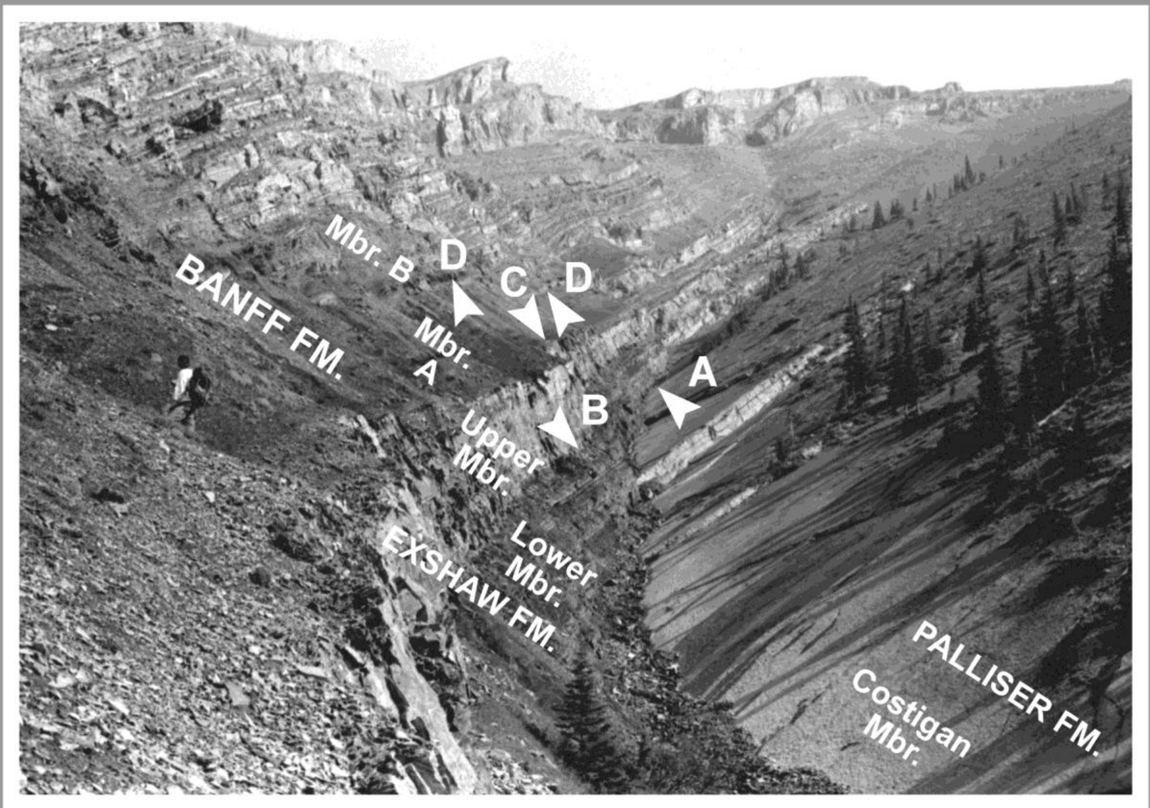
Newsletter on Carboniferous Stratigraphy

VOLUME 27 **JULY 2009**



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!

Cover Illustration:

Strata spanning the Devonian–Carboniferous boundary at the southeastern end of the Rundle Range near the city of Canmore in the Rocky Mountain Front Ranges of southwestern Alberta, Canada. The succession comprises the Famennian Palliser Formation, Famennian to lower Tournaisian Exshaw Formation (20.4 m thick), and Tournaisian Banff Formation. Both the lower member of the Exshaw and member A of the Banff consist of black shale deposited below storm wave base. Several laminae and thin beds of westerly derived volcanic ash are preserved in the black shale. Conodont data from this section and nearby localities indicate that the D–C boundary lies within the upper part of the black-shale member of the Exshaw. The view is toward the north. Arrows indicate: A- top Costigan Member of the Palliser and base of the lower member of the Exshaw, B- contact between lower and upper members of the Exshaw, C- contact between the Exshaw and Banff, and D- top of lower black shale (member A) of the Banff.

Illustration: courtesy of B.C. Richards

EXCECUTIVE'S COLUMN

Dear Fellow Carboniferous Researchers,

During August 2008, the former executive of the Subcommission on Carboniferous Stratigraphy (SCCS) reached the end of its mandate and was replaced by the current leadership at the 33rd International Geological Congress in Oslo, Norway. Phil Heckel (Chairman), Geoff Clayton (Vice-Chairman) and David Work (Secretary/Editor) stepped down after serving for two consecutive four-year terms. All Carboniferous researchers owe them a huge vote of thanks for their outstanding leadership and services over the past eight years. We also would like to thank the retiring voting members and task-group leaders for all of the contributions they made during the last four years.

The new officers will strive to provide successful leadership to the numerous ongoing SCCS projects, and attempt to maintain the high standards established by the previous executive. Numerous interesting and challenging problems remain for Carboniferous scientists to resolve but our principal goals are to redefine the Devonian-Carboniferous boundary and select the best positions for GSSP's defining stage boundaries within the two Carboniferous subsystems. Our ultimate goal is to calibrate biostratigraphy with other methods of correlation such as chemostratigraphy, radiometric dating and magnetostratigraphy so that successions dominated by terrestrial and endemic cold-water marine biotas can be correlated with the biostratigraphic framework of the pan-tropical standard succession. We anticipate that during the next four years the SCCS will contribute substantially to a better understanding of several aspects of global Carboniferous geology particularly stratigraphy.

The newsletter is the prime source for communication between the members of the subcommission. Today, the newsletter is mailed to more than 330 voting and corresponding members and libraries. We will attempt to maintain the high editorial standard established by David Work. As you can see from the layout of the front cover and the heading for this column, formerly titled the chairman's column, we have slightly modified the layout and structure of the newsletter. These minor changes will not prevent you from finding the information you are used to in the newsletter. The changes have been made to avoid repetition in the more formal parts of the newsletter and gain some space for scientific contributions and news. The newsletter cannot continue to be successful without your assistance in providing task-group progress reports, news about members, scientific contributions, memorials, and financial donations. Thus we encourage our membership to continue assisting us with the preparation of the newsletters and thank everyone who provided contributions for Volume 27 of the Newsletter on Carboniferous Stratigraphy. In addition, we thank those who assisted in its production.

Early this year, we started to revise the lists for the corresponding members provided in the membership section of the newsletter, eliminating the names of deceased and inactive members and updating the contact information for the remaining scientists. Thanks to all the members who assisted in the revision by providing their correct contact data.

The update was necessary for two reasons:

(1) We will keep producing a printed version of the Newsletter for the immediate future but want to avoid the unnecessary costs and work resulting from mail that is undeliverable because of invalid addresses.

(2) It is commonly necessary to communicate with our members by methods other than the annual newsletter. To enable rapid and reliable communication, we want to obtain the current e-mail and postal addresses of all members.

Unfortunately, we could not confirm the addresses of all our members and request that the corresponding members check their contact information, printed in the membership section. In order to receive the 2010 issue of the SCCS newsletter, please either notify Markus Aretz that the information is correct or provide him with the appropriate details by e-mail or postal mail.

We are pleased to announce that the long-awaited website for the SCCS is online (www.nigpas.ac.cn/carboniferous). It offers a new vehicle for fast and efficient communication of news, events, decisions and publications to the subcommission and broader geological community. On the website, the 2002 to 2008 issues of the newsletter are available in pdf format for download. In the near future, we plan to provide pdf files for all of the back issues including number 1, printed in 1980. The website is currently somewhat basic but will be improved shortly through the input of additional information, photographs and diagrams by the task groups. Later this year, we will be requesting that the task-group and project-group chairs provide information and illustrations that are relevant to the boundary their group is working on. Efficient communication and updated information through the SCCS webpage and printed newsletter can only be achieved if the entire subcommission provides appropriate information to the SCCS officers, who will post it.

Beginning with this newsletter, we include a section alerting our Carboniferous researchers to scientific meetings, both sponsored by the SCCS and the broader geological community that will be of particular interest. This also includes the outcomes of those meetings in the form of abstract volumes, special volumes and proceedings.

On July 7, 2009 the new executive established a business account for the SCCS at a branch of the Bank of Montreal in Calgary, Alberta. Both the chairman and the secretary have signing authority for writing checks and making deposits and withdrawals. The account, maintained in Canadian currency and designed for a non-profit organization, has negligible service fees but pays no interest. The money from the former account in the U.S.A. will be transferred to the new Canadian account. Following a desicion of its new president Stan Finney, ICS supports SCCS activities in 2009 with $800 US.

Our task groups should communicate their field activities via the newsletter and SCCS homepage. In this way we hope that a maximum number of interested people can join the field parties.

In the next year SCCS executives will attend the ICS workshop at Prague (May 30th–June 3rd 2010). Following this meeting, the SCCS secretary Markus Aretz invites the Task Group for the Reappraisal of the Devonian–Carboniferous boundary GSSP to attend a two-day workshop in Toulouse France that will include an excursion to the GSSP at La Serre and other sections in the Montagne Noire of southern France. After this workshop, a field trip to the Cantabrian Mountains in Spain to examine potential boundary stratotype sections for some task groups (e.g. Vis–Serp) will be organised with the help of Spanish colleagues from Oviedo and Coruña. If you are interested in partic ipating at the workshop and/or excursion to Spain, please contact Markus Aretz as soon as possible.

In October and November of 2009, members of several task groups plan to work at the Nashui and Yashui sections in Guizou Province south China. If you are interested in partic ipating in this field work, please contact Wang Xiangdong as soon as possible.

Editing of next year's newsletter will be done in June 2010. Although the deadline for contributions is the 31st of May 2010, we encourage you to send your contributions earlier. Please follow the instructions on the back of this issue, and for the references please utilize the format used in this issue.

Barry C. Richards, Wang Xiangdong and Markus Aretz

SCCS ANNUAL REPORT 2008

This version of the SCCS annual report for the last fiscal year (November 1st 2007 to October 31st 2008) is a brief summary of the full report submitted by our chairman Barry C. Richards to the ICS in November 2008. The complete report will be posted on our website in the near future and we encourage all of our members to carefully examine that report in order to obtain a more complete overview about the activities and goals of the SCCS.

Membership

As of November 1st 2008, the Subcommission had 21 voting members [see list at end of Newsletter]. In addition, the corresponding membership at the time of publication stands at 300 persons and 6 libraries from 33 countries.

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Task Groups and Project Groups

Task Group for the Reappraisal of the Devonian–Carboniferous boundary GSSP, so far no chairperson designated.

Task Group to establish the Tournaisian–Viséan boundary [which is also the base of the Middle

Mississippian Series], chaired by George Sevastopulo of the Republic of Ireland.

Task Group to establish the Viséan–Serpukhovian boundary [which is also the base of the Upper Mississippian Series], chaired by Barry Richards of Canada.

Task Group to establish the Bashkirian–Moscovian boundary [which is also the base of the Middle Pennsylvanian Series] chaired by John Groves of the U.S.A.

Task Group to establish the Moscovian–Kasimovian boundary [which is also the base of the Upper Pennsylvanian Series], chaired by Katsumi Ueno of Japan. This group is also dealing with the Kasimovian–Gzhelian boundary within the Upper Pennsylvanian Series.

Project Group on Carboniferous magneto-stratigraphy, chaired by Mark Hounslow of the United Kingdom.

Project Group on Upper Paleozoic boreal biota, stratigraphy, and biogeography, chaired by Marina Durante of Russia.

Details on the current activities of the task/project groups are presented in the newsletter after this report.

Chief Accomplishments in late 2007 and 2008:

The SCCS task groups made considerable progress toward achieving their principal goals - the section of taxa to define the bases of their respective time slices and the choosing of candidate sections for GSSP's (see their reports in the Annual Report for 2008 and in volume 26 of the Newsletter). The task group for the Tournaisian–Viséan boundary has almost accomplished its mission. After publication of the final report it will be officially dissolved according to ICS rules.

Work on the Viséan–Serpukhovian, Bashkirian–Moscovian and Moscovian–Kasimovian boundaries have reached the point where one to three conodont lineages are now under intensive investigation as potential event markers for boundaries. Also, each task group is intensively studying one or more stratigraphic sections as candidates for GSSP's.

An additional important development in 2008 was the formation of a reappraisal task group for the Devonian–Carboniferous boundary GSSP comprising 10 members from the SCCS and 10 from the Subcommission on Devonian Stratigraphy. Although the task group comprises members from two subcommissions, the mandate of the group is to select the base of the Carboniferous and not the top of the Devonian. Therefore, the SCCS is in charge and all major decisions have to formally pass through SCCS voting.

The Newsletter on Carboniferous Stratigraphy, Volume 26, was published in July 2008. As in recent years, it contains the reports of the SCCS executive, task-group project reports, and scientific contributions by members.

Work Plan for 2009 and Following Years:

The SCCS is looking forward to the Russian Field Meeting from August 11th to 19th, 2009 (see announcement in volume 26 of newsletter and website at http://carbon.paleo.ru/. The focus of the meeting will be the examination of historical type sections and the proposed and potential GSSP's of the Carboniferous in Russia. The field trips and technical session will provide many possibilities for discussing problems and presenting progress on GSSP related issues.

Devonian–Carboniferous boundary. The objectives for 2009 are to review the problems associated with the current boundary GSSP at the La Serre section in southern France, get the task group started on the reappraisal, establish priorities, and develop a work schedule. Initially, the task group needs to restudy the lineage containing the current event marker for the D–C boundary, the FAD of the conodont *Siphonodella sulcata*. Because the appearance of *S. sulcata* may not be the best event to define the boundary, other appropriate lineages particularly within the genus *Protognathodus* in the upper part of the *praesulcata* Zone require evaluation.

Tournaisian–Viséan boundary**.** This task group is preparing its final report on the ratified GSSP in the Pengchong section, south China.

Viséan–Serpukhovian boundary. This task group needs to prepare a formal proposal and ballot for a vote on using the FAD of *Lochriea ziegleri* in the conodont lineage *L. nodosa–L. ziegleri* for the boundary-event. The group continues to search for other biostratigraphically useful fossils, particularly foraminifers and ammonoids, for boundary recognition in North America, where the conodont lineage has not been found. Two potential candidate sections for the GSSP are being thoroughly investigated: Nashui section (near Naqing), Guizhou Province, south China and the Verkhnyaya Kardailovka section on the eastern slope of the southern Urals, Russia.

Bashkirian–Moscovian boundary. The principal short-term goal of the task group is to find a suitable event marker to define the base of the Moscovian Stage. Investigations will continue to centre on the biostratigraphic integrity of the conodonts *Declinognathodus donetzianus*, *Idiognathoides postsulcatus* and *Diplognathodus ellesmerensis* for boundary characterization. Both the Nashui section (by village of Naqing) in Guizhou Province, south China and the Basu River section in the southern Urals will continue to undergo intensive study as a potential GSSP candidate sections.

