# NEWSLETTER ON CARBONIFEROUS STRATIGRAPHY

Volume 18 July 2000


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SCCS

I.U.G.S. SUBCOMMISSION ON CARBONIFEROUS STRATIGRAPHY

# Table of Contents


**CHAIRMAN'S COLUMN** ... 1

**SECRETARY/EDITOR'S REPORT 1999-2000** ... 2

**SCCS ANNUAL REPORT 1999** ... 4

**WORKING/PROJECT GROUP REPORTS** ... 6

Working Group to establish a boundary close to the existing Tournaisian-Visean Boundary within the Lower Carboniferous ... 6

Project Group 3: A chronostratigraphical level around the Visean V3a/V3b bouindary ... 7

New Project Group proposal: a GSSP close to the Visean-Namurian/Serpukhovian boundary ... 7

**CONTRIBUTIONS BY MEMBERS** ... 8

On the number of Carboniferous series and stages (Menning et al.) ... 8

Carboniferous-Permian Gondwanan palynostratigraphy (Playford & Dino) ... 10

The search for a new T-V boundary GSSP. Report of field work in Yunnan and Guangxi (South China), April 2000 (Devuyst et al.) ... 11

Recent advances in the study of Upper Palaeozoic molluscs from the Tepuel-Genoa and Sauce Grande-Colorado Basins, Argentina (Sabattini and Pagani) ... 13

A Provisional Conodont Zonation for Late Pennsylvanian (late Late Carboniferous) Strata in Midcontinent Region of North America (Barrick and Heckel) ... 15

Exposures of the Westphalian Series in the upper Neath and Swansea Valleys, South Wales – a geoconservation project (Evans et al.) ... 23

Possible candidate section for stratotype of Mid-Tournaisian boundary (Konstantinov Creek, Subpolar Urals) (Kossovaya et al.) ... 26

A correlation of Carboniferous marine biozones of Argentina and Australia (González, & Taboada). ... 30

Global cooling in the middle Carboniferous (Durante) ... 31

Is cuticular functional-carbon biochemistry genetically dependent in Carboniferous pteridophyllous foliage? (Zodrow and Mastalerz) ... 33

In situ pecopterid microspores from near the Westphalian D-Cantabrian Boundary in Sydney Coalfield, Nova Scotia, Canada (Zodrow et al.) ... 33

Paleobiological interpretations and biostratigraphic problems (Remizova) ... 35

**CONFERENCE REPORTS**

International Congress on the Carboniferous-Permian (XIV ICCP) August 17-21, 1999 ... 38

XIV ICCP SCCS Session Abstracts ... 39

First Argentine Symposium on the Upper Paleozoic: Anillaco, La Rioja Province, Argentina, May 1999 ... 45

**NEW BOOK ANNOUNCEMENT** ... 45

**FORTHCOMING CONFERENCES** ... 46

**PUBLICATIONS BY SCCS MEMBERS** ... 47

**OBITUARY:** Jos Bouckaert ... 48

**SCCS VOTING & CORRESPONDING MEMBERSHIP 2000** ... 49

**SCCS OFFICERS AND VOTING MEMBERS 1999-2000** ... 59

# Newsletter on Carboniferous Stratigraphy

**Edited by I. Metcalfe**

**IUGS SUBCOMMISION ON CARBONIFEROUS STRATIGRAPHY / VOL. 18 - 2000**



# Chairman's Column

Just over one month from writing this column I will end a long, active membership of the SCCS. I would like to thank all those Voting Members who contributed to SCCS projects during my term of office as Chairman, particularly those in charge of Working and Project Groups. I urge them to continue their extremely valuable work.

During my term of office I was charged with the coordination and leadership of SCCS. However, my contributions to the establishment of workable and truly global subdivisions were largely subverted. The unprecedented and unwarranted ICS takeover of SCCS ballots concerning the naming and status of the two major subdivisions of the Carboniferous has resulted in the Carboniferous becoming the 'odd system out', being the only one in the Phanerozoic having major subdivisions at the Subsystem level. All other systems use series as the second rank subdivision, followed by stages as the main units for global correlation. If these subdivisions are successfully applicable by other subcommissions, why is it that we are now saddled with a more cumbersome and potentially complicated, if not unworkable, scheme? Unfortunately, the answer has no scientific basis, but comes from a political lobby seeking to control our discipline, an entirely regrettable development. It is also interesting to recall that the draft version of the ICS Global Chart had no column for subsystems and used only series and stages. Clearly, subsystems were not required at that stage of the chart's development.

Major problems now face the SCCS. Firstly, the two subsystems of the Carboniferous cannot be identified with sufficient precision to be useable throughout a large part of the world, including the Gondwanan continents of Africa, South America, India, Australia, Antarctica, the Arabian peninsular and Madagascar, and large fragments of Gondwana in China, Southeast Asia and Tibet. Another region where there is major difficulty in recognising the subsystems include Angaran parts of Siberia. What do Carboniferous workers in these regions now use as fundamental subdivisions of the system? All they can do is to continue using the superseded units, in most cases the Dinantian and Silesian or lower and upper Carboniferous of the western European timescale.

The second major problem, which in terms of global correlation is potentially more serious than the first, concerns the use of series and stages. Should the current stages of the Carboniferous global scale be elevated to series or remain as stages? If they remain as stages, what should be done with the series? As one excluded from the ability to use the two subsystems, my suggestion is that the series of the Carboniferous global scale should be developed in such a way to accommodate the needs of workers outside the marine palaeotropical regions. Dinantian and Silesian are two possible subdivisions that could be considered.

If the opposite approach is taken and the current stages are used as series, the Carboniferous will become further out of step with other systems. I urge you to read the article by Manfred Menning in this issue which clearly indicates that the current stages of the Carboniferous are of comparable durations with those in adjacent systems. Should stages become series and current substages be elevated to stage status, the task of defining GSSPs would be entirely counter productive, if not impossible. Heckel and Villa's earlier suggestions that stages should be regional units, with series providing global correlation, is contrary to the approved definition of a stage and therefore not a viable alternative.

Following the IGC in Rio, the next SCCS will have a new executive and up to seven new Voting Members. The incoming executive has my best wishes for a fruitful and cooperative term, and I look forward to new and productive developments for all Carboniferous workers in the next four years.

John Roberts

# Secretary/Editor's Report 1999-2000

The past year, and my last as Secretary, has been a traumatic one for the SCCS. Several major disputes arose between the SCCS and the ICS and adjudication on interpretation of ICS Satutes had to be sought from the IUGS. An unprecidented direct intervention in SCCS affairs was made by the ICS in which the ICS declared an SCCS ballot invalid and undertook its own ballot of SCCS Voting Members. The rank and names of the two primary divisions of the Carboniferous are now formally established as Sub-Systems and Mississippian (Lower) and Pennsylvanian (Upper) (see below). I sincerely hope, that now this matter is settled, that the SCCS can move forward to establishing the subdivisions of these primary divisions and the establishment of GSSPs for their boundaries. The SCCS had a one day session and a General Business Meeting at the International Congress on the Carboniferous-Permian held in Calgary, Canada, August, 1999. Please see the separate report and abstracts in this issue. As this is my last year as Secretary and the last Newsletter that I shall be editing, I would like to sincerely thank all SCCS members for their contributions to the Newsletter, for their generous donations to help the Subcommission's finances and other support over the last four years. I would also like to thank the University of New England for facilities provided during the time that the Secretariat has been housed there.

**New SCCS Executive**

The four year period of the current SCCS executive expires at the IGC in Rio, August, 2000. In June, 1999 a ballot of Voting Members was conducted to elect the SCCS nomination to the ICS for the new Chair and Deputy Chair for the next four year period 2000-2004. There were two candidates for Chair, Dr Alexander Alekseev and Prof. John Roberts, and only one candidate for Deputy Chair, Dr Philip Heckel. A secret ballot was conducted to elect our nomination for Chair, the result being the election of Prof. Roberts by 9 votes to 8. This result was conveyed to ICS for ratification by a vote of the full commission. The Chair of ICS responded that this could not go ahead as Prof. Roberts had not received a 60% majority support from the membership. I pointed out that according to ICS Statutes, a 60% majority was only required where there was only one candidate and a simple majority suffices where there is more than one candidate under ICS statutes. The Chair of ICS also attempted to rule out Prof. Roberts on the grounds that he had been a long standing Voting member of the SCCS and as such he required the approval of the Chair of ICS for a second term as Chairman, which he was not prepared to give. These attempts to overule the SCCS nomination for Chair resulted in the SCCS asking for adjudication on the ICS statutes by the IUGS executive. The result was that Prof. Roberts' name was eventually put to the full commission for ratification but with detailed information that Prof. Roberts had been nominated by a majority of only 1, failed to gain a 60% majority, and that he had been on the SCCS for more than 25 years. This type of information had NOT been provided for other Chairs elect in an earlier vote of the full commission of ICS. In an unprecidented vote by the full commission of ICS, Prof. Roberts failed to receive the required 60% majority for election. Dr Heckel was ratified as the new Deputy Chair commencing at the IGC in Rio (August, 2000). In a second round to elect an SCCS nomination for Chair, only one candidate was nominated, Prof. George Sevastopulo. Prof. Sevastopulo was then ratified by the full commission of ICS and would have been up for ratification at the IGC in Rio. Unfortunately, Prof. Sevastopulo has been forced by circumstances beyond his control to withdraw as Chair elect. This may well leave the SCCS moving into its next four year period of operations without a substantive Chair or Secretary.

**Rank and Names of the two primary divisions of the Carboniferous**

The controversy regarding the rank and naming of the two primary divisions of the Carboniferous raged on during the year and came to a head at the SCCS General Meeting held at the ICCP in Calgary in August, 1999. At this meeting, a "straw" vote of those present resulted in 19 votes for Sub-System and 19 votes for Series rank and was a clear indication of the split in the wider SCCS membership on this issue. At the meeting in Calgary, the SCCS executive undertook to hold a ballot of Voting Members on the rank status of the two divisions and then move quickly to a vote on the naming of these. In October, 1999 a ballot of voting members was initiated to decide if the rank of the two divisions of the Carboniferous should be Sub-Systems or Series. Prior to the deadline for this ballot being reached, the Chair of ICS declared the ballot invalid and the ICS initiated its own ballot of SCCS Voting Members on 19 November, 1999 with a deadline of 21 December, 1999. The two proposals in this ballot were: "Proposal 1: The two main divisions of the Carboniferous shall be named MISSISSIPPIAN (Lower) and PENNSYLVANIAN (Upper). Proposal 2: The formal 1988 decision of SCCS to recognise the two divisions as Subsystems IS HEREWITH CONFIRMED". Both proposals were carried with more than the necessary 60% majority and the breakdown of voting is shown in the table below. I declined to vote in this ballot as I regarded it as illegal in that 22 persons were invited to vote, including two that had resigned as Voting Members in 1998, two more than the maximim allowable under the ICS statutes. The results of this ballot were subsequently ratified by the IUGS and are binding on the SCCS. The two primary divisions of the Carboniferous are therefore now formally determined to be Sub-Systems and named Mississippian (Lower) and Pennsylvanian (Upper).

**Next Field and General Meeting**

The next Field and General Meeting of SCCS will be held in the North American Mid-Continent in the Spring of 2001. Please see the separate report on the ICCP in this issue.

Ian Metcalfe
July, 2000.

**Breakdown of voting in ICS ballot (provided by the Chair of ICS):**

| | **MISS./PENNS.** | | **SUBSYSTEM** | |
|---|---|---|---|---|
| Alekseev | | NO | | NO |
| Brenckle | YES | | YES | |
| Clayton | YES | | YES | |
| Dutro | YES | | YES | |
| Engel | | NO | | NO |
| Gonzalez | | NO | | NO |
| Heckel | YES | | YES | |
| Lane | YES | | YES | |
| Laveine | YES | | YES | |
| Manger | YES | | YES | |
| Ouyang Shu | YES | | YES | |
| Roberts | | NO | | NO |
| Rocha-Campos | YES | | YES | |
| Sevastopulo | YES | | YES | |
| Villa | YES | | YES | |
| Wagner | YES | | YES | |
| Winkler Prins | YES | | YES | |
| **TOTAL** | **13** | **4** | **13** | **4** |

## Donations in 1999/2000:

Publication of this *Newsletter* is made possible with generous donations received from the following members/institutes during 199-2000 and anonymous donations, combined with an IUGS subsidy of US$700 in 1999, and additional support from a small group of members who provide internal postal charges for the *Newsletter* within their respective geographic regions.

E. Paproth, M. Zeller, A. Izart, Spanish Donor Group, G. Playford, S. Stojanovic, M. Ehiro, G.R. Wilde, G.P. Wahlman, N.W. Archbold.

## COVER ILLUSTRATION

Lower Carboniferous conodont: Holotype Pa element of *Emsaygnathus asymmetricus* Metcalfe, early Visean (Chadian-Arundian), Embsay Limestone, Craven Basin, Embsay, Yorkshire, northern England. Photo: I. Metcalfe.

# SCCS ANNUAL REPORT 1999

## Membership:

The Subcommission has 20 Voting members including the Executive Officers. In addition to this, corresponding membership at the date of publication stands at 257 and 7 libraries also receive the Newsletter.

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**SCCS Home Page is maintained on the internet at:**

"http://www.une.edu.au/sciences/scholphyseng/SCCS/SCCS.html"

**SCCS Session and Business Meeting at the ICCP in Calgary:**

A well attended full day SCCS session, with 19 oral presentations, was held at the ICCP in Calgary in August, 1999. In addition, a formal SCCS business meeting was held and this was attended by more than forty persons. Please see separate report in this Newsletter

**Formal ballot of Voting Members regarding the rank status of the two subdivisions for the Carboniferous:**

Following much discussion, a formal ballot of Voting was undertaken with the following two proposals being voted upon:

PROPOSAL 1:

"That the two subdivisions of the Carboniferous be of the rank of Sub-System

PROPOSAL 2:

"That the two subdivisions of the Carboniferous be of the rank of Series

Before the deadliune for this ballot was reached, the ICS Executive declared it invalid and then conducted its own ballot of SCCS Voting Members (see Secretary's Report, this issue.

**Newsletter Vol. 17:**

Apart from results obtained by formal SCCS Working Groups and Projects (see above), the Newsletter on Carboniferous Stratigraphy (Vol. 17, 1999) has also reported results of a number of investigations including: The interval between the *Levipustula* and *Costatumulus* biozones in Patagonia; Permo-Carboniferous faunas and provincialism in the South American Gondwana region; Visean miospore biostratigraphy in northern Brazilian basins; Conodont faunas of the mid Carboniferous Boundary interval; Moscovian-Kasimovian Boundary problems; Lower Tournaisian of the Timan-Pechora Province; Late Devonian and Lower Carboniferous palynostratigraphy, China.

**SCCS Work Plans for 1999-2001:**

Ensure that the existing research program is continued into the succeeding years and that the formal SCCS Working Groups and Projects (see above) proceed efficiently towards their goals, preferably within a reasonable timeframe.

Following the result of the current ballot on the status of the two subdivisions of the Carboniferous, a ballot of voting members on the names of these subdivisions will be undertaken.

*Field and General Meeting 2001:* At the SCCS business meeting in Calgary, Walt Manger and colleagues offered to organise the SCCS Field and General meeting for 2001 in the North American Mid-Continent, beginning and ending in St Louis. This will probably take place in the spring (northern hemisphere) and will visit the Type Morrowan and the Mississippian-pennsylvanian boundary.

Definition of a GSSP for the base of the Visean (mid Lower Carboniferous boundary) (W.G.)

Definition of a GSSP for the base of the Kasimovian in the late Upper Carboniferous (W.G.)

Continued investigation for possible definitions of stratotype sections establishing:

- a global boundary close to the base of the Namurian (Project Group 3)

- a boundary in the early Upper Carboniferous near the base of the Westphalian. (Project Group 4) - a boundary close to the Visean-Namurian/Serpukhovian boundary (New Project Group)

Make a concerted effort to enlist geochronologists, stable isotope geochemists and magnetostratigraphers into SCCS working and project groups and into research groups around the world concerned with Carboniferous topics.

**STATEMENT OF INCOME and EXPENDITURE FOR 1999:**
(Definitive accounts are maintained in Australian currency).

| **INCOME** (Oct. '98 - Sept. '99) | **$AUS** | **$US** |
|---|---|---|
| | Definitive | Estimated |
| IUGS Grant 1998 | 1,055.12 | 700 |
| Donations from Members | 932.32 | 606 |
| Bank Interest | 0.50 | 0.33 |
| **TOTAL INCOME** | **1,987.94** | **1,306.33** |
| **EXPENDITURE** | | |
| Newsletter 17 publication/ postage) | 1,039 | 675.35 |
| Secretarial Assistance (Newsletter 17) | 200.00 | 130 |
| Bureau postage and stationery | 192.55 | 68.16 |
| Honorarium | 150 | 130 |
| Bank Charges | 4.52 | 2.94 |
| **TOTAL EXPENDITURE** | **1,586.07** | **1,030.95** |

| **BALANCE SHEET (1998-99)** | **$AUS** | **$US** |
|---|---|---|
| | Definitive | Estimated |
| Funds carried forward from 1997 | 399.15 | 239.48 |
| PLUS Income 1998-99 | 1,987.94 | 1,306.33 |
| LESS Expenditure 1996-97 | (1,586.07) | (1,030.95) |
| **CREDIT balance carried forward to 1999-2000** | **801.02** | **514.86** |

| **BUDGET REQUEST FOR 1999/2000** | **$US** |
|---|---|
| Newsletter 17 (preparation/ printing/postage | 700 |
| (Net requirement assuming receipt of US$200 donations) | |
| Other Bureau expenses | 300 |
| **PROJECTED EXPENDITURE** | **1,000** |

The Subcommission has been advised by ICS that it has been allocated US$1000 in IUGS funding for 1999/2000.

# WORKING/PROJECT GROUP REPORTS

The following Working/Project Group Reports and a proposal for a new project group were presented at the International Congress on the Carboniferous-Permian in late 1999:

## REPORT OF THE WORKING GROUP TO ESTABLISH A BOUNDARY CLOSE TO THE EXISTING TOURNAISIAN-VISEAN BOUNDARY WITHIN THE LOWER CARBONIFEROUS

**SEVASTOPULO, GEORGE**, Department of Geology, Trinity College, Dublin 2, Ireland (gsvstpul@tcd.ie) and **HANCE, LUC**, Geological Survey of Belgium, Jennerstraat, 13, B1000 Brussels, Belgium

The aim of this project is to identify a boundary and to select a boundary stratotype and GSSP that corresponds as closely as possible to the base of the Visean as proposed in the 1967 Carboniferous Congress in Sheffield. Work has been concentrated on four topics based on stratigraphical sections around the boundary level: foraminiferal lineages; conodont lineages; the boundary between the CM and Pu Miospore Biozones in relation to the Tournaisian/Visean boundary level; and sea level changes close to the boundary level and their potential use in correlation. A lineage within *Eoparastaffella* has been established in sections in south China and it has the potential to provide a biostratigraphic tool of high resolution for correlations around the boundary level. The sections in south China are not ideal to serve as a stratotype section because of the lack of other fossils with good potential for correlation. Sections in the west of Ireland with *Eoparastaf~ella* are currently under investigation. Study of the distribution of *Gnathodus homopunctatus* in Ireland have not resulted in the recognition of an evolutionary lineage or of an ancestor for the taxon, which remains cryptogenic. The boundary between the CM and Pu Miospore Biozones appears to be older than the Tournaisian/Visean boundary level, which probably will be difficult to recognise using palynology. Work to date suggests important sea level change around the boundary level. A project has been initiated to assess the potential of these in correlation.

## GENERAL REPORT OF WORKING GROUP TO ESTABLISH GSSP CLOSE TO THE MOSCOVIAN KASIMOVIAN BOUNDARY

**VILLA, ELISA,** Departamento de Geologia, Universidad de Oviedo, 33005 Oviedo, Spain, evilla~asturias.geol.uniovi.es, and other members of the Working Group Since the 1995 Krakow SCCS meeting, the Working Group to establish a GSSP close to the Moscovian/Kasimovian boundary (formerly Project Group 5) has studied and visited candidate successions in Kiev and Donetz Basin, Ukraine (1996), Oviedo and Cantabrian Mountains, Spain (1997), and Moscow, Russia (1998), attended by most members of the group. In 1999, a similar meeting will be held in Kansas City, USA, in conjunction with a pre-XIV-ICCP field trip to Midcontinent N. America. All meetings involved fieldwork and laboratory workshops that analyzed conodonts, fusulinaceans, brachiopods, and ostracodes. Conodonts and fusulinaceans appear to provide the most reliable clues for correlation at different levels, although additional work will be necessary before proposing a particular fossil as a marker. Two main diff1culties remain concerning fusulinaceans and conodonts. In the case of fusulinaceans, the typical features associated with *Protriticites* (a relevant taxon for this level) can appear in several lineages derived from *Fusulinella*, but probably not wholly synchronously, thus introducing problems for correlation. With respect to conodonts, quite different taxonomic approaches exist as a result of the long period of isolation between eastern European and western specialists. Fortunately, these problems are being resolved by interaction among conodont specialists from different parts of the world, who viewed each other's collections, collected samples on the field trips, and are now initiating exchange of holotype photographs and discussion of taxonomy of critical morphotypes in order to initiate consensus on conodont systematics. In spite of these problems, several positive results have been achieved. Fusulinaceans within Eurasia offer possibilities for comparing both assemblage composition and evolutionary degree of some forms. Some fusulinaceans thought to be restricted to Eurasia have been discovered in North America. Also, several nearly identical conodont morphotypes occur at similar levels in both North American and Eurasian successions. Since 1998, the Working Group has sought potential levels around the Kasimovian/Gzhelian (Missourian/Virgilian) transition.

