INTERNATIONAL UNION OF
GEOLOGICAL SCIENCES
COMMISSION ON STRATIGRAPHY

—S—D—S—

SUBCOMMISSION ON DEVONIAN STRATIGRAPHY

NEWSLETTER No. 15

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I. U. G. S Subcommission on Devonian Stratigraphy

Newsletter No. 15, December 1998

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The *Newsletter* appears annually following SDS meetings. Contributions may be sent to the Editor at any time during the year for inclusion in the next issue. Guidelines for consideration in the preparation of contributions are presented on the inside of the back cover.

The printing of this issue is 150 copies with 102 mailed to titular and corresponding members, 19 to honorary members, Chairmen of the Carboniferous and Silurian Subcommissions, IUGS and ICS officers, friends of the Devonian, and libraries. Remaining copies are available from the Chairman, Secretary, or Editor. The costs of preparation, printing and postage for the *Newsletter* are shared equally by SDS and The Department of Geology, University of Texas at Arlington.

The *Newsletter* can also be viewed in electronic published format via the SDS World Wide Web site at URL **http://www.uta.edu/geology/SDS/**.

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EDITORIAL NOTES

One of my most trusted students, Melinda Blackwell, has completed her degree and, as of December 1, I could no longer rely on her to assist with the production of this newsletter. As a result I was unable to devote the time necessary to perfect figures of and correct typographical errors in contributions. The result is that several figures are basically unusable and that several contributions contain many typographical errors.

CM Gunter Freyer wrote stating that he had retired some years ago and therefore wishes to withdraw from SDS membership. CM Freyer did not provide an alternate address to that of the enclosed membership list, other than his postal code is now D-9599 (Freiberg).

MESSAGE FROM THE CHAIRMAN

The annual SDS meeting held in Bologna on June 23rd 1998 during the Seventh International Conodont Symposium in Europe (ECOS VII) and in association with a meeting of IGCP 421 was attended by more than 25 SDS members and by many participants in the ECOS VII Symposium. Conodonts, Devonian matters, IGCP 421 and historical Italian cities have proven to be an attractive combination.

To begin with I wish to congratulate and to thank our hosts from the Universities of Bologna and Modena, M.C. PERRI, E. SERPAGLI, C. SPALLETTA and many others for the extremely smooth organization. The accurate and well-reasoned proposals and the animated discussions concerning the subdivision of the Emsian, Frasnian and Famennian indicate a large interest in a further elaboration of the present global Devonian chronostratigraphic scale. A questionnaire summarizing alternative conclusions of our discussions in Bologna is submitted to all SDS members (see p.). May we insist that you return the questionnaire as soon as possible but no later than in order to enable us to assess the preliminary opinions of the about 100 SDS members and to use this information as an orientation for further discussions during the next SDS meeting in Morocco. In this Newsletter you will find the program of this meeting with field trips in the Anti-Atlas and the Meseta including sections that are most relevant to the definition of the stage subdivisions under discussion. In order to have successful discussion sessions, please inform in advance but no later than April 1, 1999 the chairman or secretary of new or more elaborated proposals.

Finally I wish to draw your attention on a SDS symposium "Devonian paleogeography and paleoclimatology of Western Gondwana" that will be organized during the IGC meeting in 2000 in Rio de Janeiro. SDS members and other Devonian-fellows are invited to submit titles of talks and posters at the next SDS meeting in Morocco.

The SDS is looking forward to your collaboration, because our activities may positively influence the support from IUGS.

P. BULTYNCK

Minutes of the SDS Business Meeting, 23rd June, Bologna

The annual business meeting was held during the afternoon of Tuesday the 23rd June, in the Dipartimento di Scienze della Terra e Geologico Ambientali of the University of Bologna. It took place during the first (Bologna) part of the 7th International Conodont Symposium held in Europe (ECOS VII) which was superbly organized by M.C. Perri, C. Spaletta, E. Serpagli, and others. In conjunction with ECOS VII and the SDS meeting, there was also a "round table session" of IGCP 421 on "North Gondwanan Mid-Paleozoic Bioevent/Biogeography Patterns in Relation to Crustal Dynamics". Many talks presented during the oral sessions, mostly on June 25th, dealt with Devonian conodonts. Other aspects of Devonian stratigraphy (Morocco, Iran, Carnic Alps, Mauretania, Victoria) were covered in talks related to IGCP 421. Pre- and post-symposium excursions to Sardinia and the Carnic Alps visited many Devonian sections and a wealth of new data was presented in voluminous field trip guidebooks.