Moscovian–Kasimovian boundary. For definition and global correlation of the base of the Kasimovian stage, the task group plans to study the systematics and biostratigraphic utility of the first appearance of two conodont species: 1) *Idiognathodus sagittalis* Kozitskaya 1978 and 2) *Idiognathodus turbatus* Rosscoe and Barrick 2008. If selected for boundary definition, their use will move the boundary level one substage higher than the traditional base of the Kasimovian. The task group also plans to investigate several stratigraphic and biostratigraphic events occurring near the FAD's of the two conodont species so that they can be used as auxiliary physical and biotic events for correlating the base of the Kasimovian.

Kasimovian–Gzhelian boundary. The task group continues its search for potential GSSP sections based on the accepted boundary event (FAD of *Idiognathodus simulator* [*sensu stricto*]). For establishment of the GSSP, Russian colleagues are undertaking a detailed redescription and recollection of the Usolka section in the southern Urals.

Carboniferous magnetostratigraphy. This project group has been experiencing major difficulties in attracting members and obtaining stable funding. The SCCS executive will attempt to better integrate the activities of the group with those of the task groups searching GSSP candidate sections for stage boundaries within the system.

Upper Paleozoic boreal biota, stratigraphy, and biogeography. This project group did not submit progress reports for inclusion in volume 26 and 27 of the newsletter and appears to be inactive. The project group needs to give an overview on the accomplishments and difficulties encountered during the last two years.

We encourage all task and project groups to move forward efficiently to ensure that the boundary marker events and finally the GSSP's for all stages within the Carboniferous are proposed and voted on in a reasonably timely manner. Following their acceptance by the task groups, the proposals need to be approved by the SCCS and subsequently ratified by the IUGS. Keep in mind that the ICS wants all GSSP's to be selected by the end of 2011.

Statement of operating accounts for 2007/8

Prepared by David Work, Secretary SCCS up to November 1, 2008
(Definitive accounts maintained in US Currency)

INCOME (Nov. 1, 2007 – Oct. 31, 2008)	
IUGS-ICS Grant 2008	$400.00
Donations from Members	818.50
Interest	9.69
TOTAL INCOME	**$1228.19**
EXPENDITURE	
Newsletter 26 (printing)	$513.32
Postage for bulk mailings	653.53
Bank Charges	30.00
TOTAL EXPENDITURE	**$1196.85**
BALANCE SHEET (2007 – 2008)	
Funds carried forward from 2006 – 2007	$3211.25
PLUS Income 2007 – 2008	1228.19
LESS Expenditure 2007 – 2008	-1196.85
CREDIT balance carried forward to 2009	**$3242.59**

TASK/PROJECT GROUP REPORTS

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

Barry Richards and Task Group

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The Devonian–Carboniferous (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 Noire of southern France (Fig. 1), 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' (Fig. 2) was selected as the D–C Boundary GSSP by Paproth *et al.* (1991).

Recent doctoral work by Sandra Kaiser (currently at University of Bonn) 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, 2007; Heckel, 2008; Kaiser, 2009). Because of the serious problems with the integrity of the D–C GSSP, Thomas Becker (chairman of the Subcommission on Devonian Stratigraphy) and Philip Heckel (former chairman of the Subcommission on Carboniferous Stratigraphy) established the Joint Devonian–Carboniferous Boundary GSSP reappraisal task group, appointing 10 members from each subcommission to form the task group.

A chairman for the D/C task group has not been appointed. The SCCS executive has decided to wait to see what direction the new task group will take and if a chair is necessary before selecting one. The chairman, if appointed, needs to be selected from the voting members of the SCCS as that subcommission rather than the Devonian Subcommission is responsible for picking the GSSP for the base of the Carboniferous. Because the definition of the boundary will probably continue to be based on a conodont lineage, it would be appropriate that a conodont specialist chair the group.

On August 8th at the 33rd International Geological Congress (IGC) in Oslo, Norway Philip Heckel and several members of the joint D/C task group met with Thomas Becker and other members of the Devonian Subcommission to discuss the reappraisal of the D–C boundary GSSP, the membership of the joint task group, and its leadership. Unfortunately, Heckel and Richards were the only SCCS members in attendance at the workshop.

Those present at the IGC workshop agreed that the issues summarized by Heckel (2008) still required resolution and are as follows. 1) The GSSP level at the base of Bed 89 in the La Serre section seems to fall in the upper part of the *Siphonodella sulcata* Zone or even in the overlying *Siphonodella duplicata* Zone. 2) The precise zonal assignment at La Serre is hampered by the fact that the beds to do not provide high numbers of well preserved siphonodellids (but a lot of reworked conodonts). 3) The GSSP level cannot be correlated with precision into any of the other numerous D–C boundary sections. 4) Point 1 gives a clear correlation of the GSSP level with a level well within (and not below) the *Gattendorfia subinvoluta* ammonoid zone. As a consequence, *Gattendorfia* would become partly a Devonian genus, which is completely unacceptable to ammonoid workers and with respect to the long tradition (Oberrödinghausen stratotype of 1937) of the definition of the Carboniferous. 5) There is no record of the phylogenetic transition from *Siphonodella praesulcata* to *S. sulcata* (Paproth and Streel, 1984) at La Serre, which was the main reason why the GSSP was fixed there (Paproth *et al.*, 1991). Some additional problems identified by the task group at the 2008 IGC meeting in Oslo include: 1) the holotype of *S. sulcata* has apparently been lost; 2) the locations of the paratypes are uncertain, 3) the original holotype of *S. sulcata* was originally from the *Siphonodella duplicata* Zone and may have been *S. duplicata*.

Three potential methods of resolving the issue were briefly discussed at the IGC workshop: 1) lower the GSSP level down from the base of bed 89 down to the first appearance of *S. sulcata* in the La Serre section, 2) select a new GSSP section using the

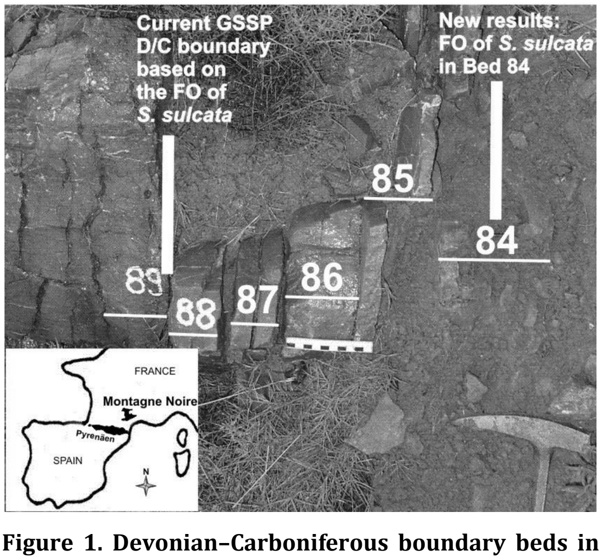

Figure 1. Devonian–Carboniferous boundary beds in La Serre Hill E' section, Montagne Noire, France showing sampled beds (from Kaiser, 2009). Figure indicates current level of D–C boundary GSSP and a proposed level.

same event level (first evolutionary appearance of *S. sulcata*), and 3) select a completely new section and definition for the GSSP. Thomas Becker indicated that resolution of the boundary issue required revision of the systematics of *S. sulcata*.

Following the workshop at the 2008 IGC in Oslo, some basic plans for future work by the D/C task group were included in the 2008 Annual Report that Richards submitted to the International Commission of Stratigraphy (ICS) in November 2008 for the SCCS. Those plans are outlined below. 1) Initially, the task group needs to restudy the lineage containing the current event marker for the D–C boundary, the first evolutionary occurrence of the conodont *Siphonodella sulcata*. 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*. Because the first appearance (FO) of *S. sulcata* may not be the best event to define the boundary, other appropriate lineages particularly within the upper part of the *praesulcata* Zone require evaluation. Since the Annual Report was submitted to the ICS, substantial progress has been made to address the problems addressed at the IGC workshop in Oslo. Sandra Kaiser continued with her work on the La Sere section and published the latest results of her work (Kaiser, 2009). New data presented

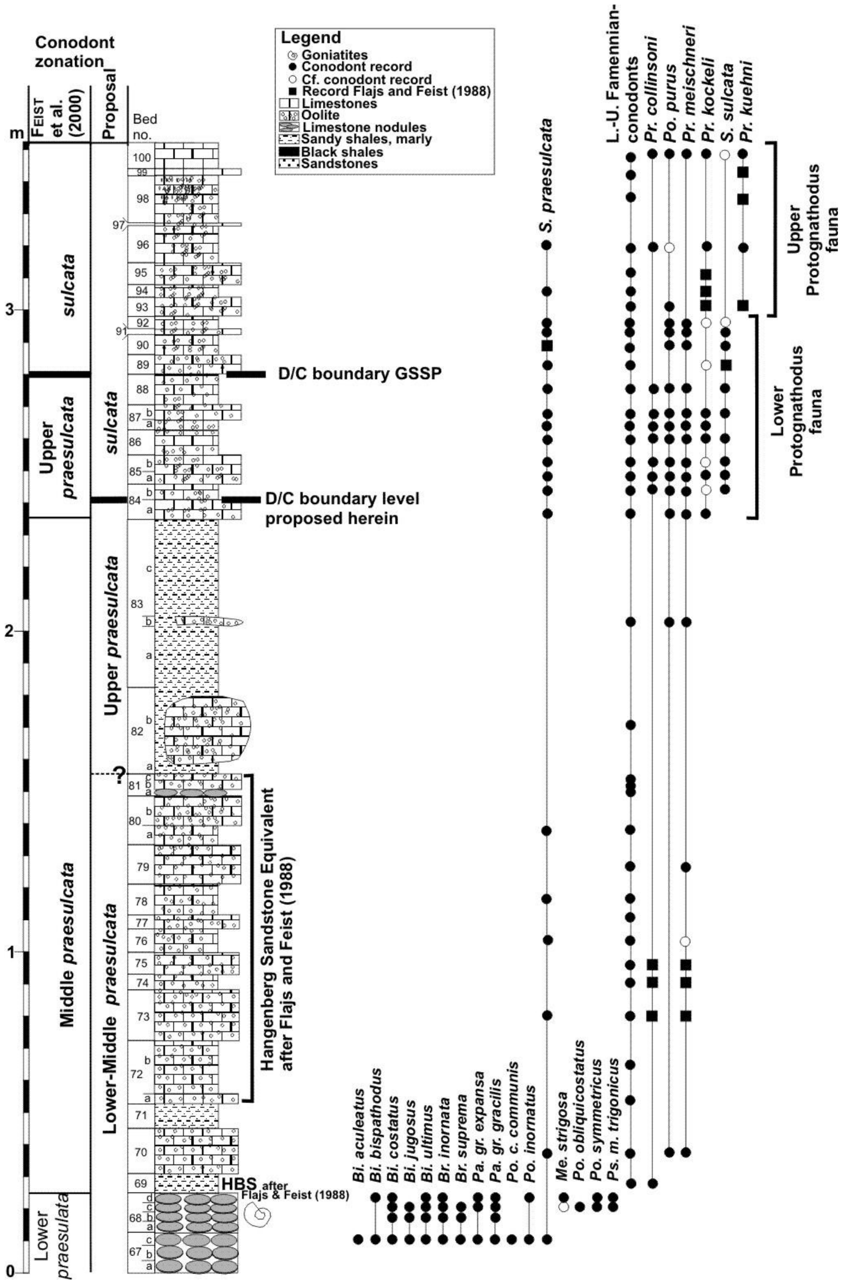

Figure 2. Stratigraphic column (from Kaiser, 2009) showing current location of the Devonian–Carboniferous Boundary GSSP at base of bed 89 and location of proposed level at base bed 84b in trench E' at La Serre Hill, southern France. Figure also shows conodont distribution. Abbreviations: HBS = Hangenberg Black Shale equivalent, Bi. = *Bispathodus*, Br. = *Branmehla*, Me. = *Mehlina*, Pa. = *Palmatolepis*, Po. = *Polygnathus*, Ps. = *Pseudopolygnathus*, Pr. = *Protognathodus*, S. = *Siphonodella*.

by Kaiser show that the first occurrence of the index fossil *S. sulcata* is slightly earlier that reported by Heckel (2008) and at the 2008 IGC workshop and is at the base of bed 84b (Fig. 2) rather than the base of bed 85. At this 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. Other protognathodid lineages also show potential for boundary definition; however, more study of those lineages is required before one can be used. 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 plan to present a paper on those topics at the ICOS 2009 in Calgary, Canada from July 12th to 17th 2009.

At the Second International Conodont Symposium (ICOS 2009), the SCCS executive and conodont specialists in the D/C task group plan to hold a workshop. The problems to be addressed include: 1) relocation of the GSSP in the La Serre section, 2) the lineage used to define the D–C GSSP, and 3) should another section be selected for the GSSP and what are the best of the candidate sections. In conjunction with the workshop, task-group members plan to visit three D–C boundary sections in the Rocky Mountain Front Ranges west of Calgary.

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REPORT OF THE TASK GROUP TO ESTABLISH A GSSP FOR THE TOURNAISIAN–VISÉAN BOUNDARY

Barry Richards and Markus Aretz

This short report is based on information we received in several e-mail messages from the task-group leader George Sevastopulo. 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 the 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 success of the task group is best documented by the global application of the boundary criteria in biostratigraphic studies in very different facies and sections, for example in central Europe (Poty *et al*., 2006; Devuyst and Kalvoda, 2007).

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

Barry Richards and Task Group

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During the past year, members of the task group have been involved in numerous activities leading toward the selection of a GSSP for the Viséan–Serpukhovian stage boundary. The task group to establish the Viséan–Serpukhovian boundary continues to find that the first evolutionary appearance of the conodont *Lochriea ziegleri* in the lineage *Lochriea nodosa–Lochriea ziegleri* presents the best potential for boundary definition. *L. ziegleri* appears near the middle of the Brigantian Substage, which is slightly below the current base of the Serpukhovian as defined by its type section in the Zaborie quarry near the city of Serpukhov in the Moscow Basin, Russia. This lineage, best documented from relatively deep-water sections, has been recently documented in the Cantabrian Mountains of northern Spain (Nemyrovska, 2005; Sanz-Lopez *et al*., 2007), Dombar Hills in western Kazakhstan (Nikolaeva *et al*., 2009a), and in the Nashui section in southern China (Qi and Wang, 2005; Qi, 2008). Although the deep-water, carbonate section near Verkhnyaya Kardailovka on the eastern slope of the southern Urals (Nikolaeva *et al*., 2005; 2009b), which contains this lineage along with moderately abundant ammonoids and foraminifers, is still an excellent candidate for the GSSP, the Nashui section and some sections in the Cantabrian Mountains present other good possibilities.

The Viséan–Serpukhovian task group and SCCS have not voted on either rejecting or accepting the first evolutionary appearance of *L. ziegleri* for boundary definition. Until recently, many task group members and other voting and corresponding members within the SCCS felt that not enough was known about the geographic distribution of the lineage and the degree of diachroneity of the first evolutionary appearance of *L. ziegleri* to warrant a vote. Despite some shortcomings, the first appearance of *L. ziegleri* appears to be a good potential marker for the boundary and better alternatives are not known.