PROJECT GROUP 3 REPORT. A CHRONOSTRATIGRAPHICAL LEVEL AROUND THE VISEAN V3a/V3b BOUNDARY. **RILEY, NICK,** British Geological Survey, Keyworth, England NG12 5AH, n.riley(~bgs.ac.uk The V3a/b interval (equivalent to the mid-Visean, Asbian Stage of Britain) is characterised across Laurussia by cyclical sediments marking the onset of marine glacioeustatic cyclicity which dominates subsequent Carboniferous marine deposits. This important change in depositional style has potential for global correlation throughout the marine realm and across all palaeolatitudes. It serves to qualify the V3a!b interval as a candidate locus for a Lower Carboniferous GSSP. Around the V3a/b boundary there is a particularly severe marine flooding event which is associated with the introduction of new faunal elements (B2a Ammonoid Subzone, *Gnathodus bilineatus* Conodont Zone, Cf6d Foraminiferal Subzone). Candidate sections need to be sought which display this flooding event and its associated faunal assemblages with a view to identifying a GSSP stratotype for this level in the Lower Carboniferous.

NEW PROJECT GROUP PROPOSAL: A GSSP CLOSE TO THE VISEAN NAMURIAN/SERPUKHOVIAN BOUNDARY **RILEY NICK,** British Geological Survey, Keyworth, England, NG12 5GG, n.riley@bgs.ac.uk The base Namurian is an important European chronostratigraphical boundary. Defined at a widely recognised marine flooding surface (Pendleian Stage), in the Craven Basin of Britain, it introduces the earliest primitive cravenoceratid ammonoids. The base of the Serpukhovian Stage, defined in the Moscow Syneclise (Tarussky Horizon), Russia, correlates closely with the base Namurian and is applied across the former USSR In Gondwana this boundary interval corresponds to a major, glacially induced, deterioration in climate coupled with severe marine biotic endemism . In N. America, the boundary interval lies in the Chesterian Stage. Close correlation with the base Namurian of Europe is achievable in basinal sections (e.g. Arkansas, Utah and Nevada) both in terms of marine biostratigraphy and marine flooding events. Recent advances in ammonoid (Titus 1996, Korn, 1997) and conodont biostratigraphy (Skompsi et al. 1995) as well as foraminiferal data present even better assemblage criteria than has previously been available for correlating a GSSP proposal at this important Eurasian subdivisional level for Carboniferous classification.

## 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 should be timed to reach the Editor before 31 May in the year of publication. Material supplied well before this deadline would be appreciated. To facilitate setting up the Newsletter and to reduce typing errors, copy should be sent BOTH on paper and a computer disk. The Newsletter is prepared using Microsoft Word on the Macintosh but contributions on most other word processing systems can be accommodated. Material should be forwarded on 3.5 inch disks in either Macintosh or IBM format. If you can supply a disk, you should observe the following requirements. Please include a printed copy and the name of the word processing package that you have used. Supply two copies of the file on disk. The first can be the normal output of your software which can include enhancements such as bolding and italics but NO indents or leading TABS please. Avoid any unusual formatting features of your package. The second copy of the file should be saved as a plain ASCII textfile (i.e. no enhancements). Please ensure that all typing is done with only ONE space after each full stop at the end of each sentence. Unless specifically requested the disk will not be returned since the cost of return postage is generally far greater than the original value of the disk. Please follow up your message with an air mailed, formatted, paper copy so that your special formatting (e.g. italics) can be restored by the Editor. Files can also be included in an E-mail message or attached as a Rich-Text-Format (RTF) file or MS Word document compressed with BinHex 4 on the Internet. Please send contributions to:

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# CONTRIBUTIONS BY MEMBERS

*The data, viewpoints and interpretations expressed/presented in contributions by members are those of the individual authors/co-authors and are not necessarily those of the SCCS and carry no formal SCCS endorsement – Ed.

## On the number of Carboniferous series and stages

Manfred Menning[1], Zdzislaw Belka,[2] Jürgen Kullmann[3], Dieter Stoppel[4] & Dieter Weyer[5]

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Work on the volumes *Stratigraphie von Deutschland. Unterkarbon* (ed. D. Stoppel) and *Stratigraphie von Deutschland. Oberkarbon* (ed. V. Wrede) is in progress. The same stratigraphic terminology should be used for both volumes. Thus, on 5 May 2000 the Subkommission für Karbonstratigraphie der Deutschen Stratigraphischen Kommission proposed to classify the Lower Carboniferous and the Upper Carboniferous as series and to use the Tournaisian, Viséan, Namurian, Westphalian, and Stephanian as stages (Fig. 1). The 21 Carboniferous units of West/Central Europe, Hastarian to Stephanian C, should be classified as substages (e.g. Cantabrian substage) to avoid a proliferation of stages and series.

We recommend that the number of Carboniferous series and stages should be comparable with the number of series and stages of other Palaeozic and Mesozoic systems particularly with those of the neighbouring Devonian and Permian systems.

Since Munier-Chalmas & Lapparent (1893) the Devonian consists of three series and seven stages (Fig. 1). It is proposed to subdivide the most voluminous Devonian stage (Famennian, ca. 14 Ma) into four substages. The Permian is proposed to consist of three series and nine stages (Jin et al. 1994, Wardlaw et al. 1999) (Fig. 1). The Subcommission on Triassic Stratigraphy made a decision for the seven Triassic stages Induan to Rhaetian (Visscher 1992). About 16 Triassic substages are in general use. The Subcommission on Carboniferous Stratigraphy decided in 1957 to subdivide the Carboniferous globally into two subunits instead of three subunits.

Thus, for the Carboniferous of Central/West Europe the number of two series, five regional stages, and 21 regional substages is consistent with the numbers in the neighbouring systems.

A number of 21 Carboniferous stages for Central/West Europe and a number of seven to nine Carboniferous series, as discussed on the XIV International Congress on the Carboniferous-Permian in Calgary 1999, would be inconsistent with the number of stages and series in other Palaeozoic and Mesozoic systems. There, the maximum number of stages is in the Cretaceous (12), the number of series is two or three per system.

The global Carboniferous reference scale could be composed of seven to nine stages like in the Devonian and Permian. Figure 1 offers a combination of eight stages from Central/West Europe, East Europe, and North America for global use. The traditional units Dinantian and Silesian of Central/West Europe, the Lower, Middle and Upper Caboniferous of East Europe (sligthly modified) as well as the Mississippian and Pennsylvanian of North America are consistent with the prosposed global stages and series (Fig. 1).

Following these suggestions the number of the Carboniferous stages is comparable in East Europe (7), West/Central Europe (5), and North America (9) (Fig. 1). The Subcommission on Carboniferous Stratigraphy has to propose, as quick as possible, which of the regional stages should be combined and give their names for the global chronostratigraphic reference scale to avoid a global stratigraphic scale without Carboniferous stages (Steininger & Piller 1999: 18).

Many geoscientists have problems to distinguish lithostratigraphic, chronostratigraphic, and geochronologic terms. For a better understanding, lithostratigraphic terms and regional chronostratigraphic terms should be written in small letters if used in tables and figures. However, chronostratigraphic and geochronologic terms recommended by the Subcommission and confirmed by the International Commission on Stratigraphy (ICS) for global use should be typed in capital letters within tables and figures.

A more detailed paper outlining our point of view will be published in *Newsletters on Stratigraphy* later this year.

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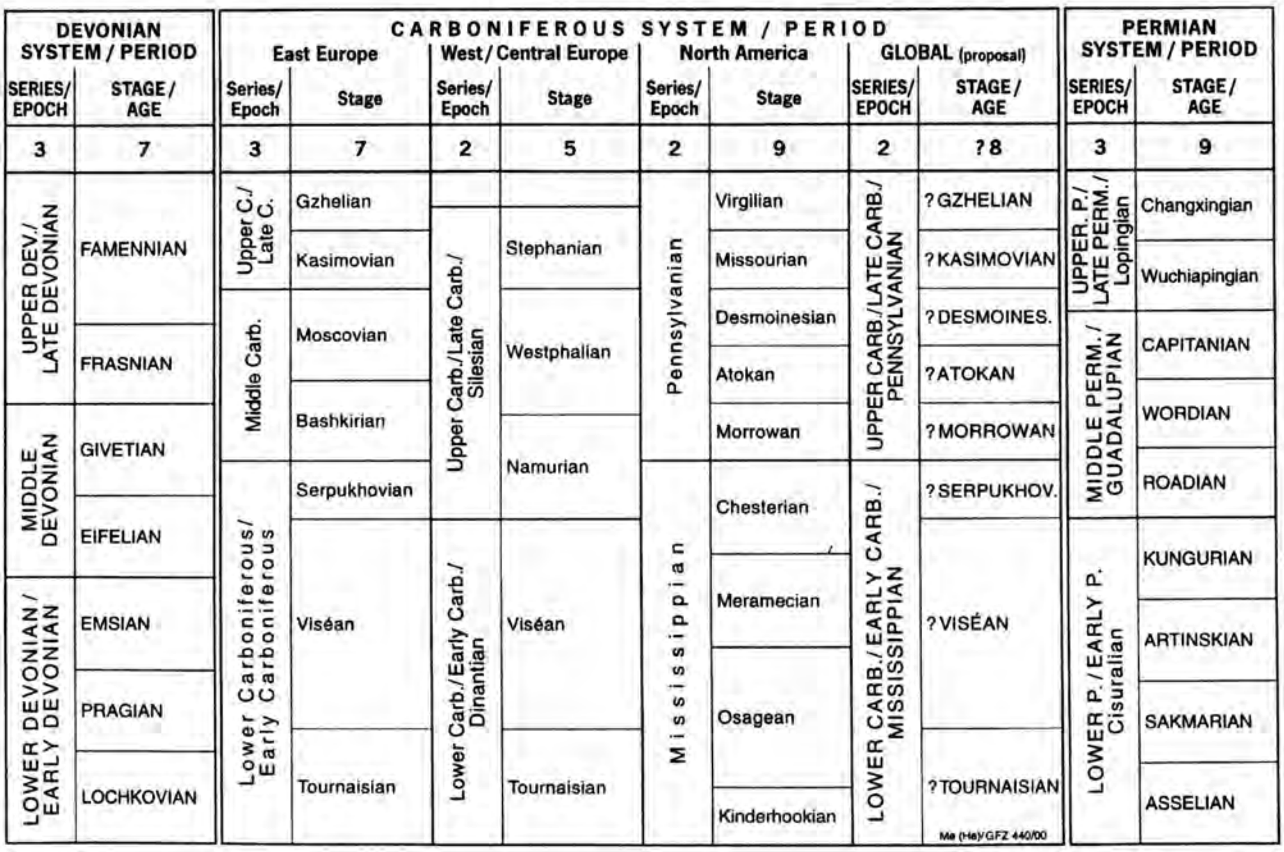


Fig. 1 An optimal number of global Carboniferous series and stages is consistent with the number of series and stages of the neighbouring Devonian and Permian systems.

**Carboniferous-Permian Gondwanan palynostratigraphy**

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Ongoing collaborative research conducted by Geoffrey Playford and Rodolfo Dino focuses on detailed subsurface palynostratigraphy of the Upper Carboniferous through Permian sequence (Tapajós Group) of the Amazonas Basin in the northern Brazilian states of Amazonia and Pará. Numerous fully cored petroleum-exploration wells, drilled by Petróleo Brasileiro S.A. (Petrobras) throughout this extensive (500 km$^2$) basin, have yielded profusely palyniferous (spore-pollen) assemblages that are well-suited to local, regional, and Gondwanic stratal correlations.

Underpinned by detailed taxonomic studies of the spore and pollen components of the palynofloras, seven stratigraphically successive spore-pollen zones are recognizable through the Tapajós sequence. Ranging in age from Westphalian A through Late Permian, these zones are defined on several criteria; in particular, the introduction and/or exiting of selected species, consistent species associations, and relative abundances of particular species or morphological groups (such as taeniate and non-taeniate pollen grains, monosaccate pollen grains, etc). The zones are readily applicable to both intra- and extra-basinal stratigraphic correlations: viz., within the Amazonas Basin, elsewhere in South America (e.g., Paraná, Chacoparanense, Parnaíba, and Paganzo Basins), and in other regions of Gondwana (Australia, southern Africa, Antarctica, and the Indian Subcontinent). Furthermore, certain palynofloral similarities are evident between the Amazonas Basin and the United States Midcontinent; these imply some floristic interchange between the latter and northwest Gondwana in late Palaeozoic time. However, the dominant floral affiliation expressed by the Amazonas Basin palynofloras is clearly Gondwanic. This applies especially to higher parts of the Tapajós Group, in which taeniate bisaccate pollen grains assume increasing prominence and reflect important contributions from, at least in part, the pteridospermous glossopterids.

A two-part monograph by Playford and Dino, which details the palynological characteristics of the Tapajós Group, has been accepted for publication by *Palaeontographica Abteilung B* and is scheduled to appear in late 2000 or early 2001. A summary of major findings of the research is to be presented orally at the Upper Palaeozoic Symposium of the X International Palynological Congress (Nanjing, China; June 2000).

Cognate to the Amazonas Basin study is an assessment of Carboniferous palynofloral affiliations between eastern and western Gondwana (notably South America and Australia), based on existing literature and on new observations by Dino and Playford pertaining to, respectively, Brazilian and Australian sequences. Numerous, morphologically distinctive species - mainly trilete miospores - are identified as being shared by these regions, and hence are applicable to interregional correlation, i.e., where there is demonstrable concordance or near-agreement of stratigraphic ranges in these disparate Gondwanan situations. Some species, however, appear to exhibit stratigraphic/temporal mismatching, thus invoking – not unexpectedly - the possible effects of plant migration across Gondwana during Carboniferous time. An obviously limiting factor in precisely assessing the stratigraphic-correlative significance of some of the miospore taxa relates to uncertain or imprecise datings of their host strata in one or both of these two broad regions. Results of this study were presented orally at the XIV International Congress on the Carboniferous and Permian (Calgary, Canada; August 1999); and are detailed in a manuscript submitted for publication in the Congress proceedings volume.

## The search for a new T-V boundary GSSP. Report of field work in Yunnan and Guangxi (South China), April 2000.

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Debated for more than 10 years, the problem of the Tournaisian-Viséan (T-V) boundary is still not solved and an appropriate stratotype has yet to be found.

Shelf settings are not good candidates for a GSSP because of the end-Tournaisian regression and resulting karstic erosion. Therefore, investigations have to be focused on deeper environments (slope, basin) which recorded a continuous sedimentation during the T-V transition. It is the case for the existing T-V boundary stratotype, in the type area of Dinant (southern Belgium), but there, facies are unsuitable for the foraminifers due to restricted conditions in a peri-Waulsortian context.

The use of *Eoparastaffella* morphotype 2 in the lineage *E.* morphotype 1 to morphotype 2 (Hance & Muchez, 1995; Hance, 1997) appears to be a promising criteria for defining the boundary. This proposal was based on material from the T-V transition in South China (Guangxi autonomous Region), in a slope and basinal setting, allowing to better correlate the foraminifer and conodont zonations.

Further investigations have been conducted in western Yunnan and Guangxi, in order to specify the use of *Eoparastaffella* as biostratigraphic criteria and to search for a GSSP candidate.

Western Yunnan is thought to have been part the Baoshan-Luxi Microplate with Gondwanian affinities during the Lower Carboniferous (Fig. 1A; Jin, 1994). Comparison with other classical areas of South China is therefore promising. Two sections situated near Shidian (Baoshan) were studied and sampled. In this area, Dinantian rocks are resting on Frasnian limestones and shales. The local occurrence of Strunian rocks is currently debated.

- ⇨ The ***Dazhaimen section*** (~140m) is particularly interesting and has yielded a very rich rugose corals fauna in its lower part. The upper part of the section exposes light-coloured thick-bedded pack- to grainstones, oolitic in the uppermost part. The position of the T-V transition is not determined yet. The oldest Tournaisian deposits have been attributed to the Upper Tournaisian.
- ⇨ The ***You Wang section*** (~110m) displays an interesting facies evolution. The Carboniferous starts with a conglomeratic layer (phosphatic pepbles) overlaid by fine-grained laminated limestones. The T-V transition is thought to be included in a succession consisting mainly of thin-bedded fine-grained crinoidal limestones, localy dolomitic, alternating with argillaceous limestones.

Among the sections visited in the Guangxi Autonomous Region, one was promising as potential T-V boundary GSSP candidate (Hance et al., 1997): the ***Pengchong section*** located near the City Liuzhou (Fig. 1B). There, the T-V transition is represented by a carbonate member, the Pengchong Member, included within the culm facies of the Luzhai Formation. This unit has yielded a rich and diversified well preserved foraminifer association, particularly with a well-documented evolution of *Eoparastaffella*.

Unfortunately, the section was not visited during the Subcommission fieldtrip in November 1996 (Hance et al., 1996), due to bad road conditions. In late April, a joint Chinese-Belgian delegation has reinvestigated the Pengchong section. Access is now easy (2 hr from the Guilin airport) and the section, studied with more details, appears much more continuous than initially thought. The Pengchong Member is more than 140 metre-thick. Exposure in the bed of a small stream is excellent. 103 new samples were collected for thin-sections and about 300 kg for conodont processing. All biostratigraphic results should be gathered within a few months. More weight will be given to sedimentology to have a better idea of palaeoenvironments and relative sea-level changes. Most likely, correlation of the Pengchong section with inner shelf facies will be improved, with implications for the global understanding of the T-V transition.

If the results are promising, the possibility of organizing a field meeting in South China in the falls 2001 will be submitted to the Subcommission. Interested members are already requested to support this project and to indicate their likely attendance to such a field trip (one week maximum).

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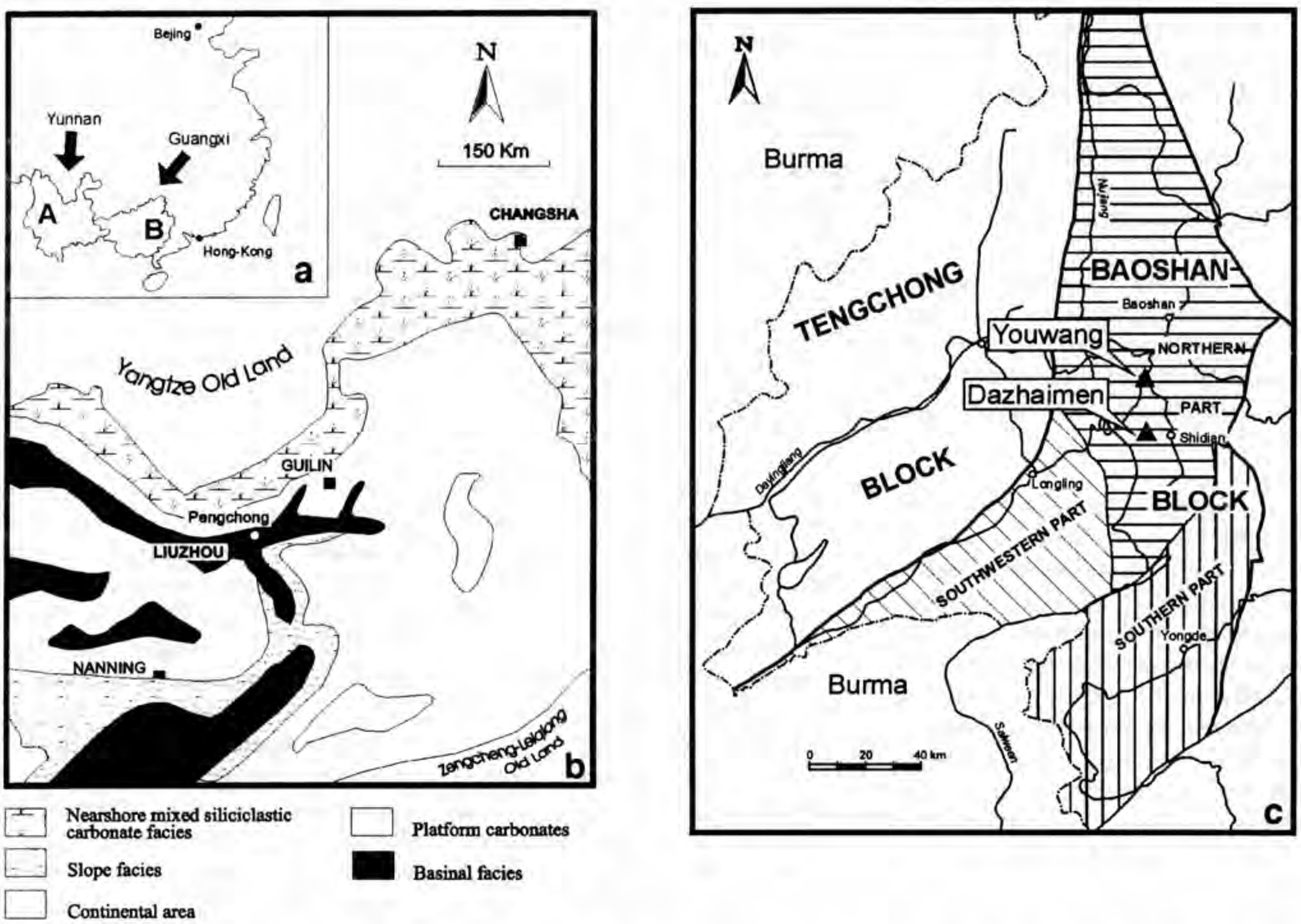


Figure 1: a) General map of China with the two provinces investigated during the field trip b) Palaeogeographic map of Guangxi at the end of the Tournaisian (after Wu & Chen 1989) c) Palaeotectonic map of western Yunnan.