PRESENT: Chairman P. Bultynck, secretary R.T. Becker; TMs: I. Chlupac, J.L. García-Alcalde, R. Feist, W.T. Kirchgasser, G. Klapper, C.A. Sandberg, J.A. Talent, K. Weddige, W. Ziegler; CMs: A. Blieck, D. Brice, P. Carls, A. El Hassani, J. Hladil, R. Mawson, M. Murphy, N. Ovnatanova, P. Sartenaer, E. Schindler, H.T. Schönlaub, M. Streel, T.Uyeno, Wang Cheng-yuan; guests: O. Babek, E.M. Benfrika, C. Derycke, B. Fordham, C. Girard, A. Harris, P. Koenigshof, B. Mistiaen, T. Nemirovskaya, M.F. Perret, G. Plodowski, N. Savage, G. Schraut, I. Schülke, L. Slavik, J. Valenzuela Rios, J. Zuskova.

1. Introduction and apologies

The chairman opened the annual meeting and thanked the ECOS organizers for hosting SDS during their symposium. The high number of attendents gave evidence that the first joint SDS-ECOS meeting was attractive to many Devonian stratigraphers, not only to conodont specialists. In order to take part in the ECOS ice-breaking party, the meeting had to be finished by 7.00 pm.

Apologies for absence were recorded from vice-chairman R. Crick, from TMs V. Menner, S. Turner, E.A. Yolkin, and Yu Chang Min, and from CMs M. Ginter, M.R. House, A. Kuz'min, Dr. J.E.A. Marshall, W.A. Oliver Jr., M.A. Rzhonsnitskaya, M. Truyóls-Massoni, T. Wright, and G. Young. [In this context the secretary would like to ask all other SDS members to take their correspondence duties seriously, to indicate their absence and/or to provide reports and written comments.]

For various topics of the agenda, a total of thirteen documents were presented at the meeting. According to their subjects, they were numbered in the following order:

Document 1: Chlupac, I. & Lukes, P.: Examples of lower Zlíchovian and Dalejan boundary intervals in the Barrandian area, Czech Republic. - 7 pp. + 4 figs.

Document 2: Yolkin, E.A.: Devonian substages in West Siberia sequences. - 2 pp.

Document 3: García-Alcalde, J.L., Truyóls-Massoni, M., Soto, F.M., García-Lopez, S. & Montesinos, J.R.: Lower Emsian/Upper Emsian in the Cantabrian Mountains (N Spain). State of the art. - 3 pp + 2 figs.

Document 4: Jahnke, H. & Jansen, U.: Subdivision of the Emsian stage - compilation of sections in W-Europe and palaeontological remarks. - 7 pp. + 6 figs.

Document 5: Jansen, U. (comp.): Subdivision of the Emsian stage - state of discussion in the German Subcommission on Devonian Stratigraphy. - 1 p.

Document 6: Becker, R.T.: Prospects for an international substage subdivision of the Famennian. - 7 pp. + 1 fig.

Document 7: Streel, M., Brice, D., Degardin, J.-M., Derycke, C., Dreesen, R., Groessens, E., Hance, L., Legrand-Blain, M., Lethiers, F., Loboziak, S., Maziane, N., Milhau, B., Mistiaen, B., Poty, E., Rohart, J.-C., Sartenaer, P., Thorez, J., Vachard, D. & Blieck, A.: Proposal for a Strunian Substage and a subdivision of the Famennian Stage into four Substages. - 5 pp. + 4 figs.

Document 8: Streel, M. & Loboziak, S.: Proposal of boundaries for subdivision of the Famennian Stage: miospore implications. - 2 pp. + 1 fig.

Document 9: Piecha, M. & Schindler, E.: Redefinition of the German Late Devonian 'Stufen'. - 2 pp.

Document 10: Sandberg, C.A. & Ziegler, W.: Comments on Proposed Frasnian and Famennian Subdivisions. - 6 pp.

Document 11: Becker, R.T. & House, M.R.: Proposals for an international substage subdivision of the Frasnian. - 8 pp. + 1 tab.

Document 12: Streel, M.: Quantitative palynology in late and latest Famennian swamp environments, an accurate tool for Marine/Non-marine correlation. - 2 pp. + 1 fig.