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 Ireland are not well known. In order to better understand its distribution in that important region, task-group member Mark Dean of the British Geological Survey is investigating the distribution 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. That work is not sufficiently advanced to present any conclusions about utility of the *Lochriea* lineage for boundary definition in that region but the preliminary results from the Yordale facies of Scotland are encouraging. In samples from Scotland, Mark Dean (written com., 2009) has identified several species of *Lochriea* including *L. cruciformis*, which generally makes its first appearance near or slightly later than that of *L. ziegleri* (Skompski *et al*., 1995; Qi and Wang, 2005; Nikolaeva *et al*., 2009b). George Sevastopulo has been searching for the lineage in Ireland. Although sections containing *L. nodosa* and *L. ziegleri* have been located in Ireland Sevastopulo (written com., 2009), the conodonts are relatively rare and sections containing a well-developed lineage have not been located.

Task-group member Yuping Qi and his associates at the Nanjing Institute of Geology and Palaeontology recognized the lineage *L. nodosa–L. ziegleri* and other lineages within the *Lochriea* group of species in the Nashui section (by village of Naqing) near the city of Luodian in southern Guizhou province, People's Republic of China (Qi and Wang 2005). Qi has finished his detailed study 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. 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 of 2009, Qi *et al*. (2009) plan to present a summary of their results from the Nashui section at the International Conodont Symposium in Calgary Alberta, Canada.

Several members of the task group, along with John Groves and Katsumi Ueno visited the Nashui section in May, 2008 to begin a detailed biostratigraphic and sedimentologic analyses of that section and a nearby shallow-water (neritic to peritidal) limestone-dominant section at Yashui that also spanned the Viséan–Serpukhovian boundary. The Yashui section, situated near the city of Huishui in Guizhou province, is important because it contains abundant rugose corals and foraminifers in addition to conodonts. The purpose of studying the latter section is to determine the relationship of the coral and foraminiferal zones to the *L. nodosa*–*L. ziegleri* lineage.

During the May 2008 expedition, John Groves and Katsumi Ueno carefully sampled the Nashui and Yashui sections for foraminifers, looking for taxa that could be used to facilitate intercontinental correlation at the level of the *L. nodosa*–*L. ziegleri* transition. Later in the summer and fall of 2008, Wang Xiangdong sampled the Yashui section for corals and Qi Yuping sampled it for conodonts. The conodonts have been processed revealing that *L. nodosa* and *L. ziegleri* are present but not common. Preparation of thin sections from the corals is in progress. Thin sections have been prepared from the samples collected for foraminifers and a study of the foraminifers, which are commonly abundant, is underway. The distinctive foraminifer *Howchinia bradyana* (Howchin) is present at Yashui, making its first appearance close to that of *L. ziegleri*. *H. bradyana* has also recently been recognized in Russia (Nikolaeva *et al*., 2009b), the Nashui section, and Spain.

In May 2008, Richards started to measure the Yashui section, placing metal pins to mark the section at one-metre intervals to facilitate description and further sampling. In the fall of 2009, team members plan to describe and sample the Yashui section in more detail for sedimentological and stable-isotope geochemical analyses. As time permits in the fall of 2009, the team plans to examine other sections in southern Guizhou province to facilitate placement of the important Nashui and Yashui sections into a regional stratigraphic and sedimentologic framework.

Nikolaeva *et al*. (2005) recognized the *L. nodosa*–*L. ziegleri* lineage in a condensed, relatively deep-water, carbonate section along the Ural River opposite the village of Verkhnyaya Kardailovka on the eastern slope of the southern Urals, southern Russia. During the SCCS field meeting, which will be held in the Moscow region and southern Urals in August 2009 (see program in 2008 issue of the Newsletter), several members of the working group plan to visit the Verkhnyaya Kardailovka section to determine how that section compares with the one at Nashui in terms of the adequacy of its exposure and depositional continuity. They also plan to study the conodont collections from the interval that contains the *L. nodosa*–*L. ziegleri* lineage. Nikolaeva and her colleagues have continued to work on this section and published a synthesis of their studies on the ammonoids, conodonts, and ostracodes (Nikolaeva *et al*., 2009b). The synthesis indicates that specimens which are transitional between *L. nodosa* and *L. ziegleri* occur in the Kardailovka section immediately below the first appearance of *L. ziegleri*.

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; Nikolaeva *et al*., 2007; Konovalova and 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.

Several conodont specialists including Silvia Blanco-Ferrera and Javier Sanz-Lopez continue to study the *L. nodosa*–*L. ziegleri* lineage in the Cantabrian Mountains of northern Spain. They plan to present some of the results of their work (Blanco-Ferrera *et al*., 2009) at the International Conodont Symposium in Calgary during July, 2009. During early June of 2010, several task-group members plan to visit some of the Cantabrian sections following an International Commission of Stratigraphy meeting from May 30th to June 3rd in Prague, Czech Republic.

Several task group members, in addition to associate member Sergio Rodriguez (Universidad Complutense Madrid) and Wayne Bamber (Geological Survey of Canada-Calgary), continue to study various carbonate-dominant sections across the 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.

A multidisciplinary study resembling that of the Etherington project is continuing in Western Europe. In collaboration with D. Vachard and L. Pille (University of Lille), Markus Aretz is working on upper Asbian to Serpukhovian calcareous microfaunas and rugose corals in Morocco, France, Belgium, Germany, and England. It is hoped that through co-ordination, the western Canadian and European coral-microfaunal projects will lead to the discovery of biostratigraphic markers that can be used to facilitate correlation of the *L. nodosa*–*L. ziegleri* transition between Europe and North America.

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

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Members of the Bashkirian–Moscovian boundary task group are conducting research at a variety of locations in Europe and Asia. Investigations continue to centre on the biostratigraphic integrity of the conodont *Declinognathodus donetzianus*, *Idiognathoides postsulcatus* and *Diplognathodus ellesmerensis* for boundary characterization. Within the past two or three years, the fusulinids *Eofusulina* ex gr. *triangula* and *Profusulinella* [= *Depratina*] *prisca* have emerged as additional taxa with considerable potential for boundary characterization, although unlike the conodonts, they have not been proposed formally as boundary markers. Progress in four geographic areas is summarized in the following paragraphs.

1. South China.

As reported last year, specialists with the Nanjing Institute of Geology and Palaeontology organized an excursion in May 2008 to Guizhou Province to collect additional conodont and foraminifers samples from the Bashkirian–Moscovian boundary interval at the Nashui section, where slope carbonates of probable debris-flow origin form a continuous stratigraphic succession. Sampling also was conducted at the Yashui section, a shallow-water equivalent in which micro- and macrofossils are very abundant, and which is punctuated by multiple paleosol horizons. Participants included Wang Xiangdong, Wang Yue, Qi Yuping, Zhang Yi Qiang, He Hong Wei, Wang Jing, Katsumi Ueno, Rich Lane, John Groves and SCCS Chair Barry Richards.

All rock samples collected for foraminifers now have been thin sectioned. Groves has completed a preliminary analysis of foraminifers from the Bashkirian–Moscovian boundary at the Nashui section. Foraminifers are generally rare and somewhat poorly preserved in the slope carbonates. 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 section. Rocks at this level contain a foraminifera association dominated by *Profusulinella* spp. and *Pseudostaffella* spp. The lowest occurrence of a demonstrably Moscovian fusulinid is at 183.45 m where a single specimen of *Eofusulina* sp. was recovered. Additional thin sections are being made from the boundary interval in hopes of finding more definitive specimens in samples close to the appearance of *D. ellesmerensis*.

2. Donets Basin.

Katsumi Ueno and Tamara Nemyrovska continue their joint work on fusulinids and conodonts from multiple sections in the Donets Basin. The Malonikolaevka section, in particular, has yielded interesting new results that were summarized in a recent paper by Ueno and Nemyrovska (2008). At Malonikolaevka, the proposed boundary marker *Declinognathodus donetzianus* first occurs in Limestone K_1 in evolutionary continuity with the ancestral *D. marginodosus*, which itself first occurs in Limestone I_2. Limestone K_1 also contains unquestioned occurrences of the Moscovian fusulinid *Eofusulina*. Possible specimens of *Eofusulina* were observed in Limestone I_3, but their identity will require confirmation by examining additional material.

3. Northwest Spain.

Javier Sanz-López, Silvia Blanco-Ferrera and Elisa Villa are conducting integrated foraminifera and conodont biostratigraphic analyses on rocks from the San Antolin-La Huelga section along the cliff and beaches of the Bay of Biscay in the Cuera area (Villa 1995; Villa *et al*. 1997). The San Antolin-La Huelga section is a progradational sequence consisting of basin/toe-of-slope deposits near the base grading into platform-top deposits near the top. The Bashkirian–Moscovian boundary provisionally has been placed about 180 m above the base of the section in beds interpreted as lower-slope deposits. The boundary is marked by the lowest occurrence of *Idiognathoides postsulcatus*, and this level is just slightly higher than the lowest observed occurrences of *Declinognathodus marginodosus* and *Profusulinella* ex gr. *prisca*. The San Antolin-La Huelga section is remarkable in that it contains all four conodont taxa identified as potential Bashkirian–Moscovian boundary markers: *Id. postsulcatus*, *Diplognathodus ellesmerensis*, *Neognathodus nataliae* and *Declinognathodus donetzianus*. The lowest occurrences of these conodont species are in the order listed, spanning a stratigraphic interval of just over 300 m.

4. South Urals.

Elena Kulagina has completed a study of *Depratina prisca* in which she documented its evolutionary origin and showed that its first occurrence in the South Urals can be used to identify the base of the Moscovian Stage (Kulagina 2009). [*Schwagerina prisca* Deprat 1912 was designated as type species of the genus *Depratina* Solov'eva *in* Rauser-Chernousova *et al*. 1996. 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 Basu section is especially noteworthy because it contains the appearance of *D. prisca* just a few meters below the appearance of *D. donetzianus*.

Plans for 2009–2010. Task group members will continue their investigations of potential boundary markers and potential GSSP sites.

In addition to ongoing research, the Paleontological Institute (RAS, Moscow) and the Institute of Geology of the Ufa Research Centre (RAS) will host an international field meeting of the SCCS, August 11–19, 2009. This meeting will be a good opportunity for members of the task group to gather and discuss issues of common interest. Alexander Alekseev will organize a meeting of our group. Members will arrive in Moscow one or two days prior to the beginning of the SCCS field meeting. The Paleontological Institute will provide a meeting room in which members can examine conodonts, foraminifers, etc., and discuss issues relating to the eventual selection of a boundary stratotype.

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

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This year, the task group itself experienced some modifications in composition. María Luisa (Lis), Martínez-Chacón (Spain), and Beate Fohrer (Germany) stepped down from task-group membership, and Steven J. Rosscoe (U.S.A), Javier Sanz-López (Spain), and Qi Yuping (China) were appointed to be new members. Moreover, former task-group chair, Elisa Villa (Spain) was succeeded by Katsumi Ueno (Japan). On behalf of all the task-group members, I would like to express our deepest gratitude to Lis and Beate for their long-standing contributions to the task group in the past years, and to Elisa for her superb leadership that always ably directed and inspired our task group to be what it should be since the task group was established in 1989.

In the previous year, the task group made two important decisions toward the selection of the two boundaries it deals with (see below). Following these decisions, task-group members are continuing to investigate in their own areas and disciplines, and have made the following recent progress.

Moscovian–Kasimovian Boundary

Villa and Task Group (2008) reported that the members of the task group who attended the 2008 Oviedo meeting reached unanimous agreement to focus further work on two conodont species: *Idiognathodus sagittalis* Kozitskaya, 1978 and *Idiognathodus turbatus* Rosscoe and Barrick, 2009a, as the potential biostratigraphic marker by which the level of the base of the Kasimovian Stage can be selected and correlated globally. At the same time, several important stratigraphic and biostratigraphic events that have been recognized near the FAD levels of these two conodont species were also examined, because they have potential to serve as auxiliary physical/biotic events for identifying the base of the global Kasimovian Stage in case one of these conodonts is finally selected as the marker. Following the "unofficial" approval at that workshop, the task group took a vote on narrowing the focus of study to an interval of correlation that encompasses the FADs of the conodonts *I. sagittalis* and *I. turbatus* for definition of the Moscovian–Kasimovian boundary. The use of either conodont would cause the potential boundary level to be raised from the traditional position at the base of the Krevyakinian, to approximately the base of the Khamovnikian. The result of the vote was: 21 task-group members agreed on narrowing the focus, 1 member disagreed, and 1 member abstained. Therefore, the proposal was passed by a 95.5% majority of the 22 votes cast, which represented 91% of the total membership of the task group at that time. This level is approximately one substage higher than the traditional base of the Kasimovian at the base of the Krevyakinian Substage, but it facilitates global correlation.

Therefore, the task group's activity for defining the Kasimovian–Gzhelian boundary will now involve examining the stratigraphic occurrences and distributions of *Idiognathodus sagittalis*, *I. turbatus*, their potential ancestors, and their stratigraphic relations with other potential auxiliary events that are recorded close the FADs of these two conodont species in each study section. Based on this new research direction, several task-group members have made the following progress in their research:

Andara Massif, NW Spain. Part of the Spanish research group (Elisa Villa, Juan R. Bahamonde, Oscar Merino-Tomé, and Javier Sanz-López) recently started a new research project in the Andara Massif (Picos de Europa, NW Spain), to study the Moscovian–Kasimovian transitional interval. They investigated two sections: the Castillo del Grajal and Morra del Lechugales sections, which embrace the uppermost part of the Picos de Europa Formation and the Las Llacerias Formation, both represented by calcareous successions. The most remarkable characteristics of these sections are the extremely high rate of carbonate deposition and the high diversity of biotic communities (Merino-Tomé *et al*., 2009).

According to fusulinid biostratigraphic data, the stratigraphic interval studied ranges from the top of the *Fusulinella* Zone (upper Moscovian) to the lower *Montiparus* Zone (Khamovnikian). The *Protriticites* Zone, with a total thickness attaining at least 245 m, is particularly well exposed and fusulinid rich. Preliminary sampling for conodonts reveals the occurrence of the species *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. (See in this volume the report by Villa *et al*. for more details on this research).

Moscow Basin, Russia. The Russian research group (Natalia V. Goreva, Aleksander S. Alekseev, Tatiana I. Isakova and Olga L. Kossovaya) published a detailed biostratigraphic analysis of the conodonts, fusulinids, brachiopods, corals, bryozoans, ammonoids, and ostracodes across the Moscovian–Kasimovian transition at the Afanasievo Quarry approximately 90 km southeast of Moscow City (Goreva *et al*., 2009), where the neostratotype section of the Kasimovian regional stage of Russia was established by Makhlina *et al*. (2001). At the quarry, the latest Moscovian limestone of the Peski Formation is overlain by shallow-water carbonates of the Krevyakinian, Suvorovo and Voskresensk formations, and the Khamovnikian Ratmirovo and Neverovo formations. These strata yield abundant micro- and macrofossil remains, and were formed under the strong influence of glacio-eustatic sea-level fluctuations with distinct paleosol horizons and minor stratigraphic gaps.