## Recent advances in the study of Upper Palaeozoic molluscs from the Tepuel-Genoa and Sauce Grande-Colorado Basins, Argentina

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This contribution is a summary of several years work on the molluscs from the Tepuel-Genoa (Chubut Province) and Sauce Grande-Colorado (Buenos Aires Province) basins. Carboniferous and Permian Gastropoda, Bivalvia, Hyolitha and Polyplacophora, all groups with biostratigraphic and/or paleobiogeographic significance, were studied.

The previous biozonation proposed for the Tepuel-Genoa basin (Simanauskas and Sabattini, 1997) was mainly based on brachiopods and molluscs. It included the *Lanipustula* Zone, *Pyramus* Faunule, *Tuberculatella* Zone, *Cancrinella* Faunule and *Neochonetes* Zone. As the specimens of *Cancrinella farleyensis* and *Cancrinella* aff. *farleyensis* (Etheridge and Dunn) were subsequently refered to the genus *Costatumulus* (Taboada, 1998), the unit characterized by those species is now distinguished as the *Costatumulus* Faunule.

The *Lanipustula* Zone yields a few gastropods (Euomphaloidea) (Sabattini, 1995a) and several bivalves species (Deltopectinidae, Streblochondriidae, Limidae, Polidevciidae, Schizodidae and Pholadomyidae) which resemble Australian taxa.

The *Pyramus* Faunule is exclusively characterized by bivalves, with the first appearance of the Malletidae, Grammysiidae, Megadesmidae and Pterineidae. Genera of the last two families are exclusively Permian. This unit shows the largest diversity of Polidevciidae and Grammysiidae. They show Australian and New Zealand affinities. The absence of the Limidae and Pholadomyidae is considered remarkable (Pagani, unpublished).

The *Tuberculatella* Zone is mainly characterized by gastropods and bivalves. Gastropods are represented by several Pleurotomarioidea families, with Permian genera known from other regions: *Callitomaria* Batten is only known from United States; *Nordospira* Yochelson (Sabattini, 1995b), from the Leonardian-Wordian of Norway and Alaska; *Platyteichum* Dickins from the Arstinkian-Kungurian of Australia and New Zealand. *Glabrocingulum* (*Stenozone*) Batten is an exclusively Permian subgenus from Malaysia, India and Argentina. This zone contains the only Paleozoic Pleurotomarioidea gastropods found with preserved opercula (Sabattini, 1998). The bivalves of this zone include the oldest Nuculidae and Cardiniidae. The remaining families had already been recorded in the previous biozones, and Limidae and Pholadomyidae are relatively important. The Malletidae show a change in species when compared with those found in the *Pyramus* Faunule. The Euchondriidae include the first record of *Euchondria sabattini* González (Pagani, unpublished). This biozone is characterized by the oldest record of cephalopods for this basin: i.e. *Sueroceras* Riccardi and Sabattini (Orthocerida) which thus far is restricted to the Lower Permian of Argentina, Australia and India. Goniatitids are represented by a pandemic genus and a few endemic species. Hyolitha are well represented with three endemic species (Pagani and Sabattini, 1999). Scaphopoda are restricted to this biozone and include *Calstevenus* Yancey, a genus known from the Lower Permian of the United States.

The *Costatumulus* Faunule is limited to Pleurotomarioidea gastropods and scarce bivalves. The appearance of *Streblopteria* M'Coy, contrasts with the absence of Limidae, Pholadomyidae, Deltopectinidae, Polidevcidae and a diversity decrease of Nuculidae and Malletidae (Pagani, unpublished).

In the *Neochonetes* Zone the molluscs are relatively important. The Bellerophontoidea are quite well represented and restricted to this biozone. The Pleurotomarioidea are characterized by the genus *Eirlysia* Batten, only known from Lower Permian of United States and Argentina. Platyceratoidea and Subulitoidea (first occurrence of Caenogastropoda in the Upper Palaeozoic of Argentina) are also present (Sabattini, 1997). The bivalves, include the oldest record of the Mytilidae, Myalinidae and Permophoriidae. Limidae, Pholadomyidae and Polidevcidae are also present (Pagani, unpublished). A Hyolitha species (Pagani and Sabattini, 1999) and the first Polyplacophora from the

Upper Palaeozoic of Argentina (Hoare and Sabattini, 2000) have also been recorded.

The significance of molluscs for the age and paleobiogeographic affinities of the biozones is as follows: 1) In the *Lanipustula* Zone molluscs are not significant, and the Namurian-Stephanian age (Simanauskas and Sabattini, 1997) was based on Australian affinities of bryozoans and brachiopods. 2) The *Pyramus* Faunule indicates the first Permian levels in the basin. Bivalves have Australian and New Zealand affinities. The age is possibly Asselian. 3) Gastropods of the *Tuberculatella* Zone show similarities with those from Australia, United States, Malaysia and Peru, whilst bivalves have Australian affinities. 4) In the *Costatumulus* Faunule molluscs are less diverse and all taxa are also present in other units. 5) In the *Neochonetes* Zone gastropods are comparable with those from North America (Sabattini, 1996), whilst bivalves have Australian affinities. The age of these three units, is Early Permian, starting in the Early Sakmarian. Research in progress suggests that the *Tuberculatella* Zone and the *Costatumulus* Faunule could be contemporary.

In the Sauce Grande-Colorado basin, the molluscs are represented by gastropods (Pagani, 1998) and bivalves (Pagani, 2000). Gastropods recorded in the Piedra Azul Formation, include a species of *Peruvispira* Chronic, showing affinities with taxa described from Peru and Brazil. Bivalves recorded in the Bonete Formation include: Inoceramidae resembling species from Western Australia; Etheripectininae, with species of *Heteropecten* Kegel and da Costa showing close affinities to those recorded in the Paraná basin (Brazil); Deltopectinidae with one species of the Permian genus *Deltopecten* Etheridge, known from India, Australia and Tasmania, resembling Australian species; Mytilidae are related to taxa from New Zealand and Eastern Australia; Permophoridae include representatives of the Permian genus *Stutchburia* Etheridge, comparable to Brazilian species; Megadesmidae are represented by species of *Myonia* Dana, a genus known from Australia, New Zealand and Russia. Two species of Pterineidae and one of Edmondiidae have also been recorded in this formation.

This fauna and the presence of *Eurydesma* Morris, suggest Gondwanic affinities related to the same transgressive event that affected the Paraná, Karroo and Kalahari basins, as well as India and Australia. Faunal composition is similar to that described by Simoes *et al.* (1998) for the Rio do Sul and Rio Bonito formations, Paraná Basin, Brazil. Thus, similar environmental conditions recorded in the Bonete Formation, resulted in the development of related faunas.

The Sierras Australes fauna is Early Permian in age. Presence of *Eurydesma*, *Deltopecten* and *Atomodesma* as well as affinities with Australian and Brasilian faunas and paleofloristic assemblages indicate Late Asselian-Artinskian (Pagani, 2000).

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| Faune / Zone | Hyolitha | Scaphopoda | Polyplacophora | Gastropoda | Cephalopoda | Bivalvia |
|---|---|---|---|---|---|---|
| *Neochonetes* Zone | Hyolithidae | | Lepidopleuridae | Bellerophontoidea Pleurotomarioidea Platyceratoidea Subulitoidea | Orthocerida Nautilida | Pholadomyidae - Euchondriidae Myalinidae - Permophoridae Limidae - Nuculidae - Mytilidae - Polidevcidae - Malletidae - Grammysiidae - Schizodidae Streblochondriidae |
| *Costatumulus* Faunule | | | | Pleurotomarioidea | Orthocerida | Nuculidae - Streblochondriidae Malletidae - Schizodidae Euchondriidae |
| *Tuberculatella* Zone | Hyolithidae | Siphonodent-aliodea Dentaliodea | | Pleurotomarioidea Trochoidea | Orthocerida Goniatitida | Nuculidae - Malletidae - Limidae - Deltopectinidae - Polidevcidae Streblochondriidae - Cardiniidae Pholadomyidae - Euchondriidae Streblochondriidae |
| *Pyramus* Faunule | | | | | | Malletidae - Grammysiidae - Streblochondriidae - Schizodidae Megadesmidae - Polidevcidae Deltopectinidae - Pterineidae |
| *Lanipustula* Zone | | | | Euomphaloida | | Schizodidae - Deltopectinidae - Streblochondriidae - Limidae - Polidevcidae - Pholadomyidae |

## A Provisional Conodont Zonation for Late Pennsylvanian (late Late Carboniferous) Strata in Midcontinent Region of North America.

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### Introduction

Over the past several years important advances have been made in the understanding of Late Pennsylvanian conodonts and their stratigraphic distribution in cyclothems in the Midcontinent region of North America. The basic results of this work have been presented in series of publications, where ranges of significant conodont taxa have been plotted against the cyclothem succession of the northern Midcontinent and north-central Texas, and their utility in identifying and correlating cyclothems in the northern Midcontinent with those in Texas and the Illinois and Appalachian Basins have been described (Heckel, 1989; Barrick and Boardman, 1989; Boardman and Heckel, 1989; Heckel and Weibel, 1991; Heckel, 1994; Ritter, 1994, 1995; Heckel, 1999;

Boardman, 1999). A preliminary correlation of the Midcontinent North American cyclothems with the succession in eastern Europe was presented by Heckel and others (1998). Although taxonomic revision of Late Pennsylvanian conodont taxa, especially the species of the important genera *Idiognathodus* and *Streptognathodus*, has not yet been completed, the most useful taxa have been sufficiently well described and illustrated in a series of papers such that the geological community can begin to use them to effect biostratigraphic correlations (Barrick and Boardman, 1989; Ritter, 1994, 1995; Barrick et al., 1996; 1999; Boardman et al., 1998; Barrick and Walsh, 1999; Barrick and Lambert, 1999; Boardman, 1999).

Despite all this work, a complete biostratigraphic zonation for the Late Pennsylvanian in the Midcontinent region has not been published. Merrill (in Lane et al., 1971) proposed a set of four zones for the Late Pennsylvanian based on faunas from the Appalachian Basin. These zones, which were distinguished by the peaks or epiboles of the name-givers, have not been widely used. More recently, Ritter (1995) published a series of range zones extending from the middle Missourian into the Lower Permian. Parts of his work are incorporated into the proposed zonation. The provisional zonation we propose here (Figure 1) is of greatest utility in central and eastern North America and can be used to some degree in the western United States (Paradox Basin, Utah) as described below. However, we recognize that with additional information it may be possible to subdivide some of the zones into smaller zones, or it may be necessary to revise zonal definitions to create units of wider application. Because species of *Idiognathodus* and *Streptognathodus* exhibit a strong degree of provinicialism during at least the Missourian (Barrick et al., 2000), we doubt that all parts of this zonation will prove to be applicable on the global scale.

**Missourian Stage**

Heckel and others (1999) have recommended that, for purposes of correlation, the base of the Exline cyclothem be used as a reference position for the base of the Missourian Stage in the Midcontinent region. (The base of the Missourian has also been regarded as the base of the Upper Pennsylvanian Series in this region). The Exline level is slightly above the traditional base of the Missourian at the unconformity at the base of the Pleasanton Group in Kansas and the laterally equivalent base of the Seminole Formation in Oklahoma. The level of the Exline cyclothem was chosen because it contains the first appearance of *Idiognathodus eccentricus* (Ellison, 1941) above the first appearance of its ancestor, *I. sulciferus* Gunnell, 1933. Because it is the first new species of *Idiognathodus* to appear above the traditional boundary, the first appearance of *I. eccentricus* can serve as a biostratigraphic marker by which basal Missourian strata can be identified in the Midcontinent region. We propose the *Idiognathodus eccentricus* Zone to extend from the first appearance of the nominate species up to the first appearance of *Streptognathodus cancellosus* (Gunnell, 1933). The thin marine cyclothem (Checkerboard Limestone – South Mound Shale) that occurs above the traditional base of the Missourian but underlies the first appearance of *I. eccentricus* has yielded non-diverse conodont faunas characterized by *I. sulciferus*, which ranges up into the *eccentricus* Zone. In the Kansas-northern Oklahoma region, the *eccentricus* Zone includes (in ascending order) the intermediate Exline cyclothem, the minor Critzer cyclothem, and the major Hertha cyclothem. Within the upper part of the *eccentricus* Zone, the more nodose species, *I.* n. sp. A and *I. clavatulus* (Gunnell, 1933) appear at the level of the Hertha cyclothem (Barrick et al., 1996).

Recognition of the *eccentricus* Zone outside of the Kansas-Oklahoma region has been hindered by the absence or limited development of basal Missourian marine units in other nearby basins. Although the zone has not been found in the Appalachian Basin, the Scottville limestone of the Illinois Basin contains *Idiognathodus eccentricus*, which permits it to be correlated with the Exline cyclothem (Heckel, 1999). The next higher Cramer marine unit (Trivoli cyclothem) of the Illinois basin contains *I. clavatulus*, which indicates a correlation with the Hertha cyclothem in Kansas (Heckel and Weibel, 1991; Heckel, 1999), and thus with the upper part of the *eccentricus* Zone. In north-central Texas, *I.* n. sp. A and *I. clavatulus* occur in the Dog Bend cyclothem (Barrick and Boardman, 1989), which also has been correlated with the Hertha cyclothem (Boardman and Heckel, 1989). Conodonts of the *eccentricus* Zone have been identified also in the western United States, where they occur in the upper Honaker Trail Formation in the Paradox Basin of Utah, a short distance above beds bearing Desmoinesian conodonts and fusulinids (Ritter et al., 1999).

The appearance of the distinctive species *Streptognathodus cancellosus* in the major Swope cyclothem above the Hertha cyclothem marks the divergence of the lineage that leads to the diverse *Streptognathodus* faunas of the later Missourian (Barrick et al., 1996). We propose the *Streptognathodus cancellosus* Zone to range from the first appearance of the nominate taxa up to the first appearance of *Streptognathodus gracilis* Stauffer and Plummer, 1932. The *cancellosus* Zone used here is not the same as the Eurasian *cancellosus* Zone of Barskov (1984) and other authors. The species identified in Eurasia as *S. cancellosus* is a different species from the Midcontinent North American taxon. All *Idiognathodus* species occurring in the *eccentricus* Zone range into the *cancellosus* zone, and some additional unnamed forms may also be present. The *cancellosus* Zone includes four cyclothems in the Kansas-Oklahoma region (in ascending order): the major Swope cyclothem, the minor Mound Valley cyclothem, the major Dennis cyclothem, and probably the intermediate Hogshooter-upper Winterset cyclothem. *Streptognathodus confragus* (Gunnell, 1933) first appears in the Mound Valley cyclothem. In the Dennis and the overlying Hogshooter-upper Winterset cyclothem, *S. cancellosus* is uncommon and *S. confragus* is the most abundant species of the genus. Some *Idiognathodus* and *Streptognathodus* Pa elements in the Dennis fauna appear to be transitional to forms occurring in later Missourian cyclothems.

The lower part of the *cancellosus* Zone (Swope equivalent) has been identified in the Appalachian basin ('Lower' Brush Creek Limestone: Heckel and Barrick, in Heckel, 1994), the Illinois basin (Macoupin cyclothem, which is next above the Trivoli: Heckel and Weibel, 1991), north-central Texas (Upper Salesville Shale: Boardman and Heckel, 1989), as well as in the Paradox basin of Utah (upper Honaker Trail Formation: Ritter et al., 1999). The upper part of this Zone (Dennis equivalent) has been recognized in the Appalachian basin (the equivalent 'Upper' Brush Creek and Pine Creek limestones: Heckel and Barrick, in Heckel, 1994), the Illinois basin (Shoal Creek cyclothem, which is next above the Macoupin: Heckel and Weibel, 1991), north-central Texas (Palo Pinto Limestone: Boardman and Heckel, 1989), as well as in the Paradox basin of Utah (upper Honaker Trail Formation: Ritter et al., 1999).

Ritter (1995) proposed the *Streptognathodus gracilis* Zone to extend from the first appearance of the nominate species to the first appearance of *S. firmus* Kozitskaya, 1978. Here we use the first appearance of *Idiognathodus simulator* (Ellison, 1941) instead of *S. firmus* to define the top of the zone (see below). The *gracilis* Zone includes a large part of middle to upper Missourian strata in the Midcontinent region, extending from the intermediate Cherryvale cyclothem through the lower part (Captain Creek Limestone) of the major Stanton cyclothem and includes five major to intermediate cyclothems (in ascending order, Cherryvale, Dewey, Iola, Wyandotte and Plattsburg) and several minor cycles (Heckel, 1999). The *gracilis* Zone is characterized by the radiation and dominance of a closely related group of *Streptognathodus* species: *S. gracilis*, *S. elegantulus* Stauffer and Plummer, 1932, *S. excelsus* Stauffer and Plummer, 1932, and *S. corrugatus* Gunnell, 1933. *Idiognathodus* Pa elements are usually assigned to *I. magnificus* Stauffer and Plummer, 1932, but preliminary study of the *Idiognathodus* faunas reveals that other species are present as well.

Subdivision of the *gracilis* Zone is not yet possible using range data alone. Heckel (1999 and earlier papers) has used the acme of a prominently lobed and delicately ribbed morphotype, *I. magnificus* sensu stricto (a concept that includes the holotype) to identify the Quivira Shale of the Dewey cyclothem. This acme has been used to correlate the Dewey with the mid-Posideon Shale (PP3, the type stratum of the species) in north-central Texas (Boardman and Heckel, 1989) and with the Flat Creek cyclothem in the Illinois Basin (Pope, 1999: Flat Creek is the preferred name for the "Fithian" cyclothem of Heckel and Weibel, 1991). In the Muncie Creek Shale of the next higher Iola cyclothem, a closely related *Idiognathodus* morphotype with a reduced lobe (informally termed "postmagnificus": Heckel et al., 1998; Heckel, 1999) is characteristic and has been used to identify the Iola cyclothem and to correlate it with the La Salle/Lower Millersville cyclothem in the Illinois basin (Heckel and Weibel, 1991) and with the lower Wolf Mountain Shale in north-central Texas (Boardman and Heckel, 1989). More recently, Heckel (1999) and Goettemoeller (2000) reported that a morphotype of *Streptognathodus* with a bent trough axis (*S.* sp. A of Ritter, 1995) occurs in the intermediate Wyandotte and Plattsburg cyclothems in the Midcontinent and in two equivalent cyclothems above the LaSalle/Lower Millersville in the central Illinois Basin near the top of the *gracilis* Zone. Above the 'Upper' Brush Creek/Pine Creek marine unit in the Appalachian Basin, the conodont faunas of the Cambridge/Nadine and the Portersville/Woods Run marine units are dominated by morphotypes of the *S. gracilis* group, placing them into the *gracilis* Zone in that region.