Document 13: Schindler, E.: Report of the German Subcommission on Devonian Stratigraphy at the SDS meeting in Bologna (Italy), June 1998. - 1 p.

2. Minutes of the Rochester Meeting 1997

The Minutes of the 1997 meeting were circulated in SDS Newsletter 14 (pp. 2-5). No comments concerning the minutes were received prior to the Bologna session. The Minutes were signed as correct.

3. Chairman's Business

In relation to problems and dissatisfaction with the definition of the Emsian, the chairman pointed out that currently no revision of Devonian stratotypes is possible. He drew attention to the new rules of IUGS as outlines by Remane et al. 1997 (see Newsletter 14: p. 19) which require a period of ten years before stratotypes may be re-considered. CM Carls suggested to give clear reference in publications to the *kitabicus* Boundary as base of the Emsian to allow distinction from the base of the Emsian as it has been used classically in other regions and by former authors. TM Weddige answered that the case of a large difference between the classical German and the *kitabicus* level is still unproven. TM Ziegler gave a summary of different statements and the Secretary asked TM Weddige to submit his views to the Newsletter in order to continue this important discussion in public.

4. Proposals for Devonian substages and additional stages

The Chairman gave a brief introduction to the task of substage definitions and the provisional agenda distributed by mail was slightly changed to give priority to discussions on the Emsian and Famennian. Frasnian and Givetian subdivisions were to be discussed only if time allows.

4A. Emsian (Documents 1-5)

The Chairman briefly summarized the current discussion and drew attention to the various levels that have been emphasized by different authors:

- the base of the Dalejan Shales near the base of the *Now. cancellata* or *Po. inversus* Zones
- the base of the *nothoperbonus* Zone in Siberia (e.g., Document 2)
- the global Upper Zlichovian Event (UZE) within the *gronbergi* Zone (see Document 3)

The document authors, as far as present, were asked to summarize their contributions.

TM Chlupac gave some brief comments on the base of the Zlichovian and raised taxonomic problems on the clear distinction between *Guerichina strangulata* and *Guer. infundibulum*. He argued strongly in favour of an intra-Emsian substage boundary near the base of the Dalejan Shale which is very close to the entry of *Gyroceratites gracilis*, the former "*gracilis* boundary". In an important section near Srbsko, *Now. cancellata* is separated by a small gap from older *Now. elegans* in the upper part of the Zlíchovian Limestones. *Po. laticostatus* enters a little above *Now. elegans* in a marker bed at the top of the local Chynice Limestone. Transitional forms between *elegans* and *cancellata* were found just below and above the marker bed. It was admitted that more precision is needed concerning the entry of marker polygnathids. For further details see Document 1.

U. Jansen (Senckenberg/Frankfurt a.M.) gave an overview of work conducted by a special Emsian Working Group of the German Subcommission on Devonian Stratigraphy. The German groups also has concentrated on the *elegans/cancellata* and *inversus* boundaries. The Cantabrian Mountains, Celtibera, and the Barrandian were regarded as key areas for more international work. Studies in Morocco are currently being undertaken. Integration with palynological data is hoped to allow correlation of the traditional early/late Emsian boundary of the siliciclastic type region with the nowakiid and conodont succession. Unresolved taxonomic problems of the *elegans-cancellata* transition and insufficient knowledge of the precise entry of *Po. inversus* were highlighted. Further details are included in Document 5.