In the Afanasievo succession, *Idiognathodus sagittalis* first appears at the base of the middle member of the Neverovo Formation (about 2 m above the base of the formation), where it occurs with *I. turbatus*, another potential marker conodont species for defining the Moscovian–Kasimovian boundary (Villa and Task Group, 2008). This level is close to the FAD of the fusulinid *Montiparus* (*M. paramontiparus*) at the very base of the Neverovo Formation. Goreva *et al*. (2009) further recognized *Idiognathodus* n. sp. 1 as the possible ancestor of *I. sagittalis*. This form is first found in the lower part of the Suvorovo Formation, but becomes more abundant in the overlying Voskresensk Formation with more advanced morphotypes. The lineage can be considered as a prospect for future fixing of the GSSP of the relevant boundary at the level of the first appearance of *I. sagittalis*.

Thus, the Afanasievo section can be considered as a possible candidate for the GSSP at the lower boundary of the Kasimovian. The best-recognized and most-correlated levels are: 1) the base of the *Montiparus montiparus* fusulinid zone, defined by the first occurrence of the genus *Montiparus,* and 2) base of the *Idiognathodus sagittalis* conodont zone, based on the first occurrence of the zonal species. Advantages of the Afanasievo section as a stratotype for the lower boundary of the Kasimovian are as follows: (1) good geographic accessibility, (2) refined characterization by conodonts and fusulinids, (3) diverse macrofauna (rugose corals, bryozoans, and brachiopods), and (4) high potential for correlation with Eurasian sections. The disadvantage of the section, which is dominated by shallow-water facies, is the occurrence of several erosional unconformities of uncertain duration, particularly between the Peski and Suvorovo, Suvorovo and Voskresensk, and Ratmirovo and Neverovo formations.

Donets Basin, Ukraine. Vladimir I. Davydov and his student Rimma R. Khodjanyazova recently studied the taxonomy and biostratigraphy of fusulinids within the Moscovian–Kasimovian transition in the Kalinovo section (Aizenverg *et al*., 1975) of the Donets Basin. They examined fusulinids from limestone units of the C_3^1 (N) and C_3^2 (O) suites and correlated them with the strata in 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 advanced *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 formations 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 Formation, as O2 contains *M. subcrassulus*, which is reported also in the middle member of the Neverovo Formation (Goreva *et al*., 2007).

The above-mentioned correlation by Davydov and Khodjanyazova is quite different from the correlation of Heckel *et al*. (2007), which is based on integrated cyclothem and dominantly conodont-based biostratigraphic correlation. Therefore, it is necessary to cross-check the result based on detailed conodont and fusulinid composite biostratigraphy in the Donets Basin. Tamara I. Nemyrovska and Katsumi Ueno are working on this topic in the Kalinovo section, from which earlier data were used by Heckel *et al*. (2007).

Midcontinent Basin, U.S.A. *Idiognathodus turbatus* established by Rosscoe and Barrick (2009a) is one of the conodont species that currently is being considered to serve as the potential biostratigraphic marker for the Moscovian–Kasimovian boundary (Villa and Task Group, 2008). Originally, this species was defined by the P1 element with an expanded and well-developed rostral accessory robe at the same level as the platform surface and a ventral platform with medial nodosity and shallow medial trough (Rosscoe and Barrick, 2009a, p. 130). Rosscoe and Barrick recently carried out a more detailed study on the morphology of this species and related forms based on materials from several sections from central Kansas to south-central Oklahoma in the Midcontinent Basin, and made a revision of *I. turbatus*. They expressed a view to restrict this species to only those forms with expanded, well-developed rostral lobes and distinctive medial nodosity. This revision results in putting the FAD of (revised) *I. turbatus* at the base of the Hertha Cyclothem, which is two cycles higher than it was originally recognized in Rosscoe and Barrick (2009a). (See in this volume the report by Rosscoe and Barrick for more details on this research).

Nashui Section, South China. The Nashui section (Wang and Qi, 2003; Qi *et al*., 2007) in southern Guizhou Province is one of the most-continuous and best-exposed sections embracing the Moscovian–Kasimovian boundary interval in South China. It consists entirely of calcareous turbidites, representing a slope environment in a carbonate platform to basin setting with moderate depositional rates, and is particularly rich in conodonts throughout the section. Qi Yuping and Wang Zhihao investigated a conodont succession across this boundary interval in the Nashui section 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 about 225 m above the base of this section. Katsumi Ueno also worked with Qi Yuping, Wang Xiangdong, and Wang Yue in this section and systematically collected samples for fusulinid study on a bed-by-bed basis. Fusulinids are rather sparse across the boundary interval and are found only at certain levels in the base of coarse-grained turbidite beds. The detailed, conodont-fusulinid composite biostratigraphy is currently being investigated by these researchers.

Kasimovian–Gzhelian Boundary

The most important outcome of task group activity on the Kasimovian–Gzhelian boundary is the publication of Heckel *et al*. (2008), which describes the formal selection of the conodont *Idiognathodus simulator* (s.s.) as the event marker for defining the base of the Gzhelian Stage. This decision was supported by unanimous agreement in a ballot of task-group members and later formally approved by the voting membership of SCCS (Villa *et al*., 2009). Thus, we are now focused on GSSP selection for the base of the global Gzhelian Stage as the next and final task related to this boundary.

Summaries of two recent research projects on this boundary by task group members are provided below.

Moscow Basin, Russia. In the historical stratotype of the regional Gzhelian Stage in the Moscow Basin, the Russian research group (Aleksander S. Alekseev, Natalia V. Goreva, Tatiana I. Isakova, and Olga. L. Kossovaya) carried out a comprehensive study on lithostratigraphy and biostratigraphy. In the Gzhel Quarry section east of Moscow, only the lower part of the stage is exposed, in strata referred to as the Rusavkino Formation. The section consists of bed 1 of Member 4 (Middle Rusavkino) and beds 2–9 of Member 5 (Upper Rusavkino) (Anonymous, 1998).

Among fusulinids, two ecological assemblages are recognized, replacing each other upwards in the section. The first (lower) assemblage is found in beds 4 and 5 and includes *Quasifusulina longissima*, *Q. ultima*, *Q. eleganta*, *Rauserites postarcticus*, *R. paraarcticus*, and others. *Quasifusulina* dominates over *Rauserites* in the assemblage. The second (upper) assemblage is observed in bed 8 and represents a rich population of *Rauserites*, including dominant *R. rossicus* and minor *R. postarcticus* and *R. paraarcticus*. Moreover, three different morphological groups are distinguished in the *R. rossicus* population from bed 8. Thus, it is necessary to take into account polymorphic status of this species for regional correlation.

Conodonts are abundant in the Gzhel Quarry section. Although a single juvenile specimen of *Idiognathodus simulator* occurs in the top of bed 3, the typical *I. simulator* started appearing in bed 4, together with *Streptognathodus pawhuskaensis* and *Idiognathodus tersus*. Alekseev and others also re-examined conodonts collected from the stratotype of the Rusavkino Formation near Rusavkino east of Moscow and in borehole 6k, drilled at Konyashino village north of the Gzhel Quarry. They showed that *I.* aff. *simulator* (= *Idiognathodus eudoraensis* Barrick, Heckel and Boardman, 2008), which is considered as a possible 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 level of *I. simulator* in the Moscow Basin is close to that of *Rauserites rossicus*.

The *Idiognathodus simulator* Zone in the Moscow Basin (Barskov *et al*., 1982, 1984; Alekseev and Goreva, 2007) is characterized by a very specific assemblage and is well recognizable. Besides the zonal species, it includes *Streptognathodus pawhuskaensis*, *Idiognathodus tersus*, *I. toretzianus*, *I. luganicus*, *I. sinistrum*, and *Gondolella bella*. The lower boundary of the Gzhelian Stage has to be situated within the Rusavkino Formation (close to the base of its upper member), based on the first appearance of *I. simulator*. Although the proposed boundary is somewhat above the base of the formation, this will not affect the regional and interregional correlation.

Nashui section, South China. Qi Yuping recently established a detailed conodont biostratigraphy of the Kasimovian–Gzhelian transitional interval in this section as a part of his dissertation (Qi, 2008). In ascending order, he recognized the *Streptognathodus gracilis*, *Streprognathodus guizhouensis, Streptognathodus simulator*, *Streptognathodus nashuiensis*, and *Streptognathodus firmus* zones. According to Qi, the first occurrence of *S. simulator* (=*Idiognathodus simulator* sensu Barrick *et al*., 2008) is about 265 m above the base of the section. Last December, Katsumi Ueno worked with Wang Yue in this section, measured the Kasimovian–Gzhelian boundary interval, and collected samples for fusulinid investigation on a bed-by-bed basis. Samples are now being processed. These works suggest a potential that firm, composite biostratigraphy based on conodonts and fusulinids could be established in this section in the future. Because the Nashui section is an almost complete continuous section with rich conodont records, which exhibits a typical slope environment in a carbonate-platform to basin setting, it is a very promising potential GSSP candidate for the Kasimovian–Gzhelian boundary.

Coming steps

In August 2009, the International Field Meeting of the I.U.G.S. Subcommission on Carboniferous Stratigraphy will be held in the Moscow Basin and the Southern Urals in Russia. This field meeting is organized by Russian colleagues, including members of our task group, and is focused on visiting several historical type sections, and proposed and potential GSSPs of the Carboniferous in Russia. Participants will see the lower Kasimovian succession at the Afanasievo Quarry and the lower Gzhelian succession at the Gzhel Quarry in the Moscow Basin, and will also visit the Usolka section, a potential GSSP candidate for the base of the Gzhelian, in the Southern Urals. It should provide us a good opportunity to do on-the-spot surveys of these important sections.

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REPORT FOR THE PROJECT GROUP "CARBONIFEROUS MAGNETOSTRATIGRAPHY"

Mark W. Hounslow

The number of members in the project group is small and we would welcome any interested persons or parties who are interested in utilizing or evaluating Carboniferous magneto-stratigraphy in combined stratigraphic projects. We would particularly welcome information from those working on specific sections where magnetostratigraphy could be attempted, to improve international correlations, and help the objectives of the SCCS. We would also welcome any news of, perhaps unpublished information, on specific sections, where magnetostratigraphy has been attempted, so as to disseminate as widely as possible both positive and negative magnetostratigraphic results to the project group.

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 of these sections are dominated by siliciclastic units which appear to provide the best potential for recovery of primary magnetisation (based on the review which appeared in the SCCS newsletter, vol. 22: 35-41). Both sections are on the flanks of the Southern Uplands landmass, and so have good potential for low thermal maturity. The first, which is at Cove (~400 m thick) in the Cockburnspath outlier on the southern flank of the Midland Valley Basin, shows a transition from fluvial red-bed facies into lacustrine and flood-plain deposits, locally with marine influence. The succession includes the Inverclyde and Strathyclyde groups and appears to represent an interval from the latest Devonian (based on scales of the Devonian fish *Holoptychius*), through the Tournaisian (based on palynological assemblages) to the late Viséan (Asbian), based on goniatites (Cossey *et al*., 2004). This section is also particularly important, since it allows faunal linkage of Scottish and English successions. The second section is at Kirkbean (~600 m thick) on the northern edge of the Northumberland Basin and covers the age interval early to late Viséan (Chadian? to Asbian?), overlapping in age with the upper part of the Cove section. The succession represents a shallow-marine setting with intervals recording fluvial and distal delta-front progradation. In spite of the section containing conodonts, it has not been systematically studied in detail for its biostratigraphy, and its precise lithostratigraphic/age relationships to other sections in the Northumberland Basin have been debated (Cossey *et al*. 2004). The Kirkbean section is adjacent to a granite batholith, unroofed in the early Carboniferous, and as such provides the possibility of fresh igneous detritus to carry the palaeomagnetic signal. Fold tests are possible in both sections.

Both sections contain frequent silty and fine-sandy intervals, and are continuously and well-exposed on wide foreshore and cliff sections, which suggests potentially good targets for palaeomagnetic work. In addition, the age-overlaps of these sections provide a possibility for cross-validation of any magnetostratigraphic data obtained.

The magnetostratigraphic work on the important Carboniferous–Permian boundary (CPB) section at New Well Peak (S.W. New Mexico; SCCS Newsletter, v. 23, p. 11-12) has indicated that this section has been remagnetised during the late Cretaceous–early Tertiary (Kate Zeigler pers. comm.). The targets for this work were short normal polarity magnetozones, both above and below the CPB, known from sections in central Asia, within the Permo–Carboniferous reverse superchron. In contrast, a review of Permian magnetostratigraphic data from Spitsbergen (Hounslow & 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 these arctic sections.

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TEHYAN AFFINITIES OF PENNSYLVANIAN NON-MARINE BIVALVES OF SOUTH-WESTERN GONDWANA (ARGENTINA)

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Late Pennsylvanian deposits of Argentina are positioned between the "middle" Carboniferous and the Early Permian glacial sequences and are described as interglacial within the Late Palaeozoic Ice Age. This sequence crops out as patches along the western Andean belt, from the northern limit of the Precordillera to the northern border of Patagonia, but shows its more complete development in the Uspallata-Iglesia Basin. There the sequence attains nearly 3000 m thickness in the Cerro Agua Negra Formation. No other sequence of this age and magnitude is known to occur elsewhere in Gondwana, where strata representing this interval of geologic time are largely absent because of the generalised regression that occurred during the Late Pennsylvanian (Roberts *et al*., 1995; Dickins, 1996). Consequently, these strata contain a sedimentary record that is of the utmost importance for representing events and conditions during the Late Palaeozoic Ice Age. We can assume that perhaps not all, but at least some of the most important events that are recorded by the Cerro Agua Negra Formation may be extrapolated to the rest of Gondwana, especially those with wide-reaching effects, such as major climatic changes.

The Cerro Agua Negra Formation encompasses two marine members that are separated by continental deposits bearing the *Nothorhacopteris* (NBG) flora. Moreover, there are paleosols and beds with remains of tree trunks in life position in the continental sediments. In some localities within the Uspallata-Iglesia Basin, these strata also include low-quality coal seams. The upper marine member of Cerro Agua Negra Formation contains the *Kochiproductus–Heteralosia* assemblage that is regarded as a "warm" fauna (González, 1997). Close above these marine strata, there is a thin bed of black silty mudstones with abundant moulds of non-marine bivalves and ostracods. A characteristic of the bivalve fauna is the abundance of specimens. It has, however, an extremely low diversity and only the genus *Anthraconaia* is present and represented by three new species.

Anthraconaia is ubiquitous in faunas of the Pennsylvanian Coal Measures of Europe, where it is associated with other genera of non-marine bivalves. None of these genera are known to occur above the Carboniferous–Permian boundary. The presence of *Anthraconaia* in western Argentina indicates that some links existed during this time with faunas of the western Tethys and that the environment was to some extent comparable. Their occurrence above marine strata bearing an invertebrate ("warm") fauna with paleotropical affinities and the existence of continental deposits with abundant remains of the *Nothorhacopteris* (NBG) flora, horizons of paleosols, modest development of forests and beds of low-quality coal, shows that, in spite of the endemism, the environment in this region was probably to some extent approaching that of the paleoequatorial realm. These conditions suggest a warm climate existed in southwestern Gondwana, although it was less humid and perhaps had less CO2 available than in the northern hemisphere (see Cleal and Thomas, 2005). The absence of known glacial sediments within the succession provides additional support for the interpretation that a time of warming or an interglacial existed between the middle Carboniferous (Serpukhovian and Bashkirian) and Early Permian (Asselian–Tastubian) glacial periods (González, 1990; González and Díaz Saravia 2008).

