Newsletter on Carboniferous Stratigraphy

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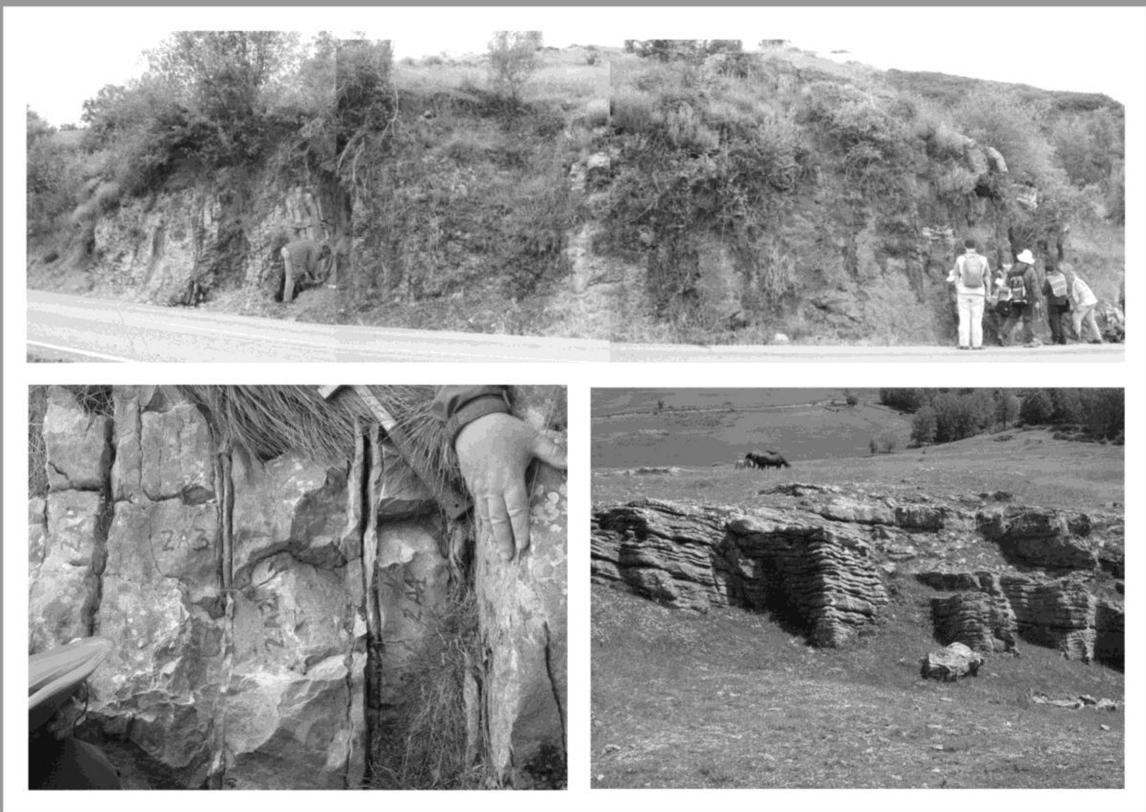

International Union of Geological Sciences
International Commission on Stratigraphy

Subcommission on Carboniferous Stratigraphy

www.nigpas.ac.cn/carboniferous

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Newsletter edited by Markus Aretz with the assistance of Barry Richards.
Thanks to all colleagues who contributed to this newsletter!

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EXCECUTIVE'S COLUMN

Dear Fellow Carboniferous Researchers,

Publication date of Newsletter on Carboniferous Stratigraphy

For many years, the Newsletter has been given a July publication date and distributed during July and August. During the last couple of years, we have found it very difficult to carry on with this tradition and, as a consequence, have decided to change the publication and distribution dates. After serious consideration, we have decided to give the newsletter a November publication date and get it printed and distributed during November and December. There are several reasons for making this change; but the principal one is the difficulty of compiling the newsletter in June and July when it is necessary for the secretary and chairman to take advantage of the short summer season to do field work in our northern climates. In previous years, we requested our contributors to submit their articles to the secretary, Markus Aretz, by May 31s; but for the future, we would like you to submit your articles by September 30th. This will give us the month of October to prepare the newsletter for printing and distribution in November.

The other main reason for changing the printing date from July to November is to reduce the amount of time that task-group chairmen spend on preparing progress reports for their groups. We can accomplish this goal to a substantial extent by making the reporting year for the task groups coincide with the fiscal year (November 1st to October 31st) of our parent organization the International Commission of Stratigraphy. Until the present, the chairs have had to prepare separate progress reports for both the July newsletter and the ICS Annual Report, which is due by mid-November. In general, we have found substantial changes need to be made to the task group reports prepared for the July newsletter to make them suitable for the Annual report. We want to eliminate some of this time-consuming work so that the same task group reports can be used for both the newsletter and Annual Report. Much of the annual progress made by the task groups is accomplished during the spring and summer field season and it is hoped that the new November printing date will still provide task groups enough time to compile the results of the year's field activities.

Website and Newsletter

This year we had hoped that it would be possible to download the annual newsletter from our website, thereby eliminating the expense and work of printing and mailing out copies. However, our website, established last year, is not working well enough to permit our members to download the newsletter; and we have decided to send out hard copies again. We hope the difficulties with the website can be eliminated during this next fiscal year.

XVI International Congress on the Carboniferous and Permian

The next congress on the Carboniferous and Permian will be held on the riverside campus of the University of Western Australia in the beautiful city of Perth, Australia from July 3rd-8th, 2011. Please see their website for details and the first circular. www.iccp2011.org. Scientists interested in all aspects of the Carboniferous and Permian are encouraged to attend and discuss recent advances in understanding one of the most dynamic intervals in Earth History. Now is the time to start considering the submission of papers. The last date for abstract submission is the 11th of February, 2011 and that date is rapidly approaching. February 11th is also the last day for the early-bird reduced registration fees. A preliminary program listing congress themes will be available in late 2010 and the final program will be available in April, 2011. We know it will be expensive to come to the Perth meeting from the northern hemisphere but it will be worth coming to interact with friends and colleagues, attend the meetings, and see some of the unique geology of Gondwana on the scheduled field trips. The Carboniferous and Permian Congress is certainly the most important of all geological meeting for SCCS members and it is only held every four years.

As part of the formal congress program, we plan to have a thematic session that will be chaired by some component of the SCCS executive and tailored for our numbers interests - Carboniferous Stratotypes, Boundaries, and Global Correlations. In this session, we would like to have the task-group chairs give progress reports for the boundary their team is studying. In addition, we encourage our task-group members to provide detailed stratigraphic and paleontological accounts about some of the best GSSP candidate sections they are currently working on. The SCCS will hold a business meeting (of about one hour duration) and we encourage all of the voting members to attend. Depending on conference attendance, the XVI ICCP could provide a good opportunity for some of our task groups to get together for workshops. If you would like to hold a workshop at the congress, please inform the SCCS executive as soon as possible so that we can have a room reserved.

Barry C. Richards, Wang Xiangdong and Markus Aretz

CONFERENCES AND FIELD MEETINGS JULY 1, 2009 - JUNE 30, 2010

During the last reporting year for the Newsletter (July 1, 2009 to June 30, 2010) there were several conferences, field meetings and workshops of substantial interest to SCCS members. Some of these meeting such as the Second International Conodont Symposium held in Calgary (July 12th to 17th 2009) and the workshop at the Third International Paleontological Congress in London (June 28th to July 3rd, 2010) were mainly of interest to the D/C boundary task group. The notes taken at those meetings have been incorporated into the task-group report for the D/C boundary working group herein. Perhaps the most significant meetings for the full subcommission were the field meeting and workshop held in Russia in 2009 (I.U.G.S. International Carboniferous Subcommission: Field Meeting "The Historical Type Sections, Proposed and Potential GSSP of the Carboniferous in Russia", August 11th - 18th, 2009), the Prague 2010 International Commission of Stratigraphy workshop (The GSSP Concept, May 31–June 3), and the 2010 field meeting held Spain (SCCS field meeting in Cantabrian Mountains, northwestern Spain, June 4th - 10th). Two informative and well illustrated guidebooks were printed for the Russian meeting (Alekseev and Goreva, 2009; Puchkov *et al*., 2009) and provide considerable new data as well as syntheses of previously published information. What we learned from the Russian trip is briefly summarized in the (2008 - 2009) SCCS annual report to the ICS, included in this volume, and discussed in detail in the article by Alekseev *et al.* (this volume). In this edition of the executive's column, we summarize relevant components of the ICS Prague meeting and subsequent Cantabrian meeting.

REPORT ON THE INTERNATIONAL COMMISSION ON STRATIGRAPHY WORKSHOP - THE GSSP CONCEPT; PRAGUE, MAY 31–JUNE 3, 2010.

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Introduction

The Prague ICS workshop, held in the Geoscience Building of Charles University, was jointly hosted by the Institute of Geology and Palaeontology at Charles University, and the Institute of Geology, Academy of Sciences, Czech Republic. About 60 delegates from around the world attended. Most delegates were executive members of ICS subcommissions, with others representing national stratigraphic commissions. Our subcommission was well represented; those in attendance were: Markus Aretz, Svetlana Nikolaeva, Barry Richards, Katsumi Ueno, Wang Xiangdong, and Qi Yuping. What we consider to be the most important aspects of the presentations and resulting discussions at the meeting in terms of the mandate of the SCCS are outlined below.

The Prague meeting was not entirely what the SCC leadership had expected. We had anticipated that days one and four of the meeting (May 31st and June 3rd) would overtly focus on what was necessary to establish an ideal GSSP and what should be avoided to prevent problems leading to the re-appraisal or redefinition of a GSSP. Instead, we listened to a number of excellent presentations about GSSPs that had been successfully defined and have withstood the tests of time. We also listened to interesting presentations discussing GSSPs that had serious problems and needed to be either abandoned or redefined. For example, on day one Mike Melchin (Canada) provided an account about GSSPs in the Silurian; some of them were holding up against the test of time while others were not. The biostratigraphic definition for the base-Silurian GSSP was unworkable, and it was felt that that such GSSPs should be suspended, pending redefinition. The D/C boundary is another good example of a GSSP that was not appropriately chosen. Thomas Becker of the SDS was invited to address that boundary because of his expertise and active involvement in that study. The emphasis was on the Paleozoic, but there were presentations about the Cretaceous, Precambrian and Tertiary. From the talks and resulting discussions, we learned about some procedures to avoid when defining a GSSP but we were also introduced to methods that should be utilized to properly locate and define them. The majority of speakers had been invited to give presentations well before the meeting.

As an outcome of the Prague GSSP meeting, the SCCS leadership can not provide you with a comprehensive set of instructions for locating and defining GSSPs. For that you need to carefully study and abide by the recommendations laid out by Remane *et al*. (1996). However, a number of good methods and practices to employ when establishing GSSPs and stratotype sections were presented during the general sessions (open to all interested people) and in the private commission meetings (ICS executive and subcommission chairs). Many of those points are presented below.

The GSSP concept

Until recently, all GSSPs were defined by fossils and global correlations achieved by biostratigraphy;

other stratigraphic disciplines were seldom employed. However, other stratigraphic techniques are increasingly being used to supplement biostratigraphy; and for many boundaries, particularly in the Precambrian, the use of non-biostratigraphic approaches is the only method available. In subdividing the Cambrian System, Loren Babcock (U.S.A.) noted that fossils can be used for boundary definition but all 10 provisional stages can also be recognized by their geochemical signature. The GSSP concept was recently extended into the Precambrian with the ratification of the Ediacaran Period (Knoll *et al*., 2004, 2006). At the Prague meeting, Martin Van Krandendonck (Australia) presented a strong case for further subdivision of the Precambrian into eons, eras and periods utilizing GSSPs that reflect global chemical and climatic events. At the other end of the time scale, the base of the Holocene has been defined by a GSSP in an ice core that lacks biostratigraphic data (Walker *et al*., 2008).

From the meeting, it became clear that multiple stratigraphic methods including biostratigraphy, sequence stratigraphy, stable-isotope geochemistry, and magnetostratigraphy should be used when establishing a GSSP. One criterion such as the first evolutionary appearance of a taxon within a lineage should be used to define a GSSP but the employment of multiple stratigraphic approaches is invaluable for global correlations. For example, in a presentation on modern stratigraphic approaches and correlations within the Cretaceous System, the speaker indicated the task group had found the best stratigraphic tools for Global correlation were magnetostratigraphy and stable-carbon isotopic analyses. When a multidisciplinary approach is used, the methods need to be coordinated and the work done at the same general time and at the same scale. If possible, the final results from a multidisciplinary approach should be published in a single paper and not scattered through numerous separate publications. In an extended discussion, about the optimal methodology to use when establishing stratotypes, a lively debate took place about the advantages of paleontological and geochemical methods. Additionally, the employment of multiple stratigraphic methods is necessary because experts for some fossil groups such as graptolites are becoming increasingly rare.

On day four of the meeting, Vladimir Davydov (U.S.A.) suggested ash beds could be used to define some boundaries such as the D-C boundary. The ashes represent instants in deep time and can be precisely dated using U-Pb isotope dilution thermal ionization mass spectrometry (ID-TIMS) methodology to date single zircon crystals. The proposal was met with moderate enthusiasm at the IGC meeting but some participants expressed concerns that biostratigraphic data would be necessary to confirm correlations. Further evaluation of the method is required.

A number of other good practices to employ when choosing stratotype sections were introduced, many by the ICS chairman Stan Finney. It is very important that boundary stratotype sections extend well above and below the GSSP as well as across it in order that important biostratigraphic and other trends can be clearly observed and documented. In some proposals, the taxon used to define the boundary is not illustrated and this should be strictly avoided. Guide fossils must be illustrated and not just named. Another common practice has been to illustrate an ideal specimen of a taxon used to define a GSSP instead of showing a typical specimen from the GSSP itself. The best practice is to illustrate the defining taxon from the boundary level and not just from other levels or localities. The location of the specimens from the stratotype sections needs to be documented in the proposal (give location of museum and the curation numbers).

The final proposal for a GSSP (one that has been voted on and approved by the SCCS or other appropriate subcommission) should not be published before being ratified by the ICS. Our less formal manuscripts proposing candidate sections for a GSSP can be published without either SCCS or ICS approval. Stan Finney recommended that two papers be use for presenting the final formal proposal: a relatively brief one for Episodes to emphasize the marker criterion, and a more substantial paper to fully document the GSSP and stratotype section. Typically, the more comprehensive document will need to be published in a journal such as Palaeoworld, which is broadly distributed and will accept relatively long holistic articles dealing with a variety of stratigraphic approaches and paleontology. Finney asked us to avoid using more than one formal GSSP proposal in a single paper. In the proposal, the history of the stratigraphic unit should be provided along with a good summary figure showing the GSSP. Boundary working groups should organize field meetings to visit potential GSSPs because they need to be carefully examined by specialists working in a variety of stratigraphic fields and not just the proposers. GSSPs should not be proposed with undue haste, as this can lead to poor decisions that will require expensive and time-consuming reappraisals such as the one being done for the Devonian-Carboniferous boundary GSSP. While it is a priority to complete the task of defining GSSPs for periods, series, and stages, there is no pressure from the IUGS or ICS to do this by a specific deadline. Stan Finney also promoted setting up monuments/placards to commemorate GSSPs. Establishing monuments is important because it gets the local community interested and involved in protecting the site.

The use of auxiliary boundary stratotype sections (GSSP sections) has been commonly used in past but there is currently no formal ICS procedure for establishing such sections (they are not formally ratified by the ICS like the GSSPs). Such subordinate sections should be designated as either reference sections or auxiliary sections but not auxiliary GSSPs. Referring to them as auxiliary GSSPs implies the sections have been approved by the ICS and are almost as important for boundary definition. The reference sections are used to supplement the data from a formal GSSP with important geologic information from other geographic regions. Establishment of reference sections is a matter for subcommissions and their task groups, and could represent important future work.

Open discussions continued the last day, and Thomas Becker (SDS Germany) presented a case for formalizing substages in the Devonian. GSSPs have not yet been used for such finely divided intervals of time, and while there was some support for using GSSPs for this purpose, it was remarked by Stan Finney that: 1) the ICS still had many higher-priority stage boundaries to define, 2) the formal definition of substages might be handled more appropriately at the subcommission than ICS level, and 3) to figure formal boundaries at such low rank on the standard geological time scale, as promoted by the ICS, ran the risk of obscuring it with detail. After the geological time scale has been defined by selecting GSSPs for the higher-level boundaries, there will still be much work for the subcommissions, including the refinement of existing GSSPs, creation of lower rank GSSPs, and selection of auxiliary stratotypes around the world.

In addition to discussing the GSSP concept, a number of other stratigraphic issues such as the use of a dual stratigraphic classification (Chronostratigraphic and Geochronologic unit terms) versus a single classification (Geochronologic unit terms) were dealt with on days two and four of the meeting (June 1st and 3rd).

On the afternoon and evening of day 2, we had an enjoyable tour through the historical centre of Prague (Prague castle, Lesser Town and Old Town). Day 3 (June 2nd) was designated for two geological field trips: 1) one to the Upper Paleozoic to Cenozoic of Central Bohemia (and GSSP of the Devonian base), and 2) the other to some classic Lower Paleozoic localities in the Czech Republic, including the Lochkovian-Pragian and Ludlow-Pridoli GSSPs. At the day's end the field trips converged on the famous GSSP for the Silurian-Devonian boundary at Klonk Hill near the village of Suchomasty (see Martinsson, 1977; Chlupac and Hladil, 2000). The Klonk section has major historical significance for stratigraphy because it contains the first boundary stratotype chosen for a boundary between two systems.

Acknowledgements

The executive of the Subcommission on Carboniferous Stratigraphy would like to thank Stan Finney, Paul Brown and the other scientist on the Organizing Committee of the Prague 2010 - ICS Workshop for arranging the meeting in the beautiful and historical city of Prague. From our perspective the meeting was very informative and interesting.

Summary

Because this article is a summary of information presented at a meeting there are really no major conclusions to make but it is worth listing some of the main points. 1) Multiple stratigraphic methods including biostratigraphy should be used when establishing a GSSP. 2) Other stratigraphic techniques such as event stratigraphy and stable-isotope stratigraphy are increasingly being used to supplement biostratigraphy. For many boundaries, particularly in the Precambrian, the use of a non-biostratigraphic approach is the only method available. 3) In some proposals, the taxon used to define the boundary is not illustrated and this should be strictly avoided. Guide fossils must be illustrated and not just named. 4) It is very important that boundary stratotype sections extend well above and below the GSSP as well as across it in order that important biostratigraphic and other trends can be clearly observed and documented. 5) A proposal for a GSSP should not be published before being approved by the ICS. 6) While it is a priority to complete the task of defining GSSPs for periods, series, and stages, there is no pressure from the IUGS or ICS to do this by a specific deadline. 7) There is no formal procedure for establishing auxiliary boundary-stratotype sections (they are not formally ratified by the ICS). 8) After the IUGS geological time scale has been defined by selecting GSSPs for the higher-level boundaries, much work for the subcommissions will remain including the refinement of existing GSSPs, creation of lower rank GSSPs, and selection of auxiliary stratotypes around the world.

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REPORT ON THE SCCS FIELD MEETING IN THE CANTABRIAN MOUNTAINS, NORTHWEST SPAIN, JUNE 4TH - 10TH, 2010

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Introduction

At the Second International Conodont Symposium, held in Calgary from July 12-17th 2009, the SCCS executive met with our Spanish colleagues Javier Sanz-López (Facultad de Ciencias, Universidad de A Coruña, Spain) and Silvia Blanco-Ferrera (Departamento de Geología, Universidad de Oviedo, Spain) to discuss their extensive and important recent work on conodonts from multiple Carboniferous sections in the Cantabrian Mountains of northwest Spain. At the end of that meeting, we discussed the possibility of arranging a four- to five-day SCCS fieldtrip for early June of 2010 to see some of the Spanish sections that they have been studying and are relevant to projects led by our task Groups. Javier and Silvia assisted by Elisa Villa (Departamento de Geología, Universidad de Oviedo, Spain), Cor Winkler Prins (Nationaal Natuurhistorisch Museum, Leiden, The Netherlands), Luis C. Sánchez de Posada (Departamento de Geología, Universidad de Oviedo, Spain) and Roberto Wagner (Centro Paleobotánico, Jardín Botánico de Córdoba, Córdoba, Spain) graciously organized a field trip to the Cantabrian Mountains for us. The itinerary along with a summary of what was examined and learned on that excursion is presented below.

The principal purpose of the fieldtrip was to visit several of the best carbonate-dominated sections that span the Viséan-Serpukhovian boundary and have yielded conodonts within the *Lochriea nodosa-Lochriea ziegleri* lineage. Task group members wanted to compare those sections with the better known Verkhnyaya Kardailovka section on the eastern slope of the southern Urals in Russia (Nikolaeva *et al.,* 2005) and the well known Nashui section (by village of Naqing) in southern Guizhou province, China (Qi and Wang 2005, Qi, 2008). Additional objectives were to obtain structural and paleogeographic overviews of the Cantabrian region and examine some of the best sections spanning the Devonian-Carboniferous, Mississippian-Pennsylvanian, and Bashkirian-Moscovian boundaries to see how they compared with other sections SCCS task groups are actively studying. Although the Viséan-Serpukhovian boundary was a special target, the very interesting and somewhat controversial results of Javier's and Silvia's research on conodonts spanning the Devonian-Carboniferous and Mid-Carboniferous boundaries (Sanz-López and Blanco-Ferrera, 2009) were presented and discussed.

Participants

The participants on the Cantabrian trip (excluding the leaders) were a multinational group: 1) Wang Xiangdong, China 2) Qi Yuping, China; 3) Markus Aretz, France; 4) Barry Richards, Canada; 5) George Sevastopulo, Republic of Ireland; 6) Vladimir Davydov, U.S.A.; 7) Svetlana Nikolaeva, United Kingdom and Russia; 8) Hans-Georg Herbig, Germany; 9) Valentina Zhaimina, Kazakhstan; and 10) Andrew Barnett, United Kingdom.

Tectonic and stratigraphic settings

The Cantabrian Mountains of northwest Spain are part of the European Variscan fold belt and comprise two tectonostratigraphic units: a preorogenic one mainly formed by pre-Carboniferous Paleozoic rocks and a synorogenic package consisting of Carboniferous strata. Late synorogenic strata (Kasimovian to Gzhelian) are preserved in the eastern part of the belt. The structure of the arcuate Cantabrian Zone consists of thrusts and napes with associated folds, with the thrusts merging into a basal thrust (Garcia-López *et al*., 2007). Because of post-Carboniferous rotations of the Iberian plate, the Cantabrian Zone is currently situated in northern Spain, but it was originally situated in a distal position on the southern side of the Variscan Orogen. The Cantabrian Zone comprises several major structural units such as the Picos de Europa Unit, mentioned in the following account.

The Carboniferous strata in the Cantabrian Zone were deposited in a marine basin whose characteristics changed as deformation related to the Variscan Orogeny progressed from west to east. During the Early Carboniferous, the basin was relatively stable and the preorogenic deposits display considerable lateral continuity. From the Serpukhovian onward, the Cantabrian Zone was occupied by a foreland basin with pronounced instability and strongly asymmetric profile (Villa *et al*., 2001). The Cantabrian Zone probably has the longest marine record in the Carboniferous of Central and Western Europe, and thus it is of great interest for global stratigraphic correlations that the SCCS aims to achieve.

Itinerary and observations

June 4th: Most of the participants arrived at the Asturias Airport near Aviles in the afternoon and were taken to Oviedo by the organizers. Later, Silvia guided the group through the city centre of Oviedo, and the evening finished with a typical Asturian diner. Participants spent the night at the Carreño Hotel in Oviedo.

Day 1, June 5th: The geological program started in the morning with a trip to the long coastal cliff section at San Antolin-la Huelga beaches (Bahamonde *et al.,* 2008) to see a carbonate-dominated Serpukhovian to lower Moscovian succession. This excellent section with its well-preserved depositional fabrics formed part of an extensive microbial boundstone-dominated carbonate platform characterized by high-relief margins and steep depositional slopes. The platform, comprising the Valdeteja and Picos de Europa formations, developed in a foreland basin at equatorial latitudes along the western coast of the Paleotethys Ocean and eastern sector of the Variscan orogen. The platform carbonates prograded toward the orogen into a starved marine basin as an isolated carbonate platform. The spectacular coastal exposures show the development of the late Bashkirian to upper Moscovian carbonate platform on top of Viséan to Bashkirian deep-water carbonates of the Alba and Barcaliente formations. Along the lower part of the coastal section (Bashkirian Valdeteja Formation) we saw spectacular turbidites, slumps and debris-flow conglomerates to breccias deposited in toe-of-slope settings. Higher in the section (upper Valdetja and Moscovian Picos de Europa Formation), we examined middle- to upper-slope carbonate breccias, carbonates showing stromatactis structure and platform-top deposits. Bahamonde *et al.* (2008) illustrate the development stages of the platform and its facies belts. The timing of the developmental stages is constrained by conodont biostratigraphic data and foraminifers (Villa, 1995). In the afternoon we traveled to the village of Arenas de Cabrales and spent the night in the Hotel Picos de Europa.

Day 2, June 6th: In the morning, we drove to the Vegas de Sotres section in the Picos de Europa Structural Unit high up in the Picos de Europa Mountain Range to examine a carbonate section spanning the Viséan-Serpukhovian boundary. At the locality, we had our first opportunity to closely examine the deep-water nodular limestone (basinal facies) of the Alba Formation, which straddles the Viséan-Serpukhovian boundary in the Cantabrian Mountains (Blanco-Ferrera *et al*., 2005; Bastida *et al.*, 2004). Because the Alba was deposited in basinal environments, the unit might be expected to be lithologically uniform throughout the region, but every Alba section has its particularities and this one contains reworked shallow-water bioclasts and a conodont fauna comprising deep-water and shallow-water genera. The Vegas de Sotres section starts in the Alba Formation (lower part missing because of trusting) and ranges into the Serpukhovian to Bashkirian Barcaliente Formation. The Vegas de Sotres section is of considerable interest to the Viséan-Serpukhovian boundary task group because of the common occurrence of both ammonoids and conodonts within the strata spanning the boundary interval. The section also contains calciturbidite beds yielding reworked foraminifers and algae (Blanco-Ferrera *et al.*, 2008) near the entry level of the first occurrence of the conodont Lochriea ziegleri, currently considered to be the best taxon for defining the base of the Serpukhovian Stage. Javier and Silvia have sampled the section in detail for conodonts, thereby enabling them to precisely document the entry of the different *Lochriea* species across the proposed boundary interval (Blanco-Ferrera *et al.*, 2009).

In the afternoon, we left the Picos de Europa Mountain Range and crossed into the Palentian Zone, a structural wedge at the southeastern end of the Cantabrian Mountains that shows a stratigraphic development similar to that of the western Pyrenees Mountains (Wagner, 2009). Bob Wagner and Cor Winkler Prins introduced the participants to the Carboniferous succession of the Palentian unit and its palaeogeographical relations to the other Variscan structural units in northern Spain. From their work, they concluded the Palentian unit was once the western continuation of the Pyrenees and was later thrust into the Cantabrian Arc. In the late afternoon, Bob and Cor showed us the Moscovian-Kasimovian boundary in a section along the Rio Pisuerga south of the town of San Salvador de Cantamuda. At the end of the day we drove to the town of Cervera de Pisuerga to spend the night in the Hostal Restaurante Peñalabra. The evening ended with a nice tour through the beautiful historic town with Bob providing many explanations about its history.

Day 3, June 7th: The third day in the field was spent west of Cervera de Pisuerga; and thanks to the explanations Bob and Cor provided for several mountain panoramas, the group started to understand the very complicated geology of the region. In the section along the road from San Martin de los Herreros to Rebanal, a spectacular karst surface at the base of the Ermita Formation was shown in the Frasnian to Viséan succession of that region.

Later in the morning, we traveled to the well-exposed La Lastra section in the Palentian Domain, eastern Cantabrian Mountains. The section studied by Nemyrovska *et al.* (2008) and Nemyrovska (2009) comprises the upper part of the uppermost Viséan Genicera Formation (=Alba Formation) and the overlying Barcaliente Formation, consisting of thinly to medium bedded lime mudstone and wackestone. The section, of deep-water origin, contains conodonts typical of the Serpukhovian and lower Bashkirian including those of the Mid-Carboniferous boundary. Although well exposed, the section is somewhat tectonized being overturned and showing numerous gash fractures, joints and minor folds.

After lunch, we traveled to the nearby Triollo section situated on the east side of the Rio Carrion near the village of Triollo in northern Palencia. The section is a structurally complex exposure of the Carrion Formation (=Genicera or Alba formation in the other parts of Cantabrian Arc) consisting of deep-water limestone containing abundant conodonts characteristic of the Viséan-Serpukhovian boundary interval including *Lochriea cruciformis* and *Lochriea ziegleri* (Nemyrovska, 2005). The section contains beds and laminae of volcanic ash near the boundary interval and these will be useful for determining the absolute age of that level.

In the late afternoon, we returned to our accommodation at the Hostal Restaurante Peñalabra at Cervera de Pisuerga. After dinner, we held a general meeting with the SCCS participants and fieldtrip leaders to discuss several topics, but the main subjects were the *Lochriea* conodont lineage, new radiometric dates for the Viséan, and the future of the IUGS/SCCS "Carboniferous of the World" project. Robert Wagner and Cor Winkler Prins, the scientists in charge of the Carboniferous of the World project, summarized the status of the project. The SCCS chairman, Barry Richards asked those attending the meeting if they thought the project was worth continuing. Following a lengthy and enthusiastic discussion about the project, an open vote, using a show of hands, was held and those present were unanimously in favour of continuing with the project. On the basis of the vote, the SCCS executive informed Robert Wagner that we would contact our membership to solicit authors to complete the remaining volumes in the series and update some of the previously completed volumes with new manuscripts.

Day 4, June 8th: In the morning, we left Cervera de Pisuerga and traveled along the southern side of the Cantabrian Mountains into the Leon Province and the Bernesga Valley. The first outcrop of the day was the Olleros de Alba section (Fig. 1), an excellent and very interesting overturned roadside section situated by an ancient church and exposing a succession raging from Famennian to Viséan (Sanz-López *et al.*, 2007). The principal reason for visiting the locality was to examine a Devonian-Carboniferous (D-C) boundary section that was typical for the Cantabrian Mountains but it also provided an opportunity to examine a Tournaisian black shale unit (Vegamián Formation) and collect upper Tournaisian to Viséan ammonoids from deep-water nodular red beds of the Alba Formation (upper Tournaisian to Serpukhovian).

At the locality, the D-C boundary lies in the upper part of the Ermita Formation, a sandstone-dominant unit containing conodonts assignable to the *Siphonodella sulcata* zone in limestone and calcareous shale in the upper part. Javier and Silvia discussed the conodont biostratigraphy of the section, presenting detailed correlations for a number of sections in the region. The stop provided an opportunity to discuss the problem of identifying the D-C boundary using the *S. praesulcata* - *S. sulcata* conodont lineage. Data from the section shed more doubts on the usefulness of the *Siphonodella sulcata* lineage for definition of the boundary. Black siliceous shale of the Tournaisian Vegamián Formation overlies the Ermita, and Vladimir Davydov (Boise State University U.S.A.) sampled a well-developed volcanic ash bed in its upper part for radiometric dating of the black shale event.

Perhaps the most interesting deposits were the ammonoid-bearing, deep-water, nodular maroon shales and limestones in the lower part of the upper Tournaisian to Serpukhovian Alba Formation. Ammonoid horizons in the Alba gained much attention from most participants and several excellent specimens were collected for our ammonoid expert Svetlana Nikolaeva.

After lunch, we drove to the well-exposed and accessible Millaró section (Sanz-López *et al.*, 2006; 2007) to examine strata spanning the Viséan-Serpukhovian (V-S) and Serpukhovian-Bashkirian boundaries. The succession at Millaró (Fig. 2) resembles that of the Olleros de Alba section but the Serpukhovian and Bashkirian components of the section are much better exposed at Millaró. The Millaró section exposes the deep-water deposits of the upper Tournaisian to Serpukhovian Alba Formation, already examined on the fieldtrip at Vegas de Sotres and Olleros de Alba. Of the sections we examined on the fieldtrip that span the Viséan-

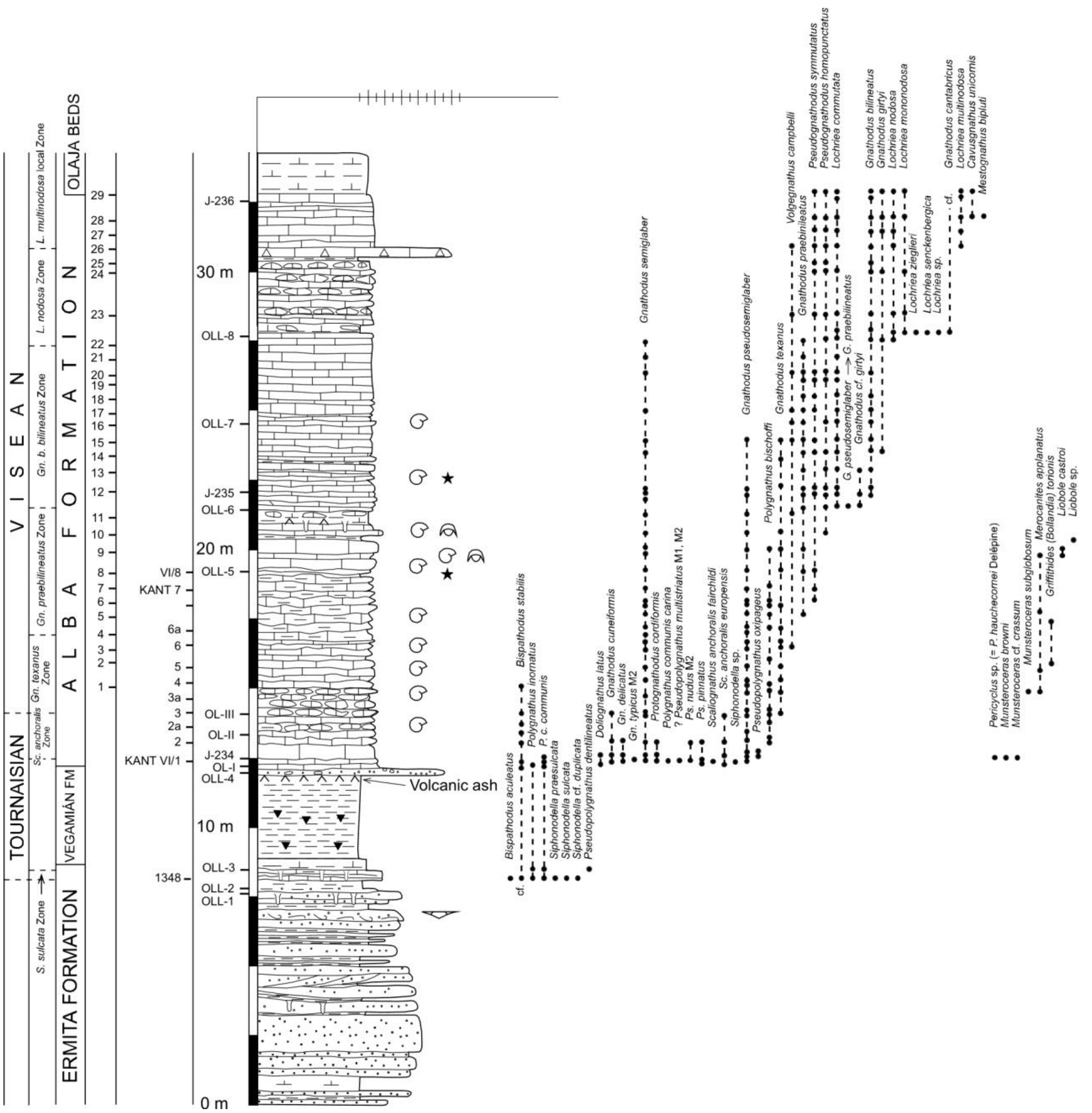

Fig. 1: Stratigraphic column for the Olleros de Alba section showing stratigraphy, main rock types, established ranges for conodonts, and levels from which ammonoids and other important fossils have been either collected or observed (Sanz-López *et al.*, 2007).