TM García-Alcalde gave a brief summary of Emsian successions and events in the Cantabrian Mountains, including the distinction between Upper Zlichovian (UZE) and Daleje-Cancellata (DCE) Events. The occurence of various brachiopods (see Document 3) in beds thought to be equivalents of the Daleje Shale were emphasized. In the subsequent discussion, TM Weddige stated that it was too early to decide on substage names and recommended the preliminary neutral use of an "Inner-Emsian" [rather Intra-Emsian] boundary. CM Carls pleaded for a conservation of the name Zlíchovian in its traditional sense rather than adopting the *kitabicus* Zone base for a Zlichovian in a new international definition. The Chairman answered, that in other cases definitions were changed. For example, the Givet Limestone enters above the base of the internationally defined Givetian. CM Sartenaer drew attention to the significance of the Ems Quarzite and suggested that the base of the *Now. richteri* Zone should be included in the discussion [see Rochester Minutes]. The Secretary commented that the UZE would be a poor level for subdivision since it lies in the middle of the *Anetoceras* faunal complex (Stufe). The *gracilis*-boundary is also still difficult since no sequence from *Gyro. laevis* to *Gyro. gracilis* has been properly documented in any section. TM García-Alcalde gave a clear statement that he agrees completely that a level near the *cancellata* boundary was the best position for substage subdivision. The Chairman drew attention to the fact that there is still insufficient information about the precise relation between the entries of *Po. laticostatus* and *Po. inversus*. CM Carls proposed to decide first on a stratigraphical level for subdivision, and later on substage names. CMs Murphy and Mawson argued that lower and upper Emsian could be used in a preliminary way until final decisions will be made. TM Chlupac reminded SDS members of a rule that requires lower rank chronostratigraphic units to have different names from higher ones. The Secretary answered that this, however, is not the case with Devonian series names. TM Sandberg explained that the terms Lower, Middle, and Upper should be preferred since they are more practical and easier to remember for the wider geoscientific audience such as mapping geologists. The discussion was closed after it was agreed to hold an informal postal ballot about the level for Emsian substage subdivision and about substage terminology.

4B. Famennian (Documents 6-10)

The Secretary summarized his proposal for a threefold substage subdivision based on the classical German Oberdevon-Stufen sequence which followed the ammonoid sequence in pelagic facies. It was emphasized that this succession has been succesfully applied in many regions outside Germany, such as SW England, southern France, North Africa, North America, the Urals, and NW Australia. The three substages should be of roughly equal length, with a Lower Famennian approximating Upper Devonian II, a Middle Famennian consisting ca. of Upper Devonian III and IV, and an Upper Famennian correlating ca. with Upper Devonian V and VI. Use of the German regional Stufen names (Nehden-, Hemberg-, Dasberg-, and Wocklum-Stufen) was discouraged, at least until further revision (under way, see Document 9). It was recommended to consider the base of the *velifer* Zone as the base of the Middle Famennian, and a level around the base of the Lower *expansa* Zone for the base of an Upper Famennian. For further details see Document 6.

TM Ziegler repeated proposals of last years Rochester Meeting for a Lower-Middle Famennian boundary at the start of the *marginifera* Zone, and for a Middle-Upper Famennian boundary at the base of the Lower *expansa* Zone (see Document 10). TM Sandberg argued that the base of the *velifer* Zone is not suitable since it coincides with a marked regressive phase and since the level is poorly represented in North America. CM Streel introduced the audience to the views of the large group of Belgian specialists (Document 7) who propose to preserve the Strunian time interval as Uppermost Famennian in a fourfold substage subdivision. The wide distribution of the shallow-water index form *Quasiendothyra kobeitusana* and of *Retispora lepidophyta* was emphasized. Since the base of the type Strunian seems to correlate with a level in the Upper *expansa* Zone, the base of the latter was proposed as the base of an Uppermost Famennian. Following traditional Belgian subdivision, the base of a Middle Famennian was suggested to coincide with the base of the *rhomboidea* Zone, the base of an Upper Famennian should coincide with the base of the *velifer* Zone. TM Sandberg replied to a question of CM Streel that the base of the Upper *expansa* Zone is not as easily identifiable as the base of the Lower *expansa* Zone. The Secretary commented that the base of the *rhomboidea* Zone lies well within the classical do IIα (lower Nehden-Stufe) of the German subdivision and that a Middle Famennian as in the Belgian proposal would probably include a shorter interval than the other substages. In a fourfold substage subdivision other levels such as the global *Annulata* Event could be considered. As with topic 4A, a preliminary postal ballot (see this Newsletter) was agreed by present members.

4C. Frasnian (Documents 10-11)

Since time had proceeded significantly, only a brief introduction to the topic was given. The Secretary summarized his joint proposal with CM House. The base of the *punctata* Zone (Montagne Noire Zone 5) was proposed as a base for a Middle Frasnian. The Upper Frasnian could either be defined following the traditional German separation of a do Iδ, roughly coinciding with the span from the Lower to the top of the Upper Kellwasser Limestone, or by using the global transgression which allowed the spread of *Pa. semichatovae* (near the base of Montagne Noire Zone 11). Further details are given in Document 11. TM Ziegler (see Document 10) agreed completely with a *punctata* Zone boundary and emphasized the wide recognition of the *semichatovae* transgression which makes it the most suitable level for the base of an Upper Frasnian. It was decided to defer further discussions of the Frasnian and of the Givetian to future meeting.

