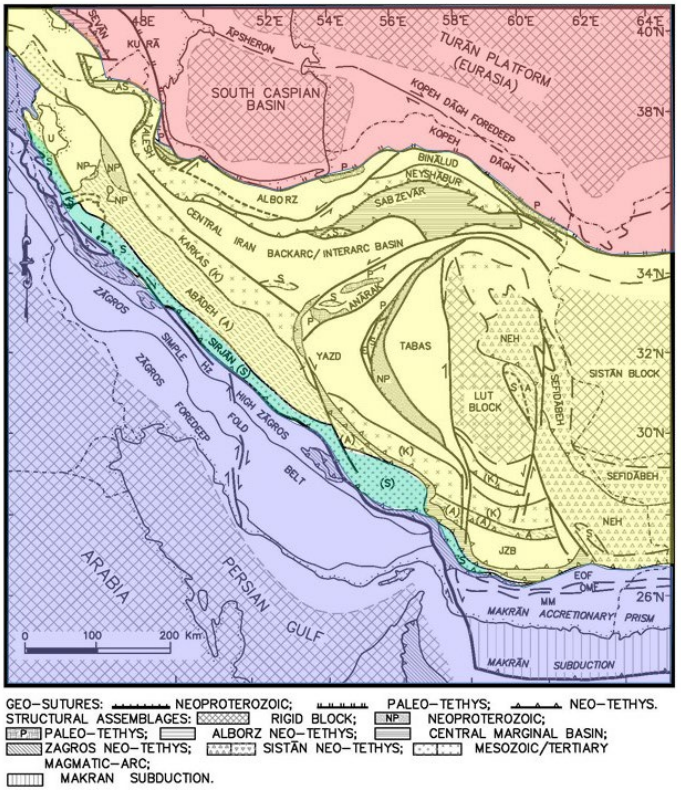

Fig. 1. Main structural zones of Iran, with the position of the Abadeh region. Modified from Berberian (2014).