Serpukhovian boundary in the Cantabrian Mountains, this one has the highest potential for high-resolution biostratigraphy, and could be a good candidate for the V-S boundary GSSP. Javier and Silvia have precisely located the Viséan-Serpukhovian boundary in it using the *Lochriea nodosa - Lochriea ziegleri* lineage. Some participants thought that an even more detailed sampling of the beds across the V-S boundary, preserved in a condensed interval of deep-water nodular limestone, could result in a currently unknown precision and knowledge of the occurrence of conodonts within the *Lochriea* lineage. Additionally, the section contains abundant well-preserved ammonoids, which can be used as secondary markers for correlations within the Cantabrian Mountains and to other continents. Detailed correlation within the region can also be achieved with through lithostratigraphy using the well-established six members of the Alba Formation.

In the lower part of the Barcaliente Formation in the Millaró section, Javier and Silvia found *Declinognathodus noduliferus bernesgae* (Sanz-López and Blanco-Ferrera, 2009; Sanz-López *et al.*, 2006), which appears to represent the current marker of the Mid-Carboniferous boundary (*Declinognathodus noduliferus* s.l.). Unfortunately the specimens of *D. noduliferus bernesgae* at Millaró lie at a position well below the currently accepted position of the Mid-Carboniferous boundary at Arrow Canyon Nevada (Lane *et al*., 1999) and this is generating controversy over the boundary definition.

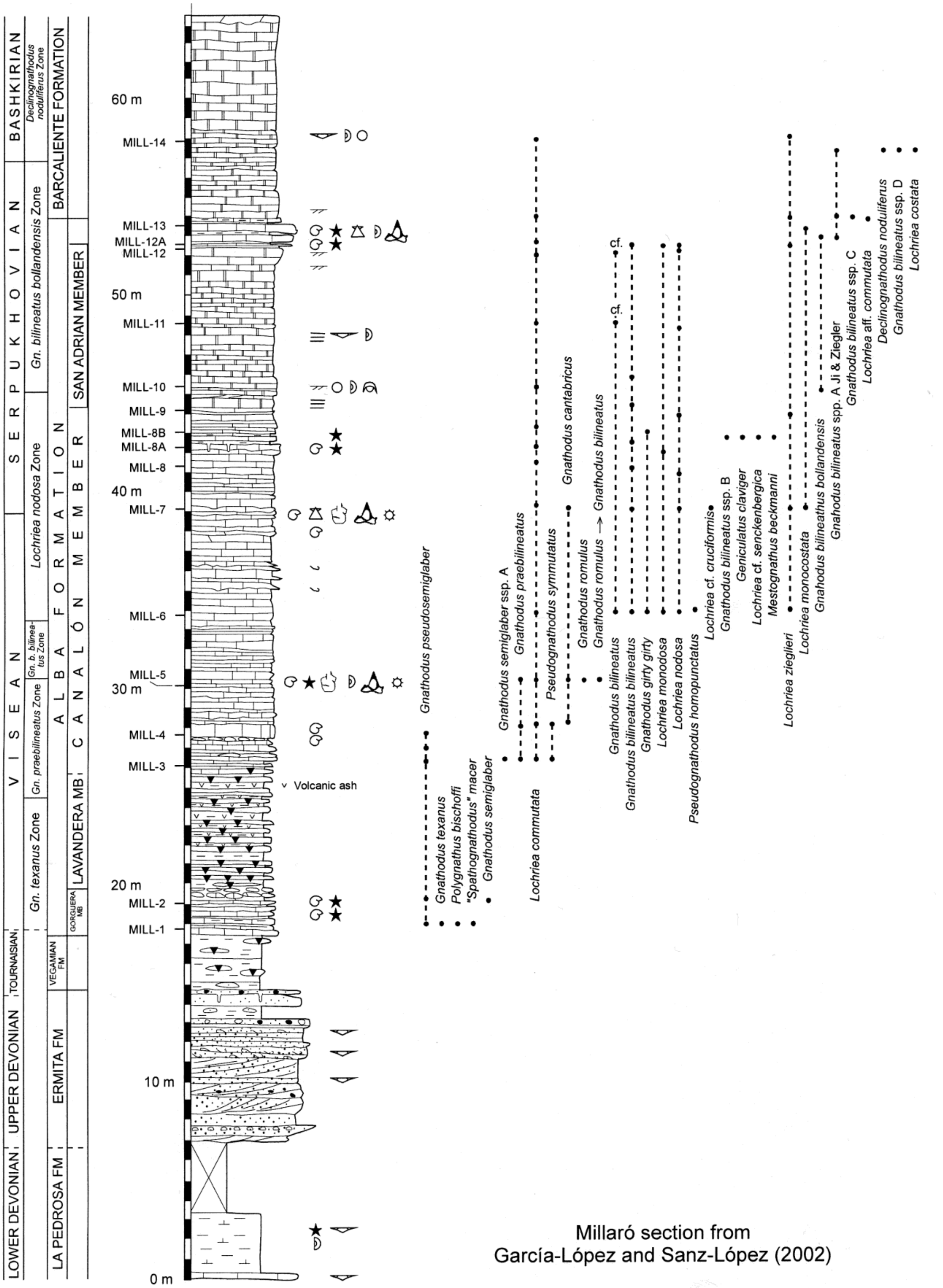

Fig. 2: Stratigraphic column for the Millaró section showing stratigraphy, main rock types, established ranges for conodonts, and levels from which ammonoids and other important fossils have been either collected or observed.

At Arrow Canyon Nevada, the GSSP for the Mid-Carboniferous boundary is defined by the first occurrence of the conodont (*D. noduliferus* s.l.); however, this name includes several taxa with different specific or subspecific status depending on the author. According to Sanz-López and Blanco-Ferrera (2009) the first entry of *Declinognathodus* at Arrow Canyon is the entry of *D. noduliferus inaequalis*. In the Millaró section and elsewhere in the region, *D. noduliferus bernesgae* appears well below the first occurrence of *D. noduliferus inaequalis* in strata dated as Serpukhovian using ammonoids and conodonts. From the work of Javier and Silvia, it appears the definition of the Mid-Carboniferous boundary at Arrow Canyon needs to be revised from *D. noduliferus* s.l. to D. *noduliferus inaequalis*. Thus the usefulness of the MCB criterion has to be debated in the future.

From the Millaró section we travelled to Leon for dinner and to spend the night in the Infantas de León hotel. The tasty excursion diner was exceptionally interesting and held in a typical Leonese restaurant in the heart of the beautiful city of Leon.

Day 5, June 9th: On day five, we drove from Leon to Barcaliente Creek in the Curueno Valley to examine the mid-Carboniferous boundary in the type section of the Serpukhovian to Bashkirian Barcaliente Formation (Sanz-López *et al.*, 2010) but were subjected to periods of heavy rain. At this locality, Javier and Silva presented their work on the conodonts at the levels of the Viséan-Serpukhovian and Mid-Carboniferous boundaries. The section provides an opportunity to see lithofacies of the upper Alba Formation and overlying Barcaliente that lie close to the Millaro section (day 4) and were deposited in a more distal basinal position (toward the foredeep) than those represented by the Alba and Barcaliente in the San Antolin-La Huelga section (seen on day 1). The Barcaliente section at Barcaliente Creek consists of dark-grey to black, laminated, argillaceous limestone containing abundant organic matter. In the type Barcaliente, *Declinognathodus noduliferus inaequalis* appears 145 m above the first occurrence of *D. noduliferus bernesgae*, and specimens of the latter are associated with conodonts that are clearly Mississippian. The substantial stratigraphic distance between the first occurrence of *D. noduliferus bernesgae* and *D. noduliferus inaequalis,* the subspecies of *Declinognathodus* that appears at the GSSP in Arrow Canyon, demonstrates there is a problem of using *D. noduliferus* s.l. to define the Mid-Carboniferous boundary.

At the locality, thick-bedded carbonate breccias (15 to 30 m thick) of upper-slope aspect and basin facies are preserved in the upper part of the Barcaliente platform and another carbonate platform represented by the (Bashkirian to lower Moscovian) Valdeteja Formation developed above. The origin of the breccia is uncertain but two possibilities have been suggested: 1) development of evaporite solution-collapse breccia, and 2) by collapse of the platform because of tectonic tilting of the foreland belt during the Variscan Orogeny. Carlos Mendez and Luis Sanchez de Posada (both Oviedo) briefly discussed the lithofacies, development and fauna, of the Valdeteja platform but the heavy rain allowed only a short look at this part of the succession. The platform represented by the Valdeteja was isolated with respect to the foreland platform visited at the San Antolin-La Huelga section and was buried by overlying prograding siliclastics in the lowermost Moscovian. The field party returned to Oviedo in the late afternoon for an exciting dinner in an Asturian restaurant and a night in the Carreño Hotel.

June 10th: On June 10th, most of the participants returned to their country of origin via the Asturias Airport at Aviles.

Acknowledgements

All of the fieldtrip participants learned a great deal about the Carboniferous of the Cantabrian Mountains and are truly grateful to the main organizers Javier Sanz-López and Silvia Blanco-Ferrera and their assistants Elisa Villa, Cor Winkler Prins, Luis C. Sánchez de Posada and Roberto Wagoner. On behalf of the SCCS and the members who went on the Cantabrian trip, it is our great pleasure to thank Javier and Silvia for organizing the trip and for providing an extensive volume of literature relevant to the fieldtrip. Javier and Silvia were fantastic hosts; their passion and love for the sections, conodonts and the overall scientific questions were outstanding. In addition, they were openly friendly and patient with the participants. The organisation was perfect and all of us left Oviedo with very positive feelings. All participants noted the high quality and importance of Javier's and Silvia's work; and as a consequence, the SCCS officials nominated both of them as task group members for the Viséan-Serpukhovian boundary task group. The conodont research of Javier Sanz-López and Silvia Blanco-Ferrera and work required to organise the SCCS fieldtrip was supported by project CGL2006-04554 of Spanish "Ministerio de Educación y Ciencia y Fondo Europeo de Desarrollo Regional".

Conclusions

1) The Cantabrian Mountains in northern Spain present an outstanding opportunity to study Carboniferous microbial boundstone-dominated carbonate platform characterized by high-relief margins and steep depositional slopes.

2) The Cantabrian Mountains contain several well-exposed sections that span the Devonian-

Carboniferous boundary. Most of them are probably not suitable candidates for detailed biostratigraphic analyses across boundary at the level of the *Siphonodella praesulcata-Siphonodella sulcata* lineage but could be useful for studying late Famennian to early Tournaisian event stratigraphy.

3) The region contains several excellent carbonate-dominated sections that span the Viséan-Serpukhovian boundary and contain abundant well-preserved conodonts within the *Lochriea nodosa-Lochriea ziegleri* lineage. Of the sections we examined that span the Viséan-Serpukhovian boundary in the Cantabrian Mountains, the Millaró section has the highest potential for high-resolution biostratigraphy, containing both conodonts and abundant ammonoids, and could be a good candidate for the Viséan-Serpukhovian boundary GSSP. The section is well exposed, accessible, and very suitable for detailed sedimentological, geochemical, and sequence-stratigraphic analyses.

4) The Cantabrian Mountains contain several excellent and well-studied sections that span the Mid-Carboniferous boundary and contain well-documented conodont assemblages that could lead to a better understanding of order of occurrence of conodonts within the *Declinognathodus* group of species and lead to a resolution of the apparent problem of using *Declinognathodus* s.l. to define the Mid-Carboniferous GSSP.

5) The region is structurally complex but metamorphic grades are relatively low and valuable regional stratigraphic and basin analysis studies can be completed through the integrated use of biostratigraphy, sedimentology and lithostratigraphy.

6) The Cantabrian Mountains contain suitable sections for integrated biostratigraphic, geochemical, and sedimentologic analyses related to the pursuit of GSSP candidates at the level of the Bashkirian-Moscovian boundary but we did not see enough sections at this level to enable us to make any recommendations.

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SCCS ANNUAL REPORT 2009

This version of the SCCS annual report for the last fiscal year (November 1st 2008 to October 31st 2009) is an abbreviated version of the document submitted by our chairman Barry C. Richards to the ICS in November 2009. The complete annual report will be posted on our website and we encourage our members to examine it to obtain a more complete overview about the activities and goals of the SCCS. The task group reports within the annual report were submitted in November 2009 and differ substantially from those prepared this June and July for volume 28 of the Newsletter.

OVERALL OBJECTIVES, AND FIT WITHIN IUGS SCIENCE POLICY

The SCCS promotes and coordinates international cooperation among geologic specialists for the purpose of defining standard Global chronostratigraphic boundaries within the Carboniferous System. The Devonian-Carboniferous boundary at the base has been selected in southern France (Paproth and Streel, 1984; Paproth *et al*., 1991), and the Carboniferous-Permian boundary at the top lies in northern Kazakhstan (Davydov *et al*., 1998). The Mid-Carboniferous boundary GSSP is in Arrow Canyon Nevada, U.S.A. (Lane *et al*., 1999) and it subdivides the Carboniferous into two subsystems, the Mississippian Subsystem below and the Pennsylvanian Subsystem above.

As indicated by the former chair, Philip Heckel, in the SCCS annual report for 2007, there are serious problems with the GSSP at the base of the Carboniferous, such that the boundary will need to be placed at another stratigraphic position, and a new event marker may also be required. The immediate SCCS goals are to redefine the Carboniferous-Devonian boundary and select the best stage boundaries within the two Carboniferous subsystems to facilitate global correlation within the system. The ultimate goal is to calibrate biostratigraphy with other methods of correlation, such as chemostratigraphy, magnetostratigraphy, and radiometric dating, so that the Carboniferous successions dominated by terrestrial and endemic cold-water marine biotas in the Gondwana and Angara regions can be correlated with the biostratigraphic framework of the pan-tropical standard succession.

Website

During the 2008-2009 fiscal year, the SCCS established an official website: www.nigpas.ac.cn/carboniferous. At present, the site is basic but the membership is striving to improve each of the main pages by including data, line figures and photographs. The site has eight main pages containing the following information: 1) Homepage - list of SCCS officers, task groups and leaders, and voting members, 2) GSSPs - shows ratified GSSPs and those in progress, 3) Working Groups - lists task groups and provides latest task-group progress reports, 4) Annual Reports - consists of annual reports submitted to the ICS by the SCCS, 5) News - information about current SCCS activities and progress, 6) Forthcoming Meetings - lists conventions for professional societies and field meetings that are relevant to membership goals and activities, 7) Newsletters - back issues of the Newsletter on Carboniferous Stratigraphy are available in pdf format for download, and 8) Links - provides web links to important websites such as those of the ICS and IUGS.

Membership

As of October 31st 2009, the SCCS had a total of 21 voting members (see list at end of newsletter). The corresponding membership at the time the 2009 annual report was submitted comprised 279 persons and 6 libraries from 33 countries (see Newsletter on Carboniferous Stratigraphy v. 27 for contact information). The main meetings of the SCCS are held every two years, both at the quadrennial meetings of the International Congress on the Carboniferous and Permian, and at a field meeting convened by the SCCS midway between the congresses.

Task groups and project groups

During the 2008-2009 fiscal year, the SCCS had six active task groups and one exploratory project group.

Task Group to redefine the Devonian-Carboniferous Boundary [which is also the base of the Lower Mississippian Series and Tournaisian Stage], a joint task group was established in early 2008 that comprises 10 members appointed by Thomas Becker of the Subcommission on Devonian Stratigraphy (SDS) and 10 members selected by Philip Heckel of the SCCS in 2008, who summarized the reasons for establishing the group in the 2008 issue of Newsletter on Carboniferous Stratigraphy [v. 26, p. 3]. The SCCS executive are currently directing the task group but a chairman will be appointed if required. Richards summarized the recent activities of the group through May 2009 in volume 27, p. 7-9 of the Newsletter on Carboniferous Stratigraphy.

Task Group to establish the Tournaisian-Viséan Boundary [which is also the base of the Middle Mississippian Series], chaired by George Sevastopulo (Ireland). Using e-mail communications from the chairman, Richards and Aretz summarized the recent activities of the group through May 2009 in the Newsletter on Carboniferous Stratigraphy for 2009 [v. 27, p. 9-10].

Task Group to establish the Viséan-Serpukhovian Boundary [which is also the base of the Upper Mississippian Series], chaired by Barry Richards (Canada), who summarized the recent activities of the group through May 2009 in the Newsletter on Carboniferous Stratigraphy for 2009 [v. 27, p. 10-12].

Task Group to establish the Bashkirian-Moscovian Boundary [which is also the base of the Middle Pennsylvanian Series], chaired by John Groves (U.S.A), who summarized the recent work of the group through May 2009 in the Newsletter on Carboniferous Stratigraphy for 2009 [v. 27, p. 12-14].

Task Group to establish the Moscovian-Kasimovian Boundary [which is also the base of the Upper Pennsylvanian Series], and the **Kasimovian-Gzhelian Boundary**, chaired by Katsumi Ueno (Japan) who succeeded Elisa Villa (Spain) at the Oslo IGC meeting in August 2008. Ueno summarized the recent work of the group through May 2009 in volume 27 [p. 14-18] of the Newsletter on Carboniferous Stratigraphy.

Project Group on Upper Paleozoic boreal biota, stratigraphy and biogeography, chaired by Marina Durante (Russia), who did not submit reports since 2005, is terminated because of her sickness and lack of contact with the other participants.

Project Group on Carboniferous magnetostratigraphy, chaired by Mark Hounslow (United Kingdom), who summarized the recent work of the group through May 2009 in Newsletter on Carboniferous Stratigraphy for 2009 [v. 27, p. 18-19].

INTERFACES WITH OTHER INTERNATIONAL PROJECTS

The SCCS works closely with the Subcommission on Devonian Stratigraphy and Subcommission on Permian Stratigraphy to establish the common boundaries with the Carboniferous. The SCCS expects to cooperate with the NSF-sponsored Chronos initiative, which has a website at www.chronos.org, and with the NSF-sponsored PaleoStrat community digital information system for sedimentary, paleontologic, stratigraphic, geochemical, geochronologic, and related data, hosted at Boise State University, and with a website at www.paleostrat.org. It also has established a working relationship with the Permian Research Group at Boise State, which initiated a program for obtaining precise ID-TIMS U-Pb radiometric dates from biostratigraphically constrained Carboniferous-Permian successions.

CHIEF ACCOMPLISHMENTS AND PRODUCTS IN 2008-2009 fiscal year

Newsletter on Carboniferous Stratigraphy, Volume 27, published in July 2009. Its 49 pages include commentaries by the current SCCS executive on various current issues, task-group reports for 2008-9, and 4 articles on various topics of interest. Volume 27 also contains a revised directory for the membership.

During the lat fiscal year, task-group and corresponding members have published a number of papers in refereed journals and in abstract volumes associated with conventions. Many of the most important of these publications are cited in the following task group reports.

Summary of Task Group Reports

Task Group to redefine the Devonian-Carboniferous Boundary Following the initial workshop of the D-C boundary task group, held at the August 2008 IGC in Oslo, basic plans for future work by the task group were included in the 2008 SCCS Annual Report that Richards submitted to the International Commission of Stratigraphy (ICS) in November 2008. The work plan outlined the problems with the current GSSP at the base of bed 89 in the La Serre section, France and made three recommendations: 1) the use of the first evolutionary occurrence of the conodont *Siphonodella sulcata* in the lineage *S. praesulcata* to *S. sulcata* for boundary definition requires re-evaluation; 2) if the FAD of *S. sulcata* is retained for boundary definition, either the position of the GSSP at La Serre must be lowered from the base of bed 89 or a more suitable section for the GSSP must be located, and 3) because the first appearance of *S. sulcata* may not be the best event for boundary definition, other conodont lineages require evaluation.

Since the 2008 annual report was submitted, substantial progress has been made. Task-group member Sandra Kaiser continued with her work on the La Serre section and published her latest results (Kaiser, 2009). New data presented by Kaiser show the first occurrence (FO) *S. sulcata* is slightly earlier than reported by Heckel (2008) and at the 2008 IGC workshop and is at the base of bed 84b at La Serre rather than the base of bed 85. At that position, *S. sulcata* co-occurs with *S. praesulcata* at a sharp facies break and the evolutionary lineage from *S. praesulcata* to *S. sulcata* is absent in the underlying strata. Because the FO of *S. sulcata* may not be the best event to define the D-C boundary, Kaiser (2009) suggested the evolutionary lineage from *Protognathodus kockeli* to *Protognathodus kuehni* could be used to define the D-C boundary as there are many sections worldwide that contain the lineage. She also indicated other protognathodid lineages show potential for boundary definition but require more study before use.

Task-group members Carlo Corradini and Sandra Kaiser have started to work on the taxonomic and phylogenetic problems within the *S. Praesulcata* - *S. sulcata* lineage and protognathodid lineages. They presented their initial findings (Corradini and Kaiser, 2009) at the Second International Conodont Symposium (ICOS 2009) held in Calgary, Canada from July 12th to 17th 2009. Their study indicates several morphotypes occur in the transition from *S. praesulcata* to *S. sulcata* and that the position of the current D-C boundary at La Serre is based on subjective interpretations.

During the SCCS workshop following the ICOS 2009 conference session, no consensus was reached on whether or not the *Siphonodella* lineage could be used for D-C boundary definition or even if *S. praesulcata* and *S. sulcata* should be considered as two different species. Specialists attending the workshop agreed that the D-C boundary can not remain at its present position at La Serre (base of bed 89) and that a new GSSP must be selected either lower in the section or in another section. They also decided that the initial problem to resolve was the selection of a suitable taxon for boundary definition. Three options were presented: continue use of the *S. praesulcata*-*S. sulcata* lineage but find a better way to speciate it, select a different conodont lineage (protognathodids), and use the first occurrence of a taxon in a fossil group other than the conodonts.

On August 14th, during the southern Uralian component of the SCCS field meeting in Russia, several SCCS members visited two sections that spanned the D-C boundary and contained the *S. praesulcata*-*S. sulcata* lineage (Pazukhin *et al*., 2009). At the related technical session, the conclusions reached about the GSSP at La Serre were similar to those made at the Calgary ICOS 2009 meeting, but the Russian conodont specialists thought the current event marker, the FAD of *S. sulcata,* could be used for boundary definition.

<u>Task Group to establish the Tournaisian-Viséan boundary</u>

Following approval of the proposed GSSP [see Devuyst *et al.* (2003) for early version of proposal] at Pengchong in southern China, by the SCCS in late 2007 and its ratification by the ICS and IUGS, task-group member François-Xavier Devuyst has been preparing the final report about the Tournaisian-Viséan boundary GSSP. After completion of the report, the task group will be dissolved according to ICS rule (7.5).

Task-group member Hongfe Hou is trying to organize an official ceremony for placement of the "golden spike" in the GSSP section at Pengchong. Several task-group members and SCCS officials plan to attend the historic ceremony.

The **<u>Task Group to establish the Viséan-Serpukhovian boundary</u>** considers the first evolutionary appearance of the conodont *Lochriea ziegleri* in the lineage *Lochriea nodosa*-*Lochriea ziegleri* to be the best event for boundary definition. The lineage along with associated faunas and strata are being studied in several areas but the Nashui section in south China and the Verkhnyaya Kardailovka section in the southeastern Urals of Russia have the best potential as GSSP candidates and are receiving intensive study.

Task-group member Yuping Qi and associates at the Nanjing Institute of Geology and Palaeontology recognized the *L. nodosa* – *L. ziegleri* lineage in the Nashui section in southern Guizhou province, People's Republic of China (Qi and Wang 2005). Qi has finished his detailed analysis of the conodonts across the Viséan/Serpukhovian boundary in the Nashui section and incorporated the results in his doctoral thesis (Qi, 2008). In the Nashui section, conodonts within the *L. nodosa* - *L. ziegleri* lineage are well preserved and abundant. Elements transitional between *L. nodosa* and *L. ziegleri* are plentiful at Nashui, occurring through several metres of section, and the oldest representatives of *L. ziegleri* could be readily distinguished from the associated transitional forms of *L. nodosa*.

Several task-group members and John Groves are continuing a detailed analysis of the foraminifers, stable-isotope geochemistry and sedimentology of the Nashui section and a nearby shallow-water limestone-dominant section at

Yashui (by city of Huishui) in Guizhou province that spans the Viséan/Serpukhovian boundary. The goal of studying the Yashui section is to establish the relationship of the coral and foraminiferal zones to the *L. nodosa* - *L. ziegleri* lineage.

Nikolaeva *et al.* (2005) recognized the *L. nodosa* – *L. ziegleri* lineage in a, deep-water, carbonate section along the Ural River opposite the village of Verkhnyaya Kardailovka in the southeastern Urals, Russia. During the SCCS field meeting, held in Russia in August 2009, task-group and other SCCS members visited the Kardailovka section to determine how it compared with Nashui in terms of its suitability as a GSSP candidate. They concluded the boundary interval was well exposed but noted only three to five metres of well-exposed strata lay below it, whereas at Nashui many metres of underlying conodont-bearing strata are exposed. More of the section below the boundary interval at Kardailovka can be excavated and the section has the advantage of containing abundant ammonoids. Nikolaeva and her colleagues have thoroughly examined the section and published a synthesis of their studies on the ammonoids, conodonts, and ostracodes (Nikolaeva *et al*., 2009). The synthesis indicates conodonts that are transitional between *L. nodosa* and *L. ziegleri* occur in the Kardailovka section immediately below the FAD of *L. ziegleri.*

The task group and SCCS have not voted on either rejecting or accepting the first evolutionary appearance of *L. ziegleri* for boundary definition.

The **Task Group to establish the Bashkirian-Moscovian boundary** is conducting research at several locations in Europe and Asia and continues to evaluate three conodont evolutionary events that have potential for defining the base of the Moscovian: 1) derivation of *Idiognathoides postsulcatus* from *Id. sulcatus*, 2) derivation of *Declinognathodus donetzianus* from *D. marginodosus*, and 3) the appearance of *Diplognathodus ellesmerensis*. The fusulinids *Eofusulina* ex gr. *triangula* and *Profusulinella* [= *Depratina*] *prisca* recently emerged as additional taxa with considerable potential for boundary characterization.

South China. Specialists with the Nanjing Institute of Geology and Palaeontology organized an excursion in May 2008 to Guizhou Province to collect conodont and foraminifer samples from slope carbonates spanning the Bashkirian-Moscovian boundary interval at the Nashui section. Sampling was also conducted across the boundary at the nearby Yashui section, a shallow-water carbonate succession containing abundant micro- and macrofossils. Thin sections have been made from the samples and Groves has completed a preliminary analysis of foraminifers from the Bashkirian-Moscovian boundary at Nashui. The provisional Bashkirian-Moscovian boundary recognized by Qi *et al*. (2007) on the lowest occurrence of *Diplognathodus ellesmerensis* falls 173 m above the base of the Nashui section. That level contains a foraminiferal association dominated by *Profusulinella* spp. and *Pseudostaffella* spp. The lowest occurrence of a demonstrably Moscovian fusulinid is at 183.45 m, where a specimen of *Eofusulina* sp. was recovered.

Donets Basin, Ukraine. Katsumi Ueno and Tamara Nemyrovska continue their work on fusulinids and conodonts from the Donets Basin. The Malonikolaevka section has yielded interesting results that were summarized by Ueno and Nemyrovska (2008). At Malonikolaevka, the proposed boundary marker *Declinognathodus donetzianus* first occurs in Limestone K1 in evolutionary continuity with its ancestor *D. marginodosus*. Limestone K1 also contains unquestioned occurrences of the Moscovian fusulinid *Eofusulina*.

Northwest Spain. Javier Sanz-López, Silvia Blanco-Ferrera and Elisa Villa are conducting integrated foraminifera and conodont biostratigraphic analyses at the San Antolin-La Huelga section along the Bay of Biscay in the Cuera area (Villa 1995; Villa *et al*. 1997). The Bashkirian-Moscovian boundary is provisionally placed about 180 m above the base of the section in lower- slope deposits. The boundary is marked by the lowest occurrence of *Idiognathoides postsulcatus*, and this level is slightly higher than the lowest occurrences of *Declinognathodus marginodosus* and *Profusulinella* ex gr. *prisca*. The San Antolin-La Huelga section contains four conodont taxa identified as potential Bashkirian-Moscovian boundary markers: *Id. postsulcatus*, *Diplognathodus ellesmerensis*, *Neognathodus nataliae* and *Declinognathodus donetzianus*. The lowest occurrences of these conodonts are in the order listed, spanning a stratigraphic interval of over 300 m.

South Urals, Russia - Elena Kulagina has completed a study of *Depratina prisca* in which she documented its evolutionary origin and showed its first occurrence in the south Urals can be used to identify the base of the Moscovian (Kulagina 2009). [Many western specialists regard *Depratina* as a junior synonym of *Profusulinella*.] Kulagina showed that *D. prisca* was derived from *Staffellaeformes staffellaeformis* via the intermediates *Staffellaeformes eoprisca* and *Depratina praeprisca*. Occurrences of *D. prisca* have been examined at the Askyn, Basu and Uklykaya sections. The well-exposed Basu section, visited during the August 2009 SCCS field meeting, contains the fist appearance of *Depratina prisca* a few metres below that of *D. donetzianus* (Kulagina *et al*., 2009). The discovery of the *Declinognathodus* lineage at the Basu River section along with a rich fusulinid fauna including the *P. prisca* group make it a good potential candidate section for a GSSP.

The **Task Group to establish the Moscovian-Kasimovian Boundary** is focusing on the stratigraphic occurrences and distribution of the conodonts *Idiognathodus sagittalis* Kozitskaya 1978 and *Idiognathodus turbatus* Rosscoe and Barrick 2009a and their ancestors as potential biostratigraphic markers for defining the base of the Kasimovian Stage. The use of either conodont would raise the boundary level one substage from the traditional position at the base of the Krevyakinian Substage, to approximately the base of the Khamovnikian but the move will facilitate global correlation. Other biostratigraphic and lithostratigraphic events near the FAD levels of the species will be examined because of their potential as auxiliary events for identifying the base of the Kasimovian. Using the new research direction, the group made the progress summarized below.

Andara Massif, N.W. Spain. Spanish task-group members are studying the Moscovian-Kasimovian transition in the Castillo del Grajal and Morra del Lechugales sections, which embrace the uppermost part of the carbonate-dominant Picos de Europa Formation and the Las Llacerias Formation. Fusulinid biostratigraphic data indicate the study interval ranges from the top of the *Fusulinella* Zone (upper Moscovian) to the lower *Montiparus* Zone (Khamovnikian). The *Protriticites* Zone, spanning at least 245 m, is well exposed and fusulinid rich. Preliminary sampling indicates the occurrence of the conodont *Idiognathodus sagittalis* and its potential ancestor *I*. n. sp. 1 of Goreva *et al*. (2009), allowing correlation with the Moscow Basin and the North American Midcontinent.

Moscow Basin, Russia. The section in the Afanasievo quarry (Kasimovian neostratotype in Moscow Basin) is a potential GSSP candidate for the lower boundary of the Kasimovian. The section has diverse macrofaunas and microfaunas and offers potential for precise correlation with Eurasian sections. The best-recognized and most-correlated levels are the base of the *Montiparus montiparus* fusulinid zone, defined by the first occurrence of the genus *Montiparus,* and base of the *Idiognathodus sagittalis* conodont zone. In the quarry, *Idiognathodus sagittalis* first appears at the base of the middle member of the Neverovo Formation along with *I. turbatus.* The position is close to the FAD of the fusulinid *Montiparus* (*M. paramontiparus*) at the base of the Neverovo. Goreva *et al*. (2009) recognized *Idiognathodus* n. sp. 1 as the possible ancestor of *I. sagittalis*. The form appears in the lower Suvorovo Formation, but becomes more advanced and abundant in the overlying Voskresensk Formation. The first appearance of *I. sagittalis* in the lineage is a potential marker for the base of the Kasimovian.

Donets Basin, Ukraine. Davydov and his student Rimma R. Khodjanyazova recently studied the taxonomy and biostratigraphy of fusulinids within the Moscovian-Kasimovian transition in the Kalinovo section of the Donets Basin, examining fusulinids from limestone units of the C_3^1 (N) and C_3^2 (O) suites and correlated them into the Moscow Basin. They concluded that within the Kalinovo succession the base of the Krevyakinian (traditional base of the Kasimovian) can be placed at the N3 Limestone, based on the occurrence of *Protriticites* with thick walls penetrated by coarse pores. Age-diagnostic fusulinids are less abundant in the N5-N5/1 interval but it is probably equivalent to the Voskresensk Formation in the upper part of the Krevyakinian Substage because of the potential Ratmirovo age of O1. The O1-O1/1 interval is correlated with the Ratmirovo and the lower part of the Neverovo Formation because O1 contains abundant *Obsoletes* but also yields *Montiparus montiparus* and *M. paramontiparus*. The O2-O3 interval is correlated with the middle to upper part of the Neverovo as O2 contains *M. subcrassulus*, which occurs in the middle member of the Neverovo in the Moscow Basin (Goreva *et al*., 2007). The correlations that Davydov and Khodjanyazova propose differ substantially from those of Heckel *et al*. (2007), which are based on integrated cyclothem and conodont correlations. To cross-check the results with those of Heckel, Nemyrovska and Ueno have initiated an analysis of the conodont and fusulinid biostratigraphy in the Kalinovo section.

Midcontinent Basin, U.S.A. Rosscoe and Barrick recently carried out a more detailed study of *Idiognathodus turbatus* (established by Rosscoe and Barrick, 2009a) and related forms using specimens from several sections in the Midcontinent Basin. They restricted the species concept to include only elements with expanded, well-developed rostral lobes and a distinctive medial nodosity. The revision placed the FAD of (revised) *I. turbatus* at the base of the Hertha Cyclothem, two cycles higher than it was originally recognized in Rosscoe and Barrick (2009a).