Ritter (1995) proposed the *Streptognathodus firmus* Zone to extend from the first appearance of the nominate species in the upper Missourian to the first appearance of *S. pawhuskaensis deflectus* Ritter, 1995, well up in the Virgilian. Here we split the *firmus* Zone into two zones, the lower one of which is called the *Idiognathodus simulator* Zone. The lower boundary is defined by the first appearance of the nominate species and the upper boundary is defined by the first appearance of *S. zethus* Chernykh, 1987. Both *I. simulator* and *S. firmus* first appear in the Eudora Shale, the core shale of the Stanton cyclothem, thus the lower boundary of the *simulator* Zone is essentially the same as that of the *firmus* Zone of Ritter (1995). We hesitate to use *S. firmus* as a zonal index in the Midcontinent region because it may be an immigrant into the Midcontinent region from Eurasia (Barrick et al., 2000). Pa elements that could be ancestral to *S. firmus* are common in Kasimovian Eurasian faunas, most of which are assigned to "*S. oppletus*", a taxon that is different from true *S. oppletus* Ellison, 1941 in the Quivira Shale of the Midcontinent region. In contrast, *I. simulator* is derived from Midcontinent forms of *Idiognathodus*, and transitional forms between *I. simulator* and typical flat-topped older *Idiognathodus* Pa elements occur in the Eudora Shale. *Streptognathodus firmus* does appear reliably in the Eudora Shale and its equivalents in the Midcontinent region, making it a useful species for correlation of shallower water facies. However, the species has been used as an index form in Eurasia, where it may have appeared at an earlier time.

Although *Idiognathodus simulator* is abundant in the Stanton cyclothem, it and other species of *Idiognathodus* are uncommon in most of the overlying cyclothems. Through the next three cyclothems (the intermediate South Bend and Iatan cyclothems, and the minor Westphalia cyclothem), *S. firmus* occurs in decreasing numbers as the closely related species *S. pawhuskaensis* Harris and Hollingsworth, 1933 rises to dominance. In the Iatan cyclothem, forms of *S. pawhuskaensis* with a few irregularly distributed marginal nodes occur.

The Little Vermilion cyclothem of the Illinois basin (Heckel and Weibel, 1991) and the upper Winchell/Merriman Limestone of north-central Texas (Boardman and Heckel, 1989) have been correlated with the Stanton cyclothem based on the co-occurrence of *Idiognathodus simulator* and *Streptognathodus firmus*. The Noble Limestone of Ohio (above the Portersville marine unit) is correlated with the Stanton based on the presence of *S. firmus* (Heckel and Barrick, in Heckel, 1994). Correlation of strata equivalent to the upper part of the *simulator* Zone has been problematic, and this interval can currently be identified only by its position between the defining species of the *simulator* and *zethus* zones.

**Virgilian Stage**

The base of the Virgilian Stage has been placed at different levels in the Midcontinent region, as discussed by Boardman and others (1994). The level that we use here to mark the base of the Virgilian is the base of the Cass cyclothem (called 'Haskell-Cass' by Heckel et al., 1998) in the middle of the Douglas Group in Kansas. This level coincides with the first appearance of the species *Streptognathodus zethus* (Heckel, 1999). Because Ritter's (1995) *S. firmus* Zone spans several cyclothems ranging in age from late Missourian through early Virgilian, we propose that the Virgilian part be placed into a new zone, the *Streptognathodus zethus* Zone, the base of which is defined by the first appearance of the nominate species. The top is defined by the base of the *pawhuskaensis deflectus* Zone.

Recognition of the lower part of the *zethus* Zone outside of Kansas is complicated by the presence of similarly noded Pa elements that occur below *S. zethus*. Boardman and Barrick (1989) reported *S. zethus* from the Lower Colony Creek cyclothem in north-central Texas, but more recent work casts doubt on that identification. Heckel and Weibel (1991) identified *S. zethus* from the Omega marine unit in the Illinois basin and correlated it with the Cass cyclothem. The Oread cyclothem in Kansas, which lies in the upper part of the *zethus* Zone, is readily distinguished from other lower Virgilian cyclothems by the acme of *Idiognathodus simulator* and closely related Pa elements. The first appearance of *I. tersus* Ellison, 1941, and the last appearance of *I. simulator* are also in the Oread cyclothem (Ritter, 1995; Heckel, 1999). This acme at the end of the range of *I. simulator* has been used to correlate the Oread cyclothem with cyclothems in north-central Texas (Finis cyclothem: Boardman and Heckel, 1989), the Illinois basin (Shumway cyclothem: Heckel and Weibel, 1991), and the Appalachian basin (Ames limestone: Heckel and Barrick, in Heckel, 1994).

Ritter (1995) erected the *Streptognathodus pawhuskaensis deflectus* Zone to encompass the interval from the first appearance of the nominate species to the first appearance of *S. virgilicus* Ritter, 1995. *Idiognathodus lobulatus* Kozitskaya, 1978 appears at the base of the zone and ranges through it into the next zone. The *deflectus* Zone includes only two intermediate cyclothems in the Kansas succession, the Clay Creek and Spring Branch cyclothems of Heckel and others (1998) and Boardman (1999). This zone has not yet been recognized outside of Kansas.

The *Streptognathodus virgilicus* Zone of Ritter (1995) includes a significant proportion of middle to late Virgilian time, spanning approximately 30 cyclothems of all scales as recognized by Boardman (1999). Its base, which is defined by the first appearance of the nominate species, lies at the Lecompton cyclothem, and its top, defined by the first appearance of *S. brownvillensis* Ritter, 1994, lies at the base of the Brownville cyclothem. Thus far, mostly long-ranging species have been reported from this zonal interval. Species of *Idiognathodus* (*I. tersus* Ellison, 1941 and *I. lobulatus*) and *Gondolella* (in any abundance) have their highest occurrence in the Midcontinent region in the basal cyclothem of the zone, the Lecompton cyclothem (Ritter, 1995). The highest occurrence of *Idiognathodus tersus* Ellison, 1941 has been used to correlate the Queen Hill Shale of the Lecompton cyclothem with the Necessity Shale of north-central Texas by Boardman and Heckel (1989) and with the Bogota cyclothem of the Illinois basin by Heckel and Weibel (1991).

Ritter (1995) showed that *Streptognathodus holtensis* Ritter, 1995 characterizes the middle portion of the *virgilicus* Zone (Topeka through Church cyclothems). We propose that the first appearance of *S. holtensis* be used to define the base of an Upper *virgilicus* Zone. The boundary between the Lower and Upper *virgilicus* zones lies at the base of the Topeka cyclothem (defined by the Dubois Limestone-Holt Shale-Coal Creek Limestone sequence in Boardman, 1999). Because neither *S. virgilicus* nor *S. holtensis* have been identified outside of Kansas, the value of these zones remains to be fully evaluated.

Ritter (1995) proposed the *Streptognathodus brownvillensis* Zone to include the interval between the first appearance of *S. brownvillensis* at the base and the first appearance of *S. wabaunsensis* Gunnell, 1933 at the top. As Ritter (1995) and Chernykh and Ritter (1997) have used the zone, the base of the zone lies at the base of the Brownville cyclothem and includes strata up to the base of the Falls City cyclothem, where they report the first appearance of *S. wabaunsensis* Gunnell, 1933. Boardman (1999) reports that *S. bellus* Cherynkh and Ritter, 1997 and the fusulinid *Leptotriticites* also appear in the Brownville cyclothem.

From the level of the Falls City cyclothem and higher, a rapid diversification in *Streptognathodus* produced a number of short-ranged species, many of which could be used to create a detailed zonation extending from the latest Pennsylvanian into the earliest Permian. The *S. wabaunsensis* Zone of Ritter (1995), which extends from the Falls City cyclothem up to the first appearance of *Streptognathodus* aff. *S. barskovi* Kozur, 1976 in the Burr Limestone Member of the Grenola Formation of the Council Grove Group, includes the interval of the initial radiation of these taxa. However, the taxonomy and stratigraphic distribution of these *Streptognathodus* species are still unresolved (Chernykh and Ritter, 1997; Boardman et al., 1998; Boardman, 1999). For example, Boardman (1999) uses a more restrictive definition of *S. wabaunsensis* and indicates that this species appears five cyclothems (mostly minor ones) higher in the section, in the Americus Limestone at the base of the Foraker megacyclothem complex. In the Falls City cyclothem, Boardman (1999) reports the species *S. alius* Akhmetshina, 1990, and in the Five Point cyclothem, *S. flexuous* Chernykh and Ritter, 1997, two taxa that are similar to *S. wabaunsensis*. For now, we retain the base of the *wabaunsensis* Zone at the base of the Falls City cyclothem. Even if it is eventually determined that *S. wabaunsensis* first appears at a higher stratigraphic level, a zonal boundary could still be placed at the level of the

Falls City cyclothem, based on *S. alius*.

When Ritter (1995) proposed his zonation, the position of the base of the Permian had not been formally decided, but he indicated that the proposed level of the base of the Permian should lie within his *wabaunsensis* Zone in the Glenrock Limestone Member of the Red Eagle Limestone. Subsequently, Chernykh and others (1997) proposed the new species, *Streptognathodus isolatus*, for a taxon that appears at the base of the Permian at the Aidaralash Creek global stratotype, and Chernykh and Ritter (1997) erected a new zone for the base of the Permian, the *S. isolatus* Zone, based on the first appearance of this species. Because *S. isolatus* occurs in the Glenrock Limestone of the Red Eagle Limestone in Kansas (Chernykh and Ritter, 1997), we replace the upper part of the *wabaunsensis* Zone of Ritter (1995) with the *isolatus* Zone as defined by Chernykh and Ritter (1997) and use this zone to identify the position of the base of the Permian in the Midcontinent region.

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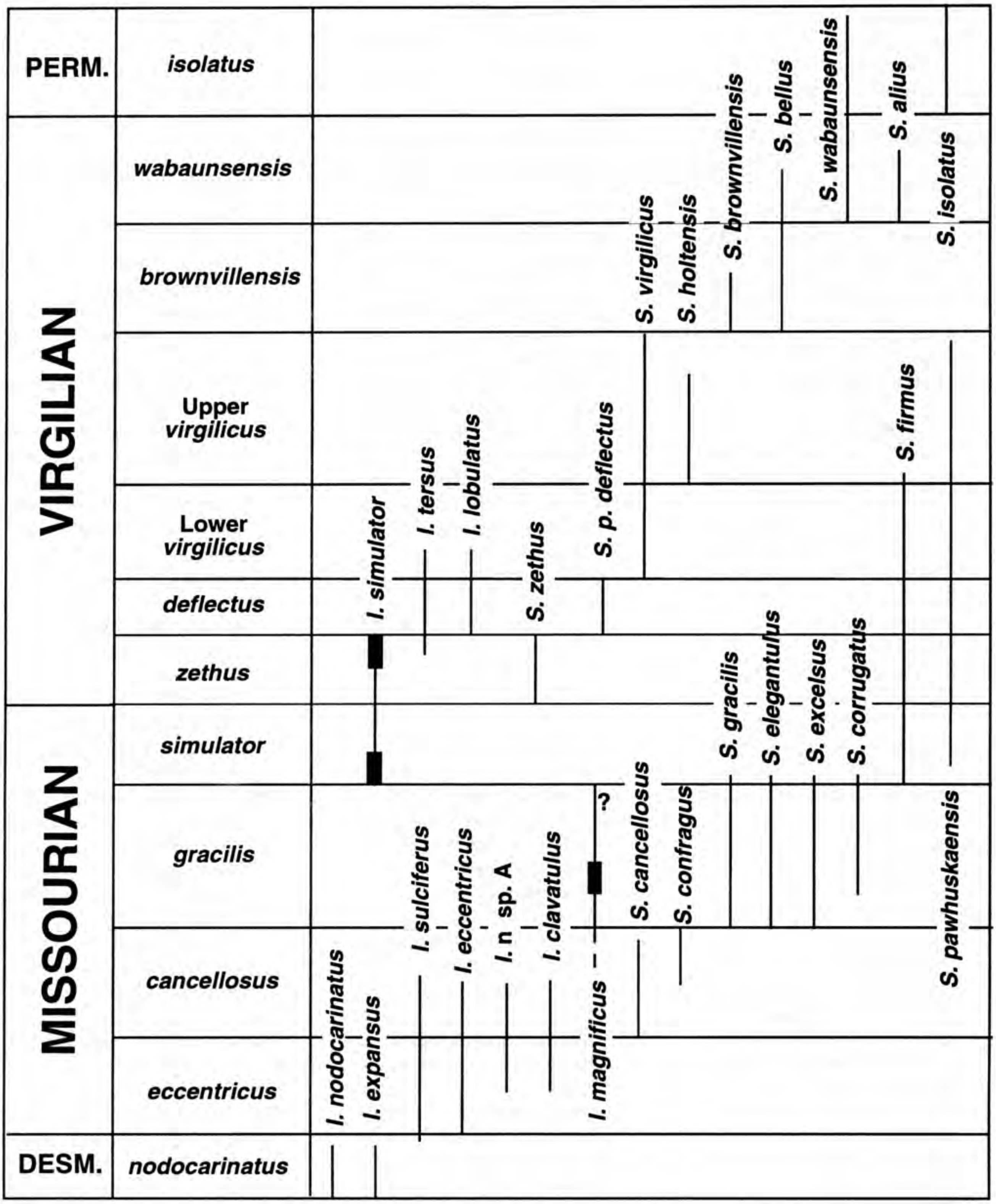


Figure 1. – Preliminary conodont zonation of Late Pennsylvanian Missourian and Virgilian Stages in Midcontinent North America. Thicker bars in ranges of certain taxa indicate conspicuous acmes. Cyclothem succession for Missourian through mid-Virgilian strata was illustrated in a previous edition of this Newsletter by Heckel and others (1998).

**Exposures of the Westphalian Series in the upper Neath and Swansea Valleys, South Wales – a geoconservation project**

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The study of the Upper Carboniferous in Europe is often hindered by restricted natural exposure. So long as the coalfields were being commercially exploited, this was not a significant problem because mining produced excellent temporary exposures. However, the decline, and in many areas disappearance, of coal mining means that this scientific resource is no longer available. There is also the problem of trying to define stage boundary stratotypes for these sequences, because the IUGS Commission on Stratigraphy requires them to be in 'natural', conservable exposures.

The largest area of coal-bearing Westphalian strata in Western Europe is on the Variscan Foreland, where there is a series of coalfields between Britain in the west and Poland in the east. The sequences here are particularly important because of their historical connection with the concept of the Westphalian Series (Wagner, 1974) and is where the boundary stratotypes for its lower three stages (Langsettian, Duckmantian and Bolsovian) are defined. However, surface exposure is all but non-existent throughout most of the area; the only significant exceptions being in the British Isles.

As part of a national review of the exposed geology of Britain (the *Geological Conservation Review*), Cleal & Thomas (1996) examined all of the important surface outcrops of Westphalian strata in the country. A number of major coastal exposures were identified showing parts of the Westphalian sequence, including Pembrokeshire, Northumberland and Fifeshire. However, the only area where there is a continuous natural exposure of most of the lower three Westphalian stages is the north crop of the South Wales Coalfield.

One section in particular stood out as providing an unrivalled record of the Westphalian of the Variscan Foreland. The streams of Cwm Gwrelych and Nant Llyn Fach near Glyn Neath together provide a continuously exposed section from the Subcrenatum Marine Band (base Westphalian) to above the Cambriense Marine Band (middle Bolsovian). Despite its importance, however, the section had never been properly documented, with the only published record being some very piecemeal and generalised logs in an old edition of the local geological memoir (Robertson, 1932); the latest edition of the memoir (Barclay *et al.*, 1988) hardly mentions the site.

The site has been scheduled as a Site of Special Scientific Interest by the Countryside Council for Wales (CCW) and is, therefore, subject to some level of protection. It is also a candidate site for the IUGS World Geosites inventory. However, practical conservation of such sites requires a detailed knowledge of the field geology, information that is not currently available. To remedy this, CCW and the National Museums & Galleries of Wales are jointly funding a geological survey of the site, including detailed stratigraphical logging and the identification of the key palaeontological levels.

The work started in early October 1999 and, despite some unfavorable weather conditions in the late winter months, just over half the total section length (4km.) has been logged at time of writing (May 2000). Mapping and correlation of the coal seams is proving very difficult due to the extent of past commercial and private coal extraction. In some cases, coal seams can only be identified by correlation with samples from other exposures by petrological laboratory analysis. Another problem is the absence of many of the marine bands normally found in the British Coal Measures, and which are important stratigraphical markers. However, several marine bands have been found in the adjoining Selar open-cast site, including the Vanderbeckei Marine Band (Langsettian – Duckmantian boundary), the Haughton and Sutton Marine Bands (upper Duckmantian) and the Aegiranum Marine Band (Duckmantian – Bolsovian boundary). It is hoped to be able to trace these marine bands the short distance overland to the studied stream section, where they can be excavated.

The base of the Westphalian (Subcrenatum Marine Band, in a goniatite-pectinoid biofacies) is over 17 m. thick here, but will require some vegetation clearance to expose it fully. The overlying thick sandstone known as the Farewell Rock, with its excellent cross bedding and slump structures, is well exposed. The Astell Coal, which occurs directly above the Farewell Rock, cannot now be seen but its position can be identified by a large adit. The Springwood, Honley, Listeri and Parkhouse Marine Bands, and the associated plant beds, are missing due to large rotational failure landsliding. It is hoped to identify alternative local sections for these horizons.

Upstream from the landslide is an exposure of a marine band, probably the Amaliae. Elsewhere in South Wales a coal known as the Cnapiog Seam overlies the Amaliae Marine Band. This is not now exposed at Cwm Gwrelych, but its position may be marked by several small mine adits that have since collapsed and are inaccessible. Much of the next part of the section is occupied by ancient ironstone workings. There is significant exposure here of the hard tabular and nodular lacustrine ironstones, traditionally known as 'mine'. These beds are devoid of any plant material but do occasionally produce *Carbonicola* remains.

Several coals above the 'mine' have provisionally been identified as the New, Grey and Rhyd seams, although their poor exposure, and the amount of thrusting that has been taken up in these horizons, makes accurate identification difficult. The Bluers (Seven Feet) Seam is a two-leaf coal found in the Nant Gwrelych stream section. It displays good outcrop characteristics and is the lowest unit identified in the adjacent Selar opencast site. Sedimentary logging of the exposure up sequence of the Bluers Seam (including the Lower Brass Seam) is currently being undertaken. Exposure in the riverbed is good and interesting thrust features can be seen. The sequence here is predominantly non-marine, with several bands containing pyritised non-marine bivalves.

There is good exposure in the adjacent Cwm Ceffyl valley of formations either side of the Vanderbeckei Marine Band, where it is preserved with associated Amman Rider Seam. The Brass seam, the lowest Duckmantian coal, is thrust out and is only found in the lowest excavated level of the opencast exposure. A significant part of the Cwm Ceffyl exposure has been lost in the recent past during the development of an access road to the opencast, and to culverts being built over the stream 0.75 km up stream by foresters. Good exposure does still exist in the Cwm Gwrelych valley and, as part of the conservation of the site, several sections are to be excavated by Countryside Council for Wales and documented for inclusion in the Geological Conservation Review.

Fossil rich horizons are numerous throughout the section, with the best plant fossil horizons being in roof shales and occasional channelised sandstones. Pyritised non-marine bivalves also occur in some mudstones below the Vanderbeckei Marine Band. Collection of fossils from the stream section and adjacent opencast pit is scheduled for later in the summer. The collected specimens will then be conserved, documented and held in the National Museums and Galleries of Wales (Cardiff) as a permanent palaeontological record of the site. It is hoped that access to the Selar opencast site will permit bulk collection of better quality specimens than the highly weathered material obtainable in the stream valleys.

The eventual outcome of this project will be a detailed conservation strategy for this internationally important site. It will also provide the first detailed stratigraphical log through a large part of the Westphalian Series, which can be compared with field observations in a conserved site. The boundary stratotypes for the lower three Westphalian stages are also in conserved outcrops, in northern England. However, they are in tiny exposures that show little more than the marine band that are used to identify the stage boundary. We have in South Wales what is, in effect, a standard section through the body of these stages in their classic facies as developed in the parallic coalfields.