The Cerro Agua Negra Formation is stratigraphically close to the Carboniferous–Permian boundary. Thus, it is not surprising to find among the invertebrates of the upper marine member a mixture of taxa having Carboniferous and Permian affinities. This gave rise to different opinions about the age of these deposits and some authors claim an Early Permian age for the brachiopods. Unfortunately, there is no other occurrence for comparison inside the Gondwana realm to confirm or refute this assertion. The presence of the genus *Anthraconaia* associated with the brachiopods suggested close similarities with the Tethyan realm and point clearly towards a Late Pennsylvanian age for the non-marine bivalve fauna of western Argentina. Moreover, it has been widely demonstrated that many bivalve genera that are better known as components of the Early Permian endemic (Gondwana) fauna appeared during the middle Carboniferous glacial period (Runnegar, 1972; González, 1972, 1983, 1997, 1998, 2002; González and Díaz Saravia, 2007). Are the brachiopods or any other group of invertebrates the exception?

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IDIOGNATHODUS TURBATUS AND OTHER KEY TAXA OF THE MOSCOVIAN-KASIMOVIAN BOUNDARY INTERVAL IN THE MIDCONTINENT REGION, NORTH AMERICA

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Introduction

Idiognathodus turbatus Rosscoe and Barrick 2009 is one of the conodont species currently being considered to serve as the biostratigraphic marker for the Moscovian–Kasimovian Boundary (Villa and Task Group, 2008). As originally published, *Idiognathodus turbatus* was defined by an expanded rostral lobe at the same level as the platform and disrupted transverse ridges along the platform. Disruption of transverse ridges included a caudal groove, medial nodosity, and complete nodosity of the majority of the platform. Based on a more detailed study of this species and related forms, we now restrict *I. turbatus* to only those forms with well-developed medial nodosity. Excluded from *I. turbatus* are similar morphotypes in which platform nodosity appears chaotic, random and not medial. Information from several sections from central Kansas to south-central Oklahoma document the stratigraphic levels at which *I. turbatus* and related *Idiognathodus* species occur within the Midcontinent Basin of North America.

Idiognathodus Species of Significance

Idiognathodus swadei Rosscoe and Barrick, 2009, is the species from which all *Idiognathodus* species in the boundary interval of the Midcontinent were derived. *Idiognathodus swadei* is the only member of the genus to survive the late Desmoinesian (~late Moscovian) extinction event. Rapid evolution following the extinction event resulted in the diversification of at least two major lineages of *Idiognathodus* from *I. swadei*, one of which is the lineage leading to *I. turbatus. Idiognathodus swadei* (Figure 1.1 and 1.2, Figure 2A) is diagnosed by its expanded and highly developed rostral lobe extending nearly one-half the length of the platform (Rosscoe and Barrick, 2009). We restrict the descendent species *Idiognathodus turbatus* to only those forms with expanded, well-developed rostral lobes and distinctive medial nodosity (Figure 1.5 and 1.6, Figure 2C). The original diagnosis of *I. turbatus* required only that the transverse ridges be disrupted. We recognize a new form, *Idiognathodus swadei* new subspecies 1 (Figure 1.3 and 1.4, Figure 2B) to include specimens with an expanded rostral lobe and a caudal groove disrupting the ridged platform, but without medial nodosity. This new subspecies appears in the Exline cycle and represents an intermediate form between *I. swadei* and *I. turbatus*. Those specimens whose transverse ridges are entirely replaced by chaotic nodosity are now considered to be a separate species, *Idiognathodus* new species Z (Figure 1.7, Figure 2D). *Idiognathodus* n. sp. Z first appears at the base of the Mound City Shale in the Hertha sequence. *Idiognathodus turbatus,* with its clearly defined medial nodes, first appears in the basal deposits of the Mound City Shale of the Hertha Cyclothem. The replacement of transverse ridges with nodes in the *I. turbatus* group represents a wholesale change in how the P_1 element processes food and therefore represents a distinctive biological change. *Idiognathodus turbatus* is the species that marks this transition from ridged to nodose platforms, while *I.* n. sp. Z represents the complete shift from ridged to nodose platforms.

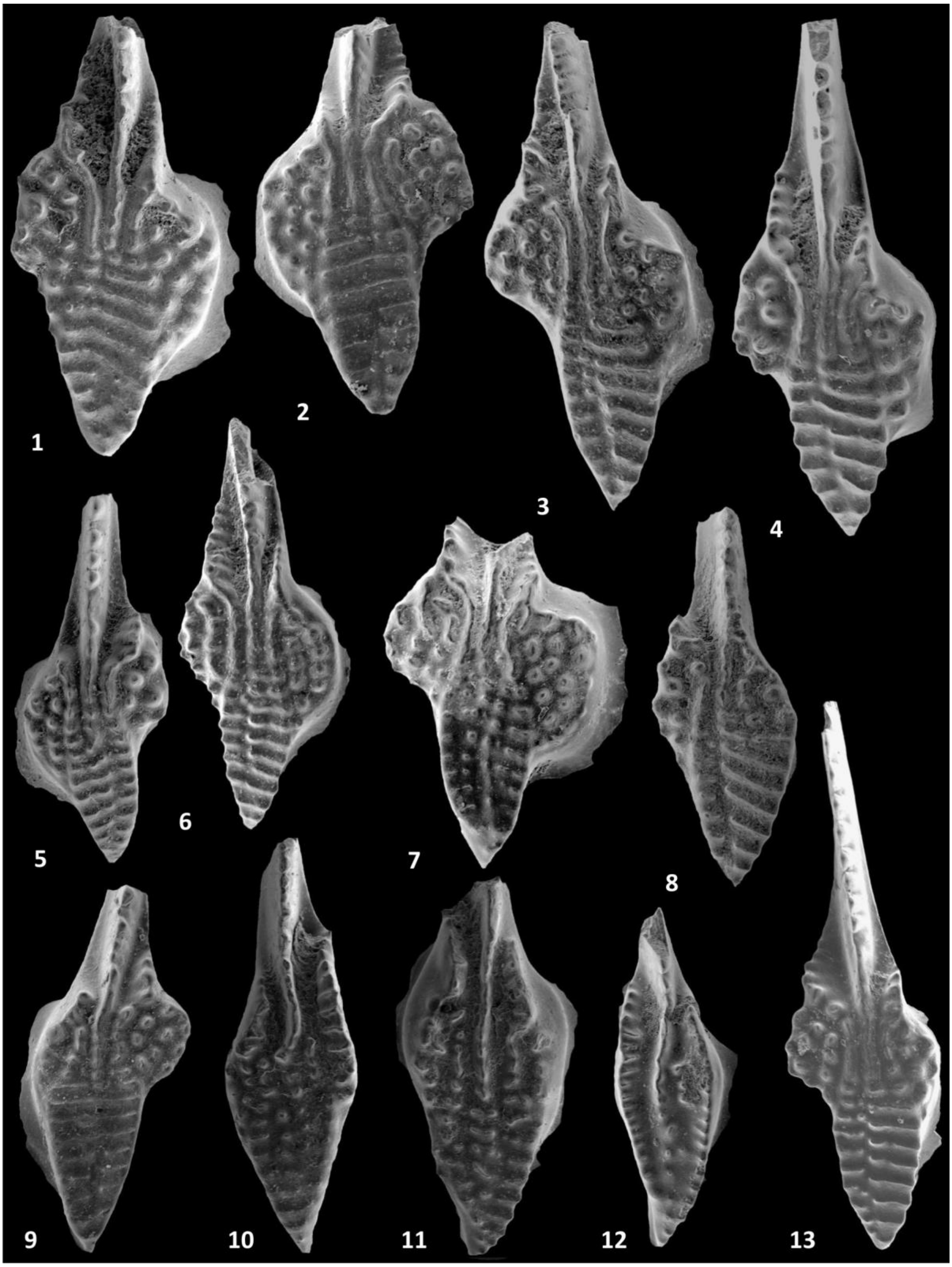

Figure 1: Biostratigraphically significant species of *Idiognathodus* in the Moscovian–Kasimovian boundary interval of the Midcontinent, North America. All specimens shown at 50X magnification. 1.1 and 1.2 - *I. swadei swadei*. 1.3 and 1.4 - *I. swadei* n. ssp. 1. 1.5 and 1.6 - *I. turbatus*. 1.7 - *I.* n. sp. Z. 1.8 and 1.13 - *I. eccentricus*. 1.9 - *I. sulciferus*. 1.10 and 1.11 - *I. cancellosus*. 1.12 - *I. biliratus*. All specimens have been previously illustrated in Rosscoe and Barrick, 2009, and Rosscoe, 2008.

The evolutionary lineage of the *I. turbatus* group is shown in Figure 2.

The most dominant species of *Idiognathodus* seen throughout the study interval is *I. sulciferus* Gunnell, 1933. *Idiognathodus sulciferus* (Figure 1.9) is diagnosed by a P_1 element with a restricted to moderately restricted rostral lobe that extends only one or two transverse ridges beyond the first ventral transverse ridge (Rosscoe and Barrick, 2009).

Idiognathodus sulciferus appears in the Checkerboard/South Mound cyclothem and ranges throughout the study interval with some variability to the overall shape of the element.

Idiognathodus eccentricus (Ellison, 1941) has been used as the biostratigraphic marker of the base of the Missourian Regional Stage (~Kasimovian) in the Midcontinent Basin (Heckel *et al*., 2002). *Idiognathodus eccentricus* (Figure 1.8 and 1.13) is diagnosed by its restricted rostral lobe and the presence of a rostral groove that disrupts the transverse ridges of the platform (Rosscoe and Barrick, 2009). This form first appears as low as the base of the Exline Limestone, but in some sections does not appear until the base of the Mound City Shale.

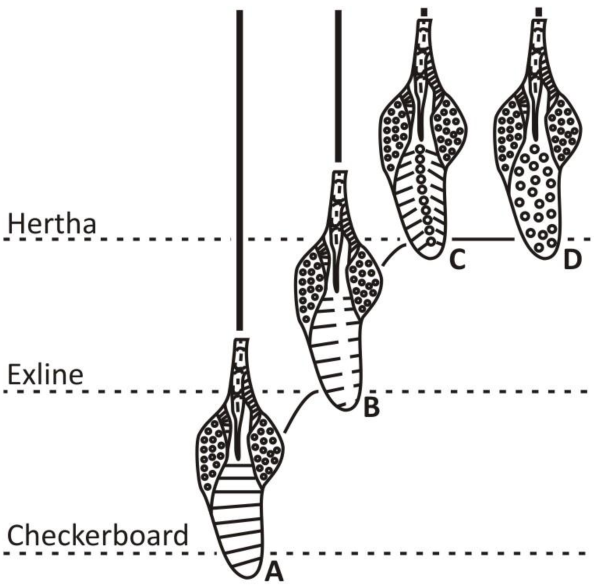

Figure 2: Line drawings representing the morphological changes exhibited along the *Idiognathodus swadei–Idiognathodus turbatus* lineage. Solid lines show relationships and range of species. Dashed lines mark the base of each cyclothem. All species shown range into the overlying Swope cyclothem, while only *I. swadei* occurs in the lower Lost Branch cyclothem.

The Swope Cyclothem, which overlies the Hertha Cyclothem, can be easily recognized by two distinctive species. These species may be useful as secondary higher markers of the boundary interval in the Midcontinent Region. *Idiognathodus cancellosus* (Gunnell, 1933) is diagnosed as a P_1 element with reduced rostral and caudal lobes, and a distinctive medial row of nodes (Rosscoe, 2008). *Idiognathodus cancellosus* (Figure 1.10 and 1.11) first appears in the basal Hushpuckney Shale of the Swope Cyclothem. Also appearing in the basal Hushpuckney Shale is the species *I. biliratus* Gunnell, 1933. *Idiognathodus biliratus* (Figure 1.12) is easily diagnosed by its lack of both rostral and caudal accessory lobes.

Conodont Ranges through the Boundary Interval in the Midcontinent Region

The geology of the boundary interval consists of the Checkerboard/South Mound minor cyclothem, the Exline intermediate cyclothem, the Critzer minor cyclothem, and the Hertha major cyclothem. Cyclothems are the deposits that the Midcontinent Sea formed as it transgressed and regressed in response to glacio-eustatic sea-level fluctuations. One transgression and regression forms a cyclothem. Minor cyclothems are thin marine intervals of limestones and shales of limited areal extent, intermediate cyclothems contain conodont-rich gray shale and are typically regionally limited in areal extent, and major cyclothems are widespread and have conodont-rich black shales at their cores (Heckel, 2002).

Figure 3 illustrates the physical stratigraphy and conodont paleontology of the Exline to Hertha interval at the Uniontown road cut of Heckel *et al*., 1999). The Uniontown section is lithologically diverse, represents each of the cyclothems, and clearly exhibits each of the biostratigraphic features discussed in this article, including the lowest first appearance of *I. eccentricus* and *I. turbatus*. Of all the Midcontinent sections investigated, the Uniontown road cut best represents the lithological and paleontological record through the Moscovian–Kasimovian boundary interval.

The lowest marine units in the boundary interval comprise the Checkerboard/South Mound minor cyclothem, which includes the Checkerboard Limestone and the South Mound Shale. The conodont fauna of the Checkerboard/South Mound cyclothem is dominated by *Idiognathodus.* The most common species are *I. sulciferus* and *I. swadei* along with some *I. harkeyi*. In the Checkerboard limestone (and its shale equivalents) *Hindeodus* is common. In sections south of Tulsa, Oklahoma, the presence of *Idioprioniodus* is also noted.

The Exline intermediate cyclothem consists of the Exline Limestone and overlying Mantey Shale. The Exline Limestone is dominated by *Idiognathodus*. The primary species of *Idiognathodus* include *I. sulciferus* and *I. swadei* with the added presence of *I. swadei* new subspecies 1, *I. harkeyi*, *I. fusiformis,* and *I. eccentricus.* The base of the Exline Limestone is the lowest first appearance of *I. eccentricus*. In the sections studied the first appearance of *I. eccentricus* ranges from the base of the Exline Limestone to the base of the Mound City Shale. The Mantey Shale, where sampled, yielded specimens of *Idiognathodus* and *Idioprioniodus*.

The Critzer minor cyclothem comprises the Critzer Limestone and the overlying Guthrie Mountain Shale. The Critzer cyclothem consists of the Critzer Limestone and overlying Guthrie Mountain Shale. The Critzer Limestone conodont fauna is dominated by *Idiognathodus*, with a species distribution similar to that of the Exline Limestone. In addition to *Idiognathodus,* specimens of *Idioprioniodus*, *Adetognathus*, and *Hindeodus* are present. The Guthrie Mountain shale did not yield conodonts where sampled.