Nashui section, south China. The Nashui section (Qi *et al*., 2007) in southern Guizhou Province is one of China's most-continuous and best-exposed sections embracing the Moscovian-Kasimovian boundary. It consists of carbonate-slope deposits that are rich in conodonts and contains some fusulinids. Qi and Wang Zhihao investigated the conodont succession across the boundary at Nashui and recognized the *Idiognathodus podolskensis*, *Swadelina subexcelsa*, *Swadelina makhlinae - Sw. nodocarinata*, *Idiognathodus sagittalis*, *Streptognathodus cancellosus*, and *Streptognathodus gracilis* zones, in ascending order. The first occurrence of *I. sagittalis* occurs 225 m above the base of the section. Ueno systematically sampled the boundary interval for fusulinids and the conodont-fusulinid biostratigraphy is being investigated.

The **Task Group to establish the Kasimovian-Gzhelian boundary** has selected the conodont *Idiognathodus simulator* (s.s.) as the event marker for defining the base of the Gzhelian Stage (Heckel *et al*., 2008) and is directing its research toward selecting a suitable section for the GSSP in three main areas.

Moscow Basin, Russia. The Russian task-group members have completed a comprehensive study of the lithostratigraphy and biostratigraphy of the stratotype of the Gzhelian Stage in the Gzhel quarry in the Moscow Basin near Moscow. In the quarry only the lower part of the stage is exposed, occurring in the Rusavkino Formation. The section comprises bed 1 of member 4 (middle Rusavkino) and beds 2-9 of member 5 (upper Rusavkino). Two ecological assemblages of fusulinids are recognized, replacing each other upwards in the section. The lower one occurs in beds 4 and 5 and includes *Quasifusulina longissima*, *Q. ultima*, *Q. eleganta*, *Rauserites postarcticus*, *R. paraarcticus*, and others. The upper assemblage is preserved in bed 8 and consists of a rich population of *Rauserites*, including dominant *R. rossicus* and minor *R. postarcticus* and *R. paraarcticus*. Three morphological groups are distinguished in the *R. rossicus* population from bed 8. It is, therefore, necessary to consider the polymorphic status of *R. rossicus* for regional correlation.

The Gzhel section contains abundant conodonts. A single juvenile specimen of *Idiognathodus simulator* was extracted in the top of bed 3, but typical *I. simulator* first appear in bed 4 along with *Streptognathodus pawhuskaensis* and *Idiognathodus tersus*. Alekseev and others also re-examined conodonts from the stratotype of the Rusavkino Formation situated near Rusavkino east of Moscow and in borehole 6k, drilled at Konyashino village north of Gzhel. They showed that *I.* aff. *simulator* (= *Idiognathodus eudoraensis* Barrick, Heckel and Boardman, 2008), a potential ancestor of *I. simulator*, appears in the late Kasimovian Troshkovo Formation and also in the lower and middle members of the overlying Rusavkino Formation. The FAD of *I. simulator* in the Moscow Basin is close to that of *Rauserites rossicus*.

In the Moscow Basin, a specific and well recognizable assemblage characterizes the *I. simulator* Zone (Barskov *et al*., 1982, 1984; Alekseev and Goreva, 2007). In addition to *I. simulator*, it includes *Streptognathodus pawhuskaensis*, *Idiognathodus tersus*, *I. toretzianus*, *I. luganicus*, *I. sinistrum*, and *Gondolella bella*. Based on the first appearance of *I. simulator,* the lower boundary of the Gzhelian lies within the Rusavkino Formation near the base of its upper member. Although the proposed stage boundary is somewhat above the formation's base, the regional and interregional correlations will not be significantly impacted.

Nashui section, South China. Qi (2008) established a detailed conodont biostratigraphy across the Kasimovian-Gzhelian transition in the Nashui section. In ascending order, he recognized the *Streptognathodus gracilis*, *Streprognathodus guizhouensis,* *Streptognathodus simulator* (=*Idiognathodus simulator* sensu Barrick *et al*., 2008), *Streptognathodus nashuiensis*, and *Streptognathodus firmus* zones. According to Qi, the first occurrence of *S. simulator* is 265 m above the base of the section. Last December, Ueno and Wang Yue measured the Kasimovian-Gzhelian boundary interval in the section, and collected samples for fusulinid study. The work suggests that a composite conodont/fusulinid biostratigraphy can be developed for the section. Because the Nashui section is a completely exposed carbonate-slope succession containing a rich conodont record throughout, it has great potential as a GSSP candidate for the Kasimovian-Gzhelian boundary.

Usolka section southern Urals, Russia

For establishment of the GSSP, Russian colleagues are undertaking a detailed re-description and recollection of the Usolka section in the southern Urals and have published a comprehensive synthesis of their preliminary results (Davydov *et al*., 2008).

Progress by the **Project Group on Carboniferous Magnetostratigraphy** has been hampered by a shortage of members and lack of integration with the activities of the other SCCS task groups. The group is particularly interested in collaborating with task groups working on sections and boundaries where magnetostratigraphy could be employed, to facilitate international correlations. Sections that have low thermal maturity and are dominated by siliciclastics are the most suitable for magnetostratigraphic analyses but carbonates can be used.

The search for Mississippian sedimentary rocks that are likely to carry a primary magnetisation, to construct a magneto-stratigraphic timescale, have focused on two sections in southern Scotland. Both sections have good potential for recovery of primary magnetisation because they are dominated by siliciclastics and their thermal maturity is low. The first section (~400 m thick) is at Cove in the Cockburnspath outlier on the southern flank of the Midland Valley Basin and shows a transition from fluvial red-bed facies into lacustrine and flood-plain deposits with local marine influence. The succession includes the Inverclyde and Strathyclyde groups and represents an interval from the latest Devonian into the late Viséan (Asbian) (Cossey *et al*., 2004). The second section (~600 m thick) is at Kirkbean on the northern edge of the Northumberland Basin and is of early to late Viséan age, overlapping in age with the upper part of the Cove section. The Kirkbean succession represents a shallow-marine setting with intervals recording fluvial and distal delta-front progradation. The section contains conodonts but their biostratigraphy has not been studied in detail and chronostratigraphic relationships to other sections in the Northumberland Basin are not well established (Cossey *et al*. 2004). The Kirkbean section is adjacent to a granite batholith that was unroofed in the Mississippian and could have provided igneous detritus carrying a palaeomagnetic signal. Both sections contain numerous silty and fine-sandy intervals and are continuously and well exposed, thereby providing good targets for palaeomagnetic work.

The magnetostratigraphic work on the Carboniferous-Permian boundary (CPB) section at New Well Peak, S.W. New Mexico (Hounslow, 2005, 2009) indicates that section was remagnetised during the Late Cretaceous to early Tertiary. The targets for that work were short normal polarity magnetozones lying both above and below the CPB and known from sections in central Asia to lie within the Permian-Carboniferous reverse superchron. In contrast, a review of Permian magnetostratigraphic data from Spitsbergen (Hounslow and Nawrocki, 2008) has indicated that a normal polarity interval in the Tyrrellfjellet Member of the Gipsdalen Group potentially validates one or other of the normal-polarity magnetozones from the latest Gzhelian or earliest Asselian, thereby providing a useful additional proxy for the CPB interval in the arctic sections.

SCCS FIELD MEETING, RUSSIA 2009-11-22

The SCCS Field Meeting held in the Moscow Basin region and southern Urals of Russia from the 11th to 19th of August 2009 was a great learning experience and well organized by members of the Russian Academy of Sciences in Moscow and Ufa. All SCCS members who attended the meeting substantially broadened their knowledge of the Carboniferous successions in western to central Russia. The principal objectives of the meeting were adequately met: 1) examined numerous key Carboniferous sections including stratotypes and neostratotypes for Global Carboniferous Stages and were introduced to their lithology, biostratigraphy, and intra- to interbasinal correlations; 2) were provided with a comprehensive overview of the Carboniferous fossil record in Russia including the major zonal schemes and their correlation; and 3) examined three Russian sections that have been selected as GSSP candidates (Basu River, Usolka, and Kardailovka sections) so they could be compared with those in other regions in terms of exposure and the development of faunal lineages used for definition and correlation of stage boundaries. All task-group members had an opportunity to present new data and accomplishments in poster and oral sessions as well as discuss plans for future research.

Two informative and well-illustrated guidebooks were printed for the meeting (Alekseev and Goreva, 2009; Puchkov *et al*., 2009) and provide considerable new data as well as syntheses of previously published information.

CHIEF PROBLEMS ENCOUNTERED IN 2009

Several problems confronted the SCCS task groups during the last fiscal year and most will be ongoing. Many of the most active specialists are working on two or more task groups and have over extended themselves, making it difficult to make substantial progress during any one fiscal year.

The most significant issue confronting the SCCS is the difficult and time-consuming task of locating suitable evolutionary lineages and first occurrences for boundary definition. Within the Carboniferous, the endemism of conodont, foraminiferal and ammonoid lineages between Eurasia and North America, which slowed down submission of the Tournaisian-Viséan boundary proposal, continues to hamper the choice of the boundary levels for the Viséan-Serpukhovian and Bashkirian-Moscovian boundaries. The problem is being overcome somewhat by correlating other fossil groups to bracket the boundary levels in major regions where the boundary-event taxa have not been found. In the case of the higher two boundary levels [Moscovian-Kasimovian, Kasimovian-Gzhelian], there are enough conodont species in common between the regions to achieve fairly precise correlations based on utilizing the positions and scales of cyclothems in conjunction with biostratigraphy. However, the strong cyclic control over sedimentation and consequent widespread disconformities across entire shelves, still hampers the selection of acceptable GSSPs for these younger boundaries, which will require successions of relatively continuous sedimentation. We are now focusing study on deeper water, carbonate-slope and basinal sections in southern China and southern Urals of Russia, which can be correlated with the shelf cyclothem successions, for potential GSSPs.

All lineages being chosen for GSSP definition are conodont based and have the most utility in carbonate-dominant lower-slope and basin deposits containing few other taxa suitable for global and shelf correlations. The best of the known deeper water successions in terms of abundance and diversity of conodonts and continuity of outcrop are in southern China and southern Urals. The direction the current work of the SCCS is advancing indicates all of the remaining GSSPs will be placed in south China and Russia. Additional suitable sections, even if they just become auxiliary stratotypes, need to be located and intensively studied in Western Europe, northern Africa/Middle East, and North America.

Some lineages used in the past for boundary definition such as the *Siphonodella praesulcata*-*Siphonodella sulcata* conodont lineage, used to define the Devonian-Carboniferous boundary, were not sufficiently known prior to being used for GSSP definition. Current specialists are finding those lineages are either no longer suitable for defining and correlating boundaries or require intensive re-evaluation.

WORK PLANS, CRITICAL MILESTONES, ANTICIPATED RESULTS AND COMMUNICATIONS TO BE ACHIEVED NEXT YEAR (2009-2010):

The following activities are planned for the 2009-2010 fiscal year (Nov. 1, 2009 to Oct 31, 2010) by the task groups, as communicated by task-group chairs and distilled from the reports above.

Devonian-Carboniferous boundary Since the project's first meeting at the IGC in Oslo 2008, Sandra Kaiser and Carlo Corradini have made considerable progress on re-evaluating the lineage containing the current D-C boundary event marker, the FAD of the conodont *Siphonodella sulcata*. Additional study of the lineage is required, however, and the task group plans to complete that work as soon as possible. At an SCCS workshop (date and venue not determined) that will be held after the May 30 to June 3, 2010 ICS Workshop (GSSP concept) in Prague, the task-group's conodont specialists will give updates on work accomplished since the D-C boundary workshop held on July 13th at the Second International Conodont Symposium in Calgary, Canada. After the June ICS workshop, some SCCS members plan to visit the La Serre section in the Montagne Noir of France, which contains the current GSSP for the D-C boundary. At La Serre, the SCCS executive plans to resample parts of the section to confirm the conodont results of Kaiser (2009) and Corradini and Kaiser (2009).

At La Serre, Corradini and Kaiser (2009) identified seven morphotypes in the transition from *S. praesulcata* to *S. sulcata*. Unfortunately, the conodonts within the transition are reworked and no apparent correlation exists between the stratigraphic level and individual morphotypes. The task group plans to determine if any correlation between the morphotypes and stratigraphic level exists in other D-C boundary sections, where reworking is not an issue. The morphotype analysis is significant because of its bearing on whether or not the lineage actually comprises two species that can be readily differentiated.

If the FAD of *S. sulcata* in the lineage *S. praesulcata* - *S. sulcata* is retained for boundary definition, a suitable section for the GSSP will probably need to be located because work at La Serre (Kaiser, 2009; Corradini and Kaiser, 2009) indicates the lack of the phylogenetic transition from *S. praesulcata* to *S. sulcata*. In addition, the section may not be suitable because the first occurrence of *S. sulcata* occurs immediately above an abrupt facies change (ooid grainstone on sandy shale) that is probably erosional. Because of the potential break, the task group plans to complete a sedimentologic assessment of that contact and entire section.

Kaiser (2009) and Kaiser and Corradini (2009) have started to evaluate the potential of using a protognathodid lineage to define the D-C boundary. Two lineages appear to have considerable potential: derivation of *Protognathodus kockeli* from *Protognathodus collinsoni* (FO of *P. kockeli* is in bed 84a slightly below current GSSP at La Serre), and derivation of *P. kunei* from *P. kockeli* (at La Serre, the FO of *P. kunei* is in bed 93, slightly above the GSSP). The SCCS executive plans to have the conodont specialists evaluate the utility of using the two lineages for boundary definition by studying them in the best of their D-C boundary sections.

Tournaisian-Viséan boundary The task group plans to continue with its preparation of the final manuscript for the project.

Viséan-Serpukhovian boundary Since determining that the first appearance of the conodont *Lochriea ziegleri* in the lineage *Lochriea nodosa—Lochriea ziegleri* is the best event to define the boundary, work has focused on correlating successions where it occurs in Eurasia with those in North America (where it has not been found) by means of other fossil groups and geochemistry, in order to bracket its appearance level in North America. This includes work on the ammonoid localities of the southern Urals and in the Chainman Shale of Nevada and Utah, and foraminiferal and coral work on the carbonate successions in Western Europe and western Canada. During 2009-2010, the task-group chair intends to submit a proposal to use the *Lochriea* lineage to the task group and SSCS membership for a vote on either accepting or rejecting that lineage as a marker for GSSP definition.

In October 2008, Yuping Qi and Zhihao Wang met with Rich Lane at the Smithsonian Institute in Washington DC to examine the extensive conodont collections extracted from the upper Viséan and lower Serpukhovian of the Mississippi Valley region. During the next couple of years, they plan to continue that work to document the conodonts from that interval and search for conodonts diagnostic of the *L. nodosa* – *L. ziegleri* transition.

The deep-water carbonate-dominant Nashui section in southern Guizhou Province, China is one of the two best candidates for the GSSP at the base of the Serpukhovian because the *L. nodosa—L. ziegleri* lineage is well defined within it. During 2008, sedimentologic, geochemical and foraminiferal studies were initiated at that locality and the task group members plan to complete that work within the next couple of years. During 2008, the nearby shallow-water, carbonate-dominant Yashui section in Guizhou Province was measured and sampled for conodonts, foraminifers, and rugose corals. During the next couple of years, task-group members plan to complete their biostratigraphic, sedimentologic, and geochemical studies at that section.

The deep-water section near Verkhnyaya Kardailovka in the southern Urals with its conodonts characteristic of the *Lochriea nodosa—Lochriea ziegleri* transition, abundant ammonoids, and moderately common foraminifers remains the other strong candidate for a GSSP. During the SCCS field meeting held in the Moscow region and southern Urals in August 2009, several SCCS members visited that section and discovered the interval below the proposed GSSP level was insufficiently exposed (about 3 m exposed). During the spring and summer of 2010, the task group intends to excavate additional strata below the boundary and study its conodonts.

Several task-group members and other SCCS members think that not enough is known about the geographic distribution of the lineage and the degree of diachroneity of the FAD of *L. ziegleri* to warrant a vote on accepting the FAD of the species for boundary definition. To address some of these problems, Mark Dean and George Sevastopulo are investigating the magnitude of diachroniety in the British Isles by correlating the first appearance of *L. ziegleri* with the ammonoid zonations.

Bashkirian-Moscovian boundary The task group plans to continue its research in three main areas: the southern Urals of Russia, southern Guizhou Province in south China, and northern Spain.

In those regions, the principal short-term goal will be the search for a suitable event marker to define the base of the Moscovian. The group has discovered three conodont evolutionary events that have potential for defining that boundary: 1) derivation of *Idiognathoides postsulcatus* from *Id. sulcatus*, 2) derivation of *Declinognathodus donetzianus* from *D. marginodosus*, and 3) the appearance of the conodont *Diplognathodus ellesmerensis*, which appears in evolutionary continuity from *D. coloradoensis* at the base of the Moscovian at the Nashui section in Guizhou Province and has been widely recognized globally. If either *D. donetzianus* or *I. postsulcatus* are chosen as the marker, the group's challenge will be to demonstrate how the base of the Moscovian Stage might be identified in areas where these taxa do not occur because both have limited geographic distributions.

The first appearance of the fusulinid *Profusulinella prisca* also has considerable merit for boundary definition. Several members plan to further evaluate the utility of that taxon, searching for more appearances near the boundary level in Spain, Turkey and the southern Urals.

At the Basu River section in the southern Urals, Russian workers plan to further evaluate the *Declinognathodus donetzianus* - *Declinognathodus marginodosus* conodont lineage and a distinctive fusulinid group that includes *Profusulinella prisca* to access the section a possible candidate for a GSSP at the base of the Moscovian.

Chinese colleagues and Lance Lambert from the U.S.A. will continue with intensive studies to provide more detailed information on the conodont succession across the Bashkirian-Moscovian boundary in the Nashui section in southern Guizhou Province as another potential GSSP. During the fall of 2010, the task group plans to hold a joint workshop in Nanjing with the Moscovian-Kasimovian and Kasimovian-Gzhelian task groups and then visit the Nashui section. Several key specialists working at the Nashui section are participants on all three groups. During 2008 foraminiferal, sedimentologic, and geochemical studies were initiated at the deep-water Nashui section and nearby shallow-water Yashui section. Task-group members plan to continue that work within the 2009-2010 fiscal year.

In northwest Spain, Javier Sanz-López, Silvia Blanco-Ferrera and Elisa Villa plan to continue their integrated foraminifera and conodont biostratigraphic analyses at the San Antolin-La Huelga section along the Bay of Biscay in the Cuera area (Villa 1995; Villa *et al*. 1997). The Bashkirian-Moscovian boundary is provisionally placed about 180 m above the base of the section in lower- slope deposits.

Moscovian- Kasimovian boundary During the 2009-2010 fiscal year, the ongoing biostratigraphic analyses reported on above will continue in the Andara Massif of NW Spain, Moscow Basin in Russia, Donets Basin in the Ukraine, and in southern Guizhou Province, China. In these regions, the task group plans to continue its integrated assessment of fusulinids and two species of conodonts as potential biostratigraphic marker by which the base of the Kasimovian Stage can be selected and correlated globally: 1) *Idiognathodus sagittalis* Kozitskaya 1978, based on material from the Donets Basin (Ukraine) and also identified from the Moscow region and southern Urals of Russia, and the Cantabrian Mountains in Spain; and 2) *Idiognathodus turbatus* Rosscoe and Barrick 2008 (*I.*

n. sp. A of Barrick *et al*., 2004), based on material from the Midcontinent region of the U.S.A., and recognized also in the Moscow region, the southern Urals, and the Donets Basin. A potential ancestor-descendent lineage from *I.* aff. *sagittalis* n. sp. to *I. sagittalis* may be present in the Moscow region. A lineage from *Idiognathodus swadei* Rosscoe and Barrick 2008 to *I. turbatus* has been described from the Midcontinent region of the U.S.A.

Chinese colleagues along with Steven J. Rosscoe and James E. Barrick will continue with intensive studies to provide more detailed information on the conodont succession across the Moscovian-Kasimovian boundary at the Nashui section in Guizhou, south China as a potential GSSP locality. During 2008 foraminiferal, sedimentologic and geochemical studies were initiated at that locality and task-group members plan to continue that work within the 2009-2010 fiscal year. During the fall of 2010, this task group and the Kasimovian-Gzhelian group intend to hold a joint workshop in Nanjing with the Bashkirian-Moscovian task group.

Kasimovian-Gzhelian boundary Since 2007, when the Task Group voted overwhelmingly in favor of using the first appearance of the conodont *Idiognathodus simulator [sensu stricto]* as the boundary-defining event, the search for a suitable section for the GSSP became the main focus of the task group. The event level is consistent with both the working ammonoid definition of the boundary and with the first appearance of a cotype of the fusulinid *Rauserites rossicus* in the Moscow region. The recent selection of the lectotype of the fusulinid *R. rossicus* at the first appearance of *I. simulator* in Russia will expedite the recognition of this boundary in Eurasia.

For establishment of the GSSP, Russian colleagues are undertaking a detailed re-description and recollection of the Usolka section in the southern Urals and have published a comprehensive synthesis of their preliminary results (Davydov *et al*., 2008). On August 14 2009, task-group members along with other representatives of the SCCS visited the Usolka section during the SCCS Field Meeting, which was held in the Moscow Basin region and southern Urals. The field-trip participants observed that only fragments of the section were exposed and they were in small, partly filled to overgrown trenches. In response to that observation, the task group plans to extensively excavate the site during its re-assessment.

Chinese colleagues and collaborator James E. Barrick are undertaking a detailed sampling across the boundary in the well-exposed, carbonate-slope succession that constitutes the upper part of the Carboniferous component of the Nashui section in Guizhou Province, south China for conodonts and fusulinids. A sedimentological and geochemical analysis of that section at the appropriate level is also in progress.

Much of the work that is ongoing in all task and project groups will be published in Volume 28 of the Newsletter on Carboniferous Stratigraphy in July 2010.

Chemostratigraphy, magnetostratigraphy and radiometric dating

The SCCS chairman is hopeful that ongoing work in chemostratigraphy and magnetostratigraphy will identify events that can be used to supplement the boundaries that will be defined by means of faunal events, and eventually will provide the basis for correlating these boundaries into the northern-hemisphere Angara region and the southern-hemisphere Gondwana region, where the pan-tropical biotas are replaced by provincial cold-climate communities.

I am also hopeful that new, more coordinated precise radiometric dating on biostratigraphically well-constrained marine successions, such as are being reported from the Pennsylvanian of the southern Urals by the Boise State group, and from the Mississippian of Belgium by the Tournaisian-Viséan task group, will both narrow the age disparities that currently exist within much of the Carboniferous and also provide better correlation with more precise modern radiometric dates that will hopefully be obtained from the Angara and Gondwana regions.

MAJOR ACCOMPLISHMENTS OVER LAST 10 YEARS

An initial 1997 ballot on the naming of the two subdivisions of the Carboniferous System resulted in a close vote that rejected the names Lower and Upper, and approved the names Mississippian and Pennsylvanian, but just short of the required 60% majority to be declared final. After a long period of wrangling over procedure as well as nomenclatural issues, the final ballot was ultimately taken at the mandate of former ICS Chair Jurgen Remane in late 1999. As reported in the 2000 Newsletter on Carboniferous Stratigraphy [v. 18, p. 3], this ballot resulted in approval of the names Mississippian and Pennsylvanian by a 76% majority, along with a reconfirmation of the previous decisions of the SCCS to regard their rank as subsystems, by the same 76% majority. In 2003 the SCCS voted to classify the two subsystems into Lower, Middle, and Upper Mississippian Series and Lower, Middle, and Upper Pennsylvanian Series, by a 74% majority of those 90% of the total membership who voted. This vote with its implicit acceptance of the stage names used in Russia as the global stage names for the Carboniferous now provides the Carboniferous with all its official global series and stage names, and all effort is now focused on selecting events and GSSPs for stage boundaries. Information on usage of the new official scheme of Carboniferous subdivision was published by Heckel and Clayton (2006a, 2006b).

Following approval of the proposed GSSP for the Tournaisian-Viséan boundary (see Devuyst *et al.*, 2003 for early version of proposal) at Pengchong in southern China, by the SCCS in late 2007 and its ratification by the ICS and IUGS, task-group member François-Xavier Devuyst has been preparing the final report about the Tournaisian-Viséan boundary GSSP.

MAJOR OBJECTIVES AND WORK PLAN FOR NEXT 4 YEARS (2010-2013)

I am strongly encouraging all SCCS working-group members to maintain progress on researching and selecting defining events and GSSPs for as many stage boundaries as possible in the next four years, keeping in mind the emphasis on selecting readily correlatable boundaries as expressed by Remane *et al.* (1996). Once the principal mandate of a task group has been fulfilled, I will encourage that group to remain together and embark on basin-analysis and Global projects that are appropriate to their time slices and employ integrated paleoclimatic, geochronologic, biostratigraphic, and geochemical studies. An anticipated outcome of the latter work is the establishment of a more precise correlation between successions dominated by terrestrial and endemic cold-water marine biotas in the Gondwana and Angara regions and those of the pan-tropical standard succession. In addition, I will encourage some task groups to consider division of their respective time slices (all of these are stages). Some stages such as the Viséan are inordinately long and require division to facilitate more precise Global correlation. Should a stage such as the Viséan be divided, the name of that stage would be applied to the corresponding series such as the Middle Mississippian in the case of the Viséan.

Meeting/field workshop schedule with themes and anticipated results.

From May 30th to June 3rd of 2010, the executive and task-group chairs of the SCCS plan to attend the ICS workshop in Prague, Czech Republic. The focus will be on the GSSP concept - successes, shortcomings, and remaining boundary issues - but other stratigraphic issues will be addressed.

Two SCCS workshops/field meetings are scheduled for the 2009-2010 fiscal year. Immediately after the ICS Prague meeting, several members of Devonian-Carboniferous boundary reappraisal task group plan to visit the La Serre section in southern France. The purpose of the trip will be to collect samples for conodont extraction across the boundary interval (mainly beds 83 to 89) to determine if the results of Kaiser (2009) and Corradini and Kaiser (2009) can be repeated. In addition, a one-day D-C boundary workshop will be held to discuss progress made since the ICOS 2009 meeting in Calgary, but the date and venue for that meeting have not been established.

In the fall of 2010, the Bashkirian/Moscovian, Moscovian/Kasimovian and Kasimovian/Gzhelian task groups plan to hold a joint workshop in Nanjing, China. The focus of the workshop will be to study specimens and lineages relevant to defining GSSPs for the boundaries and present the most recent results of ongoing stage-boundary studies. After the workshop, there will be a field trip to the important Nashui section by the village of Naqing in southern Guizhou Province and to some other key Pennsylvanian sections in Guizhou and Guangxi provinces.

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SUMMARY OF EXPENDITURES

Statement of operating accounts from November 1, 2009 to June 30, 2010
Prepared by Barry Richards, Chairman SCCS
(Accounts maintained in Canadian currency)

INCOME (Nov. 1, 2009 – June 30, 2010)	
IUGS-ICS Grant; June 14, 2010	$1,003.30
Donations from Members; November 1, 2009 - June 30	$100.00
Donations from Members; July 1- October 31, 2010	50.51
Interest; Nov. 1 - June 30, 2010	0.18
TOTAL INCOME	**$1,153.99**
EXPENDITURES	
Bank Charges: Bank of Montreal June 14, 2010	$1.70
Richards travel to Nanjing for SCCS field work; Jan. 26 - Feb. 10, 2010	$250.00
Richards attendance of SCCS field meeting in Spain; June 4-10, 2010	$250.00
Support for V. Pazukhin to attend 3IPC London; June 10, 2010	$1,000.00
Drilling equipment for SCCS use in Russia and Europe	$503.39
Generator for SCCS use in Russia	$380.36
Electrical cable for use with drill and generator	$35.48
TOTAL EXPENDITURE	**$2,420.93**
BALANCE SHEET (2009 – 2010)	
Funds carried forward from Oct. 31, 2009	$2,481.94
Plus Income November 1, 2009 – October 31, 2010	$1,153.99
Total assets	$3,635.93
Less expenditure Nov. 1, 2009 – October 31, 2010	-$2,420.93
Balance carried forward (to 2010 - 2011 fiscal year)	**$1,215.00**

TASK/PROJECT GROUP REPORTS

REPORT OF THE JOINT DEVONIAN–CARBONIFEROUS BOUNDARY GSSP REAPPRAISAL TASK GROUP

Barry Richards and Task Group

Since the last task-group report was published in the Newsletter on Carboniferous Stratigraphy (Richards and Task Group, 2009), considerable progress has been made toward addressing the work objectives outlined in that report and in the 2009 Annual Report that Richards submitted to the International Commission of Stratigraphy (ICS) in November 2009 for the SCCS (see Richards - Annual Report in this volume). Those plans are outlined below. 1) Initially, the task group needs to restudy the lineage containing the current event marker for the Devonian-Carboniferous (D-C) boundary, the first evolutionary occurrence of the conodont *Siphonodella sulcata*. 2) If the FAD of *S. sulcata* in the lineage *Siphonodella praesulcata*-*S. sulcata* is retained for boundary definition, a suitable section for the GSSP must be located because recent studies at La Serre (the current location of the GSSP) indicate the lack of the phylogenetic transition from *S. praesulcata* to *S. sulcata* (Kaiser, 2009). 3) Because the first appearance (FO) of *S. sulcata* may not be the best event to define the boundary, other appropriate lineages particularly in the protognathodids within the upper part of the *praesulcata* Zone require evaluation. However, by late summer of 2010, the task group is still far from its main objective - selecting a new GSSP for the D-C Boundary.

The D-C Boundary is currently defined by the first occurrence of the conodont *Siphonodella sulcata* in the evolutionary lineage *Siphonodella praesulcata* to *S. sulcata* (Paproth and Streel, 1984). Based on numerous detailed biostratigraphic studies including those of Flajs and Feist (1988) at La Serre Hill in the Montagne Noir of southern France, the boundary section best displaying the lineage was thought to be in trench E' at La Serre. Therefore, the base of bed 89 in trench E' was selected as the D-C Boundary GSSP by Paproth *et al*., (1991). Recent doctoral work by Sandra Kaiser (currently at Bonn University) supervised by Thomas Becker (university of Muenster) and followed by further sampling and analysis has shown that there are severe problems with the D-C Boundary GSSP at La Serre (Kaiser and Becker, 2007; Heckel, 2008; Kaiser, 2009).

The Joint Devonian-Carboniferous Boundary GSSP reappraisal Task Group was established in 2008 by Philip Heckel (former chairman of the SCCS = Subcommission on Carboniferous Stratigraphy) and Thomas Becker (chairman of the SDS = Subcommission on Devonian Stratigraphy) to study and resolve the serious problems with the integrity of the D-C GSSP. At the time the task group was established, 10 members were appointed from each subcommission to form the task group (Heckel, 2008). A chairman was not appointed, and the SCCS executive that replaced the previous officers at the 33rd International Geological Congress in Oslo during August 2008 decided to wait to see what direction the task group would take and if a chairman was necessary before selecting one. During 2009, it became apparent that problems with the GSSP would not be resolved without major taxonomic and lithostratigraphic analyses requiring strong direction and leadership from a chairman. Consequently, at the International Commission of Stratigraphy workshop about the GSSP concept that was held in Prague from May 31st to June 3rd 2010, the SCCS chairman Barry Richards appointed Markus Aretz as chairman of the task group while the SDS chairman Thomas Becker designated Carlo Corradini to be vice-chairman.

Progress made by the task group during the last year was presented and discussed at several meetings and workshops. Perhaps the most important of these were the Second International Conodont Symposium (ICOS 2009) in Calgary, Alberta Canada from July 12th to 17th 2009, the International field meeting of the I.U.G.S. Subcommission on Carboniferous Stratigraphy (11-19 August, 2009) held in Moscow and the southern Ural Mountains of Russia, and the Third International Paleontological Congress (IPC3) held in London, England (June 28th to July 3rd, 2010). Highlights from these meeting are presented below.

During 2008 to 2009, task-group members Carlo Corradini and Sandra Kaiser commenced work on the taxonomic and phylogenetic problems within the *S. Praesulcata* - *S. sulcata* lineage and protognathodid lineages. They presented their initial findings in a paper (Morphotypes in the early *Siphonodella* lineage: implications for the definition of the Devonian/Carboniferous boundary) at the Second International Conodont Symposium (ICOS 2009) in Calgary, Canada. Their study (Corradini and Kaiser, 2009) indicates several morphotypes occur in the transition from *S. praesulcata* to *S. sulcata* and that the position of the current D-C boundary at La Serre is based on subjective interpretations.

During the SCCS workshop following the ICOS 2009 conference session, no consensus was reached on whether or not the *Siphonodella* lineage could be used for D-C boundary definition or even if *S. praesulcata* and *S. sulcata* should be considered as two different species. Specialists attending the workshop agreed that the D-C boundary can not remain at its present position at La Serre (base of bed 89) and that a new GSSP must be selected either lower in the La Serre section or in another section. They also decided that the initial problem to resolve was the selection of a suitable taxon for boundary definition. Three options were presented: continue use of the *S. praesulcata*-*S. sulcata* lineage but find a better way to speciate it, select a different conodont lineage (protognathodids), and use the first occurrence of a taxon within another fossil group. In conjunction with the workshop, task-group members and other conference delegates visited three D-C boundary sections in the Rocky Mountain Front Ranges west of Calgary (Richards *et al*., 2009).

On August 14th, during the southern Uralian component of the SCCS field meeting in Russia (see Alekseev *et al*., this volume), several SCCS members visited two sections that spanned the D-C boundary and contained the *S. praesulcata*-*S. sulcata* lineage (Pazukhin *et al*., 2010). At the related technical session held in the Uralian city of Sibai, the conclusions reached about the GSSP at La Serre were similar to those made at the Calgary ICOS 2009 meeting, but the Russian conodont specialists thought the current event marker, the FAD of *S. sulcata,* could be used for boundary definition if the morphological limits of *S. praesulcata* and *S. sulcata* were defined more precisely. An informative and well-illustrated guidebook was printed for the Uralian component of the SCCS meeting (Puchkov *et al*., 2009) and provides considerable new data as well as syntheses of previously published information about the Upper Devonian and Carboniferous.

Following the 2009 SCCS meeting held in Russia, Pazukhin continued his work on the *S. praesulcata-S. sulcata* lineage (Pazukhin and Kulagina, 2010) and associated D-C boundary conodonts in the southern Urals and presented his results at the IPC3 convention in London England, 2010. In that study, the conodont zones were correlated with the regional foraminiferal zones to test the utility of using foraminifers to either define the boundary or provide corroborating data.

Task-group members Carlo Corradini, Sandra Kaiser and Claudia Spalletta along with Maria Cristina Perri are studying the taxonomic and phylogenetic problems within the protognathodid lineages. They presented some of their initial findings in a paper (Corradini *et al*., 2010) at the IPC3 convention in London, England. They concluded that a comprehensive study of *Protognathodus*, a genus appearing in the latest Devonian and extending into the Mississippian, would permit a more precise definition of the D-C boundary than is presently available using that group of conodonts. Four species of *Protognathodus* are known from the relevant time span: *Pr. meischneri, Pr. collinsoni, Pr. kockeli* and *Pr. kuehni.* Presently favoured for boundary definition are the first occurrences of *Pr. kockeli* from *Pr. collinsoni* and *Pr. kuehni* from *Pr. kockeli.* These lineages require additional study and their relative advantages, if any, over the siphonodellids require careful evaluation.