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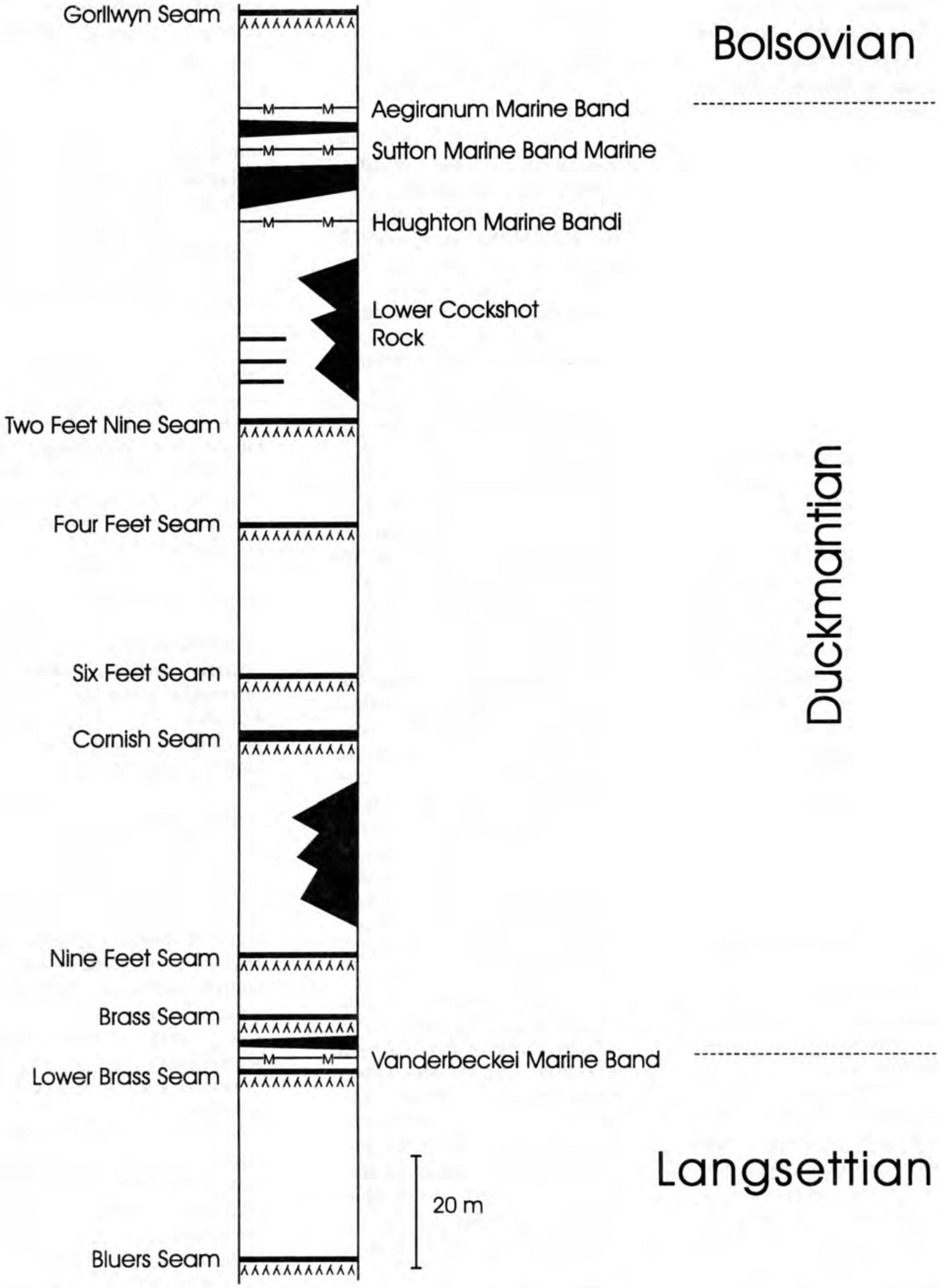


Figure 1. Middle part of the succession exposed along the Cwm Gwrelych – Nant Llyn Fach streams near Glyn Neath, South Wales, UK.

## Possible candidate section for stratotype of Mid-Tournaisian boundary (Konstantinov Creek, Subpolar Urals)

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The search for a Mid-Tournaisian boundary stratotype (SCCS Project Group 1 - see *Carboniferous Newsletter* 14, 1996, p.4) has been made difficult by realisation that a prominent eustatic couplet (sea level fall-rise) occured just before the boudary of the Lower and Upper Tournaisian. This couplet resulted in a stratigraphic interval (approx. *sandbergi* conodont zone) wherein fossils are scarce and sharp lithological change or short-term hiatus occurs.

The section is located in the road cut on the left bank of the Konstantinov Creek (left tributary of the Kozhym River, Subpolar Urals, (65.39.00 N., 59.43.48 E)). This location is available from railway station Kozhym, about 120 km north-east of town Pechora.

The section had been studied in 1986 by V. Chermnykh and A. Tereschuk, in 1987-89 by A. Zhuravlev and D. Sobolev, in 1994 by A. Zhuravlev (Zhuravlev, 1998), and in 1999 by the authors of this paper.

A number of fossils are studied from this section (conodonts, ostracodes, foraminifers), also palaeomagnetic and geochemical studies are in process.

Two levels may be considered as the middle-Tournaisian boundary, the base of the *crenulata* zone or the base of the *Siphonodella quadruplicata* zone. The first level coincides with a turbidite layer (?) base (unit 7) and it is not biostratigraphically reliable due to strong reworking of fossils. However the level is characterised by the Upper Tournaisian foraminifers (*Chernyshinella glomiformis* Lip. and *Septabrunsiina krainica* Lip). The second level is better, because of its position in the lithologically uniform member (chert, cherty limestone, and argillite alternation) and fossils are not significantly reworked there. Conodonts are rather abundant and the first appearance of *Siphonodella quadruplicata* in the evolutional lineage from *Siphonodella duplicata* sensu Hass to *Siphonodella quadruplicata* is recognised. Unfortunately, the cherty deposits contain only scarce poorly preserved ostracodes and foraminifers.

The section under consideration is located on the western flank of the Kozhym monocline (Fig.1). The Lower Carboniferous strata dip steeply westward, approximately 40-50 degrees. The sediments were altered thermally (conodont alternation index is 4-5), but strong tectonic deformation is absent.

Mid-Tournaisian boundary beds are represented by the following units (in ascendant order, Fig.2):

1. Layer of cherty spicule pack-wackestone (Tn-16/94) characterised by unclear bedding. The rock contains scattered sulfides (about 1%), oriented monaxon spicules, ostracode shells and conodonts. Unit thickness is 0.3 m.
2. Unit of thin alternation of cherty and carbonateous argillites (Tn-16-2/99, Tn-16-1/99). Fossils are represented by radiolarians, spicules, thin-shelled brachiopods, and conodots. Unit thickness is 0.5 m.
3. Lens-like bedded alternation of cherty argillite and spicule chert containing rare radiolarians (about 5%), ostracodes, and conodonts (Tn-17/94). Rock contains abundant scattered organic matter. Unit thickness is 0.25 m.
4. Cherty spicule packstone (Tn-18) with thin detritic layers, scattered sulfides (up to 5%), organic matter, abundant ostracodes (*Grammia zilimica* Kotsch.), thin-shelled brachiopods, and conodonts. Unit thickness is 0.1 m.
5. Laminated cherty argillite (Tn-18-1/99). Unit thickness is 0.15 m.
6. Cherty spicule wackstone (Tn-18-2/99, Tn-18-4/99) with thin layer of cherty argillite (Tn-18-3/99). Abundant organic matter, scattered sulfides (1-2%) and quartz silt (up to 7%), and rare thin-shelled brachiopods are characteristic. Unit thickness is 0.42 m.
7. Cross-bedded wackestone (Tn-19) containing scattered sulfides (up to 10%), abundant organic matter, conodonts, foraminifers (*Chernyshinella glomiformis* Lip., *Septabrunsiina krainica* Lip., *Archaesphaera* spp., *Parathurammina* spp. among others), ostracodes (*Gliptolichvinella spiralis*, *Armilla uralica* Sobolev), bryozoans, crinoids, and radiolarians. The bed has a sharp wavy base. Fossils are strongly reworked, some of

the conodont elements (Pa elements of *Palmatolepis gracilis* group) come from the *praesulcata* conodont zone (uppermost Famennian). This bed probably has a turbidite-like origin. The bed thickness is about 0.05-0.07m.

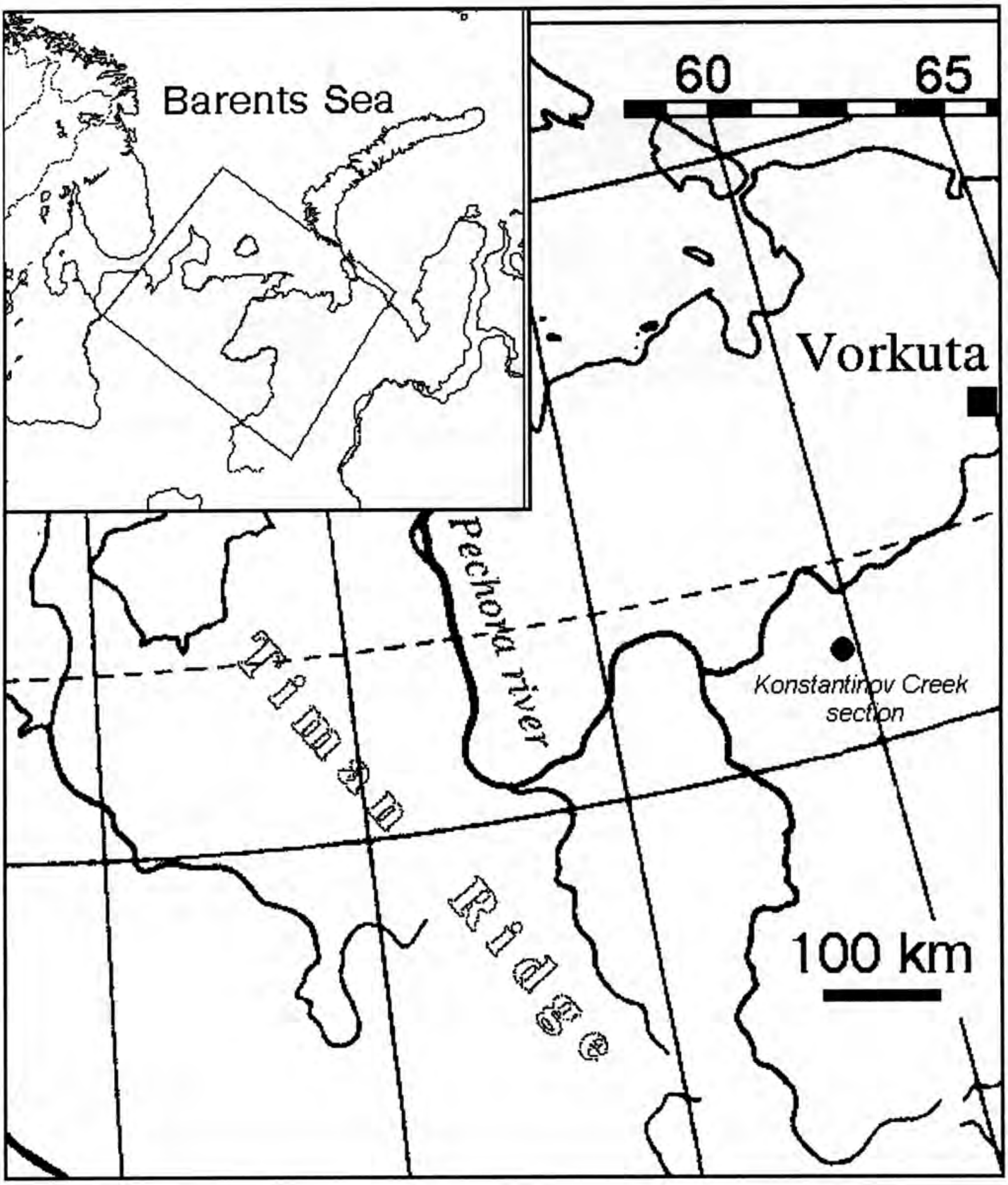


Figure 1. Location of the Konstantinov Creek section.

Konstantinov Creek section, Sub-Polar Urals

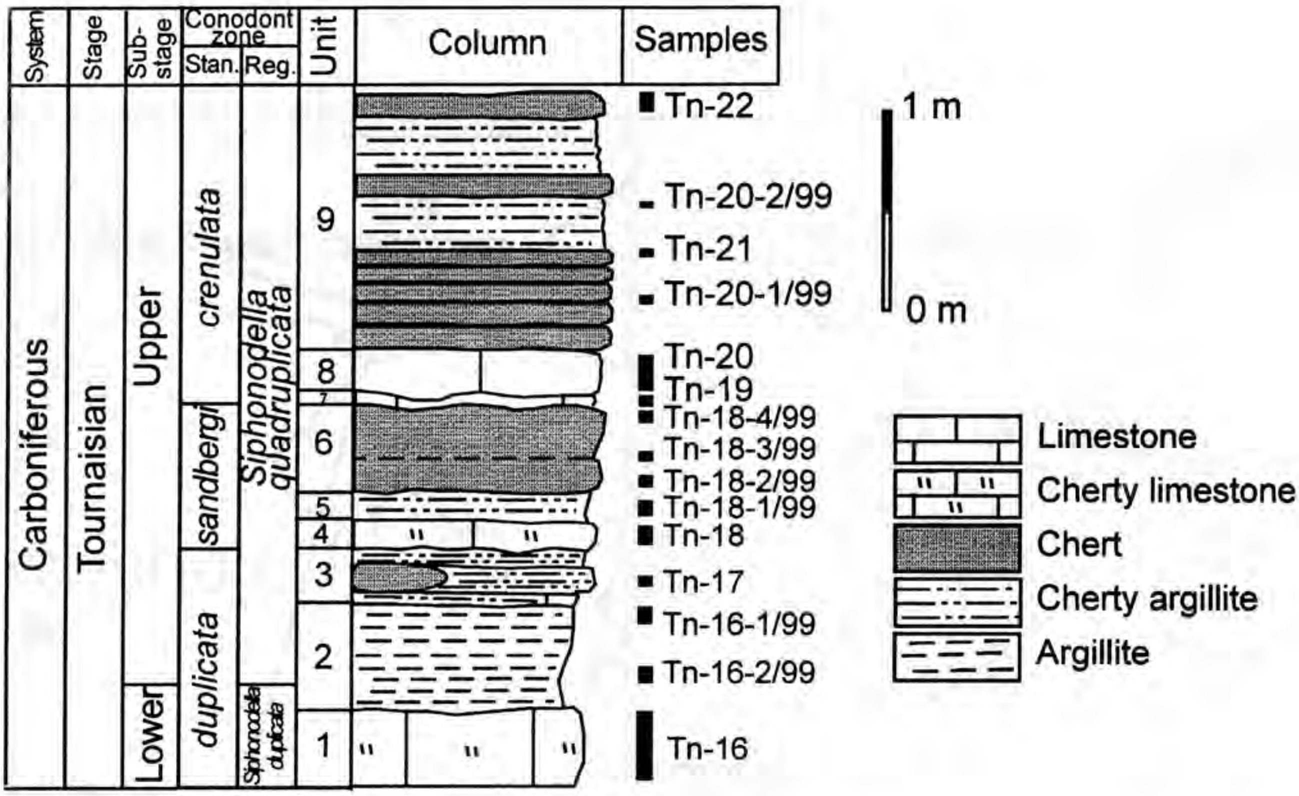


Figure 2. Konstantinov Creek section, Mid-Tournaisian boundary interval.

8. Pack wackestone (Tn-20) containing organic matter, sulfides (1-2%), crinoids, radiolarians, recrystallised foraminifers (*Archaesphaera* spp., *Parathurammina* spp. among others), conodonts, brachiopods, ostracodes, scolecodonts, algae (*Issenella* sp.), and rare gastropods. Conodonts and some other fossils are reworked. Unit thickness is 0.2 m.

9. Unit of cherty argillite and chert alternation (Tn-20-1/99 – Tn-21-1/99). Argillite content increases upward. The rocks contain radiolarians, conodonts, fish remains, and ostracodes. Unit thickness is about 4 m.

Conodont distribution is shown in the text table 1. Two versions of the conodont zonation can be recognised in the boundary interval: regional zones and European "standard" ones. Regional zonation comprises the following zones (in ascendant order): *Siphonodella duplicatai* zone (units 1 and lower part of the unit 2) and *Siphonodella quadruplicata* zone (upper part of the unit 2 and units 3-9). European "standard" zones are recognised as the following: upper part of the *duplicata* zone (units 1 - 3), *sandbergi* zone (units 4 – 6), and lower part of the *crenulata* zone (units 7 – 9).

Faunal change in the boundary interval was interpreted to be caused by a Mid-Tournaisian ecological event (Becker, 1993; Zhuravlev, 1998). The event interval comprises the uppermost part of the *Siphonodella duplicata* zone and the lower part of the *Siphonodella quadruplicata* zone, and is marked by a weak radiation in foraminifers (chernyshinellids) and by an extensive radiation in conodonts. A number of siphonodellids, and pseudopolygnathids appear at this interval.

The abundant and characteristic post-event conodont fauna has good potential for correlation of the Mid-Tournaisian boundary in deep-water facies both in the Northern Urals and worldwide.

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| Regional conodont zones | *S.duplicata* | *Siphonodella quadruplicata* | | | | | | |
|---|---|---|---|---|---|---|---|---|
| "Standard" conodont zones | *duplicata* | | | *sandbergi* | | *crenulata* | | |
| Samples | Tn-16 | Tn-16-2 | Tn-17 | Tn-18 | Tn-18-1 | Tn-19 | Tn-20 | Tn-21 |
| *Bispathodus stabilis* | + | | | | + | + | | |
| *Bispathodus sp.* | | | | + | | | | |
| *Eotaphrus bultyncki* | | | | | | + | | |
| *Eotaphrus simplex* | | | + | + | | + | | |
| *Polygnathus communis communis* | | | | + | | | + | |
| *Polygnathus communis carinus* | | | | | | + | + | |
| *Polygnathus inornatus* subsp. | | | + | | | | | |
| *Polygnathus inornatus inornatus* | | | | + | | + | + | |
| *Polygnathus distortus* | | | | | | + | + | |
| *Polygnathus lacinatus* | | | | | | | + | |
| *Polygnathus mehli* | | | | | | | + | |
| *Polygnathus proprius* | | + | | | | + | + | |
| *Polygnathus purus* | | | | + | | + | + | |
| *Polygnathus symmetricus* | | | | | | aff | aff | |
| *Polygnathus spicatus* | + | | | | | | | |
| *Polygnathus vogesi* | | | | | | | + | |
| *Pseudopolygnathus dentilineatus* | | | | + | | | + | |
| *Pseudopolygnathus fusiformis* | | | | | | + | + | |
| *Pseudopolygnathus marginatus* | | | | | | + | + | |
| *Pseudopolygnathus nodomarginatus* | | | | | | | + | |
| *Pseudopolygnathus oxypageus* | | | | | | + | + | |
| *Pseudopolygnathus pinnatus* | | | | | | | + | |
| *Siphonodella cooperi* | | | + | + | | + | + | + |
| *Siphonodella crenulata* | | | | | | + | | |
| *Siphonodella duplicata* | + | | | + | | + | | + |
| *Siphonodella duplicata sensu Hass* | + | + | + | + | | + | + | + |
| *Siphonodella isosticha* | | | | | | | + | |
| *Siphonodella lobata* | | | | | | | + | |
| *Siphonodella obsoleta* | | | + | | + | + | + | + |
| *Siphonodella quadruplicata* | | + | + | + | | + | + | + |
| *Siphonodella sandbergi* | | | | + | | | + | |
| *Siphonodella semichatovae* | + | | | | | | | |
| *Siphonodella sulcata* | cf | | | | | | | |
| *Siphonodella uralica* | | | + | + | | + | + | |
| *"Spathognathodus" crassidentatus* | | | | | | + | | |

Table 1. Conodont distribution in the Konstantinov Creek section

## A correlation of Carboniferous marine biozones of Argentina and Australia.

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The widespread Carboniferous glaciation began around the late Visean-early Namurian and extended into the early Westphalian (González, 1981; Roberts et al., 1995). During this epoch, endemic faunas developed in the periglacial seas of Gondwana. Marine deposits of western Argentina and eastern Australia show strong faunal similarities, suggesting suggesting open links between the basins of these regions.

Carboniferous faunas prior to the glaciation had cosmopolitan affinities; this is the case for the *Protocanites* fauna of Argentina (González, 1994) and the *Schellwienella burlingtonensis* fauna of Australia (Campbell & McKellar, 1969; Roberts et al., 1993). Though these faunas do not show close affinities, they are assigned to the late Tournaisian and may be equivalent in part.

During the Carboniferous glacial period faunal assemblages of Argentina and Australia can be easily compared. The *Levipustula levis* fauna is probably the most conspicuous fauna associated with the Carboniferous glacial sediments of Gondwana. The base of the *L. levis* Zone in Argentina corresponds to the base of the *Rugosochonetes-Bulahdelia* Zone, which contains species in common with the *Rhipidomella fortimuscula* and *Marginirugus barringtonensis* Zone of eastern Australia (Taboada, 1989). These faunas are assigned to the late Visean. New findings of significant fossils in the *Rugosochonetes-Bulahdelia* biozone (Taboada, 1997) include *Chonetes* s.s. and *Tylothyris* cf. *planimedia* Cvancara. These fossils occur 250 m above a horizon bearing the *Nothorhacopteris* flora, which was previously thought to occur in much younger strata in Argentina. The top of the *L. levis* Zone has been argued not to extend beyond the top of the Namurian (Roberts et al., 1995), but an extention into the Westphalian has alternatively been proposed (González, 1981, 1990, 1993).