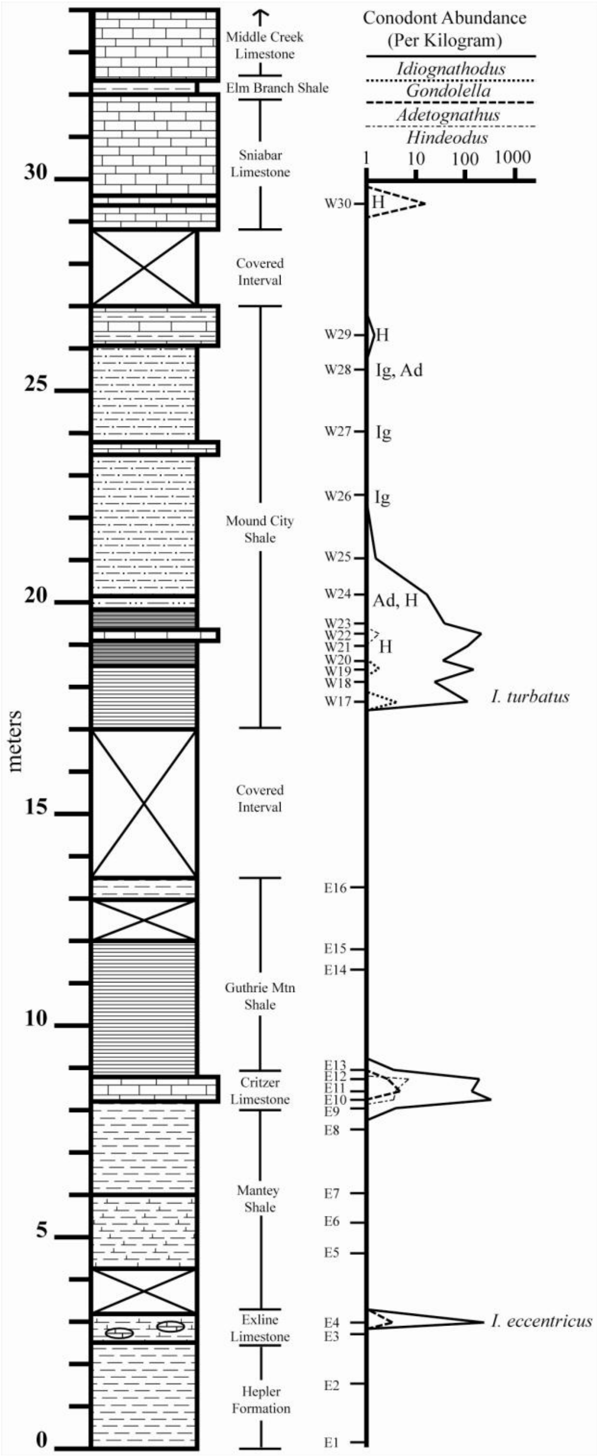

Figure 3: Stratigraphy and conodont distribution for the Uniontown section (Heckel *et al.*, 1999). Abbreviations are used to indicate presence of single specimens. The first appearances of *I. eccentricus* and *I. turbatus* are indicated.

The Hertha major cyclothem includes the Mound City Shale and the overlying Sniabar Limestone (Heckel and Watney, 2002). The Mound City Shale has a conodont fauna consisting of *Idiognathodus, Gondolella, Idioprioniodus,* and rare *Hindeodus*. The *Idiognathodus* species present in the Mound City Shale are mostly *I. swadei* and *I. sulciferus,* but also include *I. swadei* new subspecies 1, *I. fusiformis, I. harkeyi, I. eccentricus,* and *I. turbatus*. The base of the Mound City Shale marks the first appearance of *I. turbatus*, which appears consistently at this point in each of the sections studied. The overlying Sniabar Limestone is easily recognized by the acme of *Hindeodus* and *Adetognathus* above the Mound City Shale and below the Hushpuckney Shale of the overlying Swope Cyclothem. The fauna of the Sniabar Limestone also includes *Idiognathodus* species similar to those found in the Mound City Shale along with specimens of *Idioprioniodus*.

Summary and Future Work

The two *Idiognathodus* species of greatest biostratigraphic importance in the Midcontinent Moscovian–Kasimovian boundary interval are *I. eccentricus* and *I. turbatus*. The first appearance of *I. eccentricus* is less reliable than the first appearance of *I. turbatus.* In the study region, the first appearance of *I. turbatus* reliably occurs at the base of the Mound City Shale. Here, *I. turbatus* is the most biostratigraphically useful conodont.

Future work at the Uniontown section will involve more detailed sample collection, especially of those units under represented here. The Uniontown section is recognized as representing each of the lithologic and biostratigraphic features found within the study interval and region. In the future it will be necessary to characterize the conodont faunas of these same units in Northern Kansas, Missouri and Iowa.

Acknowledgements

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NOTE ON RECENTLY DISCOVERED FOSSILIFEROUS SECTIONS EMBRACING THE MOSCOVIAN–KASIMOVIAN BOUNDARY (ANDARA MASSIF, PICOS DE EUROPA, NW SPAIN)

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Marine strata spanning the Moscovian–Kasimovian boundary crop out in the Picos de Europa Mountains region (Cantabrian Zone, NW Spain). So far, this boundary has been most intensively studied in the Las Llacerias section (northern Picos de Europa), where a fossiliferous carbonate-dominant succession containing the Moscovian–Kasimovian transition is exposed (Villa and van Ginkel, 2000, and references herein). This section was thought to be the only one in the Cantabrian Mountains exhibiting such sedimentary characteristics. However, recent research in the Ándara sector (southeastern Picos de Europa) has revealed a particularly well-exposed and continuous carbonate succession, which is nearly 300 m-thick and ranges in age from latest Moscovian to early–middle Kasimovian. This study is part of a broader investigation including detailed geological mapping and sedimentological and paleontological investigations from several sections. Of these sections, the Castillo del Grajal and Morra de Lechugales sections exhibit the most favourable characteristics for establishing fusulinid and conodont biostratigaphic schemes.

The part of the Pennsylvanian succession studied from the Ándara Massif includes three unconformity-bound stratigraphic sequences (not numbered in this report) belonging to the uppermost part of the Picos de Europa Formation and three more sequences (S1–S3) belonging to the Las Llacerias Formation. Remarkable features of this succession are the high diversity of the biotic communities (Merino-Tomé *et al*., 2009) and the extremely high rate of sedimentation (at least, 25-40 cm/ky), which outpaces values estimated in coeval carbonate successions in the Russian Platform, North American Midcontinent, and the Carnic Alps. The exceptional stratigraphic thickness for a comparatively short span of time is probably the result of high rates of flexural subsidence.

Because of the thickness, the sedimentary gaps corresponding to the subaerial exposure surfaces bounding the high-frequency cycles are probably much shorter than those documented from other sections comprising deposits of similar age. Consequently, the sedimentary record of the Moscovian–Kasimovian transition (including the Myachkovian–Krevyakinian and the Krevyakinian–Khamovnikian boundaries) in the Ándara succession is expected to be more complete.

The Castillo del Grajal and Morra de Lechugales sections

The Castillo del Grajal section (Figure 1) exposes the upper part of the Picos de Europa Formation (180 m), an interval belonging to the *Fusulinella(?)* and *Protriticites* Zones. A major unconformity, resulting from tectonic uplift, karstification and erosion is recorded at the top of this formation. The Picos de Europa Formation is unconformably overlaid by strata of the Las Llacerias Formation belonging to the *Montiparus* Zone. Analysis of the Las Llacerias in several sections of the Ándara area demonstrated that the interval outcropping in the Castillo del Grajal section corresponds to its third sequence (S3, ca. 50 m).

In the nearby Morra de Lechugales section, the upper part of the Picos de Europa Formation (strata correlatable with those of the Castillo del Grajal section) is also unconformably overlain by the Las Llacerias Formation. Two depositional sequences, S1 and S2, are recognized within this last formation. Their fusulinid content indicates that S1 and at least part of S2, still belong to the *Protriticites* Zone. Consequently, the formations are older than the Las Llacerias interval outcroping in the Castillo del Grajal section (S3).

Upper part of the Picos de Europa Formation

The uppermost 180 m of the Picos de Europa Formation exposed in the Castillo Grajal section can be subdivided into two stratigraphic intervals.

1) The lower one is 80 m thick and consists of light grey, thick-bedded to massive, micritic boundstones, skeletal wackestones and packstones. This interval has not been sampled in detail in the section. According to biostratigraphic data from nearby outcrops, the deposits might record the uppermost part of the *Fusulinella* zone.

2) The upper interval is 100 m thick and shows a cyclic alternation of microbial/phylloid algal boundstones, reddish pseudonodular mudstone to wackestones and thinner packages of grain-supported shallow-water deposits capped by subaerial exposure surfaces. Three decametre-thick fifth-order shallowing-upward cycles, which are bounded by subaerial exposure surfaces, can be recognized. In turn, each of the major cycles comprises two to three sixth-order transgressive-regressive cycles.

The upper interval belongs to the *Protriticites* Zone. Fusulinid assemblages, which occur at a number of beds, consist only of three genera: *Protriticites, Pseudotriticites?* and *Fusiella. Protriticites* representatives show subcylindrical shape

Figure 1: View from the west of the area exposing the Castillo del Grajal section. Subaerial exposure surfaces in the upper part of the Picos de Europa Formation, bounding 5th-order cycles, are indicated.

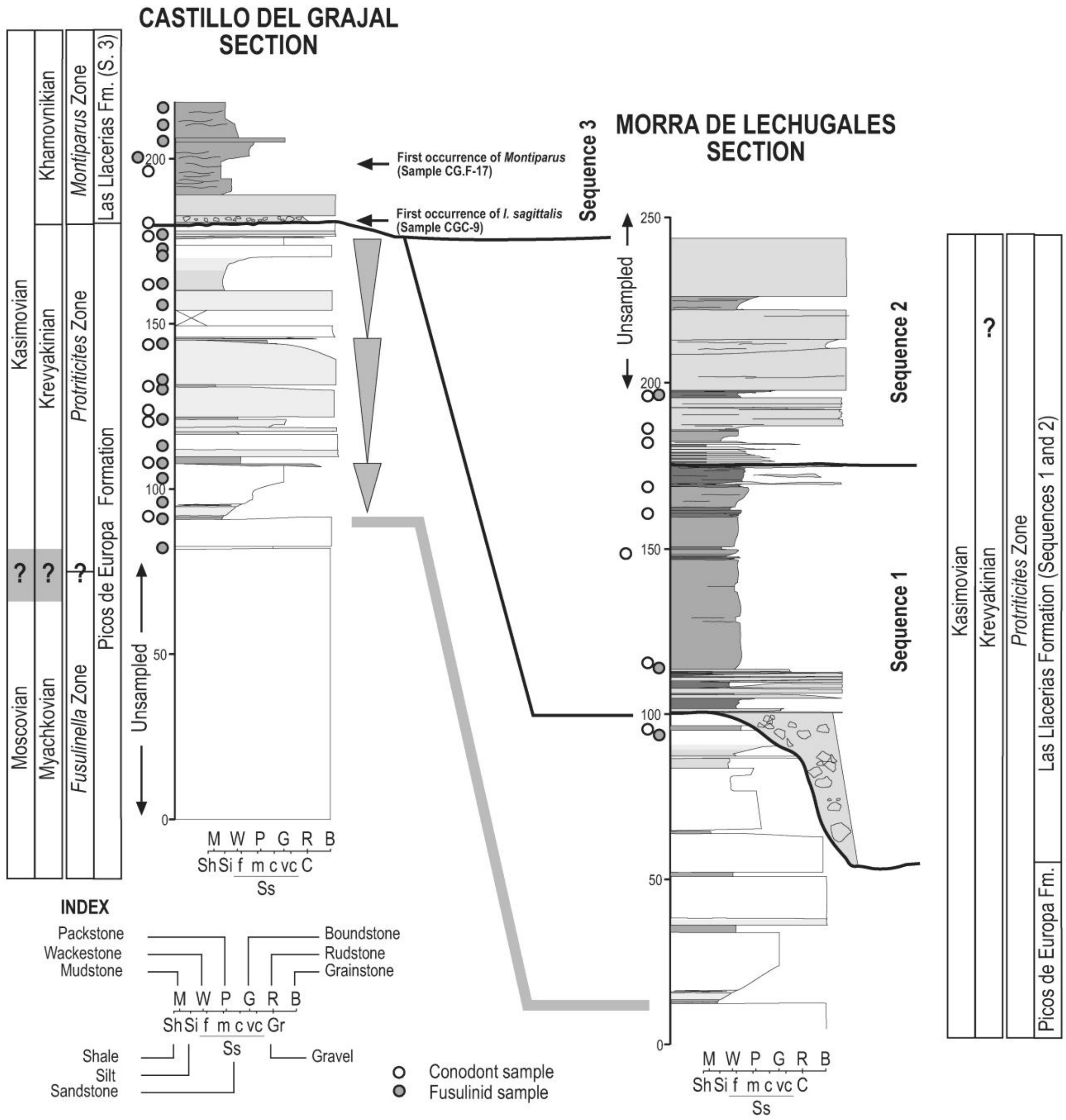

Figure 2: Correlation of the Castillo del Grajal and Morra de Lechugales sections.

resembling that of *Obsoletes grosdilovae*; however, they exhibit a four-layered and thin walltypical for *Protriticites*. Forms assigned to *Pseudotriticites*? have a three-layered wall resembling that of *Quasifusulinoides,* but their rhombic shell and regular septal folding point to the genus *Pseudotriticites*. *Fusiella* specimens are close to *F. lancetiformis* Putrja. A preliminary sampling for conodonts reveals the occurrence of *Idiognathodus expansus*, *Gondolella magna,* and elements close to *Idiognathodus* sp. 1 Swade, among other species. The fusulinid data point to a Krevyakinian age, in terms of the European stratigraphic scale, whereas the conodont data suggest a late Desmoinesian age in terms of North American stratigraphy.

The Las Llacerias Formation

The Las Llacerias Formation comprises three depositional sequences that range in age from middle–late Krevyakinian to Khamovnikian. Each sequence consists of two stratigraphic intervals. The lower one contains abundant calcareous clastics (calcareous breccias, minor conglomerates, calclithites and bioclastic-intraclastic grainstones to packstones) that laterally interfinger with dark shales, marls and marly limestones. The upper interval is dominated by autochthonous carbonate deposits with a conspicuous dark colour.

Sequences 1 and 2 are exposed in the Morra de Lechugales section and have yielded abundant *Protriticites* forms, as well as *Quasifusulinoides* (?)

and *Ozawainella* species (van Ginkel and Villa, 1991). The basal part of the second sequence yielded *Idiognathodus* sp. 1, a new species described by Goreva *et al*. (2009) from the lower Krevyakinian (Suvorovo Formation) to the base of the Khamovnikian (base of the Ratmirovo Formation) in the Afanasievo section, Moscow Basin.

According to its fusulinid content, the Las Llacerias Formation in the Morra de Lechugales section is Krevyakinian in age. Nevertheless, it must be noticed that the uppermost 50 m of sequence 2, exposed in a relatively inaccessible cliff, have not been sampled. Sampling will be undertaken in a coming campaign.