At the D-C boundary workshop held at the ICP3 meeting in London on July 2, 2010 after the SDS business meeting, Carlo Corradini summarized the current stage of knowledge of the various species within the genus *Protognathodus* across the D-C boundary level. He indicated there are problems with the first appearances and distribution of the protognathodid species and especially emphasized the group's rareness to absence in many sections (see Pazukhin and Kulagina, 2010) and facies dependence (shallow water). He concluded that none of the *Protognathodus* species has the potential to be the primary marker for the D-C boundary but could be used in conjunction with other taxa. After Carlo's presentation, the utility of using the protognathodids was further discussed at the workshop. During those discussions, it was apparent that no general agreement existed on the usefulness of the protognathodid lineages for boundary definition. It is clear that the group requires substantial additional study in the coming years.

At the IPC3 workshop, Carlo Corradini also gave an important presentation outlining the problems of the *praesulcata-sulcata* lineage. The majority of the conodont workers present at the workshop did not see much potential for the continued use of the *Siphonodella* lineage for boundary definition. However, Carlo suggested that his observations and conclusions along with those of Sandra Kaiser (Corradini and Kaiser, 2009; Kaiser, 2009) should be independently tested by other conodont specialists before the lineage is abandoned. In the La Serre section, the *S. praesulcata* and *S. sulcata* morphotypes that Corradini and Kaiser recognized lacked any apparent relationship with the stratigraphic level (several morphotypes occurred together in the beds); but it is necessary to determine if this is the case in several sections, where extensive reworking in not an issue.

At the July ICP3 workshop in London and at some other recent meetings, it was proposed that we explore the possibility of using an event such as some component of the multiphase Hangenberg extinction event (Kaiser, 2005, 2010; Cramer *et al.*, 2008) to define the boundary. The idea of using a phase of the Hangenberg event for boundary definition was discussed and received much support at the IPC3 workshop. It was pointed out that the event presents potential for correlation into both shallow and relatively deep-water marine facies. In addition, a variety of techniques can be used to recognize the Hangenberg event and it is relatively well constrained by biostratigraphic markers. Those present felt the transgressive surface marking the onset of the Hangenberg was not as useful as the maximum flooding surface or surfaces resulting from the subsequent sea-level drop. At the meeting's end, Markus Aretz asked those present to prepare for the next D-C boundary workshop by developing precise correlation charts for their regions of study showing the biostratigraphic, geochemical and depositional events within the Hangenberg extinction event interval. We would like to know how the phases of the Hangenberg are represented in different facies and how well they can be correlated globally.

At the International Commission of Stratigraphy meeting held in Prague from May 31st to June 3rd, 2010 to discuss the GSSP concept, Vladimir Davydov (Boise State University, Idaho USA) proposed that volcanic ash beds and laminae could be used to define boundaries such as the D-C boundary. The ashes represent instants in deep time and can be precisely dated using U-Pb isotope dilution thermal ionization mass spectrometry (ID-TIMS) methodology. However, precise Global correlation of such ashes would require supporting biostratigraphic data. A principal merit of the proposal is that volcanic ash beds are present to common at many locations in the D-C boundary interval including the auxiliary global stratotype at Hasselbachtal in the Rhenish Massif near the town of Hagen, Germany (Trapp *et al*., 2004; Richards *et al*., 2009). The proposal was met with moderate enthusiasm at the IGC meeting but requires further evaluation.

From the recent work completed by members of the D-C boundary task group, it is clear that the La Serre section will not be suitable for boundary definition. The biologic-sedimentologic event used to define the boundary has not been chosen, but the search for better GSSP sections is already in progress. New D-C boundary sections are being studied in regions such as Morocco (T. Becker, written com., 2010) and previously studied sections such as the Hasselbachtal and those in southern China (Yu, 1988) are being carefully re-evaluated.

Additional workshops relevant to the task group are being planned for the upcoming major meetings of the SCCS (Nanjing, China November 21st - 30th) and SDS. The SDS chairman Thomas Becker and vice-chairman El Hassani, Rabat and the SCCS secretary Markus Aretz plan to organize a field meeting (including 2 days for presentations) for early 2013 in southern and central Morocco.

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REPORT OF THE TASK GROUP TO ESTABLISH A GSSP CLOSE TO THE EXISTING VISÉAN–SERPUKHOVIAN BOUNDARY

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Introduction

During the past year, the task group to establish the Viséan-Serpukhovian boundary made encouraging progress toward the selection of a GSSP for the Viséan/Serpukhovian stage boundary. Most importantly, the group continues to find that the first evolutionary appearance of the conodont *Lochriea ziegleri* Nemirovskaya, Perret & Meischner in the lineage *Lochriea nodosa*-*Lochriea ziegleri* presents the best potential for boundary definition. *L. ziegleri* appears in the upper part of the Brigantian Substage, which is slightly below the current base of the Serpukhovian as defined by its lectostratotype section in the Zaborie quarry near the city of Serpukhov in the Moscow Basin, Russia (Kabanov, 2003, 2004; Kabanov *et al*., 2009). This lineage, best documented from deep-water carbonate sections, has been recently documented in numerous sections in Europe and Asia including the well known Verkhnyaya Kardailovka section in the southern Urals of Russia (Nikolaeva *et al.,* 2009b), the Nashui section (by village of Naqing) in southern China (Qi and Wang 2005, Qi, 2008), Cantabrian Mountains of northern Spain (Nemyrovska, 2005; Sanz-López *et al*., 2007), and the Dombar Hills in western Kazakhstan (Nikolaeva *et al.,* 2009a).

Boundary definition

The Viséan-Serpukhovian task group and SCCS have not held a formal vote to either reject or accept the first evolutionary appearance of *L. ziegleri* for boundary definition. Until this year, many task group members and other SCCS voting and corresponding members felt that not enough was known about the geographic and lithofacies distributions of the lineage and the degree of diachroneity of the first evolutionary appearance of *L. ziegleri* to warrant a vote. In particular, George Sevastopulo, chairman of the Tournaisian/Viséan boundary task group, had serious concerns that the first appearance of *L. ziegleri* might be highly diachronous. During the last two years, George and task-group member Mark Dean along with student Milo Barham at Trinity College in Dublin have tied the first appearance of *L. ziegleri* to ammonoid-bearing marine bands and the ammonoid zonation scheme used in Western Europe (see Nikolaeva and Kullmann, 2003). Fortunately, the preliminary results of this work, presented by George Sevastopulo at the June 2010 SCCS field meeting in northern Spain, indicate the degree of diachroneity is minimal.

Taxa in the lineage containing *L. ziegleri* display a broad range of morphological variations and studies by several task-group members are underway to determine the variations and more precisely define the limits of *L. ziegleri*, its immediate ancestor *L. nodosa* (Bischoff), and *L. cruciformis* (Clarke), which appears near the first occurrence of *L. ziegleri*. A principal shortcoming is the lineage has not been documented in North America; but several species of *Lochriea*, including one specimen of *L. ziegleri* have been reported (Brenckle *et al*., 2005; Qi Yuping, pers. com., 2010). Despite some shortcomings, the first appearance of *L. ziegleri* continues to be a good potential marker for the boundary and better alternatives are not known.

Field activities

During the early part of the 2009-2010 project year, field work was concentrated in the southern Urals of the Russian Federation, and southern Guizhou province, People's Republic of China. Later in the project year, during the June 2010 SCCS field trip held in Cantabrian Mountains of northwestern Spain (see itinerary in executive's column of this newsletter), conodont specialists Javier Sanz-López and Sylvia Blanco-Ferrera introduced several task-group members to a number of excellent stratigraphic sections in which the lineage was particularly well developed and documented.

Southern Urals

Kardailovka section

During August 2009, the task group along with several other SCCS members visited and worked at a condensed, deep-water, carbonate section in an unamed Formation along the Ural River opposite the village of Verkhnyaya Kardailovka on the eastern slope of the southern Urals, southern Russia (see Nikolaeva *et al.,* 2005). Nikolaeva and her colleagues have worked on this section over several years and published a synthesis of their studies on the ammonoids, conodonts, and ostracodes (Nikolaeva *et al*., 2009b). The synthesis indicates that specimens transitional between *L. nodosa* and *L. ziegleri* occur in the Verkhnyaya Kardailovka section immediately below the first appearance of *L. ziegleri.* On the August trip, to Verkhnyaya Kardailovka, task-group members had a stratigraphic overview of the section and collected samples for foraminifers, ammonoids, and conodont extraction across the probable location of the Viséan-Serpukhovian boundary. They found the most of the section well exposed and lacking major structural complications but it was not sufficiently exposed below the probable boundary level (only about 1.5 to 2.0 m of section well exposed). A major concern expressed by some of those present was that the first occurrence of *L. ziegleri* may be lower in the section than reported by Nikolaeva *et al.,* (2005) and Nikolaeva *et al.* (2009b) and more of the section's lower part required excavation to better document the transition from *L. nodosa* to *L. ziegleri*. Subsequent to a general tour of the section, a large front-end loader was rented to start exposing the thick covered interval below the main section. About six metres of additional section were exposed immediately below the boundary level but most of those deposits had slumped somewhat and additional excavation work is required to expose undisturbed bedrock. The task group plans to continue excavation work at Verkhnyaya Kardailovka in early August 2010 and measure the section on a bed-by-bed basis to the Bashkirian for sedimentologic, stratigraphic and geochemical analyses. Serpukhovian strata are well exposed above the boundary level for many metres, but data from strata below the boundary are considered more important than those above. Consequently, more of the section will be excavated. Another disadvantage of the section is its relative isolation from other sections spanning the boundary, and an attempt will be made to locate other Viséan-Serpukhovian Boundary sections in region so the section can be more adequately placed into its paleogeographic and lithostratigraphic contexts.

Dombar section

Svetlana Nikolaeva and her colleagues expanded their study of carbonate-dominant Viséan/Serpukhovian successions from the Verkhnyaya Kardailovka section to the Dombar Limestone in the nearby Dombar and Kyzl-Shin region of northern Kazakhstan. In the Dombar Limestone, the *Lochriea* lineage occurs with a taxonomically diverse association of extremely abundant ammonoids (Kulagina *et al*. 2006; Konovalova & Nikolaeva, 2007). The relationship between the regional ammonoid zones and conodont zones has been well established through their work (Nikolaeva *et al*., 2009a). The study of ammonoids in the Dombar sections combined with related ongoing work by task-group members Alan Titus and Dieter Korn on upper Viséan ammonoids in the Chainman Shale of western Utah and eastern Nevada may lead to a precise ammonoid-based correlation with North America at the proposed level of the Viséan-Serpukhovian Stage boundary.

Southern Guizhou province

Nashui section

During February 2010, several task-group members and students from the Nanjing Institute of Geology and Paleontology briefly visited the Nashui section (by village of Naqing) near the city of Luodian in southern Guizhou province and spent several days measuring two other sections (Yashui section and Dianzishang section) in the region to place the Nashui section into its paleogeographic, stratigraphic, and lithofacies contexts. In the Nashui section, conodonts within the *L. nodosa* - *L. ziegleri* lineage are well preserved and abundant (Qi, 2008). In addition, elements transitional between *L. nodosa* and *L. ziegleri* are plentiful, occurring in several samples, and the oldest representatives of *L. ziegleri* could be readily distinguished from the associated transitional forms of *L. nodosa*. During July 2009, Qi *et al.* (2009) presented a summary of their results from the Nashui section at the International Conodont Symposium in Calgary Alberta, Canada. A detailed stratigraphic section extending from the upper Viséan into the Bashkirian has been measured at Nashui. A more detailed bed-by-bed analysis across the Viséan-Serpukhovian and Serpukhovian-Bashkirian boundary levels still requires completion, and the task group plans to complete that work in November 2010.

Yashui section

The Yashui section, situated near the city of Huishui in Guizhou province, is important because it contains abundant rugose corals and foraminifers (Wu *et al*., 2009) in addition to conodonts, and is dominated by shallow-marine neritic to peritidal facies. The purpose of studying the section is to determine the relationship of the coral and foraminiferal zones to the *L. nodosa* - *L. ziegleri* transition in south China. In the summer and fall of 2008 and in 2009, Wang Xiangdong sampled the Yashui section for corals and Qi Yuping sampled it for conodonts. In February 2010, 101.4 metres of the Yashui section were measured and sampled (bed by bed) from the upper Viséan into lowermost part of the Bashkirian. The samples have been cut for thin section preparation. Conodont samples collected in 2008-2009 have been processed but yields were poor and the *L. nodosa* - *L. ziegleri* transition could not be precisely located. However, valuable sedimentologic and paleogeographic data were obtained and the diverse coral and foraminifer faunas are worthy of study. The section provides an excellent opportunity to see what the shallow-marine platform facies are like in southern Guizhou Province. A doctoral student has been assigned to study the corals. Groves and Brenckle continue their study of the foraminifers.

Dianzishang section

Strata in the Dianzishang section, situated by Dianzishang village along the Zin Zai River about 1 km upstream from the Red Flag bridge, section are intermediate between the lower-slope to basin deposits at Nashui and the shallow- marine platform deposits at Yashui. The Dianzishang section includes some spectacular syndepositional slump deposits formed in a middle-slope setting and provides another opportunity to see conodonts and foraminifers spanning the *L. nodosa- L. ziegleri* transition. In February 2010, task-group members measured 72.7 m of strata extending from the uppermost Viséan into lowermost Bashkirian but not at a bed-by-bed resolution. The well-exposed section is dominated by carbonate turbidites and slump deposits but includes minor shale and slope breccias.

Cantabrian Mountains, northern Spain

In early June of 2010, task group members were fortunate to be introduced by Javier Sanz-López and Silvia Blanco-Ferrera to several sections spanning the Viséan-Serpukhovian boundary in the Cantabrian Mountains of northwestern Spain. Two of the Cantabrian sections, the Vegas de Sotres and Millaró (Sanz-López *et al*., 2004; 2007) sections in the Alba Formation, are excellent, rivaling the better known Kardailovka and Nashui exposures. In the Vegas de Sotres section (by village of Sotres in the Picos de Europa unit, northeastern Cantabrian zone) and Millaró section (by village of Millaró, in fold and Nappe province of the Cantabrian zone), conodonts within the *L. nodosa* - *L. ziegleri* lineage are well preserved and abundant; in addition, the first occurrence of *L. ziegleri* has been located with moderate precision. A major biostratigraphic advantage of the two sections is the common occurrence of abundant, well preserved ammonoids; in addition, foraminifers and algae introduced from shallow-water settings are present at Vegas de Sotres (Blanco-Ferrera *et al*., 2009). In both sections, deposits within the *L. nodosa* - *L. ziegleri* transition are dominated by nodular, deep-water carbonates of the Alba Formation. The conodont biostratigraphy has been well established in the two sections (Sanz-López *et al*., 2007; Blanco-Ferrera *et al*., 2009) but sedimentological and geochemical analyses are required. Svetlana Nikolaeva is studying the ammonoids. Because of the significance of their conodont work in northern Spain, Javier Sanz-López and Silvia Blanco-Ferrera have been invited to join the task group (see spreadsheet below).

United Kingdom and Republic of Ireland

The *L. nodosa*-*L. ziegleri* lineage has been reported from England (Skompski *et al.*, 1995) but its geographic distribution and stratigraphic position in the United Kingdom and Republic of Ireland are not well known. In order to better understand its distribution and biostratigraphy in that important region, Mark Dean and George Sevastopulo are continuing their investigation of the lineage in the Lower and Upper Limestone formations in the Yordale facies of central Scotland and in the Bowland Shale Formation, Craven Basin, England. Much of their work is focused on the study of conodont collections used by Varker (1964) and Higgins (1975). An important goal of their work is to tie the first appearance of *L. ziegleri* to the ammonoid-bearing beds of Western Europe.

Rocky Mountains, southwestern Canada

Several task-group members, in addition to associate member Sergio Rodriguez (Universidad Complutense in Madrid, Spain) and Wayne Bamber (Geological Survey of Canada-Calgary), continue to study various carbonate-dominant sections across the Viséan-Serpukhovian boundary interval in the upper Viséan to Serpukhovian Etherington Formation in the southern Canadian Rocky Mountains. Rodriguez and Bamber are preparing a monograph on the taxonomically diverse rugose coral faunas that span the Viséan-Serpukhovian boundary within the Etherington. The coral faunas are particularly interesting in that they include a number of European species not previously reported from southwestern Canada. In conjunction with that work, task-group member Bernard Mamet has completed a preliminary analysis of the associated Etherington foraminifers in order to obtain a precise correlation with Eurasian sections containing the *Lochriea* lineage. Conodonts are being extracted from samples collected from the Etherington sections and will be studied by task-group members.

Future work

Now that several excellent stratigraphic sections containing the *Lochriea* lineage are known, the principal work of the task group will be to more precisely establish the first occurrence of *L. ziegleri* in some of the sections and document the occurrence of the other biostratigraphically useful fossils. A comprehensive study of the ammonoids is considered particularly significant and is being actively pursued by Svetlana Nikolaeva. Foraminifers are the other main fossil group with substantial biostratigraphic utility, and several task group members including Nilyufer Gibshman, Elena Kulagina, Paul Brenckle and John Groves are actively working on them. The regional stratigraphy, geochemistry and sedimentology of the GSSP candidate sections for the boundary are not well known. The Nashui and Kardailovka sections are being studied, and the two best Spanish sections will be studied in the near future.

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REPORT OF THE TASK GROUP TO ESTABLISH A GSSP CLOSE TO THE EXISTING BASHKIRIAN–MOSCOVIAN BOUNDARY

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Introduction

Members of this Task Group are conducting research at a variety of locations in Europe and Asia. Investigations focus mainly on evolutionary transitions in several conodont lineages, with fusulinid biostratigraphy providing auxiliary information. Salient work within the past year includes the following items:

1. International Field Meeting: "The Historical Type Sections, Proposed and Potential GSSPs of the Carboniferous in Russia"

This meeting was convened in Ufa—Sibai, 13–18 August, 2009. Proceedings are contained within two volumes, the first dealing with the geology and biostratigraphy of sections visited in the southern Urals, and the second comprising papers contributed at the conference on Carboniferous stratigraphy and paleontology.

A particularly relevant paper by Kulagina *et al.* (2009) addresses the biostratigraphy of the Basu section (South Urals) with emphasis on the Bashkirian-Moscovian boundary. The authors provisionally place the boundary, and that of the Solontsian Horizon, 0.9 m above the base of the section coincident with the appearance of *Depratina* [= *Profusulinella*] *prisca*. The appearance of *Aljutovella aljutovica*, an operational index to the base of the Moscovian Stage in many areas, occurs 28.8 m above the base of the section. Uppermost Bashkirian strata and basal Moscovian strata contain *Declinognathodus marginodosus*. The appearance of *D. donetzianus* is 6.2 m above the base of the section, about 5.3 m above the appearance of *D. prisca*. A more detailed account of recent work by Elena Kulagina and her colleagues is given under item 3.2, below.

A second important paper by Davydov (2009) summarizes fusulinid occurrences in the Bashkirian-Moscovian transition in the Donets Basin with proposed correlations to the Moscow Basin. Davydov follows Ueno and Nemyrovska (2008) in placing the base of the Moscovian Stage at the K_1 Limestone on the appearance of *Declinognathodus donetzianus*. He regards Limestones I_2^2, I_3 and I_4 as pre-Vereian in age, although those units contain certain fusulinids such as *Verella*? *transiens* that occur elsewhere in Moscovian strata. Further, Limestones K_1–K_3 most likely correlate with the Aljutovo and Sknigov formations of the Moscovian type area in the Moscow Basin. Davydov suggests that the appearances of *Paraeofusulina* and *Eofusulina* are potential markers for the base of the Moscovian in Tethyan regions.

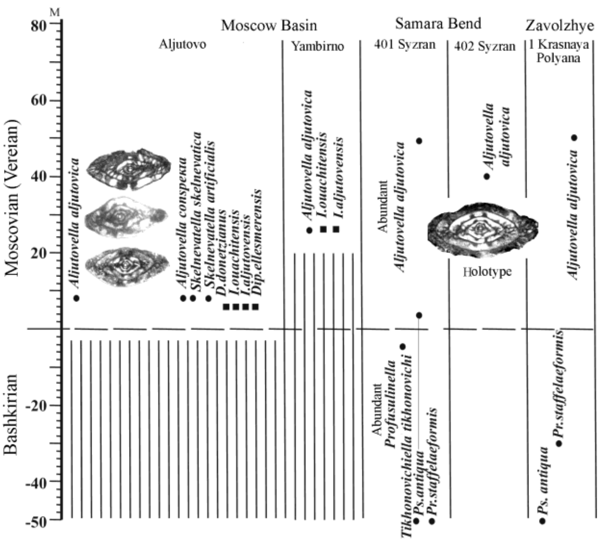
2. South China

Qi Yuping and Lance Lambert report elsewhere in this issue on their analyses of conodonts from the Nashui section in Guizhou Province, China. Briefly, they have established that conodonts are abundant and diverse in practically every sample from the lower slope carbonates of the Bashkirian-Moscovian boundary interval at Nashui. This 20 m interval can be subdivided into four biozones. Several evolutionary events offer potential for boundary characterization, including the appearances of *Diplognathodus ellesmerensis* and *Neognathodus atokaensis*, and chronoclines within *Declinognathodus*, *Idiognathoides*, *Idiognathodus*, *Gondolella*, *Mesogondolella* and *Streptognathodus* s.l.

3. Urals

R. M. Ivanova (2008) recently published a beautifully illustrated monograph on fusulinids (and calcareous algae) of the Bashkirian and Moscovian stages in the Urals. This volume now represents the most up-to-date summary of fusulinid species-level occurrences and zonal stratigraphy for Middle Carboniferous rocks in a belt extending from Pechora in the north to Aktyubinsk in the south. The author places the base of the Moscovian Stage throughout the Urals at the base of the *Depratina* [= *Profusulinella*] *prisca—Aljutovella aljutovica* Zone, although occurrences of *D. prisca* are reported from the upper part of the uppermost Bashkirian Asataussky Horizon.

E. I. Kulagina, V. N. Pazukhin, N. V. Goreva, T. N. Isakova, A. S. Alekseev, V. B. Panfilova, O. P. Nikulina and E. A. Krylova recently completed a study that addresses correlation of the Bashkirian-Moscovian boundary between the Russian Platform and the South Urals. An excerpt of their findings is given in the following paragraphs.



The Bashkirian-Moscovian boundary beds have been examined in the South Urals (Askyn, Basu), boreholes in the Bashkirian Cis-Uralia and the Orenburg Region, type sections in the Moscow Basin (Aljutovo, Yambirno Quarry) (Makhlina *et al.* 2001), and also boreholes in the Samara Bend and Zavolzhye in the eastern Russian Platform (boreholes 401 Syzran, 402 Syzran, 1 Krasnaya Polyana) (Rauser-Chernousova 1938; Reitlinger 1961). Figures 1 (from Kulagina *et al.* 2009) and 2 summarize occurrences of the key conodonts *Declinognathodus donetzianus* and *Diplognathodus ellesmerensis* and the foraminifers *Aljutovella aljutovica, Skelnevatella skelnevatica* and *Depratina prisca* in relation to the traditional base of the Vereian Substage in the Russian platform and the South Urals.

Data from Russian Platform and South Urals sections show that the basal Vereian can be characterized by the appearance of *Aljutovella aljutovica*. This datum occurs at a depth of 551 m in the borehole 402 Syzran (Rauser-Chernousova 1938). The Vereian Substage extends upward to 489 m. The holotype of *Aljutovella aljutovica* was described from this well in the interval 508–511 m, 40 m above the traditional boundary.

Abundant *A. aljutovica* occur in the 401- and 402-Syzran boreholes 40-50 m above the Bashkirian-Moscovian boundary. The level with abundant *Aljutovella* in the Ajutovo section (2.75 m above boundary) corresponds to a similar level in the Samara Bend and in the upper Solontsyan in the South Urals (beds 35-37 of the Askyn section). The appearance of *Declinognathodus donetzianus* in the Basu section occurs in the lower Solontsyan within the *Depratina prisca* Zone (Kulagina *et al.* 2009).

Plans for late 2010

This Task Group will participate along with other SCCS Task Groups in a workshop and field excursion in November, 2010, organized and hosted by Wang Xiangdong and colleagues with the Nanjing Institute of Geology and Palaeontology.

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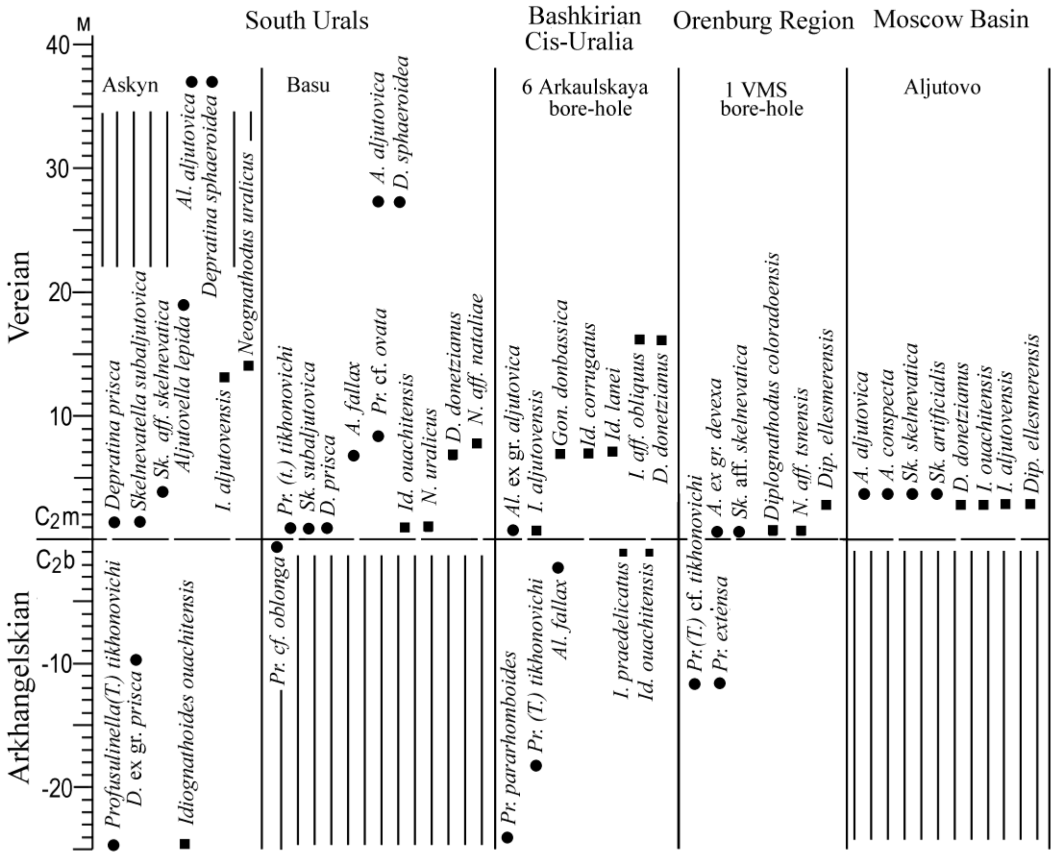

REPORT OF THE TASK GROUP TO ESTABLISH THE MOSCOVIAN–KASIMOVIAN AND KASIMOVIAN–GZHELIAN BOUNDARIES

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General activities

In August 2009, the I.U.G.S. Subcommission on Carboniferous Stratigraphy held an international field meeting in the Moscow Basin and the southern Urals of Russia, in order to examine several historical type sections and proposed and potential GSSPs of the Russian Carboniferous. This meeting was organized by colleagues mainly from Moscow and Ufa, including our task group members Alexander S. Alekseev, Natalia V. Goreva, Tatiana I. Isakova, and Olga L. Kossovaya. In addition to these Russian organizers, Qi Yuping and Katsumi Ueno participated in this field meeting from the task group. The visited sections that are intimately related to our task group activity are the Domodedovo and Gzhel sections in the Moscow Basin and the Usolka and Dalniy Tyulkas sections in the southern Urals. The Afanasievo section in the "Voskresenskcement" Quarry in the southeastern part of the Moscow Basin, which is now regarded as the neostratotype of the regional Kasimovian stage (Goreva *et al.*, 2009a), was originally planned to be visited, but unfortunately it was skipped due to difficulties in getting permission from the quarry company.

In the Moscow Basin, we examined the upper Moscovian-basal Kasimovian succession of the Domodedovo section and the lower Gzhelian succession of the classic Gzhel section. The former is the neostratotype of the regional Moscovian stage and Myachkovian substage, and the latter is the stratotype of the regional Gzhelian stage (Goreva *et al*., 2009b; Alekseev *et al*., 2009). They consist essentially of shallow-marine carbonate-, marl, and shale-dominated strata separated by subaerial exposure surfaces. These features demonstrate strong genetic control of high-frequency eustatic sea-level changes over the sedimentation of these strata. Fossils, particularly conodonts, fusulines, corals, and brachiopods are abundant, and their stratigraphic occurrences have been documented in detail. When considering the availability of these sections as GSSP candidates for the bases of relevant stages, however, the main problem would be the presence of frequent sedimentary gaps.

In the southern Urals, the Usolka section was visited to investigate the usefulness of this section as a base-Gzhelian GSSP candidate. To date, this is the only section that has been proposed formally as a potential candidate for GSSP to define the base of the Gzhelian stage (Chernykh *et al*., 2006). Later, Davydov *et al.* (2008) documented detailed faunal assemblage and correlation of the Kasimovian-Gzhelian transition in this section. Unfortunately, the Kasimovian-Gzhelian boundary interval of the Usolka section is now largely concealed by soil and vegetation. Thus, additional excavation is needed to re-expose the entire succession and inspect the results reported by Chernykh *et al.* (2006) and Davydov *et al.* (2008). The Dalniy Tyulkas section, located several kilometers south of the Usolka section, is a composite section consisting of three discrete localities (Dalniy Tyulkas 1, 2, and 3) and ranges from the upper Moscovian to the Artinskian. It represents a deeper-water succession with abundant conodonts. Of the three localities, Dalniy Tyulkas 1 covers an upper Moscovian-basal Kasimovian interval. Alekseev, Goreva, and others are studying the conodont succession in this section (work in progress). They recognized the *Streptognathodus subexcelsus* and *Swadelina makhlinae* assemblages in the upper part of this section. These assemblages are characteristic of the Suvorovo and Voskresensk formations of the regional Krevyakinian substage, respectively, in the Moscow Basin (Goreva *et al*., 2009a), and Dalniy Tyulkas 1 is the first section outside the Moscow Basin where these two lower Kasimovian conodont zones have been recognized. Dalniy Tyulkas 2 is an upper Moscovian-lower Gzhelian section, and conodonts were reported earlier by Chernykh and Reshetkova (1987). Alekseev, Goreva, and others are now reinvestigating its conodont succession (work in progress). In the middle part of this section, they found *Idiognathodus sagittalis*, one of the species that have been chosen by the task group members as a potential biostratigraphic marker by which the level of the base of the Kasimovian stage can be selected and correlated globally (Villa and Task Group, 2008; Ueno and Task Group, 2009). Moreover, Alekseev, Goreva, and others also discovered *Idiognathodus eudoraensis* Barrick, Heckel and Boardman 2008 and *I. simulator* in the upper part of the section; the latter is the event marker for the base of the global Gzhelian stage, and the former is considered as the probable ancestor of the latter (Heckel *et al*., 2008). Overall, the Dalniy Tyulkas (composite) sections seem to be promising candidates for both Moscovian-Kasimovian and Kasimovian-Gzhelian boundary stratotypes. Further detailed investigation by these Russian colleagues is underway.

Progress reports from members

South China. James E. Barrick and Qi Yuping collaborated in examining existing and new collections of conodonts from the Nashui section of southern Guizhou, China (Wang and Qi, 2003). Review of these specimens allows better recognition of the approximate positions of the Moscovian-Kasimovian and Kasimovian-Gzhelian stage boundaries. In this section, latest Moscovian conodont faunas are characterized by abundant *Swadelina* and a few *Idiognathodus*. The base of the Kasimovian is marked by the disappearance of *Swadelina* and appearance of *Idiognathodus* morphotypes of the *I. swadei*-*I. sagittalis* group, including at least one form (Wang and Qi, 2003, pl. 4, fig. 21) that may be the early Missourian species *I. turbatus* Rosscoe and Barrick 2009. Overlying Kasimovian conodonts include, in ascending order, the *Streptognathodus guizhouensis*, *Idiognathodus magnificus*? and *Streptognathodus excelsus* faunas. Uppermost Kasimovian strata are characterized by morphotypes of *Idiognathodus (I. praenuntius*?, *I. eudoraensis*?) that appear to be transitional to *I. simulator*. The base of the Gzhelian can be identified by the appearance of *I. simulator*, *I. auritus*, and rare *I. sinistrum*. The distinctive genus *Solkagnathus*, described from the Gzhelian in the Urals (Chernykh, 2005), appears with *I. simulator*. The *Idiognathodus nashuiensis* fauna occurs slightly higher in the Gzhelian, and is followed by the middle Gzhelian *Streptognathodus vitali* fauna.

Russia. In addition to the preparation and organization of the International Field Meeting, Alexander S. Alekseev, Natalia V. Goreva, Tatiana I. Isakova, and Olga L. Kossovaya recently studied materials collected in 1994 from the Stsherbatovka section in the Oka-Tsna Swell of Ryazan Region, east of the town of Kasimov on the left bank of Oka River. The section is located in an old quarry, which has been closed for many years, and so most of the walls are now covered by talus. In 1994, the lowermost part of the section was visible in a small trench in the bottom of the quarry. The middle part of the Neverovo Formation (Khamovnikian substage), consisting of marls and shales with limestone intercalations, contains abundant macrofauna. In this part, conodonts are not very common and most of their elements are juveniles, but they belong to the *Idiognathodus sagittalis-I. turbatus* group. *Idiognathodus sulciferus* was also identified there. Earlier, this interval was correlated with the Krevyakinian *Obsoletes obsoletus* Zone by fusulines, but these conodonts suggest a younger age. The Stsherbatovka section (about 250 km southeast of the Afanasievo section in the Moscow Basin) demonstrates a wider distribution of the complex of marker conodont species for the base of the Kasimovian.

Moreover, with the help of Aleksey Reimers and Yuliya Ermakova, Alekseev and others studied an important Gzhelian-Asselian reference section at Yablonovyy Ovrag in the Samara Bend of the Volga River, about 800 km ESE of Moscow. In this section, they found *Idiognathodus simulator* in the interval that has been traditionally considered as the base of the Gzhelian Stage by fusulines. This occurrence is important because it fills a geographical gap in the distribution of *I. simulator* between the Moscow Basin and the southern Urals, and reinforces the importance of this conodont taxon for the definition of the base of the Gzhelian Stage.