From the late Westphalian up to the end of the Carboniferous, that is to say in the interglacial period between the Carboniferous and the Early Permian, evidence of glaciation is absent in Argentina and Australia. Faunal affinities during this interval are not clear, but marine faunas appear to be more or less endemic in Patagonia and eastern Australia. In western Argentina two discrete assemblages occur: the *Balakhonia-Geniculifera* (Taboada, 1997, 1999) and the slightly younger *Buxtonia-Heteralosia* (González, 1993), both having clear links with faunas of warmer-water seas outside the Gondwana province.

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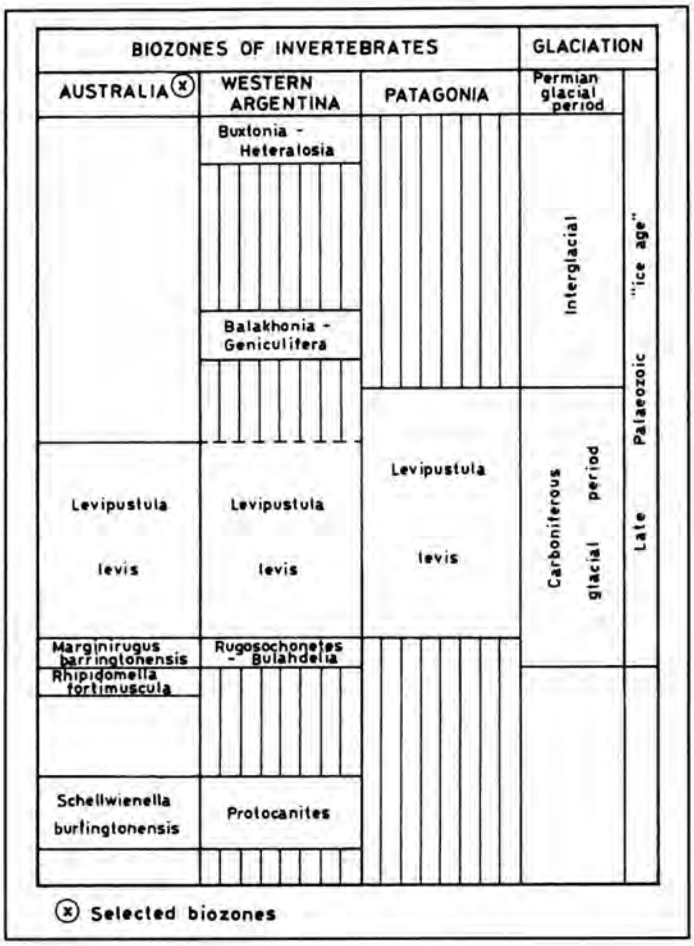


# Global cooling in the middle Carboniferous

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It is known that the change from the rich and diversified cosmopolitan Early Carboniferous biota to the rather poor and differentiated Late Carboniferous one took place near the middle of this system. Floristic data analysis permits us to determine the stratigraphical position of the global cooling event which was responsible for the initiation of this biotic change.

Within Angaraland, the sudden disappearence of treelike endemic lepidophytes (maily the genera *Tomiodendron* and *Angarophloios*) in the middle of the Kuznetsk basin Ostrogsky series have been regarded by Meyen (1969) as the result of strong cooling.

These lepidophytes were predominant in the early Carboniferous (Upper Tournaisian - Visean) flora of Siberia. Their anatomic features (manoxylic axes typical for tropical and subtropical plants) and facies constitution (the presence of red beds and bauxites) suggests a warm, rather arid Early Carboniferous climate with frostless winters.

The author agrees with Meyen's (1969) conclusion that the disappearence of treelike lepidophytes correlates with the strong cooling event, because the postlepidophytean flora was very poor, consisting mainly of some relics of the lepidophytean one. They are 1) problematical pteridosperm *Abacanidium* with cyclopteroid venation of pinnules and small seed of the *Trigocarpus* type 2) small-stem lepidophytes and 3) primitive Artropsids. This flora characterizes the upper part of the Ostrogsky series (the Kaezovsky suite) and their equivalents in central Angaraland and is replaced near the top of the Kaezovsky suite (middle Bashkirian) by the rather rich and diverse temperate Cordaitean. Therefore the Kaezovsky time period was the coldest in the Carboniferous of Angaraland.

Meyen (1968) compared the Angaran arborescent lepidophytes extinction (Ostrogsky episode) with Gothan's Florensprung near the Namurian A/B boundary (base of the *Reticuloceras* ammonoid zone). According to Gothan there floristic assemblages at this level were not transitional, but there was a sudden extinction of many Early Carboniferous plants and then gradual incoming of new genera and species.

In the seventies, the base of the *Reticuloceras* zone was taken as the global Lower/Upper Carboniferous boundary. Apart from Angaraland and Western Europe this level seems to coincide with the Mississipian/Pensilvanian boundary of North America. The importance of this boundary is emphasised by its coincidence with the global cooling event.

In the late seventies new data appeared which disproved the above mentioned global correlation. Havlena (1977, 1982) showed the absence of Gothan's Florensprung and a gradual transition of floristic assemblages through Namurian. Therefore there is no supporting evidence for the Angaran Ostrogskian episode coinciding with the Namurian A/B boundary. In addition, the series boundary has been moved from the base of the *Reticuloceras* zone to the bottom of the older *Homoceras* ammonoid zone. This coinsides with the base of the *Delinognathodus noduliferus* (sensu lato) conodont zone, which has been widely used for identifying this.

In spite of these changes to the Carboniferous series boundary position, the idea of it coinsiding with the global cooling is widely accepted up to now. Different authors give different evidence to support this idea. The most popular one is as follows:

As we know, there is a rather big stratigraphic break between the two Carboniferous series (subsystems) in Russia and most parts of the North American platforms. This gap is very often regarded as the result of regression caused by glaciation due to the great cooling. It is difficult to agree with this argument because the Gondwana glaciation maximum didn't take place at the mid-Carboniferous level, but near the Carboniferous - Permian boundary, when climate became warmer and more humid.

Therefore it is possible to observe that development of both extratropical floras are similar but not identicle as in near-tropical regions. In contrast to the gradual transition of Carboniferous floristic assemblages of the Euromerian area, the development of extratropical floras were suddenly interrupted near the middle of the Carboniferous by strong cooling. As mentioned above, the existense of this cooling event is supported by 1) an extinction of warm-liking arborescent lepidophytes in Angaraland ("Ostrogskian episode") and Gondwana and 2) an appearence of very poor extratropical floras (the *Abacanidium* one into Angaraland, the *Nothorhacopteris* flora in Gondwana), marked the cold period.

An exact determination of the cooling event age is a rather great problem. Inside the Kuznetsk basin (Angaraland) this event coinsides with a last marine transgression at the beginning of the Kaezovsky time. The age of the endemic marine faunal horizon at this level has been interpreted variously (from Lower Carboniferous to Lower Permian), but according to recent data of V.G.Ganelin (personal communication) the Ostrogskian brachiopod assemblage is very similar to that of the lower part of the Magarsky horizon (Uppermost Visean) of the North - East of Russia.

The Gondwana floristic change has nearly the same age. According to Morris (1985) the *Lepidodendron* flora of Eastern Australia disappeared in the Uppermost Visean. Retallack (1980) also determined the age of this event as Uppermost Visean - Lowermost Namurian.

This data suggests that the global mid-Carboniferous cooling event did not coinside with the recently defined Mid-Carboniferous boundary.

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## Is cuticular functional-carbon biochemistry genetically dependent in Carboniferous pteridophyllous foliage?

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Whether a cuticular carbon analysis is useful in taxonomic classification of Carboniferous pteridophyllous foliage, and has the potential for helping to decipher phylogenetic pathways, has become one of the most important questions for the budding science of foliar chemotaxonomy. Pteridophyllous foliage is defined as foliage that is dissected like a fern frond, but also includes compound leaves from true pteridosperm seed ferns.

Previous work (Lyons et al., 1995) showed the existence of subtle differences in infrared spectra (FTIR) in three well-known Carboniferous pteridosperm species: *Macroneuropteris scheuchzeri* (Hoffmann), *Neuropteris ovata* (Hoffmann), and *Alethopteris lesquereuxii* Wagner, and possible taxonomic significance was suggested. Particularly, *M. scheuchzeri* showed more abundant ester and hydroxyl groups than the other two species. That work is now followed up by the investigation of infrared spectra (FTIR) of cuticles from a larger number of species, preserved in compression specimens. Included in the FTIR analyses that are currently carried out are pteridophyllous species whose taxonomy is well charted and generally have biostratigraphic significance: sphenopterids sensu lato (*Sphenopteris brongniartii* Stur, *S. delicatula* Kidston non Sternberg, *and S. neuropteroides* (Boulay), pteridosperms (*Odontopteris cantabrica* Wagner, *Mariopteris nervosa* Brongniart, *Neuropteris flexuosa* Sternberg, *Reticulopteris muensteri* (Eichwald), and pecopterid *Pecopteris unitus* Brongniart. Some specimens are additionally preserved by the process of natural maceration; foliage preserved by this process resembles cuticles obtained by chemical maceration from the compression foliage. Natural maceration is not only relevant for the pteridosperm foliage, but also for cordaites leaves (Zodrow et al., 2000) and cordaitean fructifications, pecopterid fructifications, in sphenophylls, and in certain lycophytes specimens. It thus appears that natural maceration is a pervasive preservation process whose palaeoenvironmental significance is, however, unknown. It is thus warranted to study available naturally macerated cuticles of the above-mentioned species from the chemical (FTIR, py-GC/MS) viewpoint in order to help delineating diagenetic influences on the 300-million year old fossil cuticle. This knowledge is indispensable in the study of potential foliage chemotaxonomy.

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## In situ pecopterid microspores from near the Westphalian D-Cantabrian Boundary in Sydney Coalfield, Nova Scotia, Canada

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Bell (1938, 1944, 1962) studied pecopterid foliage from the Canadian Carboniferous coalfields in

Nova Scotia, New Brunswick, and Newfoundland without publishing on the in situ microspores (<200 m) of the fertile foliage, although he identified some of the fructification genera. Over the years, ELZ has collected over 950 pecopterid specimens from the roof rocks of coal seams that are stratigraphically near the Westphalian D - Cantabrian boundary in the Sydney Coalfield from which W.A. Bell could not have collected in his day for lack of exposure through operating coal mines. About 800 of the specimens are sterile and classified by concepts of form species as:

*Pecopteris abbreviata* Brongniart, *P. acadica* Bell, *P. arborescens* Schlotheim, *P. clarkii* Lesquereux, *P. cyathea* Schlotheim, *P. herdii* Bell, *P. lamuriana* Heer, *P. micromiltonii* Artis, *P. miltonii* Brongniart, *P. pectinata* Bertrand, *P. plumosa* (Artis) *dentata* Brongniart, *P. polymorpha* Brongniart, *P. unitus* Brongniart, and *P. sterzeliformis* Bell.

The common northern European forms *P. hemitelioides* and *P. pennaeformis*, and most, if not all, of the Spanish pecopterids, are not recorded from the Sydney Coalfield (Zodrow, 1990), nor from the Canadian Carboniferous in general. On balance, the Canadian Carboniferous clearly shows paucity of [foliar] pecopterids taxa, in comparison with the French and German Carboniferous coalfields that show larger numbers of species (vide Corsin, 1951; Dalinval, 1960; Barthel, 1967).

Research in Carboniferous in situ pecopterid microspores was done mainly by Doubinger (1961), Barthel (1967, 1976), Laveine (1969, 1970), Pfefferkorn et al. (1971), Millay (1979, 1997), Coquel and Brousmiche-Delcambre (1996), and Lesnikowska and Willard (1997). The latest research in this field is by Bek (1998), and by Bek and Oplustil (1998). In 1999, we started a research project to investigate the potential of the in situ microspores of the 150 fertile pecopterid specimens, with the purpose of filling an existing gap for the Euromerican Carboniferous in Canada. In particular, sporangia of the type *Scolecopteris* (Zenker) Millay, *Acitheca* Brongniart, and *Cyathotrachus* (Watson) Mamay 1950 were isolated from some of the pecopterid specimens, and their microspore contents were studied, emphasizing the importance of using SEM for the study of exine. Based on the results of the pilot study that contains a representative sample of fertile foliage (n=9), we propose to subdivide the microspores into 5 informal groups:

Group1: trilete , densely microgranulate *Cyclogranisporites micrograrus* Bharadwaj microspores (50[59.9]64 m). Fructification: *Scolecopteris* (Zenker). Sterile foliar representative: *Pecopteris acadica* Bell, alternatively *P. oreinervosa* Corsin

Group 2: larger (18[21.6]25 m) monolete to triletoid microspinate *Punctatosporites oculus* Smith and Butterworth. Fructification: *Scolecopteris* (Zenker) Sterile foliar representative: *Pecopteris cyathea* type

Group 3: small (17[19.9]23 m) monolete microgranulate to microspinate microspores *Punctatosporites pygmaeus* (Imgrund) Potonie and Kremp. Fructification: *Cyathotrachus* (Watson). Sterile foliar representative: not yet determined

Group 4: scabrate to microspinate (21[23.9]29 m) monolete microspores *Punctatosporites minutus* Ibrahim and *P. marattioides* Singh. Fructification: ?*Scolecopteris* (Zenker). Note that these microspores are of the same type as those from Group 3, but differ by being lager in size and by have less densely sculptured exine. Sterile foliar representative: not yet determined, and

Group 5: laevigate to very finely scabrate (18[24]36 m) monolete microspores *Laevigatosporites minimus* (Wilson and Coe) Schopf, Wilson and Bentall, *L. minimus* Dybova and Jachowicz, and *Latosporites minutus* Bharadwaj. Fructification: *Scolecopteris* (Zenker). Note that all of these spores are very similar to each other, differing only by their size (range 18-36 m), and shape. Sterile foliar representative: *Pecopteris arborescens* Schlotheim.

In conclusion, the pilot study indicates on overwhelming occurrence of scolecopterids in the Sydney samples which represent, however, differing pinnule morphologies and form species. However, the best sterile-fertile correlation we have so far is *for Acitheca polymorpha* Brongniart. Research is in progress to sort out the scolecopterid species to shed further light on the microspore populations and their sterile foliage.

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## Paleobiological interpretations and biostratigraphic problems

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The problem of uncertainty of biostratigraphic boundary establishment is caused mainly by the nature of a taxon's evolution. Usually, in the paleontological annals, the evolutionary first appearances of new taxa are not precisely known. At the level of first appearance of a new taxon, the taxon is usually not abundant and has limited geographic distribution. New taxa are formed by gradualistic processes with formation of transitional forms from old to new. The first appearance of a taxon in the geological record usually does not indicate the time it actually evolved. This poses a problem if the first appearance is used as the basis for a zonal boundary. The majority of kinds of biostratigraphic zones reccommended for use by the

Stratigraphic Code of Russia and International Stratigraphic Guide (Biozones, Range zones, Phylozones or Lineage zones, Interval zones), rely on the first appearance of a taxon. The exceptions are Acme (Abundance ) zones and Assemblage zones. The Acme zone characterising layers with the maximal distribution of a taxon, most adequately reflects existing reality, however, there is no precise criteria for boundary definition. Actually, if we consider the whole history of the phylogenetic development of a taxon, including phases of its origin, maximal development and extinction, all the above mentioned kinds of zones represent "Acme zones" or a combination of parts of these. The definition of the zonal boundaries, has only a theoretical sense, and in practice cannot be used with these kinds of zones. Of all the kinds of biostratigraphic zones, only Assemblage zones represent practical value with biostratigraphic researches, as the coexistence of several taxa provides correlation of any interval of a section to a particular biostratigraphic division. Other kinds of biostratigraphic zones are important for development of other scientific problems, such as the study of phylogenetic mutual relation of taxa, processes of a morphogenesis, laws of the evolution etc.

The above mentioned problems apply without exception to the definition of all biostratigraphic boundaries as exemplified by recent debate on criteria for recognizing the Middle-Upper Carboniferous (Moscovian-Kasimovian) boundary. Traditionally the appearance of the fusulinid genus *Obsoletes* has been used to define the base of the Upper Carboniferous. Detailed study of the genus (Remizova, 1992; Remizova and Remizova, 1998) showed, however, that *Obsoletes* evolved from *Fusulinella* through intermediate morphologic stages during the Late Moscovian. The difficulty of classifying these forms as advanced *Fusulinella* or primitive *Obsoletes* led to uncertainty in positioning the Middle-Upper Carboniferous boundary. Remizova (1992) proposed that these intermediate morphologies be grouped within the genus *Praeobsoletes*, and this concept was incorporated in the latest Russian text on Paleozoic foraminiferal taxonomy (Rauzer-Chernousova *et al.*, 1996). Other workers (*e. g.*, Ginkel and Villa, 1999) united *Praeobsoletes* and *Obsoletes* with *Protriticites*, a position that is unjustified by practical or theoretical considerations. The former two genera are a natural association and could be combined, but *Protriticites* evolved from a different ancestry. Evidence suggests that the *Praeobsoletes*-*Obsoletes* and *Protriticites* lineages evolved in parallel, respectively, from *Fusulinella schwagerinoides* and *Fusulinella bocki* and that some similarites in morphologic characters are only coincidental in keeping with divergence from the same ancestral genus. Furthermore, the range of *Protriticites* spans the Late Moscovian-Early Kasimovian interval making it impractical for the genus to define the Middle-Upper Carboniferous boundary.

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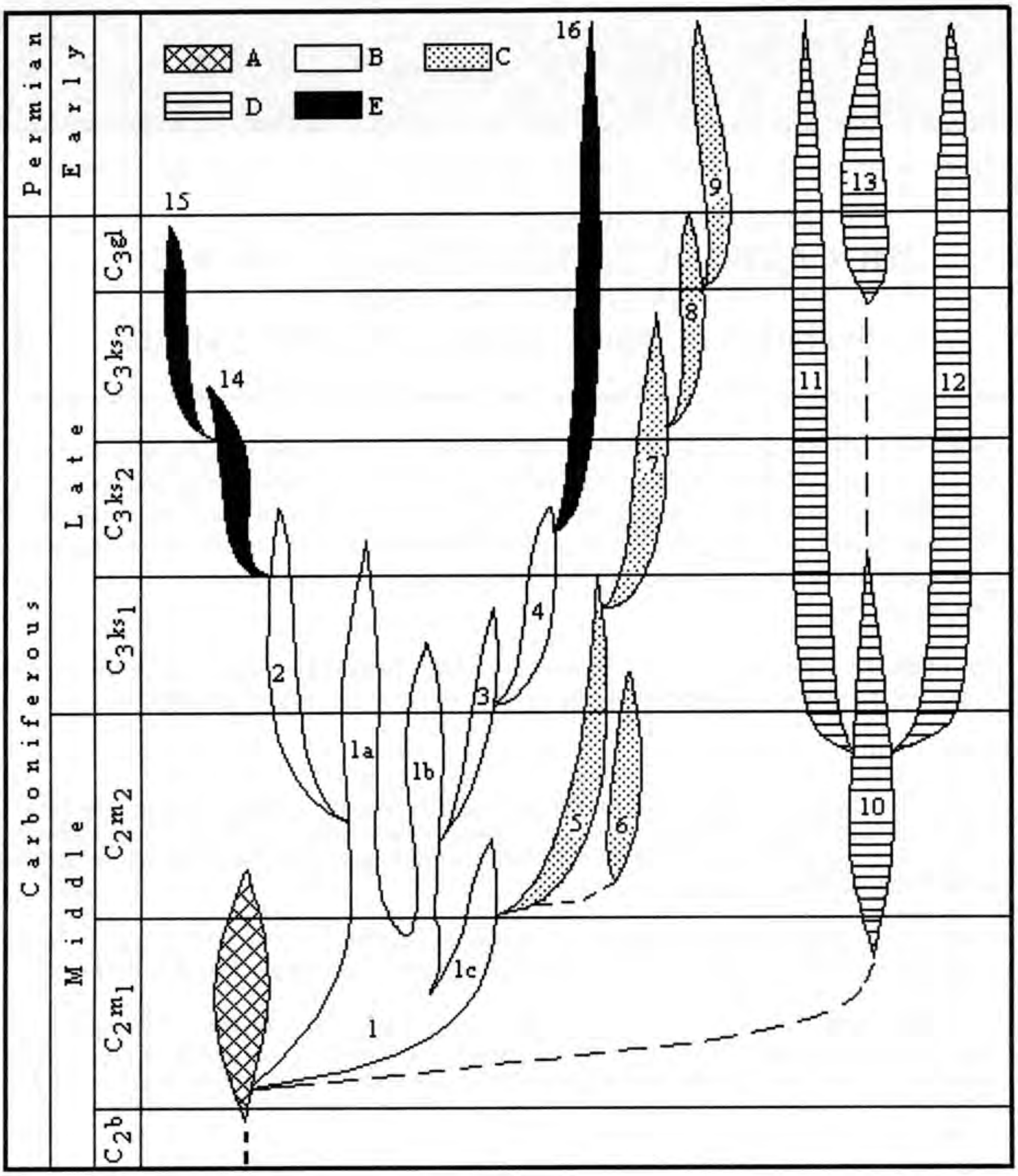


Figure 1. The scheme of phylogenetic development of some *Fusulinoida* (after Remizova & Remizov,1998):

*1 - Fusulinella: 1a - F. bocki Group; 1b - F. schwagerinoides Group; 1c - F. colania Group; 2 - Protriticites; 3 - Praeobsoletes; 4 - Obsoletes; 5 - Wedekindellina; 6 - Parawedekindellina; 7 - Eowaeringella; 8 - Waeringella; 9 - Thompsonella; 10 - Pulchrella; 11 - Kanmeraia; 12 - Usvaella; 13 - Pseudofusulinella; 14 - Montiparus; 15 - Rauserites; 16 - Triticites.*

A-D - Order *Fusulinida*:
- A - Family *Profusulinellidae.*
- B,C,D - Family *Fusulinellidae*:
  - B - Subfamily *Fusulinellinae*
  - C - Subfamily *Wedekindellininae*
  - D - Subfamily *Pulchrellinae*

E - Order *Schwagerinida*.