In the Castillo del Grajal section, the Las Llacerias section is only represented by strata of sequence 3. A conodont sample from the base of the sequence yielded *Idiognathodus sagittalis,* a species showing a worldwide distribution. *I. sagittalis* has been recorded from the upper part of the lower Kasimovian (Khamovnikian) in the Moscow Basin (Neverovo Formation), the N5/1 limestone of the Donets Basin, and the lowermost Missourian of the North American Midcontinent (Heckel *et al*., 2007). Primitive but distinct *Montiparus* specimens occur higher in the same interval, also indicating a most probable early Khamovnikian age. These data suggest that a gap exists in the Castillo del Grajal section in between the top of the Picos de Europa Formation and the base of the Las Llacerias Formation. However, the fusulinid content of the missed sequences (S1 and S2), observed in the Morra de Lechugales section, shows that, in spite of their great thickness, the span of time involved might be comparatively short.

Integrating data from the Castillo del Grajal and Morra de Lechugales sections (Figure 2), the total thickness of the *Protriticites* Zone in the Andara sector is, at least, 245 m, which represents an extraordinarily continuous record of this interval. Additionally, the joint occurrence of conodonts and fusulinids makes this area one of great interest for Upper Pennsylvanian correlation.

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THE FORAMINIFERAL ASSEMBLAGE IN THE VISEAN–SERPUKHOVIAN BOUNDARY INTERVAL AT THE YASHUI SECTION, GUIZHOU, SOUTH CHINA

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The definition of the base of the Serpukhovian Stage has long been disputed because of the common occurrence of widely distributed unconformities near the Viséan–Serpukhovian (or Namurian) boundary, which adversely affect the use of evolutionary lineages such as those of conodonts, ammonoids and foraminifers for global correlation. Thus it has been difficult to reach an agreement regarding the evolutionary lineage to use for definition of that boundary. Several years ago, we measured the late Viséan to early Serpukhovian succession at the Yashui section in Guizhou Province, South China several years ago. Abundant foraminifers, including some that appear to have considerable utility for widespread correlation at the level of the Viséan–Serpukhovian boundary, were found in the section. The foraminifers were studied in detail and this report presents some of the preliminary results.

Geological setting of the Yashui Section

The Yashui Section is located in the southeastern part of Huishui County, 90 km south of the city of Guiyang (Fig. 1). Successive sediments from the Datangian, Dewuan, Luosuan and Huashibanian Chinese regional stages of the Carboniferous are exposed along the eastern side of the provincial road connecting Guiyang and Yashui. The section was chosen as a fieldtrip stop on one of the field excursions for the 11th International Carboniferous Congress held in Beijing in 1987.

The late Viséan to early Serpukhovian succession at the Yashui Section (23.98 m thick), is mainly lime wackestone to packstone assigned to the Upper Shangsi Formation of the Datangian Stage. It is subdivided into 26 beds, numbered from 410 to 435 (Fig. 2). Among them, the 2.5 m thick interval comprising beds 420 to 424 represents the regressive system tract of an upper Viséan transgressive-regressive sequence that includes the underlying beds in the section. Biostratigraphic evidence presented herein demonstrates this 2.5 m thick interval is correlative with widely distributed unconformities occurring near the Viséan–Serpukhovian boundary in much of the world. The upper part of bed 420 and bed 421 consist of micritic limestone. Bed 422 consists of lump-peloid limestone and bed 423 is lime mudstone, which was partly altered to yellowish-green clay during a long period of subaerial weathering in a humid subtropical climate. Bed 424 comprises micritic limestone. Abundant foraminifers, corals, brachiopods and algae were found throughout the section. Besides the foraminiferal assemblage near the Viséan–Serpukhovian boundary, the foraminiferal assemblage in bed 444, which lies shortly above the boundary, is also described below to demonstrate that Yashui section continues to be abundantly fossiliferous well above the boundary level.

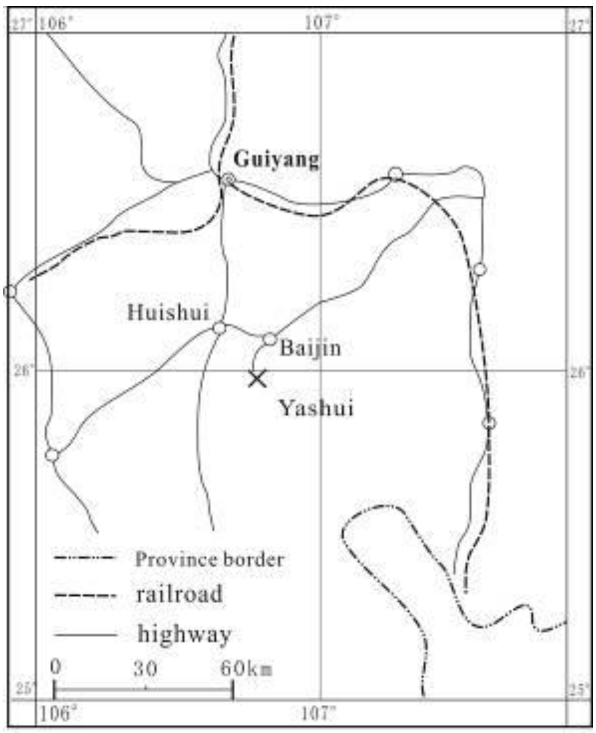

Figure 1: Locality map for the Yashui section, Guizhou, China.

<u>*Foraminiferal assemblage in the Viséan–Serpukhovian boundary interval at Yashui*</u>

Samples collected for the study of the foraminifers in the Yashui section were obtained from the majority of beds in the section. The foraminifers in the succession spanning the Viséan–Serpukhovian boundary are highly diversified with more than 160 species in 62 genera, including some new genera and species. Figure 2 shows the stratigraphic ranges of some key species in the section.

Bed 426 in the Yashui section is particularly significant because it contains the first appearances of some important foraminifers including *Zellerinella tortula/designata* (Zeller), *Asteroarchaediscus bashkiricus, As. rugosus, Betpakodiscus* sp., and *Trepeilopsis* sp. The bed is also characterized by the presence of more than 60 other species of foraminifers, including *Zellerinella pressula* (Ganelina), *Archaediscus krestovnikovi*, *Ar. nanus, Neoarchaediscus probatus, N. postrugosus*, *Biseriella parva, Bradyina rotula*, *Climacammina* cf. *prisca*, *Endothyranopsis sphaerica intermedia*, *Endostaffella asymmetrica*, *Eostaffella versabilis, E.* (*ikensis*) *ventricosa*, *Forschia* sp., *Forschiella prisca*, "*Spiroplectammina*" *syzranica*, *Spinothyra pauciseptata*, *Koskinotextularia* sp., *Koskinobigenerina* sp., *Lituotubella glomospiroides, Mikhailovella, Omphalotis, Plectomediocris*, *Pojarkovella*, *Quasilituotuba* sp., as well as abundant *Pseudoendothyra globosa*. The foraminiferal assemblage in bed 426 is interpreted to be of latest Viséan age.

Situated well above the Viséan–Serpukhovian boundary transition, bed 444 contains abundant *Planospirodiscus taimyricus*, *P. absimilis*, *Timanella eostaffelloides*, *Calcivertella* sp., *Pseudopalaeospiroplectammina* spp., *Seminovella* sp., *Eostaffellina paraprotvae*, *E. irenae*, *Neoarchaediscus postrugosus*, *Zellerinella pressula* (morphologically similar to *Millerella pressa*), *Z. tortula/designate, Spinothyra* sp.1, *S. pauciseptata* and other taxa. This foraminiferal assemblage is substantially younger than that of bed 426 and is interpreted to be of middle Serpukhovian age (middle Dewuan Stage).

<u>*Evolutionary lineage of Zellerinella designata–Z. pressula near the Viséan–Serpukhovian boundary in the Yashui section*</u>

Zellerinella pressula (Ganelina) diagnosis: Test discoidal, w/d 0.38–0.46, biumbilicate, periphery slightly subangular to rounded, 4½ to 5½ volutions, test following proloculus slightly skew-coiled or planispiral and involute, later planispiral, last 1–1½ whorls become evolute. The evolute whorls contain rapidly expanding chambers that have widths greater than the heights; margin of the evolute chambers arcuate and contain a well-developed septal furrow. Wall contains tectum and thick inner microgranular layer. Test shows poorly developed outer tectorium in specimens of younger horizons. Secondary deposits well-developed as chomata, tunnel single.

Zellerinella pressula makes its first appearance in bed 428 and is abundant from bed 430 through bed 435 within the middle and upper Dewuan stage (middle and upper Serpukhovian).

Zellerinella is renamed after *Zellerina* Mamet (Mamet and Skipp, 1970) by Mamet (1981). The validity of *Zellerinella* has been doubted, and the differences between *Zellerinella* and *Millerella* are obscure. For example, Mamet assigned *Millerella tortula* Zeller (1953) and *M. designata* Zeller (1953) to the genus *Zellerinella*. But Skipp et al. (1985) and Brenckle (1990) considered it unlikely that the two

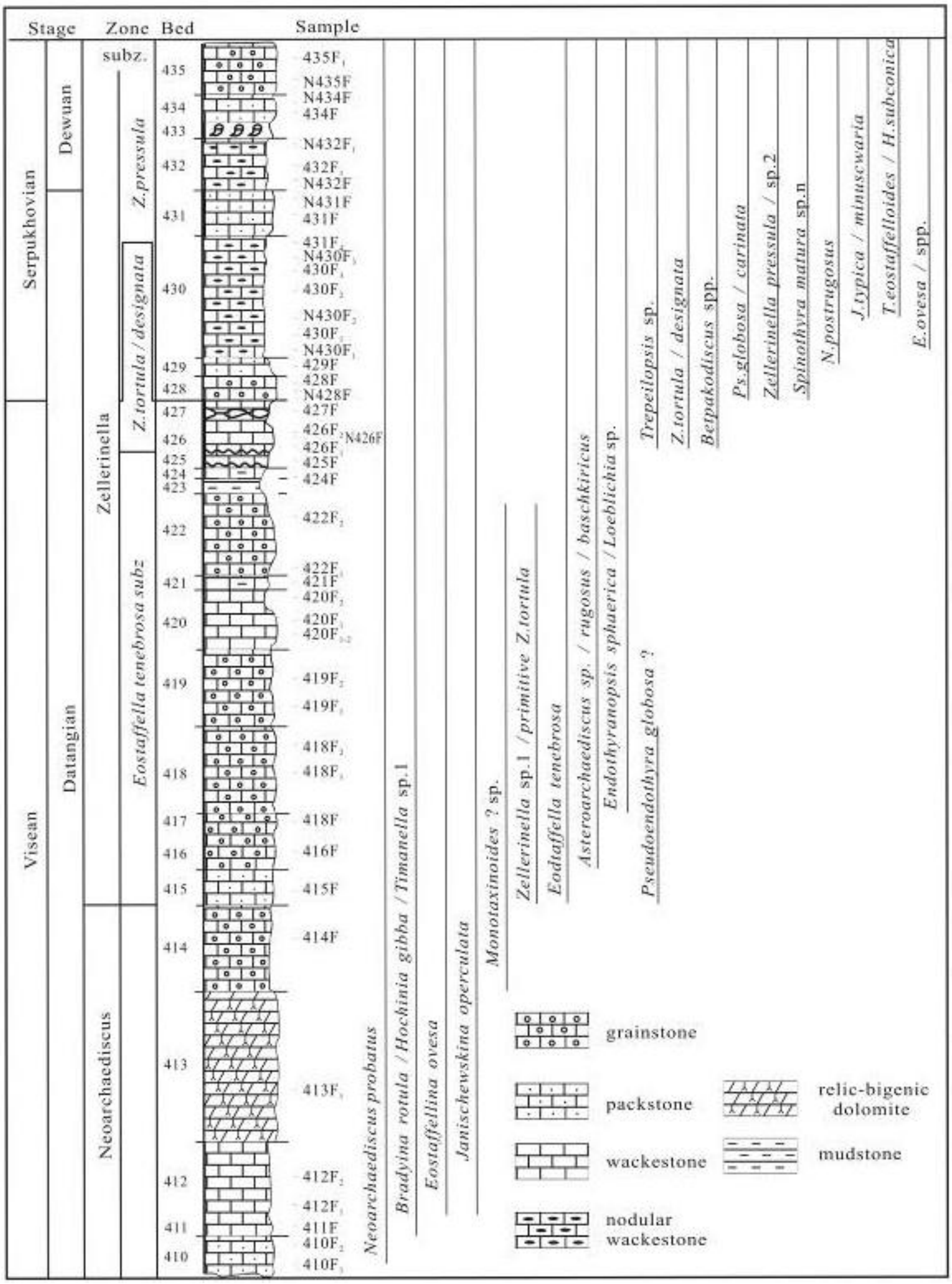

Figure 2: Stratigraphic range of some key foraminifers near the Viséan–Serpukhovian boundary at the Yashui section in Guizhou, South China.

species could be assigned to the genus *Zellerinella.* They termed "*Millerella*" *tortula/designata*. However, these two species show certain similarities to *Millerella* sensu stricto that indicate a close relationship between *Zellerinella* and *Millerella* sensu stricto. In our opinion, the specimens of *Zellerinella pressula* that appeared in the Viséan–Serpukhovian boundary interval at the Yashui section are intermediate forms within the evolutionary lineage leading from *Zellerinella* to *Millerella* sensu stricto.

The specimens of *Zellerinella tortula/designata* and *Z. pressula* in the Viséan–Serpukhovian boundary strata at the Yashui section share the following common characters: discoidal, width/diameter ratio of 0.38–0.49, initial skew-coiled, wall with tectum and thick inner microgranular layer, number of septa in outer evolute whorl decrease rapidly outward, and the width of chamber becomes larger than the height (Zeller, 1953, Pl. 26, Fig. 5 and Fig. 16 - holotype of *tortula*; Brenckle, 1990, fig. 7, M, N and K, O, and specimens of the Yashui section). The growth rate of the wall is faster than the expanding rate (increasing height of the chamber) of the whorl in late stage of these foraminifers. However, *Zellerinella pressula* differs from *Zellerinella designata* by its larger test, symmetric shape, more whorls and better-developed evolute whorls, well-developed chomata-like deposits and simple tunnel, all whorls planispiral, wall differentiated into three layers in the specimens of younger horizons (above bed 448 of Yashui section). It is noted that specimens of *Z. designata* that contain chomata-like deposits are closer to *Z. pressula.* Therefore, *Zellerinella designata* may be the direct ancestor of *Z. pressula*.

Millerella sensu stricto differs from *Z. pressula* by having all whorls planispiral, shorter coiled axis, smaller w/d ratios (generally less than 0.35), and better-developed evolute whorls with more septa. The height of the chamber is equal to or larger than the width of chamber in the evolute whorls (for example, Thompson, 1948, Pl. 24, Fig. 3; Groves, 1983, Pl. 5, Fig.1? and 10 ?), because the expanding rate (increasing highness of chamber) of the evolute whorls is faster than the growth rate of wall in later stage of *Millerella*. However, *Z. pressula* is phylogenetically closer to *Millerella* sensu stricto than *Zellerinella tortula/designata* is to *Mirellella* sensu stricto. The specimens of *Z. pressula* with all planispiral whorls, symmetric shape, differentiated three-layered wall, well-developed chomata-like structures and simple tunnel are similar to *M. pressa*. Therefore, the *Z. pressula* may be the ancestor of *Millerella* sensu stricto and thus the evolutionary link between *Zellerinella* and *Millerella* sensu stricto. The evolutionary lineage *Zellerinella designate*–Z. *pressula*–*Millerella* (*M. pressa*) appeared successively in the Viséan–Serpukhovian transition in the Yashui section.