Ukraine. Recently, Vladimir I. Davydov and his colleagues published data on high-precision U-Pb ages of tuffs and tonsteins, with an age resolution of ~100 ka, to radiometrically calibrate the detailed lithostratigraphic, cyclostratigraphic, and biostratigraphic frameworks of the Donets Basin, Ukraine (Davydov *et al*., 2010). Based on this precision, they confirmed the long-standing hypothesis that individual high-frequency Pennsylvanian cyclothems and bundling of cyclothems into four-order sequences are the eustatic response to the orbital eccentricity (~100 and 400 ka) forcing within the Milankovitch Band. This facilitates more precise cyclostratigraphic calibration for the Moscovian-Gzhelian interval of the Donets Basin.

Coming steps

In November 2010, our task group is planning to have a workshop at the Nanjing Institute of Geology and Palaeontology, China, which will be organized by Prof. Wang Xiangdong and SCCS boundary task group chairs. It will be a joint workshop with other Carboniferous boundary task groups and provide good opportunity to compare specimens from relevant areas of the world. Particularly, participants will have the chance to examine closely conodont specimens from the Nashui section of South China, which is one of the most complete and continuous carbonate-slope sections over the entire Carboniferous in South China. In this workshop, an excursion to southern Guizhou Province of South China is also planned, in order to see several Carboniferous sections that formed on the Yangtze carbonate platform, some of which might have potential to be GSSP candidates for the global Carboniferous chronostratigraphic scale.

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REPORT ON I.U.G.S. INTERNATIONAL CARBONIFEROUS SUBCOMMISSION: FIELD MEETING "THE HISTORICAL TYPE SECTIONS, PROPOSED AND POTENTIAL GSSP OF THE CARBONIFEROUS IN RUSSIA"

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On August 11--18, 2009 a field meeting of the International Subcommission on Carboniferous Stratigraphy was for the first time held in Russia. The International stratigraphic scale (ISS) of the Carboniferous System subdivided into subsystems, series and stages was ratified by the International Union of Geological Sciences in 2004, but the boundary choices for most stages still remain unresolved. The importance of the meeting was emphasized by the fact that, of seven Carboniferous stages, five have been erected in Russia. However, their boundaries (except for the base of the Bashkirian) are not yet fixed, and their GSSP are not yet chosen. The task of the Russian specialists was, in the course of the excursions, to show the members of the Subcommission the type sections of stages included in the global scale of the Carboniferous as well as the sections proposed as stratotypes for some Carboniferous boundaries. This was preceded by long-term detailed comprehensive studies of Carboniferous sections in the framework of research projects of Russian geological institutions and of the Russian Foundation for Basic Research. The meeting was designed to show the results of research work of Russian specialists obtained while developing the ISS.

The meeting was organized by the leading institutions of the Russian Academy of Sciences: A.A. Borissiak Paleontological Institute, Institute of Geology of the Ufa Research Center, Geological Institute, and the A.P. Karpinsky All-Russian Research Geological Institute, and the Moscow State University. The executive committee included A.S. Alekseev (A.A. Borissiak Paleontological Institute, Russian Academy of Sciences, Moscow State University, Moscow), V.N. Puchkov, E.I. Kulagina, V.N. Pazukhin (Institute of Geology, Ufa Research Center, Russian Academy of Sciences, Ufa), N.V. Goreva (Geological Institute, Russian Academy of Sciences, Moscow), S.V. Nikolaeva, V.A. Konovalova (A.A. Borissiak Paleontological Institute, Russian Academy of Sciences, Moscow), O.L. Kossovaya (A.P. Karpinsky All-Russian Research Geological Institute, St. Petersburg).

The meeting was attended by more than 50 specialists from 11 countries: Russia, Slovenia, UK, Ireland, Canada, USA, Israel, Japan, China, Uzbekistan, and Kazakhstan. These included eight (out of 21) voting members of the Subcommission: the Chairman B. Richards (Canada), Vice-Chairman Wang Xian-Dong (China), N.V. Goreva, O.L. Kossovaya, E.I. Kulagina, S.V. Nikolaeva (Russia), K. Ueno (Japan), Qi Yuping (China) (Figure 1).

The program included visits to the type sections of the Serpukhovian, Moscovian, Kasimovian, and Gzhelian stages of the Moscow Basin, the region of their original recognition, and other reference sections in Bashkortostan (South Urals), the type area of the Bashkirian Stage and the region where a number of sections can be used as standard for the boundaries within the Carboniferous. The meeting consisted of two parts. On August 11--12, two excursion were organized in the Moscow Basin. The participants were shown four sections in the interval from the upper part of the Viséan (Novogurovsky and Zaborie quarries) to the Upper Carboniferous (Domodedovo and Gzhel quarries). On August 13-19 the participants visited another 10 sections in the South Urals. One day was left entirely for a scientific session and discussion of proposed stratotypes. A detailed guide-book on the Carboniferous sections in the Moscow Basin (in English) was published specially for the excursion

(Alekseev and Goreva, 2009). The book contains descriptions and biostratigraphic characterization of the type and reference sections of the Serpukhovian, Moscovian, Kasimovian and Gzhelian stages. A guide-book on the South Uralian sections shown to the participants and expanded abstracts of the talks presented at the scientific session were also published for the field trip (Puchkov, 2009).

The base of the Serpukhovian was the major topic of the field meeting. The definition of the base of the Serpukhovian has been identified by the Subcommission as a high priority task, and an International Working Group was organized specially in 2002 to explore all possible boundary choices (Richards *et al.*, 2007). The Serpukhovian Stage was first established in the Moscow Basin by S.N. Nikitin in 1890. Its lectostratotype is the section in the Zaborie Quarry in the southern vicinity of the town of Serpukhov. The Serpukhovian in its type area is composed of limestones with diverse fossils including algae, foraminifers, bryozoans, brachiopods, crinoids, gastropods, many fish remains, and conodonts. Another reference section of the Serpukhovian is in the Novogurovsky Quarry in the Tula Region exposing Viséan and Serpukhovian limestones. This is the only section in which it is possible to observe an almost complete succession from the Aleksinian (Viséan) to the Protvian (Serpukhovian). During the excursion in the Novogurovsky Quarry, the participants could observe major lithological types and cyclicity of the Lower Carboniferous in the Moscow Basin. Paleozoic boundaries are largely defined based on conodonts as these were marine organisms of wide geographic distribution and were not strongly facies biased, but at the same time had a high evolutionary rates. Most specialists agreed that the first evolutionary appearance of the conodont species *Lochriea ziegleri* Nemirovskaya *et al.* is the boundary marker of the highest correlative potential in the Visean-Serpukhovian transition beds. In the Moscow Basin, including the Novogurovsky Quarry, *Lochriea ziegleri* enters in the middle of the Venevian (uppermost Viséan). In addition, it was possible to visit the Zaborie Quarry (lectostratotype of the Serpukhovian Stage), where at present only the upper beds of the Steshevian and the lower Protvian are available for study.

In the South Urals, the main locality to show was the Verkhnyaya Kardailovka section located south of the town of Sibai (on the west bank of the Ural River) because this section had been proposed for a GSSP candidate of the base of the Serpukhovian. The Serpukhovian is here represented completely by relatively deep-water facies, in a condensed section (total thickness 37 m). The Viséan-Serpukhovian boundary beds contain a rich fossil assemblage, including conodonts, ammonoids, foraminifers, ostracods, radiolarians, and rugose corals. In recent years new data have been received on the distribution of the fauna in the boundary deposits. The covered intervals of the section were opened in trenches to expose a complete succession of the Upper Viséan and Serpukhovian conodonts in one section and to define the boundary by stratigraphically important taxa of ammonoids and foraminifers. The participants appreciated the GSSP potential of this section, but the exposed and trenched part of the upper Viséan is only 3 m thick, which is considered insufficient for a GSSP stratotype. During the excursion, the participants managed to open another three meters of limestones but the underlying sandy-siliceous-tuff member was not opened. In 2010 the excavating of the section will be continued and the section will be sampled for microfacies (virtually every centimeter of thickness), and a sedimentary curve will be built and the sedimentary cycles will be identified.

The base of the Moscovian has also not been positively defined, three conodont species: *Declinognathodus donetzianus* Nemyrovska and Idiognathoides postsulcatus Nemyrovska, entering near the base of the Moscovian (Limestone K2) in the Donets Basin, and one of the morphotypes of *Neognathodus nataliae* Alekseev & Gerelzezeg from the Atokan of the USA.

The preliminary vote by the International Working Group on the base of the Moscovian resulted in the majority of votes going for the second species, but subsequent analysis showed that this species is understood differently by different paleontologists, that it is extremely uncommon and is not found in the Moscow Basin, whereas in Japan it is distributed beginning from the Lower Bashkirian. The species *D. donetzianus* described from the Moscovian of the Donets Basin present in the basal part of the Vereian of the Moscow Basin, type Moscovian region. However, in the type area this boundary cannot be positively fixed because here the Vereian overlies the older Carboniferous beds with a large gap. The South Urals, the type area of the Bashkirian Stage, is one of the best-studied regions in Russia, where continuous carbonate successions of the Bashkirian--Moscovian boundary beds are present. In these beds the conodont ranges were examined in a number of places, but the assemblages have their specific features, and *D. donetzianus* has been found in one section only, in a small quarry on the tight bank of the Basu River, which was shown to the participants. The significance of the Basu section is emphasized because it, apart from conodonts, contains foraminifers and brachiopods. In this section, *D. donetzianus* was found near the level of the first appearance of the fusulinid species *Depratina prisca* (Deprat), proposed by E.I. Kulagina as a marker for the base of the Moscovian. Another currently discussed proposal, of using another evolutionary lineage of conodonts, discussed *D. ellesmerensis* Bender as a definition of the base of the Moscovian. This lineage is traced in the Nasqin section in South China, which has been proposed as a possible GSSP for the base of the Moscovian, but this section contain no other fossils, except for conodonts, and most importantly lacks fusulinids.

No marker has been selected for the Moscovian-Kasimovian boundary because of the high degree of endemism of marine faunas of that time due to frequent periods of cooling and isolation of marine basins. The participants were shown a section in the Domodedovo Quarry, which is the neostratotype of the Moscovian Stage and its upper (Myachkovian) substage. The section raised a lot of interest primarily because of the rich shallow-water lithofacies, and the abundance of fauna. The program of the meeting included a planned visit to the section of the Afanasievo Quarry (Voskresensk District), which is the neostratotype of the Kasimovian Stage and was proposed as a possible GSSP for this stage. The section is rich in fossils (conodonts, fusulinids, brachiopods, corals, ostracodes, etc.) and is well-studied. However, the current owner of the quarry, the French company "Lafarge-Cement" refused access to this scientifically important section, providing no explanation. This is in contravention of the international convention of free access to objects proposed as standards for the international stratigraphic scale.

The Subcommission adopted a fundamental decision to fix the base of the Gzhelian at the level of first appearance of the conodont species *Idiognathodus simulator* (Ellison) close to fusulinid species *Rauserites rossicus* (Schellwien). This event is fixed in many regions, including the type Gzhelian section in the Moscow Basin in Gzhel, and in the deep-water Usolka section in Bashkortostan on the western slope of the South Urals. Because of this, the program of the Moscow part of the meeting included a visit to the type Gzhelian section where both these markers are present in a narrow interval above a large subaeral unconformity. In the Usolka section, which had been proposed by V.I. Davydov *et al.* as a GSSP for the Gzhelian Stage, this level is no longer exposed, and therefore the participants visited the neighboring section Dalniy Tyulkas 2, which belongs to the same facial zone. This section also contains *I. simulator*, but here this is within an olisthostrome horizon. The question about the stratotype choice is still unresolved, and probably the chosen stratotype will be in South China.

The well-known and detailed sections of the Devonian-Carboniferous boundary beds on the Sikaza and Zigan rivers on the western slope of the South Urals were also demonstrated to the participants because of the increasing interest due to the proposed replacement of the existing D-C boundary GSSP (section La Serre in Montagne-Noir, France). During the crossing of the Urals, the participants stopped to view the Kugarchi section subdivided on ammonoids, conodonts, and foraminifers. In this section, the Serpukhovian-Bashkirian boundary is recognized, although this part of the section is strongly dislocated. The sections of the eastern slope of the Urals (Khudolaz - stratotype section of the Uralian Carboniferous regional substages) and the Bolshoi Kizil section (Bashkirian bioherms). On August 17, a scientific session was held in the hotel "Zolotaya Yurta" in the town of Sibai. The session included 16 oral reports on a wide range of topics in the field of Carboniferous paleontology and stratigraphy and 11 posters. Principles of definition of stratigraphic boundaries, potential biomarkers, and event criteria for the recognition and substantiation of stage boundaries were discussed. The emphasis was on the presentations on Russian type and reference sections. Barry Richards, Subcommission Chairman, in his opening report, talked about the membership of the Subcommission and its major accomplishments in recent years, and outlined the new tasks. Apart from the GSSP choice for the Serpukhovian, Moscovian, Kasimovian, and Gzhelian stages, the need to reconsider the GSSP for the base of the Carboniferous and of the Bashkirian Stage became apparent. With regard to the D-C boundary, the conodont species *Siphonodella sulcata* (Huddle), index species marking the base of the Carboniferous appears considerably lower than the accepted boundary, in the beds, which contain redeposited material. The known taxonomic problem of distinguishing between *S. praesulcata* Sandberg and *S. sulcata* has become more acute because of the extremely high variability in this conodont group. A similar problem emerged with regard to the base of the Bashkirian (Mid-Carboniferous boundary), which is fixed in the shallow-water sequence in the Arrow Canyon Section (Nevada, USA). The conodont species *Declinognathodus noduliferus* s.l. (Ellison and Graves) used as a marker of this boundary is now found below the designated boundary level, which lies within a limestone member separated from the overlying and underlying beds by gaps and paleosols. A.S. Alekseev *et al.* talked about the state of knowledge on Carboniferous stratigraphy in Russia, gave an overview of as yet unresolved tasks (Gumerovian and the Devonian-Carboniferous boundary, Visimian in the Middle Tournaisian, base of the Serpukhovian, etc.). To the east of the Urals, the regional scales are considerably less detailed. The reports by M. Menning and D. Weyer (Germany), and M.A. Pointon *et al.* (Ireland) were on the numerical calibration of the Carboniferous time scale. K. Ueno gave a summary report of the Task Group to Establish the Moscovian-Kasimovian and Kasimovian-Gzhelian boundaries. V.N. Puchkov in his comprehensive report "Structure of the Urals (with special reference to the Carboniferous complexes)" summarized the existing data on the tectonic evolution of the area of the South Urals trip, which was very important for all participants. D.N. Salikhov reported on the Carboniferous volcanism of the Magnitogorsk-Bogdanovsk graben in the Southern Urals, which supplemented the general report of V.N. Puchkov. Two reports (E.I. Kulagina *et al.* and S.V. Nikolaeva *et al.*) were on the detailed characterization of the Lower Carboniferous of the South Urals. G.Yu. Ponomareva spoke about the present state and problems of the foraminiferal scale of the upper Viséan and Serpukhovian, based on the Western Urals. M.R. Hecker presented a detailed review of major guide taxa for correlation of the Moscow and Donets Basins Dinantian successions with the type area (Belgium). N.V. Goreva *et al.* reported on the comprehensive characterization of the stratotype of the Gzhelian Stage (Upper Carboniferous) in Moscow Basin, Russia. M. Ichida (Japan) spoke about Bashkirian to Artinskian fusulinids of a lost carbonate platform in the Jurassic accretionary complex of Japan. M. Novak (Slovenia) and H.C. Forke (Germany) reported on the fusulinoidean biostratigraphy of the Upper Carboniferous (Gzhelian) mixed carbonate-siliciclastic ramp deposits in the Karavanke Mts. (Southern Alps, Slovenia). Two short reports were presented by Gary Webster on behalf of his coauthors. These reports were on early Permian crinoids from British Columbia and Early Pennsylvanian echinoderms from eastern Iran. The poster session included reports by M.S. Afanasieva and E.O. Amon "The role of radiolarians in Carboniferous stratigraphy", M.S. Afanasieva, L.I. Kononova "Late Tournaisian radiolarians and conodonts from the Orenburg Region", M.T. Dean "Upper Viséan and lower Serpukhovian conodonts from the Lower and Upper Limestone formations of central Scotland and the Bowland Shale Formation, Craven Basin, England, UK", H.-G. Herbig "Sphinctozoan habitats in the Pennsylvanian platform carbonates of the Cantabrian Mountains (Spain)", O.L. Kossovaya "Some Middle Carboniferous Rugosa from the Southern Urals", E.I. Kulagina *et al.*, "Serpukhovian and Bashkirian bioherm facies of the Kizil Formation in the South Urals", T.I. Stepanova and N.A. Kucheva "Palaeontological substantiation of the horizons of the Serpukhovian stage of the Eastern-Uralian subregion in the stratotype section on the Khudolaz River", O. Orlov-Labkovsky (Israel) "The Viséan /Serpukhovian boundary and foraminifers in the Middle Tien-Shan", V.N. Pazukhin *et al.* "Devonian and Carboniferous boundary on the western slope of the Southern Urals", Qi Yuping *et al.* (China) "Conodont biostratigraphy of the Nashui Section, South China: proposed GSSP for the base of the Serpukhovian and Moscovian Stages."

The participants noted the generally high level of the detailed and comprehensive studies conducted by Russian geologists on type sections and potential GSSPs. It was noted in the discussion that the Verkhnyaya Kardailovka section should be re-examined. It is also necessary to examine the morphological diversity of conodonts of the genus *Lochriea*, because the identification criteria of the species of this genus were shown to be unclear, which prevents precise recognition of the base of the Serpukhovian. With the prospect of the re-consideration of the Mid-Carboniferous boundary, it is becoming important to search for new complete sections, for instance in Uzbekistan and Tajikistan.

The Chinese members of the Subcommission proposed to hold a joint meeting in Nanjing in November 2010 of working groups on the Carboniferous Stage boundaries, because many specialists work simultaneously in several groups. Apparently the meeting will focus on viewing of Chinese sections, primarily the Naqing (Nashui) Section. Russian scientists should by that time have re-examined the proposed and potential GSSPs on the Russian territory in order to approach solutions to previously unresolved problems.

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Figure 1: Participants of the Field meeting of the International Carboniferous Subcommission, South Urals, August 2009

CONTRIBUTIONS BY MEMBERS

(Views and interpretations expressed / presented in contributions by members are those of individual authors / co-authors and are not necessarily those of the SCCS and carry no formal SCCS endorsement.)

CARBONIFEROUS-PERMIAN TRANSITION IN NONMARINE REDS BEDS, CANON DEL CORBRE, NORTHERN NEW MEXICO, USA

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Cañon del Cobre is a large box canyon in southeastern Rio Arriba County, New Mexico, USA, along the southeastern border of the Colorado Plateau. The main portion of the canyon is a complexly faulted valley with extensive exposures of the El Cobre Canyon Formation and overlying Arroyo del Agua Formation of the Carboniferous-Permian Cutler Group (Lucas and Krainer, 2005). These Cutler Group siliciclastic red beds were deposited by syntectonic fluvial systems in relatively upland and inland settings along the southern flank of the Uncompahgre uplift of the ancestral Rocky Mountains.

Cañon del Cobre is a rare example of a locality where the Carboniferous-Permian transition is recorded in a succession of nonmarine red beds in which little facies change and no obvious unconformity (hiatus) corresponds to the System boundary. A recently published volume (Lucas *et al.*, 2010) documents geological and paleontological research in Cañon del Cobre, most of which took place during the last decade as a collaborative project coordinated by the New Mexico Museum of Natural History and Science in conjunction with the National Museum of Natural History (Smithsonian Institution), Carnegie Museum of Natural History, Freiberg Academy and Innsbruck University. This research uncovered numerous new fossils in the canyon, especially invertebrate traces, palynomorphs, megafossil plants and vertebrates. Some of these fossils have provided the basis for reasonably certain (but not exact) placement of the Carboniferous-Permian boundary in the red-bed section exposed at Cañon del Cobre (Figure 1). Also, these fossils and their enclosing sediments document relatively little biotic change across the system boundary. Here, we summarize some of the trends across the Carboniferous-Permian boundary evident in Cañon del Cobre.

Megafossil plants, palynomorphs and fossil vertebrates indicate that the Pennsylvanian-Permian boundary (slightly younger than the Virgilian-Wolfcampian boundary) is stratigraphically high in the El Cobre Canyon Formation in Cañon del Cobre, though the exact position of the boundary is not certain (Figure 1). The fossil record of the Carboniferous-Permian transition in Cañon del Cobre is more extensive for the Pennsylvanian portion of the section than for the Early Permian (Figure 1). Fortunately, a diverse Early Permian record of plants and vertebrates is known from the upper part of the El Cobre Canyon Formation at Arroyo del Agua, about 25 km southwest of Cañon del Cobre (e.g., DiMichele and Chaney, 2005; Lucas *et al*., 2005). Using the Arroyo del Agua record to enhance the Early Permian record, the following trends (or lack of trends) are evident across the Carboniferous-Permian boundary at Cañon del Cobre:

1. There is a change in the architecture of the fluvially-deposited red beds from braided systems of the Pennsylvanian (Virgilian) to more laterally extensive floodplains (with mature caliches) of the Early Permian (Wolfcampian). Eberth and Miall (1991) attributed this change to increasing aridity. The presence of a thick section of eolianites at the base of the Yeso Group (DeChelly Sandstone) conformably overlying the Arroyo del Agua Formation in the Arroyo del Agua area is evidence of even increased aridity by approximately the beginning of Leonardian time.
2. The paleoflora declines in diversity from the Pennsylvanian to the Permian (though the species pool for both time periods is substantially unchanged), a trend also seen in the co-eval north Texas section (DiMichele and Chaney, 2005).
3. As shown by Roscher and Schneider (2006), the generally increasing aridity during the Permian reflects a cyclical sequence of wet and dry phases in which each subsequent phase progressively becomes dryer. Therefore, the paleoflora of the red beds in Cañon del Cobre is very similar in composition to the paleofloras of the Late Pennsylvanian gray facies, particularly of the Virgilian/Gzhelian. During the Late Pennsylvanian-Early Permian, each successive paleoflora in the Euramerican paleo-equatorial belt was increasingly dominated by mesophilous and xerophilous elements, especially by an increase in conifers ("walchians"). The rarity of walchians in the Pennsylvanian red beds of Cañon del Cobre points to a relatively wet-subhumid to perhaps dry-subhumid climate, most similar to the wet red beds of the European Stephanian B (Roscher and Schneider, 2005, 2006).

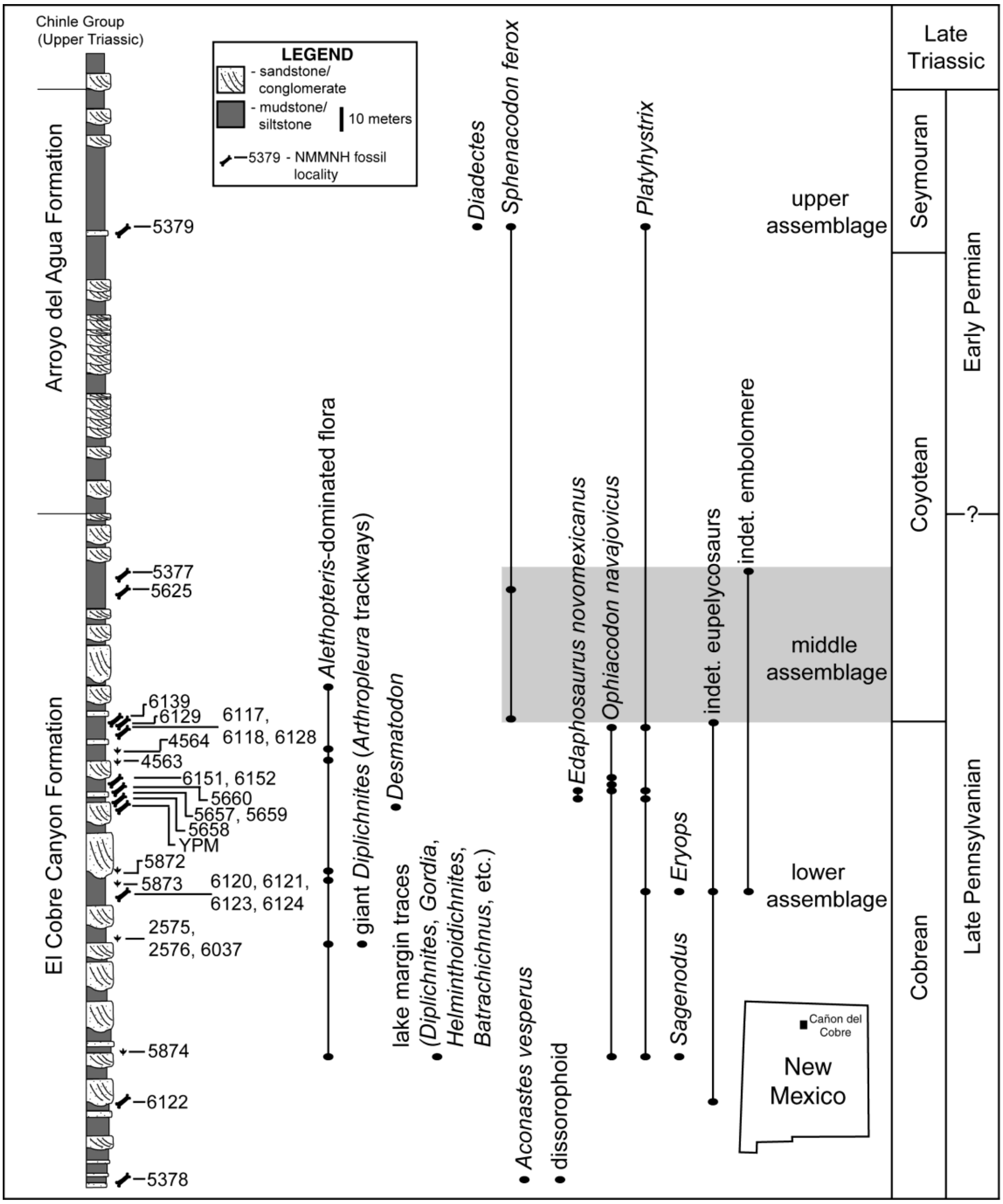

Figure 1: Composite lithostratigraphic section in Cañon del Cobre, showing distribution of fossil localities (numbers are localities of the New Mexico Museum of Natural History and Science) and taxa. Timsecale on right is land-vertebrate faunachrons correlated to Pennsylvanian-Permian boundary after Lucas (2006).

4. The terrestrial tetrapod assemblages remain substantially unchanged from Late Pennsylvanian to Early Permian -- they represent what can be termed the Coyotean chronofauna dominated by eryopid temnospondyls, diadectomorphs and sphenacodontid pelycosaurs (Lucas, 2006).

The red-bed succession across the Carboniferous-Permian boundary in Cañon del Cobre thus documents increasing aridity that caused a slight drop in paleofloral diversity and a change in composition to a more conifer-dominated paleoflora. These changes, however, are not mirrored by tetrapod assemblages, which do not change substantially across the Carboniferous-Permian boundary.

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STAUS REPORT ON CONODONTS FROM THE BASHKIRIAN-MOSCOVIAN BOUNDARY INTERVAL AT THE NAQING (NASHUI) SECTION, SOUTH CHINA

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Introduction

The type area of the Moscovian Stage in the Moscow Basin is characterized in most places by an unconformity between uppermost Bashkirian strata that lack marine fossils and basal Moscovian strata. Accordingly, the search for a lower Moscovian GSSP must extend away from the traditional reference area (Groves and Task Group, 2003). Currently, richly fossiliferous and relatively complete successions across the Bashkirian-Moscovian boundary are known from the Cantabrian Mountains (Spain), the Donets Basin (Ukraine), the southern Ural Mountains (Russia) and in southern Guizhou Province, South China (Wang and Jin, 2005).

Conodonts and fusulinid foraminifers are the two most widely utilized biotic groups for subdividing and correlating Bashkirian and Moscovian strata. Among fusulinids, lineages within *Profusulinella*, from *Profusulinella* to *Aljutovella*, from *Pseudostaffella* to *Neostaffella*, and from *Verella* to *Eofusulina* are important in the Bashkirian-Moscovian boundary interval. However, it is clear that fusulinids were too provincial to be useful for precise intercontinental biostratigraphic correlations (Groves and Task Group, 2003, 2005; Qi, 2008; Qi *et al.*, 2009).

The IUGS-SCCS Task Group to establish a GSSP close to the existing Bashkirian-Moscovian Boundary was formed in mid-2002 with an initial membership of 18 specialists representing 12 countries (Groves and Task Group, 2003). They have analyzed several conodont lineages that have been considered particularly promising for defining a lower Moscovian boundary. Those potential definitions are based on the evolutionary transitions from *Idiognathoides sulcatus* to *I. postsulcatus*, *Declinognathodus marginodosus* to *D. donetzianus*, early to late morphotypes of *Neognathodus nataliae*, and *Diplognathodus coloradoensis to D. ellesmerensis*. Each of these proposed lineages has both advantages and drawbacks to providing the basal Moscovian Stage definition.

Review of potential basal Moscovian boundary definitions

The appearance of *Idiognathoides postsulcatus* may be a good marker for the Bashkirian-Moscovian boundary in the Donets Basin, Ukraine, and Moscow Basin areas. But it cannot be considered a reliable marker beyond those areas for several reasons. The major problem is that its first appearance is diachronous from region to region (Groves and Task Group, 2006). Furthermore, *I. postsulcatus* is less widespread than *I. sulcatus sulcatus*, and it does not occur in cratonic North America. The species is also very difficult to differentiate from *I. sulcatus sulcatus* because their morphologies are very similar. In the Naqing section *I. postsulcatus* ranges up from at least the *Streptognathodus expansus* Zone, and it co-occurs abundantly with *I. sulcatus sulcatus*.

Like *Idiognathoides postsulcatus*, the first occurrence of *Declinognathodus donetzianus* may be a good basal Moscovian marker in the Donets and Moscow basins, and the southern Ural Mountains (Nemyrovska, 1999; Makhlina *et al*., 2001; Pazukhin *et al*., 2006). The geographic distribution and stratigraphic level of its appearance closely tracks the

Profusulinella–Aljutovella fusulinid transition. (Groves and Task Group, 2005, 2006, 2009). However, *D. donetzianus* has not been reported from other areas despite its distinctive morphology. Note that in the South Urals *D. marginodosus* is very common, whereas *D. donetzianus* is quite rare. In the Naqing section, *D. marginodosus* is also very abundant, but *D. donetzianus* has not been recovered among the rich conodont faunas. Similarly, the Arbuckle Mountains of Oklahoma, USA produce abundant *D. marginodosus* specimens, but *D. donetzianus* has not been reported (Grayson, 1984; Groves and Task Group, 2006).

The evolutionary transition from early to late morphotypes of *Neognathodus nataliae* has also been proposed to mark the basal Moscovian Stage. That transition is gradual and complete in North America, and *N. nataliae* also occurs in the Donets Basin of Ukraine and Moscow Basin of Russia. The transition could not be recognized in the Naqing section because *Neognathodus* is relatively rare, although *N. nataliae* has been found in several samples. The taxonomic concepts of *N. nataliae* are unsettled, primarily because there are significant differences in the stratigraphic range of various *Neognathodus* species between North America and Eurasia. Thus a distinctive first occurrence for the “late form” of *N. nataliae* cannot be confirmed in areas of the world other than North America.

A final potential marker under consideration is the evolutionary first occurrence of *Diplognathodus ellesmerensis*. At present the first appearance of *D. ellesmerensis* is tentatively considered to be the best conodont marker for the Bashkirian-Moscovian boundary in the Naqing section. There, the first occurrence of *D. ellesmerensis* is roughly associated with the appearance of other characteristic species such as *Neognathodus atokaensis* that have been used to mark the base of the Moscovian Stage. However, there are three problems with *D. ellesmerensis* as a GSSP definition: 1) *D. ellesmerensis* occurs sporadically in most localities; 2) evolutionary relationships among *Diplognathodus* species are not adequately known; and 3) most specimens of *D. ellesmerensis* (as well as all other *Diplognathodus* species) seem to be juvenile morphologies, with large, fully developed adult specimens being exceedingly rare. Nevertheless, conodont specialists agree that the appearance of *D. ellesmerensis* in most areas coincides with the early Moscovian.

Overview of the Naqing Section, South China

The discussion above indicates that either a less than satisfactory definition can be established based on the conodonts in one region—with workers in other areas forced to cope as best they can, or that other potential boundary definitions should be investigated. The characteristics of the Bashkirian-Moscovian boundary interval in the Naqing section enhance the chances of success for the latter approach.

The Naqing section, which was formerly known as the Nashui section, represents a platform margin to slope depositional setting. The Carboniferous part of the section is comprised of continuous carbonate deposits from the upper Viséan through Gzhelian stages. Conodonts are abundant through most of the section, and allocthonous flow deposits contain many fusulinid and non-fusulinid foraminifers. These characteristics help make the Naqing section ideal for correlations between shallow and deeper water facies. That potential is strengthened by two newly discovered sections nearby that include the Bashkirian-Moscovian boundary interval: One is the Dongjiacun section, comprised of upper-slope to platform-edge deposits with relatively abundant fusulinid and non-fusulinid foraminifers, and the other is the Zhongqingcun section, comprised of coarse-grained platform limestones with abundant foraminifers.

The stratigraphic succession in the Bashkirian-Moscovian boundary interval at Naqing consists mainly of gray thin- to medium-bedded lime wackestones and packstones intercalated with chert beds. These beds dip at 60~70 degrees, and are easily accessible along an extended road cut. Conodonts are very abundant in the boundary interval, with over 31 species representing 9 genera. All of the numerous samples that have been collected have produced conodonts.

Four conodont zones are currently recognized in the Bashkirian-Moscovian boundary interval. In ascending order they are the *Streptognathodus expansus*, *Diplognathodus coloradoensis*, *D. ellesmerensis*, and *Mesogondolella donbassica-M. clarki* zones, which cover a stratigraphic interval of about 20 meters (from 163.1 to 183.6 meters). Qi *et al.* (2007) proposed a provisional definition for the base of the Moscovian Stage at the FAD of *D. ellesmerensis* at 173.0 m above the base of the Naqing section. This boundary approximately coincides with the entry of the fusulinid *Profusulinella* (Qi, 2008; Qi *et al*., 2007, 2009). *D. ellesmerensis* had a cosmopolitan distribution, is easily identified, and has a restricted and well-defined stratigraphic range as discussed above (Grayson 1984; Nemyrovska, 1999; Nemyrovska *et al*., 1999; Makhlina *et al*, 2001; Groves and Task Group, 2006; Qi *et al*., 2007; Qi, 2008). Therefore, at present the first occurrence of *D. ellesmerensis* is the best marker to bracket the Bashkirian-Moscovian boundary in the Naqing section, and it denotes the middle of the strata we are intensively studying. Also noteworthy is the first definite occurrence of *Neognathodus atokaensis* at 183.55 meters. The fusulinid *Eofusulina* has been recovered just below, at 183.45 meters (Groves and Task Group, 2009). Both taxa are considered in current task group discussions as definite Moscovian indices. A single juvenile specimen may represent *N. atokaensis* as low as 176.9 meters.