# CONFERENCE REPORTS

## INTERNATIONAL CONGRESS ON THE CARBONIFEROUS-PERMIAN (XIV ICCP) AUGUST 17-21, 1999 University of Calgary, Calgary, Alberta, Canada

The well-attended XIV ICCP in Calgary saw a large number of SCCS members in attendance. The SCCS held a full one-day session, chaired by John Roberts and Ian Metcalfe on Carboniferous Boundaries. At this session, nineteen oral presentations were made, including several reports on SCCS Project and Working Groups and one proposal for a new SCCS Project Group. For Project and Working Group reports see the separate section in this newsletter. Abstracts of the other presentations in the SCCS session are reproduced below with permission.

In addition to the SCCS session at the ICCP, a formal General Business Meeting of the SCCS was held in Earth Science 162, University of Calgary, Calgary, Canada on Thursday, August 19, 1999.

*Brief Report:*

The meeting was attended by about 50 members and visitors (including sixteen Voting Members). The minutes of the previous General Meeting held in Krakow, Poland were confirmed. The Chairman and Secretary then presented their reports. Reports of Project and Working Groups were deferred as they would be presented in the SCCS session later in the congress.

A short report on progress of the Carboniferous of the World was presented by R.H. Wagner including an outline of Volumes 4/5 which will cover North America and Europe outside the former U.S.S.R.

Discussion then took place on the current voting membership and on the geographic and discipline balance within the voting membership. A list of retiring members and potential new members proposed by the SCCS executive was discussed. Further potential voting members were nominated from the floor and it was also decided that the Secretary should request further nominations from the Voting Membership by a 4 October deadline.

A lengthy and at times heated and emotive discussion took place on the rank of the two primary divisions of the Carboniferous. An informal "straw" vote was eventually held on Sub-System vs. Series with 19 votes for Sub-System, and 19 votes for Series. This vote reflected the ongoing split within the SCCS regarding the ranks of the primary divisions of the Carboniferous as defined by the MCB. Chairman Roberts then informed the meeting that the SCCS executive would have a formal ballot of Voting members on this question in the near future.

Ian Metcalfe then reported that an initial ballot on the naming of the two primary divisions of the Carboniferous had supported Mississippian and Pennsylvanian but that the majority was insufficient for formal acceptance under ICS statutes. Chairman Roberts informed the meeting that a further ballot on this issue would be held as soon as the result of the ballot on the rank of these divisions had been held.

*Next Field & General Meeting:* Walt Manger proposed that the next Field and General Meeting be held in the North American Mid-Continent in the Spring of 2001, beginning and ending in St. Louis. It was proposed that the type Mississippian, type Morrowan and the Mississippian-pennsylvanian boundary wopuld be examined. Dr Manger undertook to organise this meeting. The proposal was unanimously accepted and Dr Manger thanked for his offer to organise this meeting.

*New Project Group on the Visean-Serpukhoivian/Namurian Boundary:* Dr N.J. Riley presented a short outline on the need and importance for a new project group on this important boundary. The proposal was accepted by the meeting and Dr Riley asked to convene a project group.

*New Project Group on comparative Angara & Gondwana biostratigraphy:* The Secretary informed the meeting that Dr Marina Durante from the Geological Institute, Russian Academy of Sciences, had proposed the formation of a new project group to study the post Visean successions of Angara and Gondwana. In both regions the post Visean successions cannot be correlated satisfactorily with sequences in the palaeotropical regions. After a short discussion, the meeting accepted the proposal for the new Project Group.

**Ian Metcalfe**
**Secretary, SCCS**

# SCCS SESSION ABSTRACTS

CHEMOSTRATIGRAPHY OF THE MID CARBONIFEROUS BOUNDARY STRATOmE SECTION, BIRD SPRING FORMATION, ARROW CANYON, NEVADA, U.S.A. **BRAND, UWE,** Depar~nent of Earth Sciences, Brock University, St. Catharines, Ontario Canada L2S 3A1, ubrand@spartan.ac.brocku.ca, and **BRENCKLE, PAUL,** 1 Whistler Point Road,Westport, MA 02790 U.S.A. Precisely located brachiopods and carbonate matrix and cements were used to delineate depositional and diagenetic geochemical changes at the Mid Carboniferous (Mississippian-Pennsylvanian) Global Boundary Stratotype Section and Point (GSSP) within the lower Bird Spring Formation, Arrow Canyon, Nevada. Chemostratigraphic and isotopic trends reveal an overall more varied seawater chemistry for the latest Mississippian than for the early Pennsylvanian, although trace elements and stable isotopes from brachiopods indicate drastic fluctuations in water chemistry during the earliest Pennsylvanian. Several oxygen minima mark the Mississippian part of the section, followed first by rapid oxygen level changes close to (or across) the boundary and then by normal and constant conditions for the remainder of the Pennsylvanian. Mississippian water temperature fluctuated from 21 to 31°C; while for the Pennsylvanian it varied from 24 to 33°C. 875r/86Sr values are consistently lower in the Mississippian, and the rapid shift to higher and more invariant values at the base of the Pennsylvanian provides the most useful geochemical indicator to recognize the Mid Carboniferous Boundary on a global scale. This change toward higher strontium ratios, moreover, mimics a general trend throughout the Upper Paleozoic. Mississippian seawater appears to have been dominated by oceanic processes, while continental processes influenced Pennsylvanian seas, except for a more marine geochemical excursion during the Late Pennsylvanian (Virgilian). Key Words: Stable & Radiogenic Isotopes, Global Correlation

MOSCOVIAN-KASIMOVIAN TRANSITION IN NEVADA AND PROBLEMS OF ITS INTERCONTINENTAL CORRELATION **DAVYDOV, VLADIMIR I., SNYDER, W. W., and SCHIAPPA, T.** A. Pemmian Research Institute, Department of Geosciences, Boise State University, 1910 University Drive, Boise, ID, 83725, vdavydov@boisestate.edu The Early Pennsylvanian-earliest Pemmian carbonate shelf and ramp successions in Nevada contain an abundant and well preselved fusulinid fauna that provide critical data on fusulinid phylogeny. Present studies have focused particularly on the Moscovian-Kasimovian transition. In the westem hemisphere this transition was studied mostly in the Midcontinent, where fusulinid faunas are quite endemic and therefore it is difficult to use this fauna for global correlation. In 1997 Wahlman *et al.* found primitive *Protriticites* and probably *Praeobsoletes* together with *Bartramella bartrami, Plectofusulina,* and several *Beedeina* species in latest Moscovian (mid-late Desmonesian) in Idaho, Nevada and Utah. They reported the first appearance of *Triticites* about 60 m stratigraphically above this fauna. In most of the Westem US, the basal Kasimovian is probably absent due to eustatic sea-level drop. In the Moscow Basin (Russia), Central Asia, and the Arctic this event is represented by an unconfommity. In the Moscow Basin this unconfommity is estimated of 0.5-0.6 Ma in duration. However, in Nevada Test Site (NTS) the succession (carbonate ramp) appears to lack this unconfommity. At the NTS, above the beds with assemblage of *Bartramella* and primitive *Protriticites* there is a thin conglomerate bed that may represent the basal Kasimovian unconfommity. Immediately above advanced *Protriticites* were recovered that are similar to those from Krevyakinian (L. Kasimovian) in the Moscow Basin; one sample contained *Beedeina, Fusulinella* and *Bartramella* together with *Protriticites.* The next higher stratigraphic assemblage is represented by typical schwagreinids with real keriotheca. Some of these fomms belong to the genus *Montiparus* and therefore could correlate with middle Kasimovian in the Moscow Basin. Conodont data from NTS region are necessary to test fusulinid correlation and particularly to provide precise correlation between the Great Basin and Midcontinent and globally with the Moscow Basin, Donets Basin Central Asia, Camic Alps, Cantabrian Mountains, and the Arctic.

SUBSTANTIATION OF BOUNDARY BETWEEN MOSKOVIAN AND BASHKIRIAN STAGES IN SOUTH TIEN SHAN **DJENCHURAEVA, A.V.,** State Agency on Geology and Mineral Resources, of the Kyrgyz Respublic, Bishkek. Middle Carboniferous marine carbonate the sediments are widespread in the South Tien Shan. They outcrop in sublatitudinally extended ridges in foothills of the Alai and Turkestan Ranges. Lithologically these sediments are subdivided into the: Metingbel, Gaz, Tuiukdanga, Pirkaf, Tolubai and Turtcala Fms. The first four are represented mainly by carbonate rocks and differ by the presence of: I) thin-bedded limestones with chert intercalations (Metingbel and Gaz fms); 2) thick-bedded and mottled limestones (Tuiukdanga Fm), and 3) massive limestones with chert nodules (Pirkaf Fm). The latter two formations are terrigenous with carbonate interbeds. According to formation occurence four areas are outlined in the foothills of Alai and Turkestan Ranges: Akhuntau, Khaidarkan-Chauvai, Akbura and Tokhtabuz Batken areas. The Akhuntau area is characterized by the Gaz, Pirkaf and Tolubai fms. Located northward the Khaidarkan-Chauvai area is characterized by presence of Metingbel and Tuiukdanga frns in the eastern portion and are absent in the area's central portion. As for the Pyrkaf Fm it is present throughout the region. The Akbura area is characterized by thin sections of the Metingbel and Turtkala fms. The most representative sequences of Bashkirian and Moskovian stages are located within the Akhuntau area. (Gaz, Turtkala, Garaty, Khodja-Tush). Foramenifer and brachiopod assemblages were studied in all sections, conodonts only in the Gaz and Akhuntau sections. Foraminiferal complexes were used to distinguish fauna zones within the Upper Bashkirian and Lower Moskovian substages, in all key sections, in ascending order: *Protumlinella primitiva* Zone, *Ozawainella pararhomboidalis* Zone, *Verella spicata* Zone, *Aljutovella alutovica* Zone, *Ayutovella priscoidea* Zone, *Fusulinella subpulchra* Zone. Bashkirian-Moskovian boundary Zones of *Verella spicata* and *Aljutovella alutovica* have their own specific complexes in the different sections.

A PENNSYLVANIAN SYSTEM STRATOTYPE **ENGLUND, KENNETH J.** Retired, U.S. Geological Survey, 40236 New Road, Aldie, VA. 20105, **WNUK, Christopher**, Global Resources Information Group, 1050 17th Street N.W., Washington, D.C. 2036, e-mail JinnyEng@aol.com The Pennsylvanian System stratotype program was initiated by the U.S. Geological Survey in 1972 in consultation with an advisory committee of interested geologists from the state Geological Surveys, U.S. Geological Survey, academia, and industry. This committee designed a program to provide rock representative sections for the loosely defined Lower, Middle, and Upper Pennsylvanian Series in the Appalachian basin. The most favorable locality proved to be in West Virginia, where Pennsylvanian strata extend continuously from the base of the system in the Pocahontas area northwestward to the top of the system in the Dunkard basin. During the next 10 years, Pennsylvanian rocks in the study area were subjected to extensive lithostratigraphic, biostratigraphic, and depositional environment investigations that also included geologic mapping and core hole drilling projects. On the basis of these investigations, 14 overlapping component sections were selected to represent the Pennsylvanian System. The proposed Pennsylvanian System stratotype was presented to the international scientific community at the Ninth International Congress of Carboniferous Stratigraphy and Geology, held in the United States in 1979. Results of investigations were published in more than 60 papers, including abstracts, geologic maps, field trip guidebooks, bulletins, and professional papers. Recent publications report that a bed of spherules occurs near the gradational Mississippian-Pennsylvanian boundary.

PROPOSAL FOR DESMOrNESIAN-MISSOURIAN STAGE BOUNDARY STRATOTYPE, A CANDIDATE FOR A GSSP **HECKEL, P.H.**, Dept. of Geology, Univ. of Iowa, Iowa City, IA 52242, philip-heckel(~uiowa.edu; **BOARDMAN, D.R,** School of Geology, Oklahoma State Univ., Stillwater, OK 74078; **BARRICK, J.E.,** Dept. of Geosciences, Texas Tech Univ., Lubbock, TX 79409 The Desmoinesian Stage, named from Midcontinent North America, is characterized by the conodonts *Neognathodus, Idiognathodus delicatus* and related species, and a troughed clade of *Idiognathodus* (at the top); by the fusulinids *Wedekindellina* and *Beedeina;* by diverse palynomorphs including *Lycospora* and *Granasporites;* by the ammonoids *Gonioglyphio-ceras* and *Wellerites;* by the brachiopod *Mesolobus;* and by the sponge *Chaetetes.* The top of the Desmoinesian Stage is marked by the extinction of all these fomms except a flat clade of *Idiognathodus* and a few stragglers of *Lycospora.* The Missourian Stage, named from the same region, is characterized by descendant flat species of the conodont *Idiognathodus* and the newly evolving troughed clade *Streptognathodus;* by the fusulinids *Eowaeringella, Triticites,* and *Kansanella;* by low diversity fem and other non-lycopod palynomorphs; and by the ammonoids *Pennoceras* and *Parashumardites.* The rocks of both stages comprise a succession of glacial-eustatic marine cyclothems separated by exposure surfaces and paleosols across the northem shelf of the basin, but most of these subaerial horizons disappear basinward to the south, where more of the succession was continuously marine across the lowstand horizons. The banks of a small creek in northem Nowata County, Oklahoma, expose a succession of marine units from the top of the Desmoinesian into the lower 3 major cyclothems of the Missourian. Here 1. *sulciferus,* a descendant of 1. *delicatus,* occurs in the base of the South Mound Shale, and is joined 2 m upward by its descendant 1. *eccentricus* in the darker shale bed that represents the basinal facies of the Exline cyclothem, which contains limestone northward on the shelf. The confommable base of the Exline cyclothem at this locality defnes the Desmoinesian-Missourian Stage boundary This boundary is recognized in the Exline-equivalent Scottville Limestone in the Illinois Basin, but signifies a greater hiatus at the base of equivalents of higher Missourian cyclothems at places that were position-ed higher on the shelf at that time, such as the Appalachian Basin.

PROPOSAL TOWARD CONSENSUS ON NAMES AND RANK OF TWO BASIC SUBDIVISIONS OF CARBONIFEROUS SYSTEM **HECKEL, P.H.,** Dept. Geology, Univ. Iowa, Iowa City, IA 52242, philip-heckel@uiowa.edu; **VILLA, ELISA,** Depto. Geologia, Univ. Oviedo, 33005 Oviedo, Spain Arguments for 'Lower' and 'Upper' for the two basic divisions of the Carboniferous System involve traditional use in most of the world. Arguments against 'Lower' and 'Upper' involve the serious ambiguity of traditional use in published literature around the world because traditional boundaries of particularly 'Upper Carboniferous' vary greatly in different parts of the world, especially where the tripartite subdivision is used. Arguments for 'Mississippian' and 'Pennsylvanian' involve 1) consistent usage within North America, because of a disconformity between them in most places, and 2) coincidence of the ratified Mid-Carboniferous boundary in Nevada with the recognized paleontological change across the elsewhere disconformable boundary. Because these names can thus be used consistently and precisely elsewhere in the world, the scientifically best choice for the two subdivisions of the bipartite Carboniferous is 'Mississippian' and 'Pennsylvanian'. Nevertheless, because the Mississippian is the lower part, and the Pennsylvanian is the upper part, of the Carboniferous System, the terms 'Lower' and 'Upper' will still be used. However, if they are used formally with initial capital letter, they must be defined in future work by using Mississippian and Pennsylvanian accompanying them in the article or on the diagram in which they appear. Arguments for 'series' for the two basic subdivisions involve tradition. Arguments for 'subsystem' include: I) lengths of each within the range of other Paleozoic systems, 2) their long-term recognition as systems in North America, and, most importantly, 3) their long-standing global recognition of being distinctly different from one another, more so than series in any other system; this difference relates to Gondwanan glacial-influenced stratigraphy and biotic endemism during the Pennsylvanian (Upper Carboniferous). 'Subsystem' is the most appropriate rank for the basic subdivisions of the Carboniferous System, both to recognize their significant system-scale differences in most of the world and to maintain more options for further subdivision as the work of the SCCS continues.

PROPOSAL TOWARD CONSENSUS ON FURTHER SUBDIVISION OF THE TWO SUBSYSTEMS OF THE CARBONIFEROUS SYSTEM **HECKEL, P.H.,** Dept. Geology, Univ. Iowa, Iowa City, IA 52242, philip-heckel@uiowa.edu; **VILLA, ELISA,** Depto. Geologia, Univ. Oviedo, 33005 Oviedo, Spain Continued usage of regional stages relates partly to the difficulty of determining accurate correlation among them, particularly in the Pennsylvanian (Upper Carboniferous) Subsystem when biotic endemism was greatest. It is now apparent that the strong glacial eustatic control has resulted in many disconformable boundaries throughout the entire Pennsylvanian, particularly in high-shelf cratonic settings where the regional stages have been established. This and the endemism make it very difficult to select a GSSP near the base of any currently named regional stage. More study is needed in basinal areas continuous and correlatable with the areas where the regional names are derived. It is possible that appropriate boundaries for some regional stages will not be globally correlatable, and also that globally correlatable boundaries will not be close to boundaries of any current regional stages. Therefore, we propose a working procedure that regional stage names and rank be retained, but series rank be reserved for globally correlatable units that will emerge with further effort. Initially, geographic names should be avoided for series, in favor of more neutral terms (Lower, Middle, Upper) for series of the Mississippian and Pennsylvanian subsystems. Basal boundaries for the Middle and Upper Series can be selected wherever an appropriate GSSP is defined. In the meantime, boundaries of regional stages should be selected to stabilize regional temlinology, and any of these can be a candidate for a series GSSP. Regional stage names can continue in use where the endemic biotas allow easy correlation, but the structure will be in place for ultimate designation of globally correlatable series for the subsystems. It is possible that westem European series names and Russian stage names (if raised to series) could ultimately be used as subequal altemative series names, if GSSPs are acceptably close to traditional boundaries: e.g., Toumaisian, Visean for Lower and Middle Mississippian; Westphalian, Stephanian for Middle and Upper Pennsylvanian; and/or Serpukhovian, Bashkirian, Moscovian for Upper Mississippian, Lower and Middle Pennsylvanian.