The evolutionary lineage Spinothyra pauciseptata–S. sp. 1 near the Viséan–Serpukhovian boundary at the Yashui section

In the diagnosis of Mamet (1976) *Spinothyra* is described as follows: the secondary deposits occur as anteriorly curved, long projections, present in each chamber. Loeblich and Tappan (1988, p. 245-246) on the basis of holotype (type species *Endothyra pauciseptata* Rauser-Chernousova, 1948) described it as having 'secondary chomata-like deposits at the floor of the chambers, those of the final whorl appearing as prominent anteriorly directed hooks'.

Spinothyra sp.1 is characterized by secondary deposits occurring as a strong tubercular prominence at the floor of each chamber.

One of the key characters in the genus *Spinothyra* is the form of the secondary deposits at the floor of the chamber. Three morphotypes are recognized on the basis of the secondary floor deposits: the first with a single, anteriorly curved, long projection; the second with the final whorl appearing as anteriorly directed hooks and chomata-like deposits in other chambers, and the third with strong tubercular prominence in all chambers. The former two morphotypes belong to *Spinothyra pauciseptata,* which appeared during the middle Viséan, flourished in the Viséan–Serpukhovian transition, and continued to the base of the Upper Carboniferous. *Spinothyra* sp.1 first appeared in bed 428 of the Yashui section, flourished in bed 430 to Bed 432, and persisted to the Early Late Carboniferous. Therefore *Spinothyra* sp.1 is the last phylogenetical stage of *Spinothyra* and has biostratigraphic significance.

Discussion on Viséan–Serpukhovian boundary

We tentatively suggest that the first appearance of *Z. pressula* in the lineage *Zellerinella designate–Z. pressula* could be used as a biostratigraphic marker to define the base of the Serpukhovian. This lineage was found in the continuous carbonate succession constituting beds 426 to 435 at the Yashui section. The first appearance of *Zellerinella pressula* occurred in bed 428 (0.51 m thick), which coincided with the first appearance of *Spinothyra* sp.1 in the lineage *Spinothyra pauciseptata–S.* sp.1 and the first appearance of *Quasilituotuba* sp. In association with them, are abundant *Pseudoendothyra globosa* and *Zellerinella tortula/designata*. In beds 426 and 427 (a total of 0.99 m thick), there are abundant *Zellerinella tortula/designate, Asteroarchaediscus rugosus*, *Neoarchaediscus probatus*, *N. akchimemsis*, *Spinothyra pauciseptata* and other foraminifers. The first appearance of *Asteroarchaediscus bashkiricus*, *Betpakodiscus* sp. and *Trepeilopsis* sp. also occurred in the interval. Above bed 428, *Neoarchaediscus*

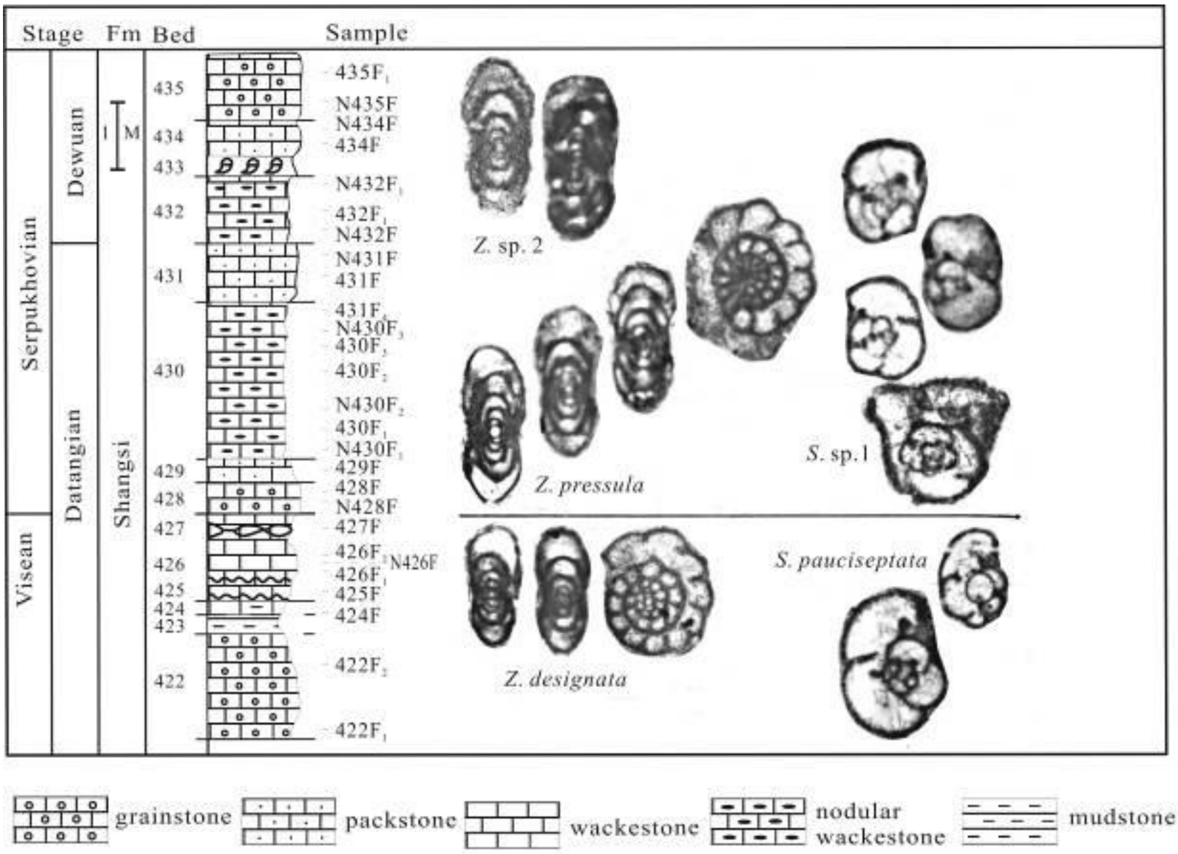

Figure 3: The Viséan–Serpukhovian boundary transition showing the first appearance of *Zellerinella pressula* in the lineage *Zellerinella designate–Z. pressula* and the first appearance of *Spinothyra matura* sp. nov. in the lineage *S. pauciseptata–S. matura* sp. nov. in bed 428.

postrugosus first appeared in bed 429 (0.27m thick). Beds 430 to 435 (a total of 6.05 m thick) are characterized by the typical Serpukhovian to Early Late Carboniferous foraminifers, including *Janischewskina typical*, *J. minuscularia*, *Howchinia subconica*, *Zellerinella* cf. *pressula, Pseudoendothyra globosa*, *Neoarchaediscus postrugosus*, *Spinothyra* sp.1, *Zellerinella tortula/designata* and some newly appeared species, such as *Pseudobradyina pulchra*, *Pseudoendothyra carinata*, *Timanella eostaffelloides*, *Endothyranella* (?) *recta*. Among these foraminfers, *Zellerinella* cf. *pressula*, *Pseudoendothyra globosa*, *Neoarchaediscus postrugosus*, *Spinothyra* sp.1 and *Zellerinella tortula/designata* are abundant.

The species *Neoarchaediscus postrugosus* is regarded as the index fossil for the base Serpukhovian by some Russian authors. It first appeared near the bottom of bed 3a-2 at the Serpukhovian stratotype section in the Zaborie Quarry (Moscow region, Russia) (Gibshman, 2003). It is highly possible that bed 429, which has the first appearance of *N. postrugosus* at the Yashui section, correlates with bed 3a-2 at the Zaborie Quarry. Consequently, bed 428 in the Yashui section, containing the first appearance of *Zellerinella pressula* and *Spinothyra* sp.1, in association with the abundant *Pseudoendothyra globosa* and *Zellerinella tortula/designate,* correlates with bed 3a-1 in the Zaborie Quarry section. Bed 3a-1 represents the base of the Tarusa horizon at Zaborie. Based on the information presented above, we suggest that bed 430 is assignable to the Serpukhovian Stage.

The first appearance of *Zellerinella pressula* in the evolutionary lineage *Zellerinella designata–Z. pressula* is a distinctive global event. It might, therefore, be suitable for defining the base of the Serpukhovian in shallow-water facies. The use of the FAD of *Zellerinella pressula* for boundary definition would not significantly change the position for the base of the Serpukhovian as defined by its type section in the Zaborie Quarry.

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MEETINGS

SCCS Activities in 2010

Task Group for the Reappraisal of the Devonian-Carboniferous boundary GSSP
planned dates: 4-5 or 5-6 June 2010
Venue: Toulouse, France

Field trip to the Cantabrian Mountains, Spain
planned dates: 3-5 days immediately after the workshop for the D–C boundary.

Field work at Nashui and Yashui sections in Guizou Province south China.
planned dates: late autumn

Future Meetings

2009

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
Dates: 11-19 August 2009
Venue, Moscow and Ufa
webpage: http://carbon.paleo.ru

2010

Prague 2010 - ICS Workshop
The GSSP Concept
Dates: 30 May– 3 June 2010
Venue: Charles University, Prague, Czech Republic
http://www.stratigraphy.org/

Third International Palaeontological Congress
Dates: 28 June - 3 July 2010
Venue: Imperial College and Natural History Museum, London, UK
webpage: www.ipc3.org

2011

17th International Congress on Carboniferous and Permian
Dates: July 1-4
pre- and post-conference field trips will be organised.
Venue: Perth, Australia

2012

34th International Geological Congress
Dates: August 2-10
Venue: Brisbane Convention and Exhibition Centre, Brisbane, Australia
webpage: http://www.34igc.org

Past Meetings

16th International Congress on Carboniferous and Permian
Nanjing 2007

Three volumes of proceedings have or will be published:

1st volume: (One memorial paper and 17 scientific papers)

Shen, S.Z., Wang, X.D. & D.H. Erwin (2007): Contributions to Permian and Carboniferous Stratigraphy, Brachiopod Palaeontology and End-Permian Mass Extinctions, In Memory of Professor Yu-Gan Jin. - *Palaeoworld* **16** (1–3): 1–263.

2nd volume: (11 scientific papers)

Wang, X.D. Shen, S.Z. & I.D. Sommerville (2009): Carboniferous and Permian biota, integrative stratigraphy, sedimentology, palaeogeography, and palaeoclimatology. - *Palaeoworld* **18** (2–3): 77-212.

3rd volume: will be published in *Geological Journal* in 2010 with a theme "Lopingian (Late Permian) stratigraphy in the world, major events and environmental changes".

Carboniferous Conference Cologne 2006. From Platform to Basin
Cologne 2006

Thirteen scientific papers related to very different aspects of Carboniferous geology were published in a double issue of Geological Journal.

ARETZ, M., HERBIG, H.-G. & I. SOMERVILLE (2008): Proceedings of the Carboniferous Conference Cologne 2006. From Platform to Basin. - Geological Journal, **43** (2/3): 119-396.

15th International Congress on Carboniferous and Permian
Utrecht 2003

Fourty-eight scientific papers have been included into the proceedings volume:

Wong, Th.E. (2007): *Proceedings of the XVth International Congress on Carboniferous and Permian Stratigraphy Utrecht, 10-16 August 2003*.- 584pp., Royal Netherlands Academy of Arts and Sciences , Amsterdam: Edita-KNAW.

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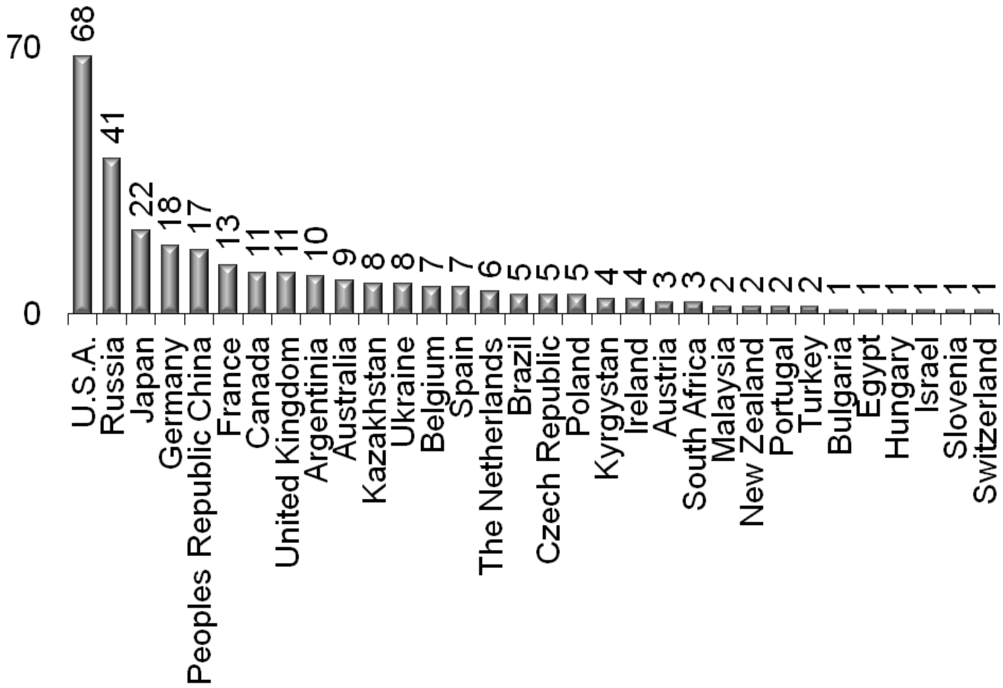

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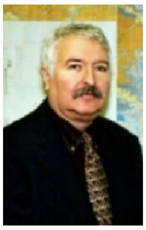

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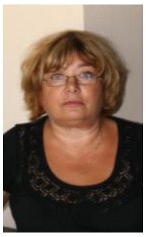

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CONTRIBUTIONS TO THE NEWSLETTER

The Newsletter on Carboniferous Stratigraphy is published annually (in July) by SCCS. It is composed of written contributions from its members and provides a forum for short, relevant articles such as:
* reports on work in progress and / or reports on activities in your work place
* news items, conference notices, new publications, reviews, letters, comments
* graphics suitable for black and white publication.

Contributions for each issue of the Carboniferous Newsletter should be timed to reach the Editor before 31 May in the year of publication. It is best to submit manuscripts as attachments to Email messages. Except for very short news items, please send messages and manuscripts to my Email address. Manuscripts may also be sent to the address below on CD prepared with **Microsoft Word (preferred)** or WordPerfect but any common word processing software or plain ASCII text file can usually be accommodated. Word processing files should have no personalized fonts or other code. Maps and other illustrations are acceptable in tif, jpeg, eps, or bitmap format. If only hard copies are sent, these must be camera-ready, i.e., clean copies, ready for publication. Typewritten contributions may be submitted by mail as clean paper copies; these must arrive well ahead of the deadline, as they require greater processing time.

Due to the recent increase in articles submitted by members we ask that authors limit manuscripts to 5 double spaced pages and 1 or 2 diagrams, well planned for economic use of space.

Please send contributions as follows,
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