Our work is ongoing, but our preliminary results are very encouraging. The Naqing section is so complete with abundant conodont faunas that we have found numerous transitions among several genera in the boundary interval. We are evaluating transitional forms in *Declinognathodus* and *Idiognathoides* at 168.1 and 176.9 meters in particular, but also at other horizons. *Idiognathodus* morphotypes also have numerous transitions in the sections, but the genus occurs irregularly until higher in the section, where a good transition occurs at 179.9 meters. Distinctive transitional morphologies in *Streptognathodus* sensu lato (not true Kasimovian *Streptognathodus*—e.g., Barrick and Boardman 1989; Lambert *et al*., 2002) occur at 165.0 and 171.5 meters, as well as less distinctive transitions at 171.8 meters and elsewhere. *Gondolella* similarly has numerous potential transitional horizons, with the most distinctive at 176.9 and 182.5 meters. *Mesogondolella* has a distinctive transition at 182.5 meters. Further analysis of *D. ellesmerensis* has shown that morphologic transition continues up through 176.9 meters, so there is still opportunity to use that taxon to define the basal Moscovian.

Future Work

Strong provincialism around Pangea means that it will not be easy to find a universally acceptable marker for the base of the global Moscovian Stage. However, the diverse conodont lineages with transitional morphologies in the Naqing section of South China should increase the chance of finding a suitable basal Moscovian Stage definition, and enhance the likelihood of consensus among Bashkirian-Moscovian task group members. While these results are preliminary, they are very promising. We are continuing with taxonomic and biostratigraphic work on these faunas. A workshop to present these data in detail and discuss the advantages and disadvantages of each transition is planned for the task group in late November 2010, at Nanjing Institute of Geology and Paleontology, Chinese Academy of Sciences in Nanjing, China.

Acknowledgements

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MORPHOLOGICAL FEATURES OF SOME FAMENNIAN CONODONTS

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The second half of the Famennian is marked by the appearance of several conodont genera, which have specific morphological characters on the lower surface of the platform of the Pa-element. Four morphotypes of the lower surface of the platform can be recognized (Fig. 1). The first morphotype is characterized by the development of the pseudokeel. The pseudokeel has an appearance of a flat or weakly concave, narrow field, with a basal cavity in the shape of a small pit with no flanks. This morphotype of the lower surface of the platform is known to exist in the genera *Scaphignathus* Ziegler, 1959, *Alternognathus* Ziegler and Sandberg, 1984, and in the earliest species of the genus *Siphonodella* Branson and Mehl, 1944 – *Siphonodella praesulcata* Sandberg, 1972 (Fig. 1, I A-C).

The second morphotype is characterized by an indistinct keel resembling a pseudokeel. In conodonts with this morphotype, the keel has the appearance of an elongated flat or weakly concave, wide or narrow field. A large basal cavity with a pit rimmed by wide flat flanks is located posterior to the anterior third of the keel. This morphotype is present in *N*. gen. nov. Tragelehn, 2010 (Fig. 1, II).

The third morphotype has a sharp keel, with a large basal cavity with a small pit rimmed by wide flanks in its anterior third. This morphotype is recorded in the genus *Pseudopolygnathus* Branson and Mehl, 1934 (Fig. 1, III).

The fourth morphotype is characterized by the absence of a keel. The lower surface of the platform of a P-element is occupied by a wide, weakly concave basal cavity. This morphotype is recorded in the genus *Protognathodus* Ziegler, 1969 (Fig. 1, IV).

The above morphotypes of the lower surface of the platform are recorded in the Famennian short-lived genera. These genera appear in the second half of the Famennian, but not simultaneously. Apparently they represented phylogenetic dead-ends. In the taxonomy of the Pa-elements of *praesulcata* with these morphotypes, such as the separation of the genera *Siphonodella* and *N*. gen. nov. Tragelehn, the morphotype of the lower surface of the platform should be taken as the most important character.

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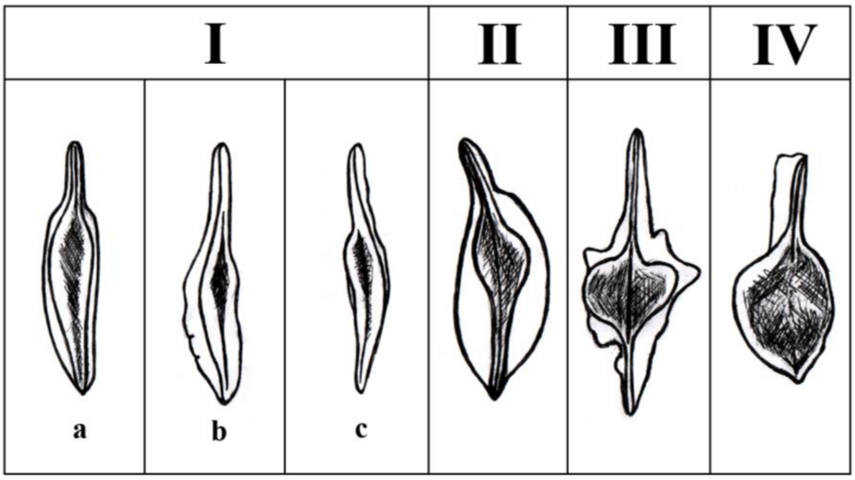

Fig. 1 Four morphologies of the lower surface of the platform Pa-element: I – a) *Siphonodella praesulcata*; b) *Scaphignathus*; c) *Alternognathus*; II – *N* gen. nov. Tragelehn; III – *Pseudopolygnathus* and IV – *Protognathodus*.

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INTEGRATED AMMONOID, CONODONT AND FORAMINIFERAL STRATIGRAPHY IN THE PALTAU SECTION, MIDDLE TIEN-SHAN, UZBEKISTAN

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The search for the best section to select the GSSP of the base of the Serpukhovian, which is also the base of the Upper Mississippian, is a high priority task of the SCCS (Richards 2005, 2006). The appearance of the conodont species *Lochriea ziegleri* is discussed as the best marker for this level in Europe and in Asia (Nikolaeva *et al*., 2002, 2005; 2009; Wang and Qi, 2003; Qi and Wang 2005, etc.; Nemyrovska, 2005), but there are concerns about limited geographical range of *L. ziegleri*, because it not found in North America (Richards, 2006). While there is an evident problem of a Trans-Atlantic conodont-based correlation of the base of the Serpukhovian, the *Lochriea* lineage appears to be recognizable in many regions across Eurasia and North Africa and *Lochriea ziegleri* or a closely related form *Lochriea cruciformis* may serve as a reliable marker of this boundary, when controlled by FADs of other fossil groups (ammonoids, corals, foraminifers, etc.) and the latter may be a basis for the recognition of a synchronous level in North America.

With this in mind, we re-examined fossil occurrences in a section on the right bank of the Paltau River, in the Koksu Range, Middle Tien-Shan (Uzbekistan). This section is commonly referred to as the “Paltau Section” and was examined by Sergunkova, 1973, 1978; *Mikhno et al.*, 1982; Nigmadjanov, 1988; Nikolaeva, 1994, 1995; Orlova (1994, 1997; Orlova and Bensh, 2004; Orlov-Labkovsky, 2002, 2005). The section contains ammonoids, conodonts, foraminifers and brachiopods in continuous succession around the Viséan-Serpukhovian boundary level and shows a presence of *Lochriea* species.

Foraminifers were identified by Mikhno and Orlova, conodonts by Nigmadjanov, brachiopods by Tyulandina and Zhizhlo, and ammonoids by Pitinova and Nikolaeva. Lithology was examined by Dzhabarov and Piven.

Geographical position

The section is located 100 km northeast of Tashkent, in the Bostanlyk District of the Tashkent Region, within the boundaries of the Ugam-Chatkal National Park. The section was measured along a small ridge between the Paltau and Chatkal rivers, at an altitude of 1300-1400 m 41°33'34"N, 70° 7'14 "E (Fig. 1).

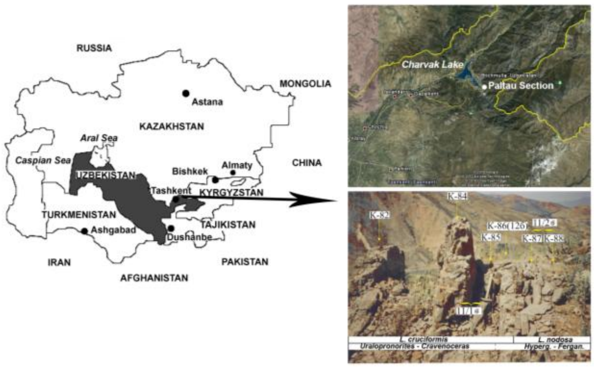


Fig. 1. Location map of the Paltau Section, Uzbekistan.

Lithology and Fossils

The section is composed of deep-water outer-shelf carbonates of the Paltau Formation. This outcrop is the type section of the upper part of the Paltau Formation, and of the Talassian and Tienshanian Regional Stages (Fig. 2).

Biostratigraphy of the Viséan-Serpukhovian boundary beds

Conodonts

(1) The section begins with the *Gnathodus bilineatus bilineatus* Zone Bed 18 to the level within the upper part of Bed 16. The base of this zone is not exposed. The assemblage contains *Pseudognathodus homopunctatus*, *Gnathodus bilineatus bilineatus*, *Gn. praebilineatus*, and *Gn. ex gr. girtyi.*

(2) *Lochriea nodosa* Zone. From the upper part of Bed 16 to the lower part of Bed 14 (ca. 47.25 m). Conodonts include *Ps. homopunctatus, Ps. symmutatus, Gn. bilineatus bilineatus, Gn. praebilineatus, Lochriea commutata,* and *L. nodosa*. (3) The FAD of *L. ziegleri* coincides with FAD of *L. cruciformis*. The *L. cruciformi* Zone comprises the interval from the upper part of Bed 14 to the lower part of Bed 12 (ca. 26.25 m). The lower boundary is identified by the first appearance of *Lochriea cruciformis*. The assemblage contains first *L. cruciformis* and many other conodont taxa (see Fig. 3). *Lochriea cruciformis* is closely related to *Lochriea ziegleri*, the species completing the evolutionary lineage *L. commutata – L. mononodosa – L. nodosa – L. ziegleri* (Nemirovskaya *et al.* 1994). In *L. cruciformis* tubercles are elongated and merged with the carina with no depression at the pont of mergence, and are not split as in *L. ziegleri*. Its first appearance is recorded in the basal Namurian and Serpukhovian in the sections of the Donets Basin, Lublin Basin, in Germany, and French Pyrenees (Nemirovskaya *et al*., 1994; Skompski *et al*., 1995; Nemyrovska with and appendix by Samankassou, 2005). In Germany this species enters within the *Emstites schaelkensis* ammonoid zone (Skompski *et al*., 1995). The assemblage of this zone also contains *G. bilineatus bilineatus, L. nodosa, L. mononodosa*, *L. commutata*, etc. (4) The *Gnathodus bilineatus bollandensis* Zone is recognized in the upper part of the Paltau Formation (from the upper part of Bed 12 to the top of Bed 9, ca. 37 m). The base of the zone is drawn by the first appearance of the index species. *Gnathodus bilineatus bilineatus* continues from the underlying beds, and conodonts transitional from *Gn. girtyi simplex* to *D. noduliferus* have been found in this zone.

(5) The *Gnathodus postbilineatus* Zone comprises the most part of Bed 7 and Bed 8 (ca. 25 m) of the Paltau Formation. Apart from the index species, the assemblage includes *Gn. bilineatus bollandensis*, *Lochriea nodosa*, *L. mononodosa, L. ziegleri, and L. cruciformis*.

(6) The *Declinognathodus noduliferus* zone comprises the top part of Bed 7 to Bed 1 (ca. 37.6 m). The base of the zone is drawn based on the appearance of the index species. Apart from the index species, the assemblage contains *D. praenoduliferus*, *L. monocostata,* and *Adetognathus unicornis*.

Ammonoids

In the Paltau Section, we were able to recognize three distinct ammonoid assemblages. The species composition of the ammonoid assemblages of the Paltau Section is similar to that of the South Urals, but is different from the assemblages of Western Europe, although the generic composition is close.

(1) The two lowermost ammonoid occurrences are in bed 14 and belong to the uppermost Viséan *Hypergoniatites-Ferganoceras* Genozone. The assemblage contains *Dombarites parafalcatoides*, *Megapronorites* sp., and *Ferganoceras* sp. *Dombarites parafalcatoides* has also been recorded from Western Kazakhstan (Dombar Hills) (Ruzhencev and Bogoslovskaya, 1971) in sample 11 (synchronous of sample 8 of the same authors and of sample 108 of Nikolaeva *et al*., 2009) in association with *Dombarigloria miranda, Alaoceras bajtalense*, and according to Ruzhencev and Bogoslovskaya (1971) indicates the Nm_1a_2 Zone, the upper of two zones within the *Hypergoniatites-Ferganoceras* Genozone. The genus *Ferganoceras* is the index genus for this genozone. In the Kzyl-Shin

section in western Kazakhstan (Ruzhencev and Bogoslovskaya, 1971), this species occurs in sample 1 in association with *Platygoniatites omniliratus, Dombarites falcatoides, Dombarocanites chancharensis* and *Lusitanites subcircularis*, also indicating the *Hypergoniatites-Ferganoceras* Genozone. *Dombarites parafalcatoides* has also been recorded from the upper Viséan of China (Lian and Wang, 1988) and Portugal (Oliveira and Wagner Gentis, 1983), although the latter record may possibly belong to *Lusitanoceras*.

(2) The second assemblage belongs to the *Uralopronorites–Cravenoceras* Genozone (= Nm_1b). The earliest occurrence of this assemblage is in bed 14, sample 11/1(12) - 0.7-1 m above the latest occurrence *D. parafalcatoides* in sample 11/2(12). sample 11/1 contains *Dombarites paratectus* and *Dombarocanites catillus*. A second occurrence of ammonoids of the *Uralopronorites–Cravenoceras* Genozone is in bed 10- sample 10/3(12) ca. 17-18 m above sample 11/1 and contains *Dombarites paratectus*, *Rhymmoceras* sp. and *Tympanoceras guttula*. These three taxa indicate equivalents of the Nm_1b_2 Zone of Ruzhencev and Bogoslovskaya (1971), e.g., the species *Dombarites paratectus* found in many sections in the South Urals, including the Verkhnyaya Kardailovka where it enters in bed 22 (Kosogorskian). The genus *Tympanoceras* also occurs in the Serpukhovian of Spain (Grey Marl Alba Formation) (Kullmann, 1962) and in western Kazakhstan (Dombar, sample 28) (Ruzhencev and Bogoslovskaya, 1971). The presence of genus *Rhymmoceras* - a typical taxon of the Nm_1b_2 Zone in the Urals supports this dating.

(3) The next level upward in the section is that with *Proshumardites fraudulentus* of the *Fayettevillea –Delepinoceras* Genozone and is most probably equivalent to that of the Nm_1c_2 Zone of the South Urals Bed 26 (Verkhnyaya Kardailovka section) in the Chernyshevian (Yuldybaevian) Horizon. In Western Europe equivalent faunas are found in the upper part of the E_2 Zone of the British Isles (Bisat, 1924, 1928; Hudson, 1945; Currie, 1954; Ramsbottom, 1969; Ramsbottom and Saunders, 1985; Riley, 1987), and in the USA in the *Eumorphoceras girtyi*, *Cravenoceratoides nititoides*, and *Delepinoceras thalassoide* Zones (Gordon, 1965; Miller and Youngquist, 1948; Elias, 1956; Titus, 2000).

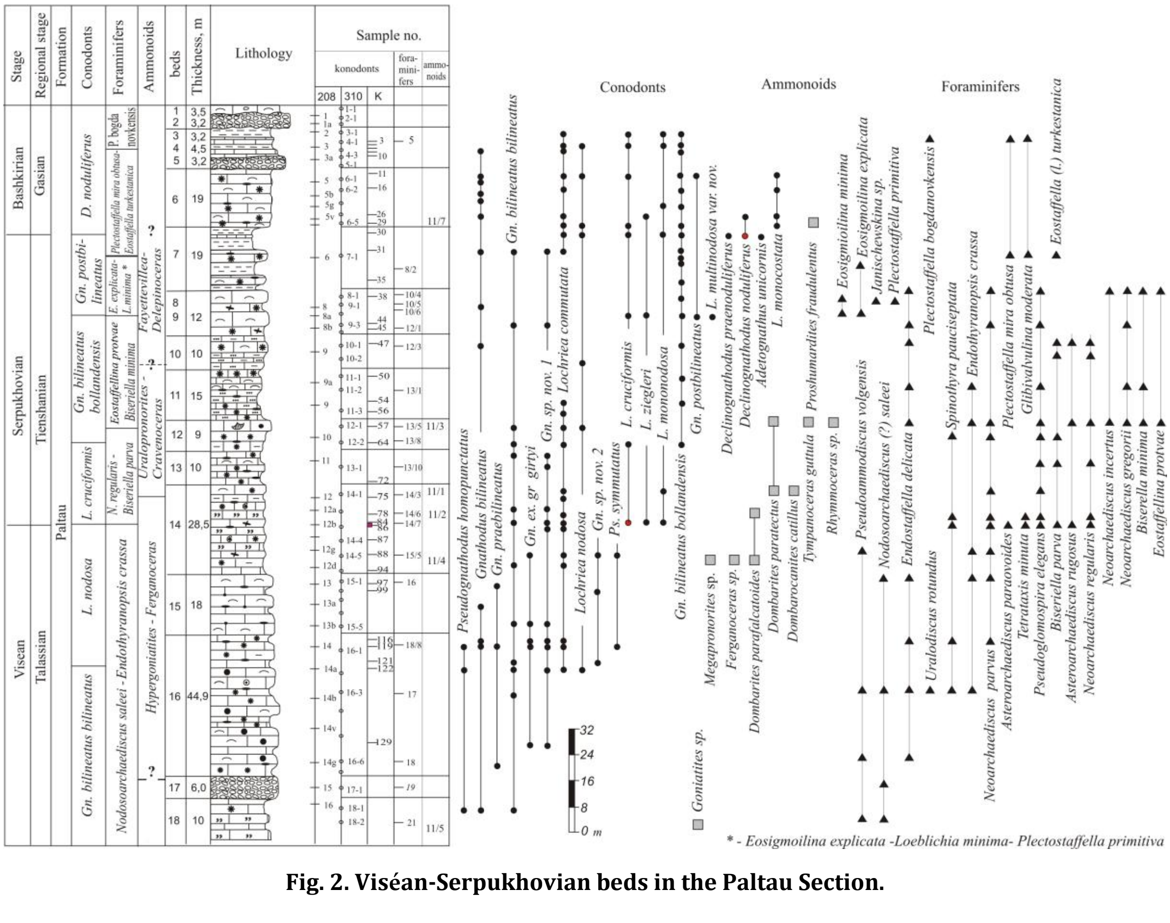
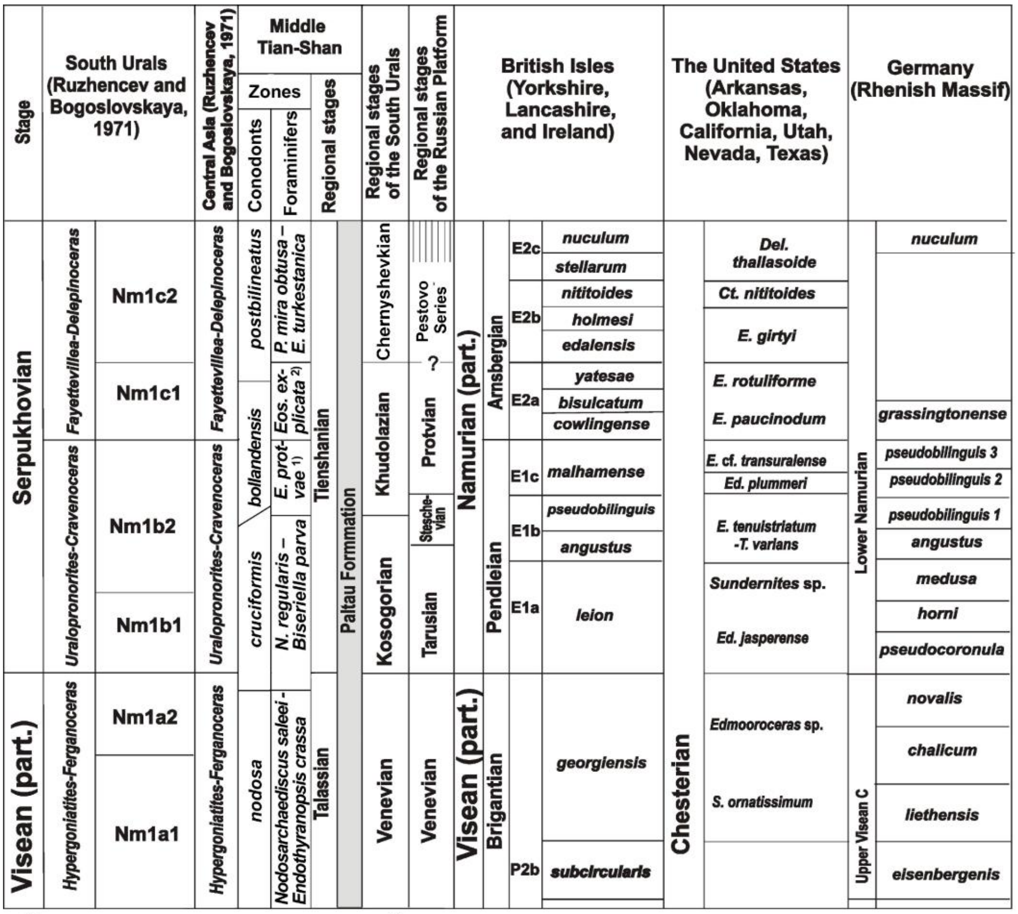


Fig. 2. Viséan-Serpukhovian beds in the Paltau Section.



1) *Eostaffellina protvae - Biseriella minima*; 2) *Eosigmoilina explicata - Loeblichia minima - Plectostaffella primitiva*

Fig. 3: Correlation of the regional stages, ammonoid and conodont zones of the Viséan-Serpuk-hovian beds.

Foraminifers

(1) The *Endothyranopsis crassa* Subzone comprises beds 14-17 and includes *Earlandia elegans*, *Pseudoammodiscus volgensis*, *Forshia mikhailovi*, *Janishewskina* sp., *Endothyra similis*, *Spinothyra pauciseptata*, *Omphalotis omphalota*, *Endothyranopsis crassa*, *Endostaffella delicata, Archaediscus moelleri, Paraarchaediscus syzranicus*, and the first primitive *Biseriella*. The *Endothyranopsis crassa* Subzone is recognized in the upper part of the *Nodosarcaediscus saleei - Archaediscus gigas* Zone and correlates with the upper part of the *Endothyranopsis crassa-Archaediscus gigas* Zone of the Euroasiatic Scheme in the Urals and the Russian Platform (Kagarmanov and Donakova, 1990), the *Eostaffella tenebrosa* Subzone proposed by Kulagina, Gibshman and Pazukhin (2003) for the Venevian.

(2) The *Neoarchaediscus regularis – Biseriella parva* Zone comprises top part of bed 14 to the top of bed 12 (ca. 35 m). The base of the *N. regularis* - *B. parva* zone is defined by the appearance of the genera *Biseriella* (*B. parva*), *Monotaxinoides* (*M. priscus*), and *Neoarchaediscus (N. regularis*, *N. rugosus*), as well as numerous species, among which are *Eostaffella parastruvei*, *E. postmosquensis*, *Planoendothyra spirillinoides*, *Tetrataxis minuta*, *Neoarchaediscus regularis*, *N. rugosus*, *Asteroarchediscus paraovoides* and rare *Endothyranopsis schaerica*. Its top is defined by the last appearance of *Paraarchaediscua syzranicus*, *"Archaediscus" saleei* and *Spinothyra pauceptata*. The *Neoarchaediscus regularis – Biseriella parva* Zone partly correlates with the *Pseudoendothyra globosa- Neoarchaediscus parvus* Zone of the Euroasiatic Scheme in the Urals and the Russian Platform (Kagarmanov and Donakova, 1990), and the *Neoarchaediscus postrugosus* Zone proposed by Kulagina, Gibshman and Pazukhin (2003) for the Tarussian and lower part of the Steshevian.

(3) The *Eostaffellina protvae - Biseriella minima* Zone roughly corresponds to beds 10-11 (ca. 25 m). Species appearing at the base of the zone include *Neoarchaediscus incertus*, *Neoarchaediscus gregorii, Biseriella minima, and Eostaffellina protvae*. The *E. protvae - B. minima* zone is characterized by the development of the genus *Eostaffellina* (*E. paraprotvae, E. protvae),* and the first appearance of primitive representatives of the genus *Plectostaffella* (*P*. sp.) and of the species *Planoendothyra aljutovica, Monotaxinoides subplana,* etc. The top of this zone is defined by the last appearance of representatives of the genera *Forshia, Omphalotis* and *Globoendothyra.* The *Eostaffellina protvae - Biseriella minima* is a very important zone, it is well correlated and is widespread in the

countries of the former USSR: central Kazakhstan (Marfenkova, 1989), southern Urals (Kulagina *et al*. 1992), Donets Basin (Brazhnikova and Vdovenko, 1983) and Russian Platform (Machlina *et al.* 1993). Apparently this zone corresponds to the *Eostaffellina paraprotvae* Zone proposed by Kulagina, Gibshman and Pazukhin (2003) for the Upper Steshevian and Protvian.

(4) The *Eosigmoilina explicata - Loeblichia minima - Plectostaffella primitiva* Zone corresponds to beds 8, 9 and part of 7 (ca. 19 m). Apart from the index species, the assemblage includes *Eosigmoilina minima, Brenckleina rugosa*, *Plectostaffella primitiva, Eoplectostaffella* sp*., Rectoendothyra donbassica*, *Endothyra bowmani*, *Monotaxinoides transitorius*, *M. convexus*, *Endotaxis planiformis*, *E. brazhnicovae* and some species continuing from the underlying zones. This zone correlates with the lower portion of the *Brenckleina rugosa - Monotaxinoides transitorius* Zone proposed by Kulagina, Gibshman and Pazukhin (2003) in the Verkhnyaya Kardailovka Section (Nikolaeva *et al.* 2001) and Muradymovo Section (Kulagina *et al*., 1992).

(5) The *Plectostaffella mira obtusa – Eostaffella turkestanica* Zone comprises top part of bed 7 to the top of bed 6 (ca. 34 m). Apart from the index species, the assemblage includes *Plectostaffella indecora*, *Planoendothyra spirillinoides evolut*., *Archaediscus donetzianus*, *Rectoendothyra parasymmetrica*, *Eolasiodiscus donbassicus*, and also numerous *Pseudoglomospira, Mediocris* and the small variety of *Archaediscus, Asteroarchaediscus, Monotaxinoides transitorius*. This zone corresponds to the upper part of the *Brenckleina rugosa - Monotaxinoides transitorius* Zone, proposed by Kulagina, Gibshman and Pazukhin (2003) in the Verkhnyaya Kardailovka Section (Nikolaeva *et al.,* 2001) and Muradymovo Section (Kulagina *et al*., 1992).

Integrated biostratigraphy of the Viséan-Serpukhovian boundary beds

The appearance of *L. ziegleri* and *L. cruciformis* almost coincides with the base of the ammonoid *Uralopronorites-Cravenoceras* Genozone and foraminiferal *Neoarchaediscus regularis* zone.

The *Lochriea nodosa* conodont zone correlates with the upper part (Nm_1a_2) of the *Hypergoniatites–Ferganoceras* Genozone (in the Dombar Hills levels 108, 200/1, 200/2; in Verkhnyaya Kardailovka levels 014/1, 013 in bed 21). Its base lies within bed 16 somewhat above the base of the *Endothyranopsis crassa* foraminiferal Zone. The base of the conodont *Lochriea cruciformis* Zone lies within the Viséan ammonoid *Hypergoniatites-Ferganoceras* Zone, and the situation is identical with the base of the *Lochriea ziegleri* Zone in the Dombar Hills and Verkhnyaya Kardailovka sections. The *Lochriea cruciformis* Zone comprises the upper part of the *Hypergoniatites-Ferganoceras* Genozone and of the *Uralopronorites – Cravenoceras* Genozone (samples 200/3, 201, 203, 114 in the Dombar Hills and beds 22 and 23 in the Verkhnyaya Kardailovka section). It coincides with the base of the *Neoarchaediscus regularis* foraminiferal Zone.

The base of the *Gnathodus bilineatus bollandensis* conodont zone lies within the *Uralopronorites-Cravenoceras* ammonoid Genozone and slightly below the base of the *Eostaffellina protvae* foraminiferal Zone.

The base of the *Gnathodus postbilineatus* conodont Zone is within the *Fayettevillea-Delepinoceras* ammonoid Genozone and above the base of the *Eosigmoilina explicata* foraminiferal Zone.

Thus, the Viséan-Serpukhovian boundary, which is defined by the appearance of *L. ziegleri* in the Urals, Kazakhstan and Europe, can be confidently correlated with the base of the *Lochriea cruciformis* Zone in the Paltau Section, being controlled by the ammonoids of the topmost part of the *Hypergoniatites-Ferganoceras* Genozone, which is partly placed in the Serpukhovian, like in the Verkhnyaya Kardailovka and Dombar sections. The lower part of the *Hypergoniatites-Ferganoceras* Genozone (below the first appearance of *Lochriea cruciformis*) approximately correlates with the upper Brigantian in Western Europe and Morocco (for records see Korn *et al*., 1999; Klug, 2006; Korn and Feist, 2007).

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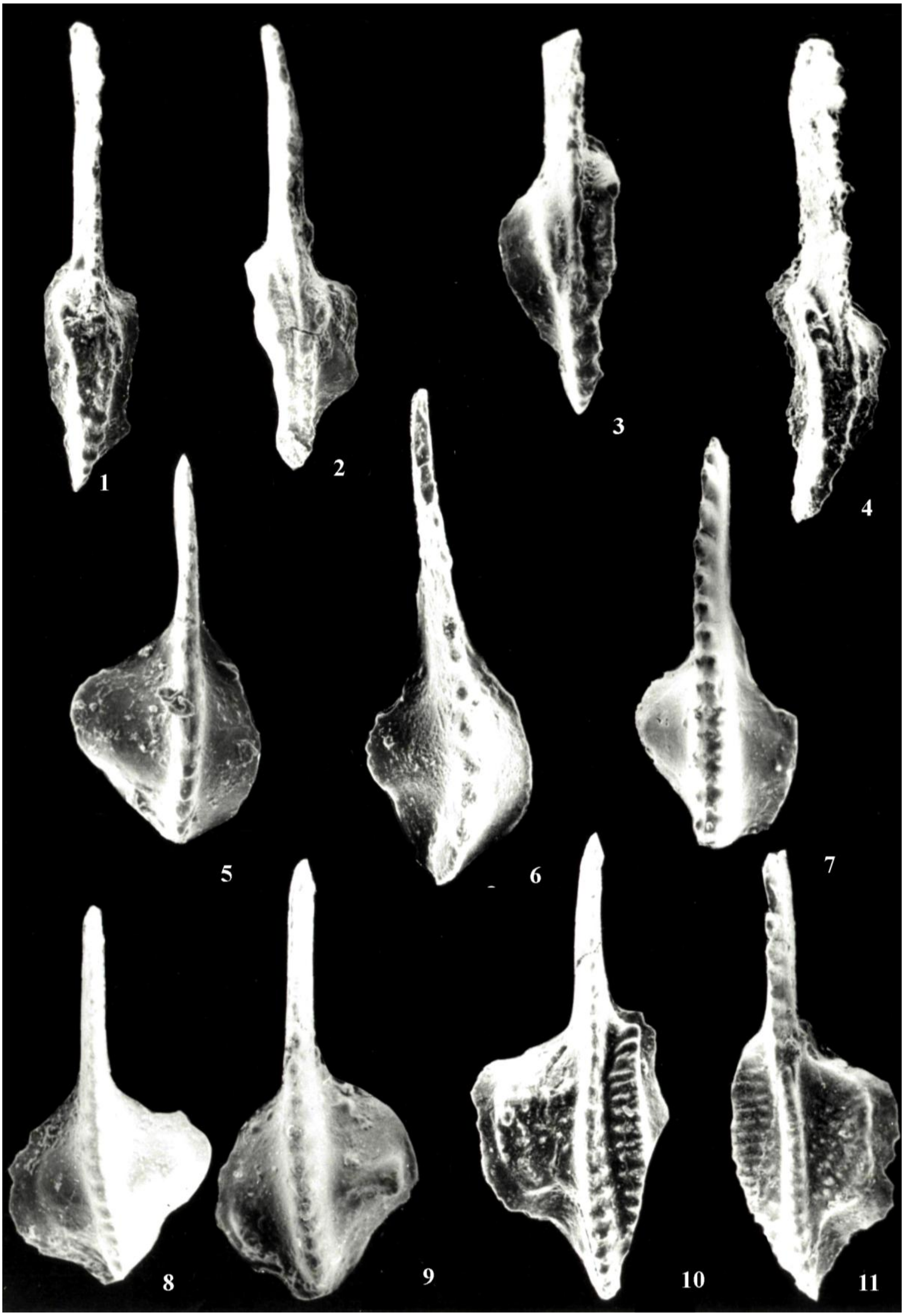

Plate 1. Conodonts from the Paltau Section. Figs. 1-2. *Gnathodus* sp. A.; (1) Sample K-90, x 70; (2) Sample K-121, x 60; Figs. 3-4. *Gnathodus* cf. *girtyi collinsoni* Rhodes Austin & Druce; (3) Sample K-61, x 60; (4) Sample K-129, x 60; Figs. 5, 6. *Lochriea commutata* (Branson a Mehl); (5) Sample K-6, x 120; (6) Sample K-129, x 60 Serpukhovian; Fig. 7-8. *Lochriea mononodosa* (Rhodes, Austin & Druce); Fig. 9. *Lochriea nodosa* (Bischoff), Sample 30, x 120; Figs. 10-11. *Gnathodus bilineatus bollandensis* Higgins; (10) Sample K-35, x 80; (11) Sample K-6, x 70.