THE CONODONT SUCCESSION AT THE MID CARBONIFEROUS BOUNDARY, ARROW CANYON (NEVADA, USA): IMPLICATIONS FOR INTERCONTINENTAL CORRELATION **LANE, H. RICHARD,** National Science Foundation, 4201 Wilson Blvd., Arlington, VA 22230, USA, hrlane@NSF.gov, **BRENCKLE, PAUL L.,**1 Whistler Point Road, Westport, MA 02790, USA, and **RICHARDS, BARRY C.,** Geological Survey of Canada, 3303-33rd St. NW, Calgary, Alberta T2L 2A7, Canada Arrow Canyon, the Global Stratotype Section and Point (GSSP) for the Mid-Carboniferous boundary, contains the most continuous, fossiliferous succession known globally for this chronostratigraphic interval. The GSSP occurs near the middle of a 1.68 m thick limestone unit within the lower Bird Spring Formation at a position 82.9 m above the base of the underlying Indian Springs Formation. It is located at the evolutionary first occurrence of the conodont *Declinognathodus noduliferus s.l.* The stratigraphic interval from the basal Indian Springs to about 14 m above the GSSP contains a complete succession of four conodont zones from the Late Mississippian *Adetognathus unicornis* Zone up to the Early Pennsylvanian *Idiognathoides sinuatus Rhachistognathus minutus* Zone. This succession, which can be recognized in other regions, appears to be missing in northern England (Stonehead Beck and Crowdon Brook sections) where *I. sinuatus-R. minutus* Zone conodonts found in the lowest *Homoceras* ammonoid zone overlie pre-*A. unicornis* Zone conodonts in the upper *Eumorphoceras* ammonoid zone. Therefore, the time represented by the *A. unicornis* to *I. sinuatus-R. minutus* zonal interval in Arrow Canyon cannot be recognized in beds containing the *Eumorphoceras* to *Homoceras* transition of the British standard ammonoid zonation. A hiatus and/or several metres of largely unfossiliferous beds separate these ammonoid zones suggesting that the standard ammonoid succession in northern England is incomplete and that these sections are unsuitable for a global boundary reference standard. The section at Arrow Canyon is composed of glacio-eustatic, transgressive-regressive sequences. A thin paleosol occurs at the top of the sequence containing the Mid-Carboniferous boundary and at the top of the sequence immediately below. Unconformities developed on these paleosols represent minor hiatuses because they occur within conodont zones.

MOSCOVIAN STAGE OF THE MOSCOW SYNECLISE (RUSSIA) **MAKHLINA, MARIYA KH.**, Geological Institute of the Russian Academy of Sciences, Pyzhevsky, 7, 109017 Moscow, Russia. E-mail goreva@ginran.msk.su, **ALEKSEEV, ALEXANDR S.**, DepaTt. Paleontology, Geological Faculty, Moscow State University, 119899 Moscow, Russia, **GOREVA, NATALIA V., ISAKOVA, TATYANA N.**, Geological Institute of the Russian Academy of Sciences, Pyzhevsky, 7, 109017 Moscow, Russia The Moscovian Stage was established by S.N. Nikitin in 1890 in the Moscow Basin, and in 1926 A.P. Ivanov subdivided it into four horizons (Vereya, Kashira, Podolsk, Myachkovo). After 70 years of comprehensive study of these horizons, their characteristics and worldwide distribution allows their consideration as substages (Vereyian, Kashirian, Podolskian, Myachkovian). Each substage is characterized by zones of fusulinids, conodonts and other fossil groups. In the years 1994-1998 stratotypes of these substages were reinvestigated for the Moscow Syneclise. Analysis of all available lithological and paleontological data with the use of paleoecological and biory~nostratigraphic methods enabled detailed subdivision of the local stratigraphic scheme in the Moscow Syneclise. Detailed investigations, in the type area, resulted in the recognition of 13 formations and 28 members. **The Vereyian Substage** (16-45 m) composed of variegated terrigenous rocks with subordinate limestone layers. Three formations (Aljutovo, Skniga, Ordynka) are recognized within this substage. **The Kashirian Substage** (35-90 m) is characterized mainly by limestones, micrograined dolomites) variegated clays and marls are subordinate in thickness. It is subdivided into 4 formations (Tsna, Nara, Lopasnya, Smedva) and 12 members. **The Podolskian Substage** (22~6 m) differs from the Kashirian in the prevalence of bioclastic limestones and in a considerable decrease of dolomite and variegated clayey rocks. Three formations (Vaskino, Ulitino, Stshurovo) and 8 members are recognized within this substage. **The Myachkovian Substage** (10-44 m) is composed of mainly bioclastic limestones and unlike the Podolskian, it contains lesser amounts of clayey rocks and dolomites. These are the Novlinskoe Group (two formations) and Peski Formation and 8 members in the proposed local scheme.

NEW HORIZON (SUBSTAGE) OF THE GZHELIAN STAGE **MAKHLINA, MARIYA KH., ISAKOVA, TATYANA N.**, Geological Institute of the Russian Academy of Sciences, Pyzhevsky, 7, 109017 Moscow, Russia E-mail, isakova@lginran.msk.su The Carboniferous and Permian boundary corresponds to the boundary between the Gzhelian and Asselian Stages. This occurs between the *Daixina bosbytauensis D. robusta* and *Sphaeroschwagerina vulgaris-S. fusiformis* Zones. The boundary stratotype was established in the Aidaralash section, South Urals. This means that the *Daixina bosbytauensis-D. robusta* Zone has to be included in the Gzhelian Stage of the Russian Platform (1992) and changes the position of the upper boundary of the Gzhelian. This necessitated the introduction above the Noginskian a new horizon corresponding with the *Daixina bosbytauensis-D. robusta* Zone in the Moscow Basin. The new horison proposed for the Gzhelian and named the Melekhovo Horison (Melekhovian Substage) is traceable in boreholes and in quarries in the Moscow Basin. The horizon consists of dolomitized limestones and secondary dolomites. The rocks are cavemous, calcitizied, and partially silicified and include chert layers and molds of fusulinids of the *Daixina bosbytauensis-D. robusta* Zone. Two elementary rhythms composed mainly of bioclastic, highly dolomitized limestones, can be recognized in the lower half of the Melekhovian. Each of the rhythms is terminated by laminated dolomite or claystone. Its upper half appears to consist of two rhythms as well. The base of the lower rhythm is limestone with chert intercalations and the top is marked by limestone with clay interlayers. The upper rhythm is represented by its basal bed alone and consists of limestone.The total thickness of the horizon is 13 m. The lower boundary of the Melekhovian is distinctly traceable in the succession of the rocks and correlatable on the basis of its fusulinid fauna. Its lower boundary is defined by a change in the fusulinid assemblage from the *Daixina sokensis* Zone (Noginskian) to the *Daixina bosbytauensis-D. robusta* Zone (Melekhovian) . The last fusulinid assemblage includes *Daixina robusta* Raus., *D. vozhgalensis* Raus., *D. pomposa* Sjom., *D. insolita* Isak., *Praepseudofusulina diligens* Isak., *Pseudofusulina kljasmica* (Sjom.), P. *paraanderssoni* Raus., *Triticites* ex gr. *plummeri* Dunb. et Condra.

INTEGRATED LATE KINDERHOOKIAN (MISSISSIPPIAN-LOWER CARBONIFEROUS) AMMONOID, BRACHIOPOD AND MIOSPORE BIOSTRATIGRAPHY, UPPER CUYAHOGA-LOWER LOGAN FORMATIONS, OHIO, UNITED STATES **MANGER, W.L.**, Dept. of Geosciences, Univ. of Arkansas, Fayetteville, AR 72701 USA; **KOLLAR, A.D.**, Section of Invertebrate Paleontology, Carnegie Museum of Natural History, Pittsburgh, PA 15213 USA; **CLAYTON, G.**, Dept. of Geology, Trinity College, Dublin 2, Ireland; **OWENS, B.**, Dept. of Geology, Univ. of Sheffield, Sheffield, Sl 3JD United Kingdom; e-mail <wmanger@comp.uark.edu> The Cuyahoga and Logan fms of eastern Ohio reflect a northwestward-trending deltaic regime. Pebble-bearing sandstones formed distributary systems coeval with interdistributary bays and delta front-upper shore face siltstones and shales, the latter preserving marine fossils, including the ammonoids *Protocanites lyoni* and *Muensteroceras*. Previous age assignments based on ammonoids have fallen on either side of the Kinderhookian-Osagean Series boundary fomenting nearly 50 years of controversy that can be resolved by integration of biostratigraphic data from articulate brachiopods and miospores. The Cuyahoga-Logan articulate brachiopod assemblage consists of 33 species representing 27 genera, with 16 genera and species occurring with ammonoids at the Sciotoville Bar locality, southern Ohio. Restudy (Kollar) has assigned a late Kinderhookian age to this assemblage based on *Caenaoplia logani*, *Camarophorella mutabilis*, *Hamburgia flora*, and *Rhytiophora raricostatus*. The latter two species are restricted to the Kinderhookian Series, and no species are exclusively Osagean. Diverse Dinantian miospores assemblages are dominated by *Yallatisporites* spp. and *Spelaeotriletes* spp. and have been recovered from upper Cuyahoga lower Logan strata in the vicinity of the Sciotoville Bar locality and the type area of the Wooster Member, northeastern Ohio. The assemblages represent the middle Tournaisian *Spelaeotriletes pretiosus-Raistrickia clavata* (PC) Miospore Biozone of western Europe equivalent to the middle to early upper Courceyan Stage (late Tn2 and early Tn3) thus supporting a late Kinderhookian age for the upper Cuyahoga-lower Logan Formation. Placement of the boundary in the Ohio sections remains equivocal.

SEQUENCE STRATIGRAPHY AND SEDIMENTOLOGY OF THE MID CARBONIFEROUS BOUNDARY AT THE STRATOTYPE SECTION, ARROW CANYON, NEVADA **RICHARDS, BARRY, C.**, Geological Survey of Canada, 3303-33 St. NW., Calgary, Alberta T2L 2A7, and **LANE, H. RICHARD**, National Science Foundation, 4201 Wilson Blvd., Arlington, VA 22230, USA The Mid-Carboniferous Global Stratotype Section and Point (GSSP) lies in a 1.68 m thick }imestone unit in the Chesterian to Morrowan lower Bir~ Spring Formation. The lower Bird Spring and underlying Chesterian Indian Springs Formation comprise tropiGal carbonates and siliciclastics that constitute a second-order sequence containing multiple high-order transgressive-regressive (TR) sequences of largely glacio-eustatic origin. Five, third- to fourth-order TR sequences comprising neritic to intertidal ramp carbonates overlain by relict paleosols (granular to nodular peds), are recognized in a 15.5 m thick section of the lower Bird Spring containing the GSSP. The limestone unit containing the GSSP constitutes a representative example of these sequences. A surface of transgressive ravinement, developed on the nodular paleosol of an underlying TR sequence, defines the base of the sequence. Shallow-neritic, pelmatozoan grainstone constitutes the transgressive systems tract (TST). The boundary between the TST and regressive systems tract (RST) is placed at the transition from pelmatozoan grainstone to mixed-skeletal grainstone and brachiopod packstone; an intervening maximum-flooding surface is not evident. The GSSP, 68 cm above the base of the sequence, lies within the TST/RST transition, an interval recording essentially continuous marine deposition. Brachiopod wackestone in the RST passes upward into a paleosol comprising limestone lithorelicts and argillans recording deep, humid-climate weathering of open marine limestone subsequent to a sea-level drop. The paleosol (C soil horizon) is unconformably overlain by peritidal conglomerate representing the TST of the overlying sequence. Beds on either side of the unconformity are within the same conodont zone. All of these high-order sequences lack restricted-shelf carbonates. The top of the subsequence containing the GSSP is a first-order boundary defining the top of the regionally-developed, second-order sequence comprising the Indian Springs and lowermost Bird Spring. The first-order boundary also marks the cratonward-expanding hiatus between the Kaskaskia and overlying Absaroka tectonostratigraphic sequences.

THE VISEAN-NAMURIAN BOUNDARY IN EASTERN AUSTRALIA **ROBERTS, JOHN**, School of Geology, University of New South Wales, Sydney, NSW 2052, Australia, E mail J.Roberts@unsw.edu.au Precise recognition of the Visean-Namurian boundary within eastern Australia cannot be made from palaeontological evidence because the boundary coincides with a sudden deterioration of climate and the onset of glaciation. Tournaisian and Visean faunas were mainly cosmopolitan, warm water assemblages, widl some provincialism (Visean conodonts), allowing correlation with the international timescale by means of sparse ammonoids, conodonts (Tournaisian and parts of the Visean) and brachiopods. A significant drop in diversity of faunas, especially brachiopods, took place in the latest Visean *Marginirugus barringtonensis* Zone. The Visean-Namurian boundary appears to be located at the top or within the uppermost parts of the *M. barringtonensis* and the *Gnathodus texanus-G. bileatus* Zones. The latter represents the uppermost occurrence of conodonts within the autochthonous Australian Carboniferous succession. The succeeding *Levipustula levis* Zone, the first Gondwanan assemblage, contains few species which range up from the Visean, as well as several brachiopods which may be related to forms from the cold water Baikal region of Russia. The early Namurian ammonoid *Cravenoceras* is known from a single locality within the zone. In NSW, the age of the *L. levis* Zone can be inferred from SHRIMP zircon dates to be younger than 328.5 11.4 Ma (Paterson Volcanics, an apparent equivalent of part of the *M. barringtonensis* Zone) and older than 321.9~3.8 Ma (overlying Johnsons Creek Formation). The zone may be younger in Queensland where conditions remained marine, as opposed to a change to non-marine NSW. In Queensland, the *L. levis* Zone is succeeded by the *Auriculispina levis* Zone, which cannot be dated. **Key Words:** Visean-Namurian boundary - eastern Australia

THE CARBONIFEROUS OF THE WORLD' PROJECT **WAGNER, RH.,** Jardin Botanico de Cordoba, Avda de Linneo s/n, E 14004 Cordoba, Spain, crlwagro@uco.es; **WINKLER PRINS, C.F.,** Nationaal Natuurhistorisch Museum, Postbus 9517, NL 2300 RA Leiden, The Netherlands; **GRANADOS, L.F.,** Instituto Tecnologico Geominero de Espa~ca, Rios Rosas 23, E 28003 Madrid, Spain. 'The Carboniferous of the World' is an ongoing project of the IUGS Subcommission on Carboniferous Stratigraphy, which started in the 1980s on the initiative of Carlos Maltinez, Scientific Secretary of X ICC, held in Madrid 1983. Its aim is to produce regional summaries of Carboniferous stratigraphy and palaeontology in a palaeogeographic context that is linked to the recognition of palaeotectonic and palaeo climatic areas. Although regional chronostratigraphic classifications are given, the overall format was adopted of lower, middle and upper Carboniferous major units, following the recommendation of SCCS to use these informal units provisionally. This recommendation has never been revoked, but SCCS has subsequently adopted a subdivision of the Carboniferous System into lower and upper subsystems. A vote by the SCCS titular membership has sanctioned the use of Mississippian and Pennsylvanian for these subsystems, thus avoiding the problems involved with the terms Lower and Upper Carboniferous, which have been used in so many different ways that a qualifying statement is required for any reference to these terms today. Of course, Mississippian fits the lower Carboniferous, and Pennsylvanian combines middle and upper Carboniferous, so the newer emphasis on a basic subdivision into two major units can be accommodated within the framework adopted when 'The Carboniferous of the World' was conceived. Three volumes have been published, covering most of the world, but leaving Central and North America as well as Europe West of the ex-USSR and Asia Minor still to be dealt with. Since these are the most classical areas for Carboniferous studies, with an immense amount of information, two additional volumes are envisaged. The publication schedule has to be a flexible one, but it is hoped to avoid excessive delays such as the one experienced with volume III (The former USSR, Mongolia, Middle Eastern Platform, Afghanistan, & Iran), which needed extensive editing.

THE ASTURIAN STAGE: A PRELIMINARY PROPOSAL FOR THE DEFINITION OF A SUBSTITUTE FOR WESTPHALIAN D **WAGNER, RH.,** Jardin Botanico de Cordoba, Avda de Linneo s/n, E 14004 Cordoba, Spain, crlwagro@uco.es; **VILLA, E., SANCHEZ DE POSADA, L.C., MARTINEZ CHACON, M.L., FERNANDEZ, L.P.,** Departamento de Geologia, Universidad de Oviedo, c. Arias de Velasco s/n, E 33005 Oviedo, Spain; **WINKLER PRINS, C.F.,** Nationaal Natuurhistorisch Museum, Postbus 9517, NL 2300 RA Leiden, The Netherlands. In the West-European chronostratigraphic classification the Westphalian D Stage is the only subdivision of the Westphalian Series which has not yet received a formal stage name combined with an adequate (boundary) stratotype. The original definition of Westphalian D was based on subsurface sections in Lorraine (France), which show exclusively terrestrial deposits and are obviously unsuitable for stage definition. The mixed marine and terrestrial successions of the Cantabrian Mountains (NW Spain) would form a suitable alternative. A boundary stratotype is proposed in the Canales section at Riosa in the Central Asturian Coalfield, hence the name 'Asturian Stage'. This section contains the fossil floras that allow correlation with Saar-Lorraine and elsewhere. It is also quite reasonably correlated with more marine sections to the East. Fusulinid foraminifera, brachiopods and other marine faunas can thus be brought to bear and are presented in summary range charts to show their variety. These successions do not go beyond mid Westphalian D, but the upper Westphalian D is well represented in the Guardo Coalfield in the province of Palencia, further ESE in the Cantabrian Mts. This is the area in which the boundary stratotype of the Cantabrian Stage (lowermost Stephanian) has been established, which fixes the top of Westphalian D. Outcrop conditions are generally good and about 5000 m of strata are involved altogether. This is still a preliminary proposal aimed at focusing discussion and uniting the efforts necessary to document further the biostratigraphic and sedimentological data that will provide an even more solid foundation for the recognition of the Asturian Stage and its proposed stratotype. **Key Words:** Westphalian D, Asturian Stage

## THE FIRST ARGENTINE SYMPOSIUM ON THE UPPER PALEOZOIC
## Anillaco, La Rioja Province, Argentina, May 1999

Since the XII International Congress on Carboniferous and Permian Stratigraphy held in Buenos Aires, there were no meetings held in Argentina concerning these periods. The 1° Argentine Symposium on the Upper Paleozoic was organized in May 1999 in Anillaco, a little town in La Rioja province (1350km from Buenos Aires city). The CRILAR (Regional Research Center of La Rioja) sucessfully hosted the meeting. The sessions were dedicated to the memory of the late Dr. Roberto Caminos, an active, talented scientist and kind men, who greatly contributed to the knowledge of La Rioja geology. Thirty participants from different Argentinian institutions and from Brazil covered diverse subjects. These studies focused mainly on detailed biostratigraphic analyses and research of Early Carboniferous deposits, which recently acquired relevance when their large geographic distribution in the NW of Argentina was known. After two days of interesting discussions the assistants participated in a field trip to representative sections of the Carboniferous and Permian in the Paganzo Basin. An Abstracts volume was distributed during the meeting (it will be published also in Ameghiniana, the Review of the Argentine Paleontological Association). The next meeting is scheduled for the year 2001 and will be held at the Paleontological Museum "E. Feruglio", at Trelew City, Chubut province. We hope that this new impulse will resume scientific activities related to the Late Paleozoic in Southern South America. Silvia Césari and Pedro Gutiérrez.

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# OBITUARY

## JOS BOUCKAERT (1930-1999)

Jos Bouckaert died on December 6th, 1999. He was born in Aalst (Belgium) and started his career working for the Association for the study of the geology and stratigraphy of the Silesian. He graduated as Doctor in Sciences with a dissertation on Namurian goniatites. In `1959, he joined the Geological Survey of Belgium, becoming the director in 1986 until he left in 1993. During his career, Jos Bouckaert was active in mamy fields of the Earth Sciences. The first years of activity were mainly devoted to the geology of the upper Mississippian-lower Pennsylvanian around Namur. Then, discovering micropaleontology, he became one of the pioneers of conodont stratigraphy in Europe. He published first, with Ziegler and Thorez, a memoir on Famennian conodonts (1965). Later, he pubished another on Namurian conodonts with A. Higgins (1968). During the Golden sixties, Belgium started a lot of big civil works. During that period, Bouckaert was an applied geologist for water dams, locks, speedroads etc. which were build in the Belgian Ardennes. At the same time, he produced the Ardenne sheet of the Mineral deposits map of France (1964) and, with P. De Bethune, a geological map of Belgium and surrounding countries (1966). Together, with Streel and Conil, he created a team of young geologists who reinvestigated the classical sections from the Paleozoîc. They organized the International symposium on micropaleontological limits from Emsian to Visean at Namur in 1974. Later, he erected, mainly together with Paproth and Bless, a new team specialized in paleogeographical reconstructions and which will elaborate a number of theories on the origin of hydrocarbons and energy resources. When he retired from the survey, he lived with his wife Nicole most of the time at Marche-en-Famenne, where he became the expert on local natural history and history. One of his subjects of interest was the history of the Citadel of Namur, build on a hill where he started studiyng geology at the beginning of his career.

His activity was not restricted to the Geological Survey. In 1973 he became Professor at the Catholic University of Leuven where he taught micropaleontology and paleobotany. He has been president of many scientific associations: the National Commettee of Geological Sciences, the Geological Society of Belgium, etc. He was one of the founding members, and the first president, of the Professional Belgo-luxembourg Association of Geologists. He obtained many scientific awards, among which the Leopold von Buch Award (1989) from the Deutsche Geologische Gesellschaft and the Prix Baron van Erborn from the Royal Belgian Academy are most noteworthy.

**Eric GROESSENS**

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