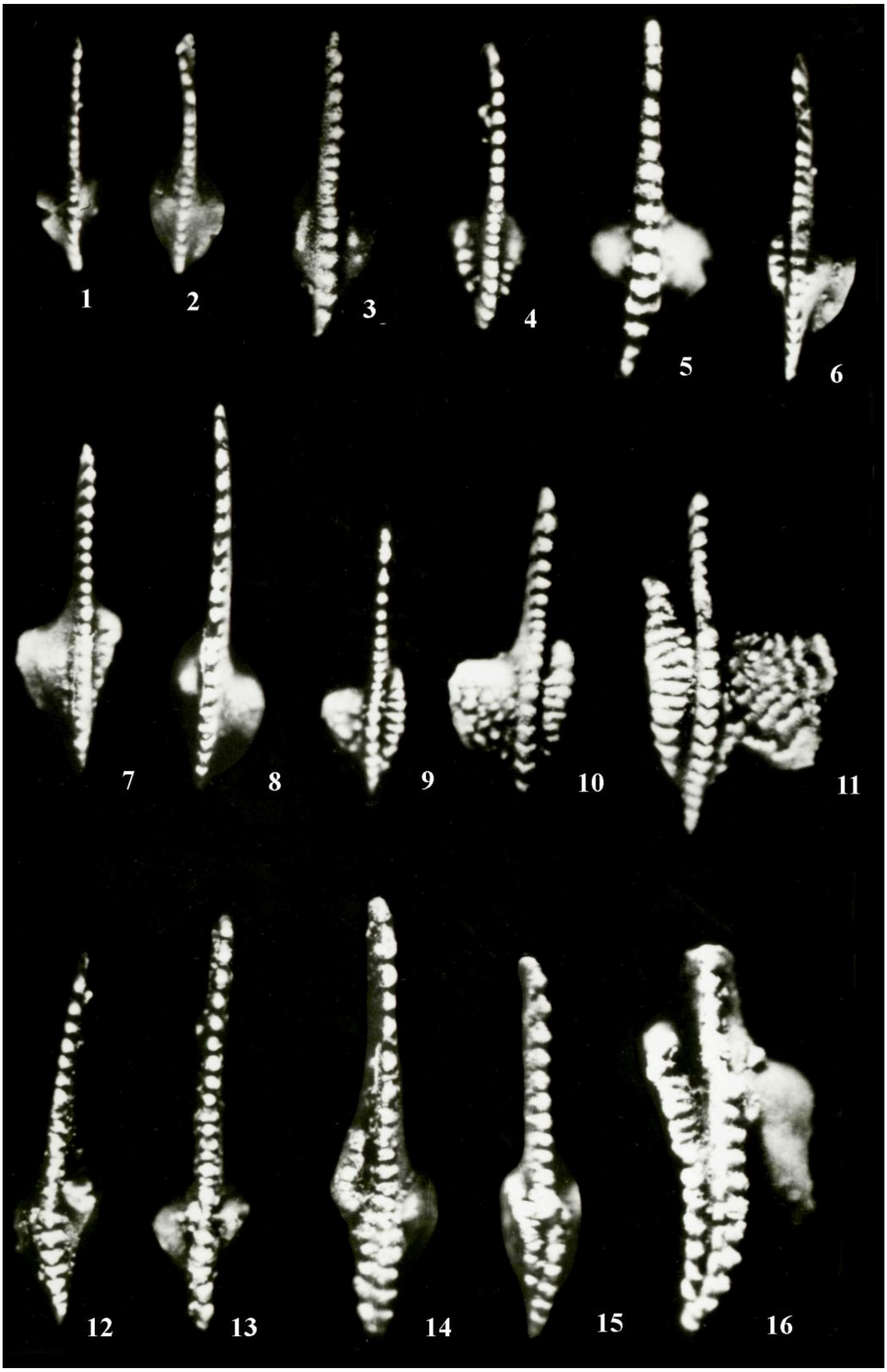

Plate 2. Conodonts from the Paltau Section: Figs. 1, 2. *Paragnathodus symmutatus* (Rhodes, Austin & Druce), x 40; (1) Sample 430/28b; (2) Sample 523/2; both Viséan; Figs. 3, 4. *Paragnathodus homopunctatus* (Ziegler); (3) Sample 430/28c; (4) Sample 523/3; both Viséan; Fig. 5. *Lochriea commutata transition* from *Par. cracoviensis*, x 50; Sample 430/30; Viséan; Figs. 6-8. *Gnathodus typicus* Cooper, x 40; (6, 7) sample 506, Tournaisian; (8) Sample 522/3, Viséan; Figs. 9-11. *Gnathodus bilineatus bilineatus* Roundy, x 40; Sample 310/9-1 Serpukhovian; Figs. 12, 13. Gnathodus texanus Roundy, x 40; Sample 501/3; both Viséan; Fig. 14. *Gnathodus pseudosemiglaber* Thompson & Fellow; Sample 525/5; Fig. 15. *Gnathodus subbilineatus* Lane & Ziegler, x 40; Sample 438/3-3, Viséan; Fig.16. *Gnathodus* sp. nov. 1, x 60; Sample 310/6-3, Serpukhovian.

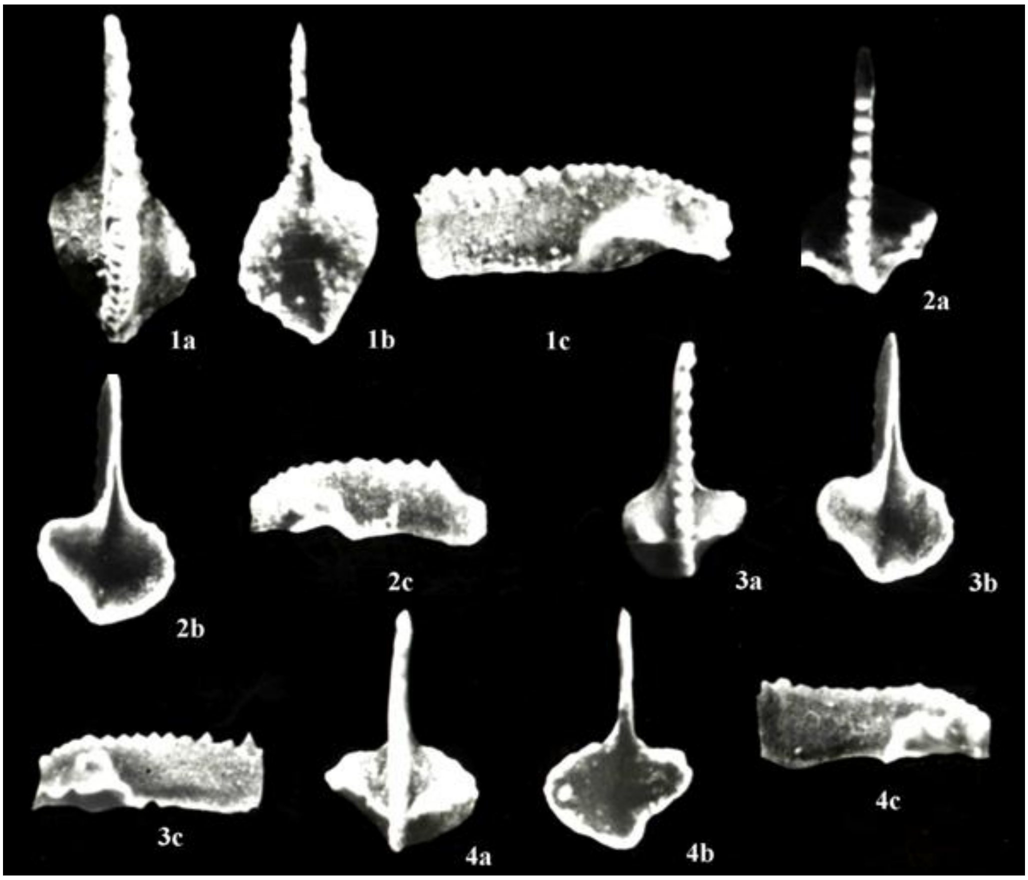

Plate 3. Conodonts from the Paltau Section: Fig. 1. *Lochriea* aff. *commutata* (Branson & Mehl), x 45, Sample 208/5; Serpukhovian; Figs. 2, 4. *Lochriea cruciformis* (Clarke), x 45; (2) Sample 310/12-2; (4) Sample 310/7-1; Serpukhovian; Fig. 3. *Lochriea nodosa* (Bischoff), x 45; Sample 208/5; Serpukhovian.

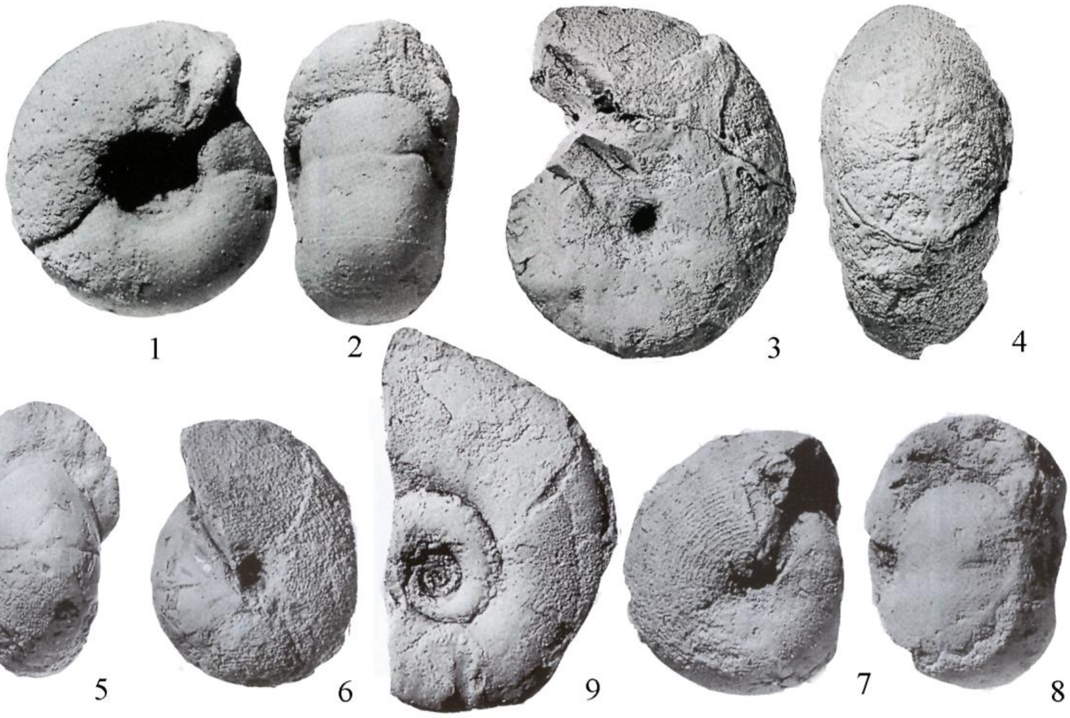

Plate 4. Ammonoids from the Paltau Section: Figs. 1-2. *Tympanoceras guttula* Nikolaeva; holotype 4374/41, x 4.5; Koksu Range, Paltau River; Sample 11/3(10); Serpukhovian, *Uralopronorites-Cravenoceras* Genozone; Figs. 3-4. *Proshumardites fraudulentus* Nikolaeva; holotype 4374/32, x 1; Koksu Range, Paltau River; Sample 11/7(5); Serpukhovian, *Fayetteville-Delepinoceras* Genozone; Figs. 5-8. *Dombarocanites paratectus* Ruzhencev & Bogoslovskaya; (5-6) specimen 4374/1, x 1.5; (7-8) specimen 4374/7, x 4.5 Koksu Range, Paltau River; Sample 11/3(10); Serpukhovian, *Uralopronorites-Cravenoceras* Genozone. Fig. 9. *Dombarocanites catillus* Ruzhencev & Bogoslovskaya; specimen 4374/44, x 2; Koksu Range, Paltau River; Sample 11/1(12); Serpukhovian, *Uralopronorites-Cravenoceras* Genozone.

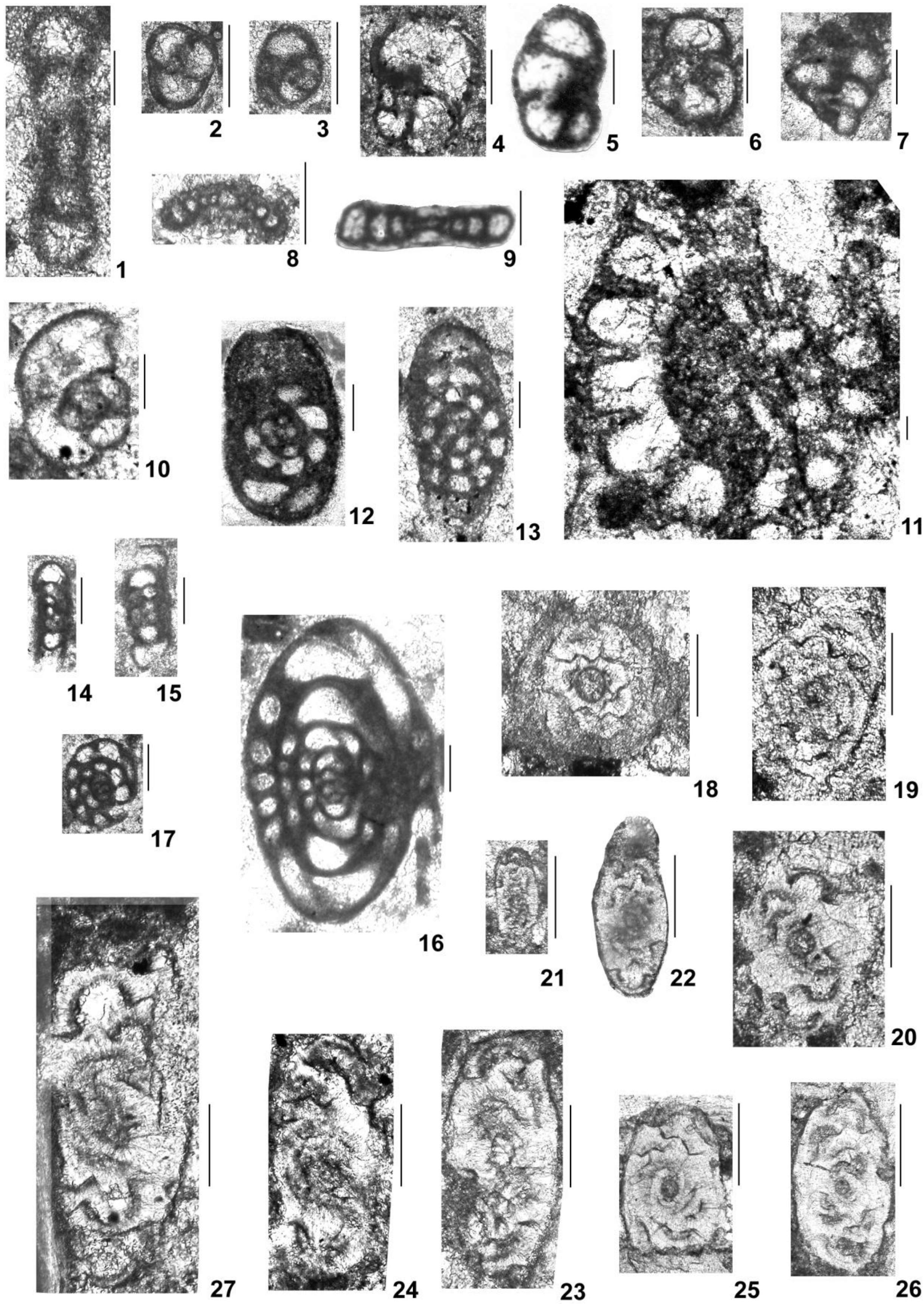

Plate 5. Foraminifers from the Paltau Section: Fig. 1. *Pseudoammodiscus volgensis* (Rauser-Chernousova), x 100, Sample XII – 17/4 (01); subaxial section; Viséan, *Nodosarchaediscus saleei - Endothyranopsis crassa* Zone; Figs. 2, 3. *Biseriella prima* (Mikhno, in litt.), x 150, Samples: 2 - XII - XII 16z (07), subaxial section, 3 - XII 16b (08), subaxial section, Viséan, *Nodosarchaediscus saleei - Endothyranopsis crassa* Zone; Figs. 4, 5. *Biseriella parva* (Chernysheva), x 100, Samples: 4 – XII 14/6 (014), subaxial section, 5 - XII 14/7 (012), subaxial section, Serpukhovian, *Biseriella parva - Neoarchaediscus regularis* Zone; Figs. 6, 7. *Biseriella minima* (Reitlinger), x 100, Samples: 6 – XII 13/4 (033), subaxial section, 5 - XII 13/5 (029), subaxial section, Serpukhovian, *Eostaffellina protvae - Biseriella*

minima **Zone; Fig. 8. *Monotaxinoides subconica* (Brazhnikova & Jarzeva), x 150, Sample XII 14/6 (014), axial section, Serpukhovian, *Biseriella parva - Neoarchaediscus regularis* Zone; Fig. 9. *Monotaxinoides subplanus* (Brazhnikova & Jarzeva), x 100, Sample XII 14/6 (014), axial section, Serpukhovian, *Biseriella parva - Neoarchaediscus regularis* Zone; Fig. 10. *Spinothyra pauciseptata* (Rauser-Chernousova), x 100, Sample XII 14/6 (014), sagittal section, Serpukhovian, *Biseriella parva - Neoarchaediscus regularis* Zone; Fig. 11. *Endothyranopsis cf. crassa* (Brady), x 40, Sample XII 17 (05), sagittal section, Viséan, *Nodosarchaediscus saleei - Endothyranopsis crassa* Zone; Fig. 12. *Pojarkovella honesta* Simonova, x 80, Sample XII-16/9 (07), axial section, Viséan, *Nodosarchaediscus saleei - Endothyranopsis crassa* Zone; Fig. 13. *Pojarkovella nibilis* (Durkina), x 80, Sample XII-16/9 (07), axial section, Viséan, *Nodosarchaediscus saleei - Endothyranopsis crassa* Zone; Fig. 14. *Endostaffella shamordini* (Rauser-Chernousova),x 80, Sample XII-16/3 (08a), axial section, Viséan, *Nodosarchaediscus saleei - Endothyranopsis crassa* Zone; Fig. 15. *Endostaffella fucoides* Rosovskaya, x 80, Sample XII-16/9 (08a), subaxial section, Viséan, *Nodosarchaediscus saleei - Endothyranopsis crassa* Zone; Fig. 16. *Eostaffella* ex gr. *ikensis* Vissarionova, x80, Sample XII-16/9 (07), subaxial section, Viséan, *Nodosarchaediscus saleei - Endothyranopsis crassa* Zone; Fig. 17. *Eostaffellina* cf. *protvae* (Rauser-Chernousova) x80, Sample XII 13/5 (029),subaxial section, Serpukhovian, *Eostaffellina protvae - Biseriella minima* Zone; Figs. 18-20. *Nodosarchaediscus saleei* Conyl et Lys, x 150, Samples: 18 –XII 17/3 (03), subaxial section, 19 - XII – 17/3 (02), subaxial section, 20 - XII – 17/4 (01), subaxial section, Viséan, *Nodosarchaediscus saleei - Endothyranopsis crassa* Zone; Fig. 21. *Neoarchaediscus parvus* (Rauser-Chernousova), x 120, Samples XII 17/3 (02), axial section, Viséan, *Nodosarchaediscus saleei - Endothyranopsis crassa* Zone; Fig. 22. *Neoarchaediscus regularis* (Suleimanov), x 120, Samples XII 14/7 (11), axial section, Serpukhovian, *Biseriella parva - Neoarchaediscus regularis* Zone; Fig. 23. *Neoarchaediscus rugosus* (Rauser-Chernousova), x 120, Samples XII 14/7 (12), axial section, Serpukhovian, *Biseriella parva - Neoarchaediscus regularis* Zone; Fig. 24. *Neoarchaediscus* ex gr. *rugosus* (Rauser-Chernousova), x 120, Sample XII 14/7 (11), axial section, Serpukhovian, *Biseriella parva - Neoarchaediscus regularis* Zone; Figs. 25, 26. *Asteroarchaediscus baschkiricus aksarsaica* Mikhno, x 120, Samples: 25 - XII 14/7 (11), axial section, 26 - XII 14/7 (11), axial section, Serpukhovian, *Biseriella parva - Neoarchaediscus regularis* Zone; Fig. 27. *Neoarchaediscus* ex gr. *incertus* (Grozdilova et Lebedeva), x 120, Sample XII 14/6 (13), subaxial section, Serpukhovian, *Biseriella parva - Neoarchaediscus regularis* Zone.**

CONODONT AND FUSULINE COMPOSITE BIOSTRATIGRAPHY ACROSS THE BASHKIRIAN-MOSCOVIAN BOUNDRARY IN THE DONETS BASIN, UKRAINE: THE MALO-NIKOLAEVKA SECTION

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Traditionally the Bashkirian-Moscovian boundary in Eastern Europe including the Urals was defined by foraminifers (Anonymous, 1990). The difficulties in correlation were caused by the widely separated locations of the type Bashkirian at the South Urals and the type Moscovian in the Moscow Basin. Moreover, the lower part of the Moscovian Stage in its type area is composed of terrestrial deposits that lack marine fossils, particularly foraminifers, which were used to be the main fossils to define the Bashkirian-Moscovian boundary. A great variety of fossils in the relatively continuous Carboniferous succession of the Donets Basin, Ukraine, make it one of the most important successions for Carboniferous stratigraphy and for defining the Bashkirian-Moscovian boundary in particular. A number of paleontological links with other major Carboniferous basins have been recovered in the Donets Basin Carboniferous; for example, several conodont lineages for intercontinental correlations across the Pennsylvanian stage boundaries (e.g., Nemyrovska, 1999; Villa and Task Group, 2005; Heckel *et al*., 2008).

The Bashkirian - Moscovian boundary was traditionally defined in Donbas by correlating its foraminiferal zones to those of the Moscow Syneclise. The position of the boundary has not been changed much during the last half century. In the 1950s, it was placed at the base of Limestone K_1, and later at the base of Limestone K_3 (Kireeva, 1951; Putrja, 1956; Pogrebnyak, 1975; Aizenverg *et al*., 1979; Einor, 1996).

The conodont studies of a series of sections spanning the Bashkirian-Moscovian transition in the Donets Basin resulted in discovery of two major conodont lineages for defining the Bashkirian-Moscovian boundary. These are the *Declinognathodus marginodosus–Decl. donetzianus* and *Idiognathoides sulcatus–Id. postsulcatus* lineages. The most complete section where these lineages were distinguished was the Zolotaya Valley section (Nemyrovska, 1999; Groves and Task Group, 2004) to the southeast of Lugansk, eastern Ukraine. Although conodonts are considered as eventual boundary-defining markers due to their optimal global correlation potential, foraminifers are still very important for correlating the Bashkirian-Moscovian boundary. Here we present the result of our recent joint study on conodonts and foraminifers in a new section of the Bashkirian-Moscovian transitional interval – the Malo-Nikolaevka section. A brief introduction of this section, in association with its preliminary conodont and fusuline result, was reported earlier (Ueno and Nemyrovska, 2008). Recently we carried out additional fieldwork to complete the boundary information.

The Malo-Nikolaevka Section

The Malo-Nikolaevka section is located about 35 km southwest of Lugansk in the eastern part of the Donets Basin (Figure 1). It is exposed along 140.5-

142.5 km of the Regional Highway H-21 to the northeast of Malo-Nikolaevka Village. Although clastics crop out rather poorly, limestones are generally persistent and those in the C_2^4(I) to C_2^5(K) suites are recognized successively. In this area, the strata strike in an almost E-W direction, dipping gently toward the north. They attain approximately 520 m in thickness. In this section, we examined eight limestone beds; they are Limestones I_2, I_2^1, I_2^2, I_3, I_4, K_1, K_2, and K_3 (Figure 2).

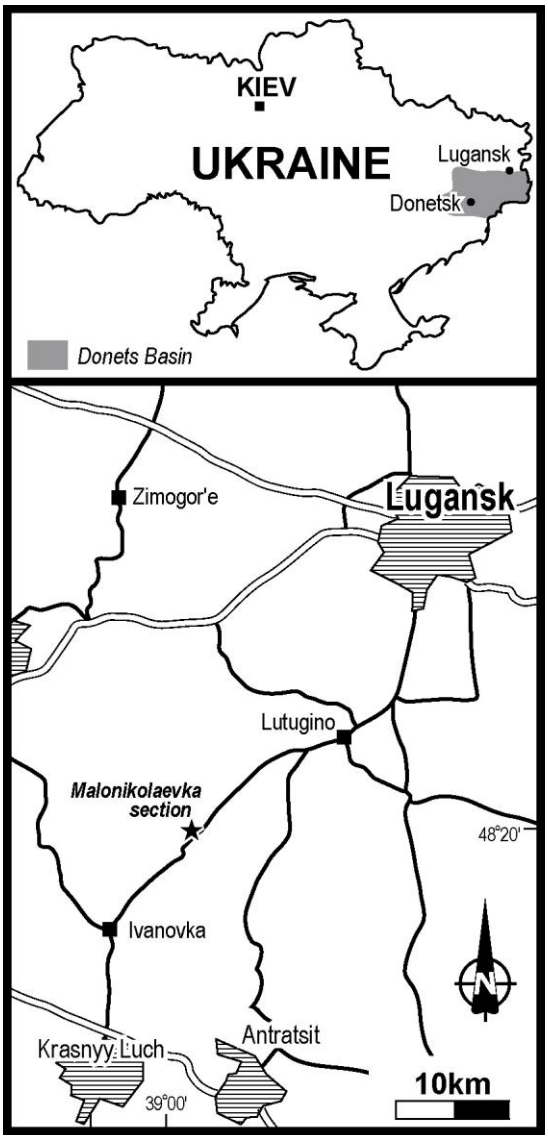

Figure 1: Index map of the Malo-Nikolaevka section in the eastern part of the Donets Basin, Ukraine.

The section starts from bedded sandstone with trough cross-stratification, which crops out in an exposure along the highway. Overlying this sandstone is Limestone I_2, which is bioclastic and consists of brachiopod and other shell fragments. Following an approximately 40 m-thick dark-gray shale and laminated siltstone, Limestone I_2^1 consists of several 20-40 cm thick limestone layers composed of *Beresella*-dominated algal-bioclastic packstone and grainstone. The next unit, Limestone I_2^2, forms a continuous low ridge to the east of the highway. It contains brachiopods and corals and is associated with gray shale just above it. The microfacies of this limestone is similar to that of Limestone I_2^1. The overlying, approximately 85 m-thick interval is poorly exposed and contains intervals of sporadically exposed thin-bedded medium-grained sandstone. Limestone I_3 is dark-gray bioclastic packstone with crinoidal debris and fragments of *Beresella*, and found only as some loose blocks. About 45 m above this limestone, Limestone I_4 is exposed, forming a low but continuous ridge along its strike. It is composed mainly of fine-grained bioclastic packstone, but in some levels, large biomorphs such as phylloid algae, tabulata (auloporids), and small solitary corals are observed.

Limestone K_1, the first limestone bed of the C_2^5(K) suite, is well exposed along a small creek to the west of the highway, forming a continuous prominent ridge. It is an about 90 cm-thick limestone with more or less nodular appearance and consists mainly of bioclast-poor muddy limestone. This limestone is then overlain by dark-gray shale and persistent, thick, coarse-grained brown sandstone, which is called the “Tobacco” sandstone (Aizenverg *et al*., 1975). It is a widely-distributed fluvial sandstone unit and is regarded as a good marker bed for recognizing the K_1-K_2 stratigraphic interval in the eastern part of the Donets Basin (Aizenverg *et al*., 1975; Izart *et al*., 1996). The next limestone - K_2 consists of coarse-grained, dark-gray bioclastic packstone and grainstone with abundant debris of crinoids, calcareous algae, brachiopods, and foraminifers. The uppermost limestone in the Malo-Nikolaevka section is Limestone K_3 and is exposed stratigraphically about 60 m above Limestone K_2. It is dark-gray and nodular, and is associated with a coal seam (k_2^B) just below it. This limestone interval is dominated by bioclastic wackestone.

Biostratigraphy

Conodonts

More than five hundred conodont elements were recovered from all the limestones of the C_2^4(I) suite and the lowermost part of the C_2^5(K) suite. They are mainly represented by typical Bashkirian genera *Idiognathoides, Declinognathodus*, and *Idiognathodus* (Figure 2). *Idiognathoides sinuatus* (including its dextral P_1 elements, i.e. *Id. corrugatus)*, which dominated during Bashkirian time, is common in the lower Moscovian deposits. The entries of the latest species of *Idiognathoides* – *Id. fossatus* and *Id. tuberculatus* were registered in Limestones I_2 and I_4 although a single questionable specimen of the latter species was found in Limestone I_2 *Idiognathoides fossatus* becomes more abundant in every limestone upwards in the studied section.

Declinognathodus, the most important conodont genus for Lower Pennsylvanian biostratigraphy, is represented in the studied section by its latest species – *Declinognathodus marginodosus* and *Decl. donetzianus* (Figure 3). The last occurrence of their ancestor *Declinognathodus noduliferus noduliferus*, a common Bashkirian species and an index-species for the mid-Carboniferous boundary (Brenckle *et al*., 1997), was recorded in the lowest limestone of the Malo-Nikolaevka section - Limestone I_2 where it dominates. The first appearance datum (FAD) of its direct descendant *Declinognathodus marginodosus* was registered at the same level – namely Limestone I_2. This species is common in every limestone of the C_2^4(I) suite, and it becomes dominant upwards the section in Limestones K_2 and K_3. The FAD of its descendant *Declinognathodus donetzianus* was recorded in this section at the top of Limestone K_1.

The genus *Idiognathodus* known from strata as old as mid-Bashkirian is represented in this section by several species, such as *I. aljutovensis I. volgensis*, *I. sinuosus*, and *I. incurvus*. It also contains several forms with more primitive structure, which are here left open nomenclaturally, and they occur in every limestone of the C_2^4(I) suite.

The lineage *Declinognathodus noduliferus–Decl. marginodosus–Decl. donetzianus* is well documented in the Malo-Nikolaevka section as well as in the Zolotaya Valley section – the other known section covering the Bashkirian-Moscovian boundary interval in the Donets Basin, where this lineage was introduced for the first time (Nemirovskaya, 1990; Nemyrovska, 1999, Nemyrovska *et al*., 1999). Unfortunately, the other potential marker conodont lineage for the Bashkirian-Moscovian boundary, which is *Idiognathoides sulcatus–Idiognathoides postsulcatus* and was discovered in the Zolotaya Valley section and in the Pashennaya section to the south of Lugansk (Nemyrovska, 2005), was not proved in the Malo-Nikolaevka section as *Id. postsulcatus* was not found there. Both lineages were recovered in different regions and therefore were proposed as potential markers to define the Bashkirian-Moscovian boundary (Groves and Task Group, 2004; Nemyrovska, 2005, 2006 a, b).

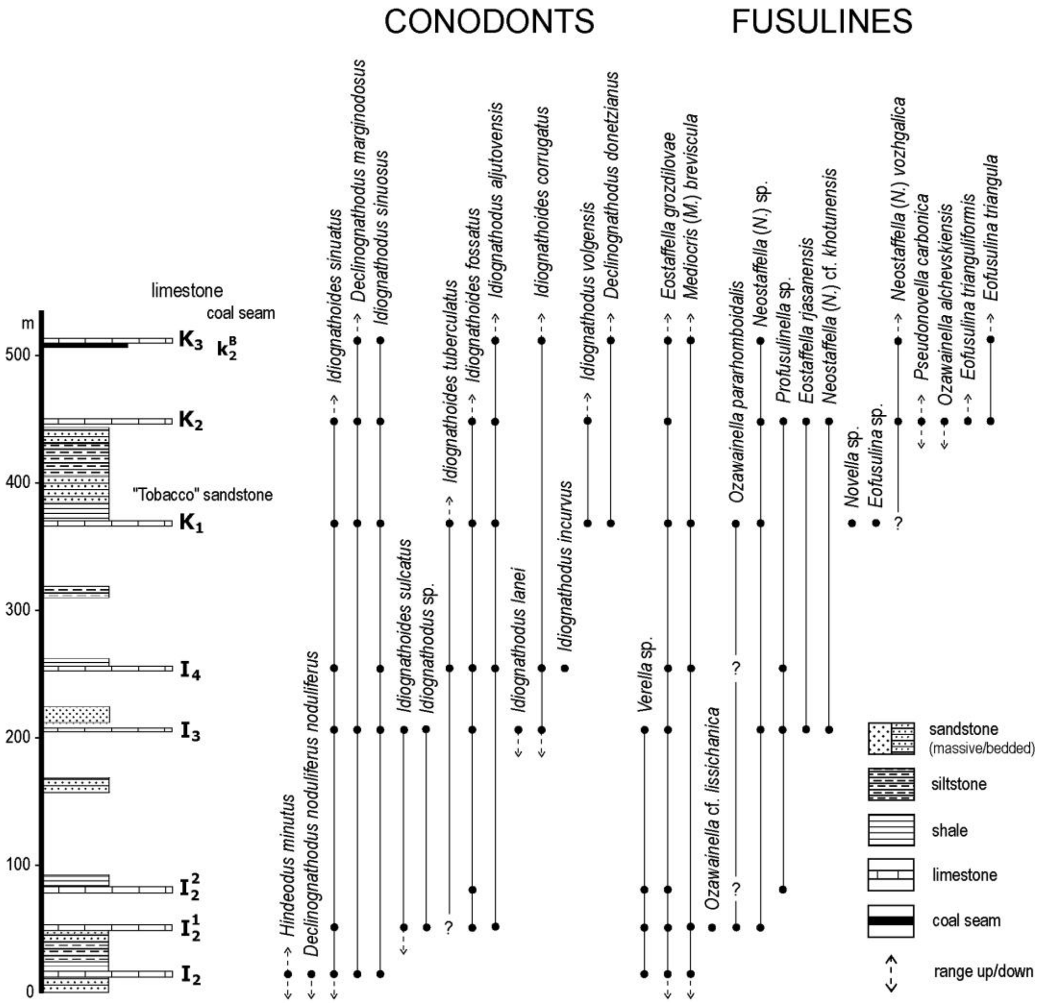

Figure 2: Stratigraphic log of the Malo-Nikolaevka section (Limestones I_2~K_3) and its conodont and fusuline distributions.

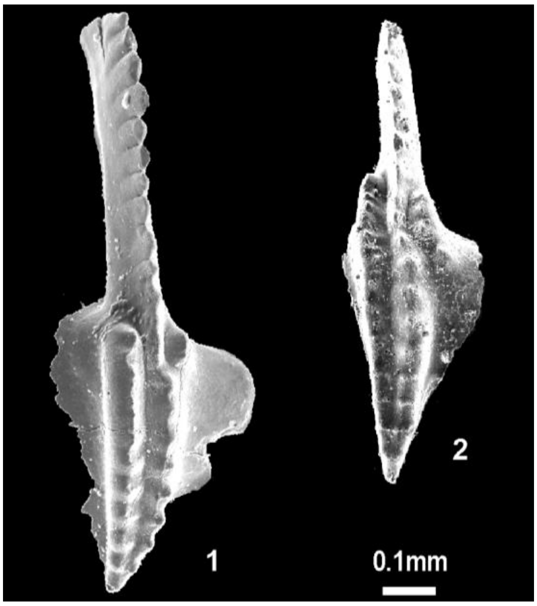

Figure 3: The *Declinognathodus marginodosus* – *Decl. donetzianus* lineage from the Bashkirian-Moscovian boundary interval of the Malo-Nikolaevka section.
1 - *Declinognathodus marginodosus* (Grayson) from Limestone K_1. 2 - *Declinognathodus donetzianus* Nemirovskaya from Limestone K_1.

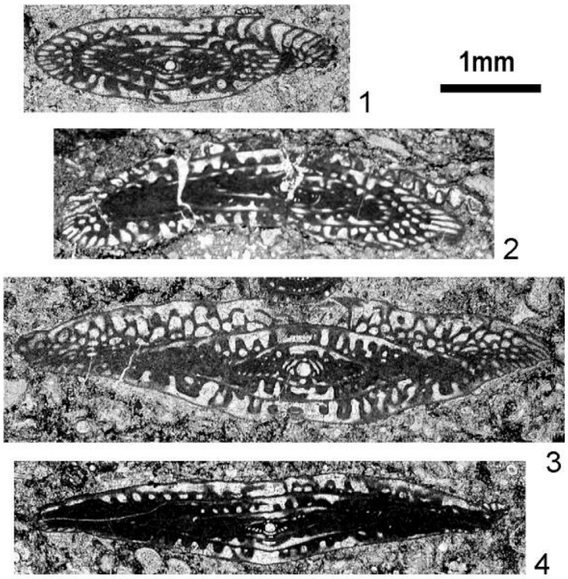

Figure 4: Several representative fusuline specimens of the *Verella* – *Eofusulina* lineage from the Bashkirian-Moscovian boundary interval of the Malo-Nikolaevka section. 1 - *Verella* sp. from Limestone I_3. 2 - *Eofusulina* sp. from Limestone K_1. 3 - *Eofusulina triangula* (Rauser-Chernousova and Beljaev) from Limestone K_2. 4 - *Eofusulina trianguliformis* Putrja from Limestone K_2.

Fusulines

Sixteen fusuline taxa were identified from the Malo-Nikolaevka section (Figure 2). Of them, several small lenticular species such as *Eostaffella grozdilovae*, *E. rjasanensis*, and *Mediocris* (*M.*) *breviscula* are found throughout the succession, while others (*Novella* sp. and *Pseudonovella carbonica*) are restricted in some particular levels. *Ozawainella* is represented by several species, including *O. pararhomboidalis* and *O alchevskiensis*. They are generally less common in samples from the section. *Neostaffella* also occurs throughout the succession although they are not very abundant except in Limestone K_2. Moreover, specimens of *Neostaffella* from the C_2^4 (I) suite are generally small, but those from the C_2^5 (K) suite, particularly *Neostaffella* (*N.*) *vozhgalica* from Limestone K_2, are relatively large and have shells with 5.5 to 7.5 volutions. Specimens of *Profusulinella* are found in several limestone levels, but they are not identified in species level in this study.

The most important and conspicuous lineage in the fusuline fauna of the Malo-Nikolaevka section is represented by *Verella* and *Eofusulina* (Figure 4). Of them, *Verella* sp. is restricted in the C_2^4 (I) Suite and is found from Limestones I_2, I_2^1, I_2^2, and I_3. The first *Eofusulina* is registered in Limestone K_1. Due to insufficiency of available materials, however, it is not identified in species level in this study. In Limestone K_2, *Eofusulina triangula* and *E. trianguliformis* are dominant, and the former species also occurs in overlying Limestone K_3.

Bashkirian-Moscovian boundary of the Malo-Nikolaevka section

Originally, three potential evolutionary events were suggested in conodonts to define the Bashkirian-Moscovian boundary (Groves and Task Group, 2004). Two of them were proposed based on data from the Donets Basin. The first is the evolutionary first appearance of conodont *Declinognathodus donetzianus*, which derived from *Decl. marginodosus*. The second event is characterized by the first appearance of *Idiognathoides postsulcatus*, which derived from *Id. sulcatus*. Both lineages are represented by the latest species of the respective genera: *Declinognathodus* and *Idiognathoides,* which dominated during Bashkirian time. The members of these lineages are known in many regions all over the world. However the lineages themselves are not very common. In many sections, we have one descendant but without ancestor, and vice versa. The third event is related with the appearance of late morphotype of *Neognathodus nataliae*. However, it was considered as an unsuitable candidate for making the base of the Moscovian because of its restricted distribution and the uncertainty with the taxonomic concepts involved in the transition from early to late morphotypes (Groves and Task Group, 2005).

The fourth lineage was later proposed by Qi *et al.* (2007) based mainly on data from the Nashui section of South China (Groves and Task Group, 2007). It comprises the *Diplognathodus coloradoensis*–*Diplo. ellesmerensis* lineage. These compositional species are common in China and

Canada, but they are rare in other areas. Moreover, Groves and Task Group (2008) noted that evolutionary relationships among *Diplo. ellesmerensis* and other species in the genus are not adequately known and most recovered specimens of this species seem to be juveniles, with larger, adult specimens being extremely rare. Although *Diplo. ellesmerensis* was reported elsewhere in the Donets Basin (Nemyrovska, 1999), both species have not been found in the Malo-Nikolaevka section.

In the Malo-Nikolaevka section, the first conodont lineage includes three members, forming an evolutionary series of *Declinognathodus noduliferus–Decl. marginodosus–Decl. donetzianus* (Figure 3). The lowest Limestone I_2 includes common *Decl. noduliferus* and single *Decl. marginodosus*. The FAD of *Decl. marginodosus* in the Zolotaya Valley section is registered in Limestone I_3 (Nemyrovska, 1999). *Declinognathodus donetzianus*, which was proposed as a potential global marker for the base of the Moscovian stage, was reported earlier in Limestone K_2 of the Zolotaya Valley section (Nemyrovska, 1999), but it was recently found in Limestone K_1 of both the Zolotaya Valley and Malo-Nikolaevka sections. Thus its evolutionary first appearance is proved by its occurrence in the Malo-Nikolaevka section.

The second lineage *Idiognathoides sulcatus–Id. postsulcatus* was recorded in the Donets Basin and partly in the other regions. The FAD of *Id. postsulcatus* was registered earlier in Donbas in Limestone K_2 of the Zolotaya Valley section and in Limestone K_3 of the Karaguz section (Nemyrovska, 1999). This species is most common in the overlying limestones of the C_2^5(K) suite. It was not found in the Malo-Nikolaevka section so far and in additional samples from Limestone K_2 in the Zolotaya Valley section either.

In recognizing the Bashkirian-Moscovian boundary, Groves and Task Group (2004) preliminarily suggested four potential evolutionary events within fusuline foraminifers that occur near the boundary, although none of them possesses optimal global correlation potential and are geographically restricted in Eurasia. They are: 1) evolutionary changes within the *Profusulinella* phylogeny, 2) the evolutionary appearance of *Aljutovella* (from *Profusulinella*), 3) the evolutionary appearance of *Neostaffella* (from *Pseudostaffella*), and 4) the evolutionary appearance of *Eofusulina* (from *Verella*). In the present circumstances, the first and second lineages within profusulinellids have less potential for Bashkirian-Moscovian boundary definition in the Malo-Nikolaevka section due to their scarce occurrences. The third lineage within pseudostaffellids may not be helpful for defining the boundary because *Neostaffella* makes its first appearance in Limestone I_2^1, which corresponds to the lower part of the C_2^4(I) suite and is much lower than the existing Bashkirian-Moscovian boundary. In this respect, Groves (1988) also clearly demonstrated that the first *Neostaffella* is observed in the Tashastinsky Horizon (lower part of the upper Bashkirian) in the stratotype section of the Bashkirian in the South Urals. These lines of evidence suggest that the evolutionary appearance of *Neostaffella* from *Pseudostaffella* took place sometimes within the Late Bashkirian, much below the existing Bashkirian-Moscovian boundary. Nevertheless, large neostaffellids like as *Neostaffella* (*N.*) *vozhgalica* certainly start occurring from Limestone K_1.

At the moment, the fourth *Verella–Eofusulina* lineage within the family Eofusulininae seems to be more promising for Bashkirian-Moscovian boundary definition in the Malo-Nikolaevka section. We found *Verella* sp. (Figure 4-1) from four limestone beds in the interval of Limestones I_2-I_3. This species looks advanced in the relevant genus in its relatively strongly and regularly fluted septa in axial regions, and is somewhat similar to *V. transiens*, which was originally reported by van Ginkel and Villa (in van Ginkel, 1987) from the Lena Formation of northwestern Spain and is known to occur from a stratigraphic interval just below that containing true *Eofusulina* species. In contrast, Limestone K_1 yields the first *Eofusulina* (*E.* sp.: Figure 4-2). This species somewhat resembles *E. plicata*, which was originally proposed by Rumyantseva (1962) as a species of *Verella* based on materials from Central Kyzylkum of Uzbekistan, but should be better subsumed in the genus *Eofusulina* as it has a slightly larger shell and more regularly and strongly fluted septa than typical species in *Verella*. Thus, *E. plicata* would be regarded as one of the first representatives of the genus. The overlying Limestone K_2 contains a diversified fusuline assemblage of stronger Moscovian signature, such as *Eofusulina triangula* (Figure 4-3), *E. trianguliformis* (Figure 4-4), and *Neostaffella vozhgalica*.

It is significant to emphasize that Limestone K_1, the first major limestone of the C_2^5 suite and registering the FAD of the conodont *Declinognathodus donetzianus,* which is considered as one of potential conodont marker species for defining the Bashkirian-Moscovian boundary (Groves and Task Group, 2004, 2005, 2009), also corresponds to that of strongly Moscovian-type *Eofusulina* in the fusuline fauna. Large neostaffellids also start occurring almost from this level. We are also investigating detailed conodont and fusuline composite biostratigraphy of the Bashkirian-Moscovian boundary interval in the nearby Zolotaya Valley section and several other potential sections in the eastern part of the Donets Basin. In addition to the Malo-Nikolaevka section, they will provide us better understanding of the true nature of biotic succession in the Bashkirian-Moscovian transition.

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STUDY OF THE EARLY CARBONIFEROUS AT MILIVOJEVIĆA KAMENJAR SECTION IN DRUŽETIĆ AREA (JADAR BLOCK, NW SERBIA)

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Palaeozoic ammonoid faunas are known from only a few places on the Balkan Peninsula. The longest known of these is the occurrence of early Late Viséan ammonoids at Prača near Sarajevo, from which Kittl (1904) described the peculiar *Entogonites grimmeri*. *Entogonites* was also collected at Milivojevića Kamenjar in Družetić village near Valjevo (Jadar Block, NW Serbia), a section in a limestone olistolith first described by Stevanović and Kullmann (1962). These authors attributed the entire outcrop into the Namurian, not knowing the olistostromal nature of the succession. Subsequent investigations and studies of conodonts from the section undermined the original statement that only Namurian sedimentary rocks exist in the limestones of the Milivojevića Kamenjar Section. First, Spasov and Filipović (1967) found besides Namurian conodonts also Late Devonian (Famennian) conodonts above the "upper fossiliferous layer".

At the Milivojevića Kamenjar site, two ammonoid-bearing intervals are exposed in inverse succession: (1) an early Late Viséan horizon containing the genera *Entogonites*, *Beyrichoceras*, *Goniatites*, and *Prolecanites*, and (2) a latest Viséan – early Serpukhovian horizon with *Ophilyroceras*, *Dombarites*, *Rhymmoceras*, *Irinoceras*, and *Uralopronorites*. Both intervals can be rather precisely correlated with the time-equivalent ammonoid occurrences in Central and North-western Europe, North Africa, the South Urals, and western United States.

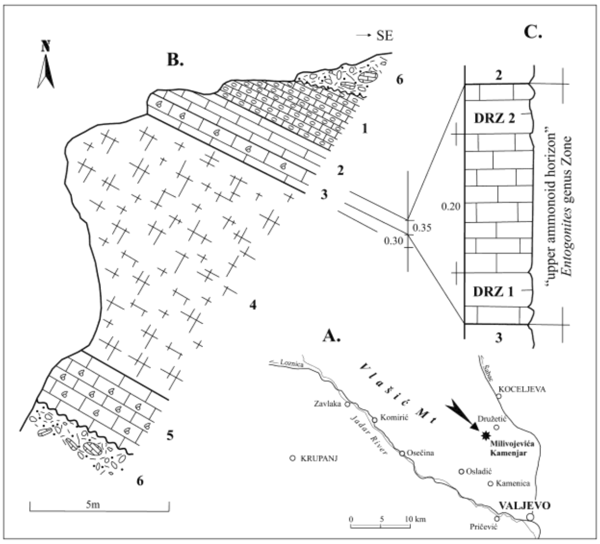

Figure 1. Milivojevića Kamenjar Section (modified from Filipović 1995, Filipović *et al.* 2008, Korn *et al.*, 2010, and incorporating the new data). A. Sketch of the geographical position in the area of Družetić village (Jadar Block, NW Serbia). B. Section of the Milivojevića Kamenjar olistolith. Legend. Unit 1. Dark grey nodular limestones with thin shaly beds (Famennian according to Filipović 1995); Unit 2. Grey bedded nodular limestones (Tournaisian according to Filipović 1995); Unit 3. Grey bedded limestones with ammonoids (Namurian "upper fossiliferous layer" according to Stevanović & Kullmann 1962; early Late Viséan according to Korn *et al.* 2010); Unit 4. Grey massive, thick-bedded and bedded limestones (Viséan according to Filipović 1995); Unit 5. Grey bedded limestones with ammonoids (Namurian "lower fossiliferous layer"according to Stevanović & Kullmann 1962; Lower Serpukhovian according to Filipović 1995; latest Viséan to earliest Serpukhovian in Korn *et al.* 2010); 6. Podolskian olistostromal deposits of the Ivovik Formation (Filipović 1995). C. Detail of the upper part of unit 3 ("upper ammonoid horizon", *Entogonites* Genus Zone of the early Late Viséan (middle Asbian).

The outcrop in the Družetić area (Fig. 1) is important for a number of reasons. It is the most diverse Carboniferous ammonoid locality on the

Balkan Peninsula, situated in a region, which is not fully understood in terms of its palaeogeographic position between Laurussia and Gondwana. It contains two productive ammonoid horizons, allowing precise biostratigraphic assignment and thus a correlation with time equivalent faunas from Northern and Western Europe, North Africa, the Urals, and Novaya Zemlya. The succession is fully composed of limestones, enabling the sampling of conodonts and thus the chance to study a second fossil group for biostratigraphy.

In a research project supported by the German Research Foundation (DFG), the authors started the re-investigation of the outcrop in 2008, sampling the entire section in terms of ammonoids, conodonts, and carbonate microfacies. During this investigation, the hypothesis of Spasov and Filipović (1967) was fully confirmed, with Late Devonian nodular limestones at the "top" of the section, in which the first clymeniids from the Balkan Peninsula were recorded. Early late Viséan ammonoids including *Entogonites* and the new genus *Ubites* Korn and Sudar in Korn *et al.* 2010 were found approximately one metre "below" (i.e. stratigraphically above) the clymeniid horizon, indicating either a gap in the succession or extreme condensation (Korn *et al.* 2010).

Ammonoid faunas from the Viséan-Serpukhovian boundary occur 12 metres "below" *Entogonites* in an interval of two metres of dense, often micritic limestones at the "base" of the section. This is the "lower fossiliferous layer" of Stevanović and Kullmann (1962); it contains conodonts of the *Kladognathus* – *Gnathodus girtyi* group Zone and belongs to the lower part of the Serpukhovian (Stojanović-Kuzenko and Pajić in Filipović 1995). Further investigations will show if the Viséan-Serpukhovian transition can be defined in terms of ammonoids and conodonts.

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NEW HIGH-PRECISION CALIBRATION OF THE GLOBAL CARBONIFEROUS TIME SCALE: THE RECORDS FROM DONETS BASIN, UKRAINE

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This is a summary and includes some figures from a recently published paper *Davydov, V. I., J. L. Crowley, M. D. Schmitz, and V. I. Poletaev. 2010. High-precision U-Pb zircon age calibration of the global Carboniferous time scale and Milankovitch-band cyclicity in the Donets Basin, eastern Ukraine. Geochemistry, Geophysics, Geosystems, 11(1):1-22.* The paper can be uploaded from the site www.agu.org/journals/gc/gc1002/ 2009GC002736/ 2009GC002736.pdf

High-precision ID-TIMS U-Pb zircon ages for twelve interstratified tuffs and tonsteins are used to radiometrically calibrate the detailed litho-, cyclo- and biostratigraphic frameworks of the Carboniferous Donets Basin of eastern Europe. Chemical abrasion of zircons, use of the internationally calibrated EARTHTIME mixed U-Pb isotope dilution tracer, and improved mass spectrometry guided by detailed error analysis have resulted in an age resolution of < 0.05%, or *ca* 100 ka, for these Carboniferous volcanics. This precision allows the resolution of time in the Milankovitch band, and confirms the long-standing hypothesis that individual high-frequency Pennsylvanian cyclothems and bundles of cyclothems into fourth order sequences are the eustatic response to orbital eccentricity (*ca* 100 and 400 ka) forcing. Tuning of the fourth-order sequences in the Donets Basin to the long-period eccentricity cycle results in a continuous age model for the middle to late Pennsylvanian (Moscovian-Kasimovian-Ghzelian) strata of the basin and their record of biological and climatic changes through the latter portion of the Late Paleozoic Ice Age. Detailed fusulinid and conodont zonations allow the export of this age model to sections throughout Euramerica. Additional ages for Mississippian strata provide among the first robust radiometric calibration points within this subperiod, and result in variable lowering of the base ages of its constituent stages compared to recent global time scale compilations.

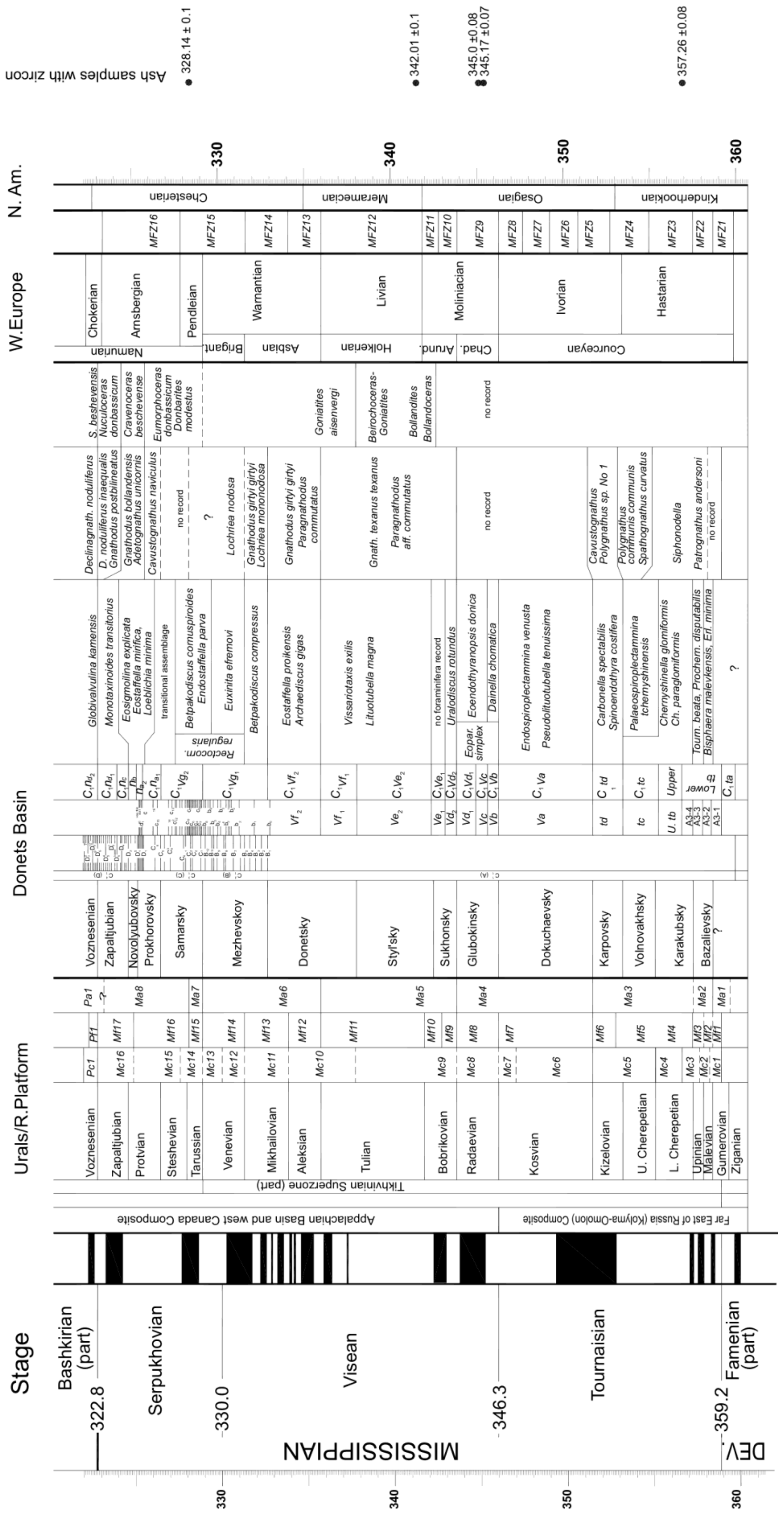

Figure 1. Mississippian: Chronostratigraphic scale for the Donets Basin and correlation chart to regional stages of the Russian Platform/Urals, western Europe and North America.

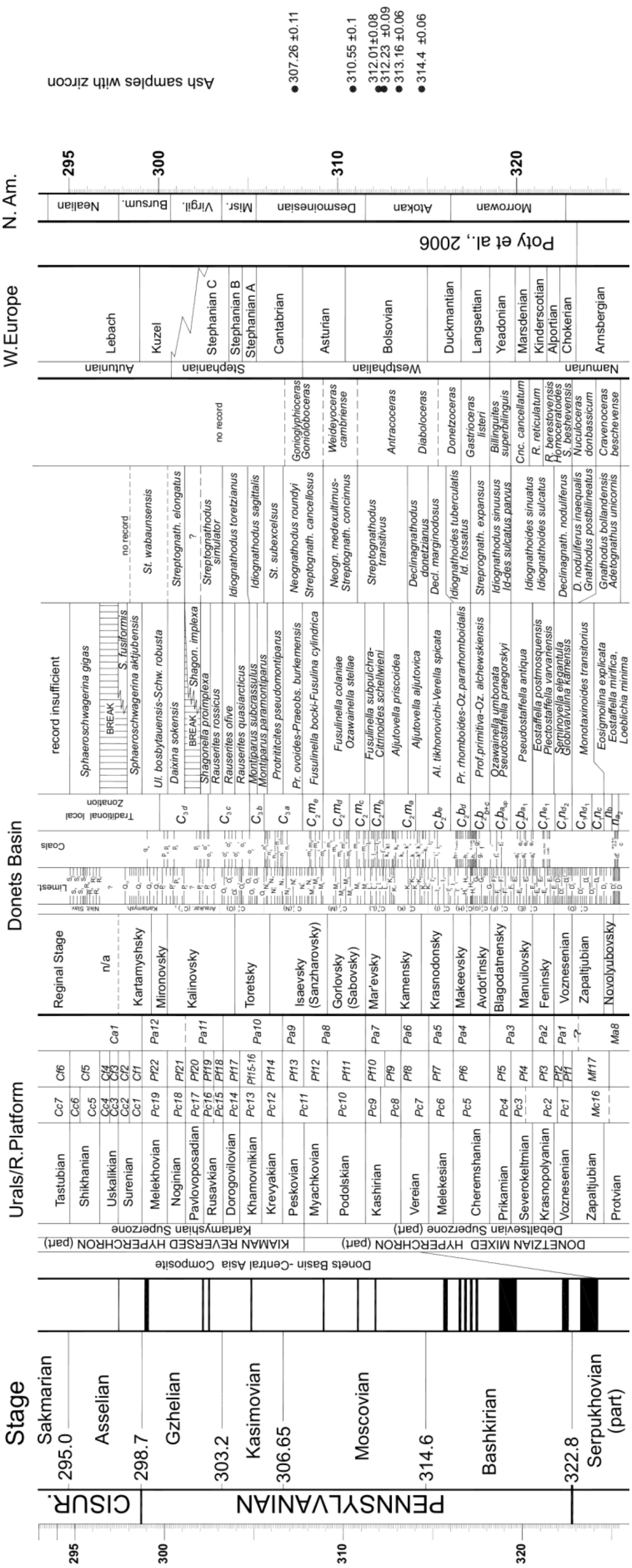

Figure 1 (continued): Pennsylvanian:. Chronostratigraphic scale for the Donets Basin and correlation chart to regional stages of the Russian Platform/Urals, Western Europe and North America.

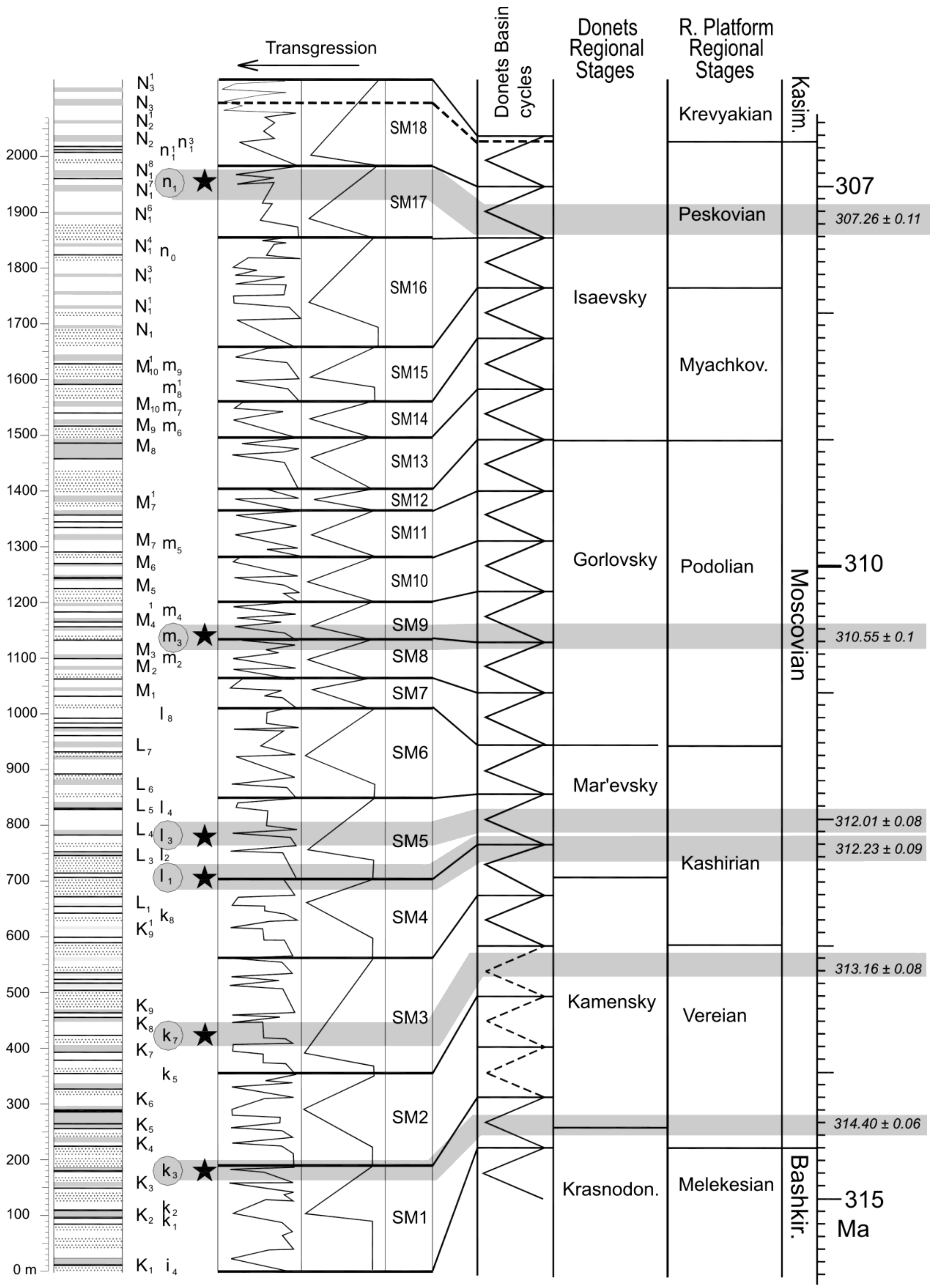

Figure 2. Lithostratigraphy and sequence stratigraphy through the Moscovian succession of the central exposed Donets Basin (modified from Izart *et al.*), with positions of six radiometric ages obtained in our study. Projection of stratal architecture onto a time linear scale constrained by ash bed ages reveals the consistent 400 ka tempo of the fourth-order sequences of Izart *et al.* Only a few high-frequency cycles in the lowermost Moscovian must be reinterpreted as fourth-order major transgressions to maintain consistency with the model. Tuning of these fourth-order sequences to the long eccentricity cycle allows calibration of the biostratigraphic record at a resolution of 100 ka.

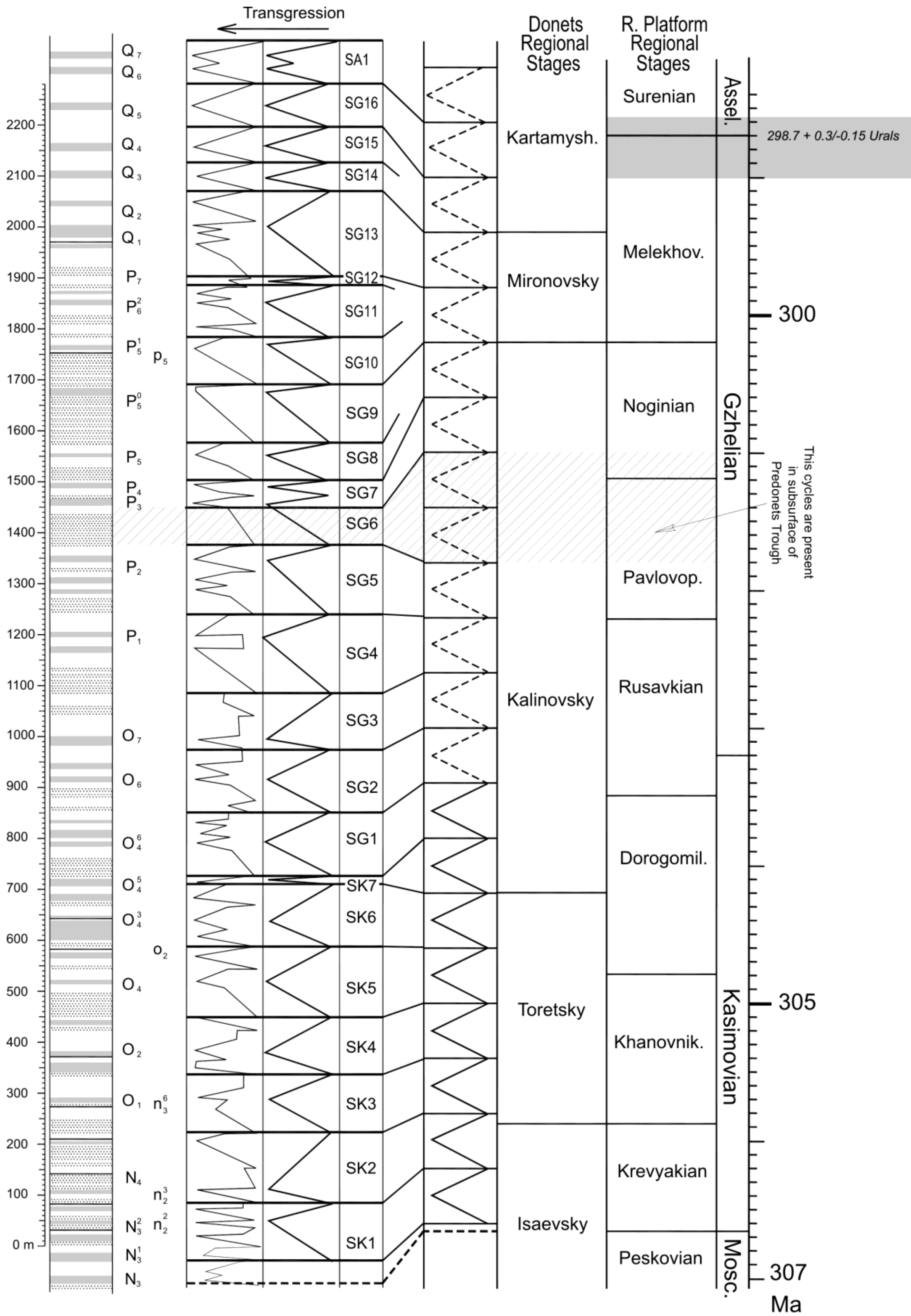

Figure 3. Lithostratigraphy and sequence stratigraphy through the Kasimovian-Gzhelian succession of the central exposed Donets Basin (modified from Izart *et al.*). The long eccentricity cycle tuning of fourth-order sequences derived for the Moscovian succession is extrapolated upward to the Carboniferous-Permian boundary constrained at 298.7 Ma in the Usolka parastratotype section of the Urals. High frequency and fourth-order sequences of the Kasimovian and early Gzhelian are well developed, lending more confidence to the cyclostratigraphic calibration. Although cyclicity becomes more ambiguous in the increasingly continental upper Gzhelian succession, only modest reinterpretation of Izart *et al.*'s fourth-order sequences as higher-frequency cycles is necessary to align the base of the Asselian in the Donets Basin with the radiometric constraint from the Urals

MEETINGS

SCCS Activities in 2010-2011

GSSPs of the Carboniferous System
- SCCS Workshop and Field Excursion -
Dates: November 21st -30th 2010
Venue: Nanjing Institute of Geology and Palaeontology and South Guizhou, China

Buisness meeting of SCCS at the *17th International Congress on the Carboniferous and Permian* at Perth

Future Meetings

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17th International Congress on the Carboniferous and Permian
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pre- and post-conference field trips will be organised.
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webpage: http://www.iccp2011.org

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Dates: August 2-10
Venue: Brisbane Convention and Exhibition Centre, Brisbane, Australia
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2013

The Carboniferous-Permian Transition
An international meeting devoted to all aspects of Carboniferous-Permian geology with special emphasis on the Carboniferous-Permian transition.
Venue: Hosted by the New Mexico Museum of Natural History and Science, Albuquerque, New Mexico, USA
Tentative schedule:
18-19 May: Pre-meeting fieldtrips in central New Mexico
20-22 May: Talks and posters
23-25 May: Post-meeting fieldtrips in southern New Mexico

Proceedings of the symposium and a field guide will be published by the New Mexico Museum of Natural History and Science. Deadline for publishable contributions will be January 1, 2013.

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Two volumes have been published:

PUCHKOV V.N. (Ed.) (2009): *Carboniferous type sections in Russia, potential and global stratotypes: Proceedings of the International Conference. South Urals Session. Ufa – Sibai, 13–18 August, 2009.* Ufa: DesignPolygraphService.

ALEKSEEV A.S. & N.V. GOREVA (Eds.) (2009): *Type and reference Carboniferous sections in the south part of the Moscow Basin. Field trip guidebook of the International Field Meeting of the I.U.G.S. Subcommission on Carboniferous Stratigraphy "The historical type sections, proposed and potential GSSP of the Carboniferous in Russia". Moscow, August 11--12, 2009. Moscow*: Borissiak Paleontological Institute of RAS.

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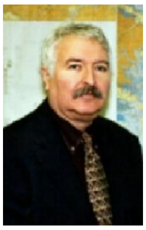

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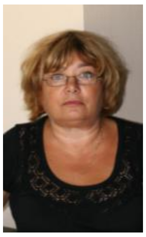

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