5. Marine-Non-marine correlation (Document 12)

CM Streel briefly explained new palynological methods to use indicators of upstream and coastal swamp extensions and retraction to reconstruct climatic and sealevel changes which allow correlation. CM Blieck announced that IGCP 328 was finished and that a volume with final results will contain 25 papers by a total of 40 authors. Publication is planned in 1999 in the Courier Forschungs-Institut Senckenberg series. [Loud noise from the street and by car drivers pushing their horns interrupted the meeting and indicated that Italy had won their world championship soccer game.]

6. IUGS matters

The Chairman introduced the new geological chart produced by IUGS. Unfortunately, there are printing errors such as the misspelling of Pragian. [The new Geological Time Table (5th Edition), compiled by Haq & Eysinga is now available - costs: 25 US $]. An IUGS internet discussion forum connecting all IUGS officers has been established early in 1998.

7. Membership

7A. Withdrawels from Membership

CM G. Freyer has retired from the Saxonian Geolological Survey [see 1997 Minutes] and has stated that he wishes to withdraw from membership. SDS has also lost any contact with CM Yatskov after he left the Paleontological Institute of the Academy of Science and even Russian colleagues could not supply any new address.

7B. Election of CMs

There were four written nominations presented prior to the meeting:

Jed Day (Illinois State University, Normal, Illinois): specialist in brachiopod and sequence stratigraphy of North America (USA, Canada).

James R. Ebert (Department of Earth Sciences, State University of New York, Oneonta, New York 13820-4015, USA, ebertjr@oneonta.edu): specialist in Devonian stratigraphy of New York (Lower Devonian) and working on radiometric dating.

Zhu Min (Institute of Vertebrate Paleontology and Paleoanthropology, Academia Sinica, P.O. Box 643, Beijing 100044, People's Republic of China, zhumin@ht.rol.cn.net): specialist in Devonian fish with emphasis on Yunnan and the Tarim Basin.

Christoph Hartkopf-Fröder, Geologisches Landesamt Nordrhein-Westfalen, De-Greiff-Str. 195, D-47803 Krefeld, Germany, hartkopf-froeder@mail.gla.nrw.de): specialist in palynostratigraphy of the Rhenish Massive.

All proposals were approved unanimously.

7C. Election of TMs

The Chairman drew attention to the problematical lack of any TM from Canada which always has been an important region for Devonian stratigraphy and traditionally has made valuable contributions to SDS matters. CM Uyeno noted that currently there is no active young worker at hand that is in an appropiate permanent position and that there are also funding problems to attend SDS meeting. The topic remained unsolved. [After the meeting, however, CM Uyeno agreed to stand for TM election.]

8. Reports

8A. Financial Report

The Chairman gave the financial report which is as follows:

Income for 1998	in US $
— carried forward from 1997	342.66
— IUGS subvention for 1998	1,425.00 (same as in 1997)
total	1,767.66
Expenditure for 1998	
— Secretary expences	220.00
— Newsletter allocation for no. 15	250.00
— Support for the forthcoming Moroccan Meeting	1,000.00
total	1,470.00
Provisional balance November1998	297.66

Following a suggestion by TM Klapper, support for the Moroccan Symposium and SDS Field Trip was decided at the meeting.

8B. German SDS (Document 13)

CM Schindler gave a brief summary of activities of the German Subcommission on Devonian Stratigraphy. An annual meeting was attended by ca. half of all 63 members. Very active working groups (see topic 4) on Emsian and Famennian subdivision were established. The long-awaited monograph on the Devonian of Germany is close to completion. TM Weddige drew attention to the last supplement of the Devonian Correlation Charts which are published in Senckenbergiana lethaea [e.g., 76 (1/2), 1996 and 77 (1/2), 1998]. Contributions from anywhere in the world are welcomed for future issues. CM Schindler also informed about a new German Research Foundation initiative, led by W. Buggisch, on "Evolution of the system Earth during the younger Palaeozoic in the light of sedimentary geochemistry" which includes co-operation between geochemists, sedimentologists, palaeobiologists and stratigraphers. The Secretary asked other national Subcomissions and Working Groups to submit activity reports.

8C. Radiometric Dating

TM Talent reported that G. Dunning has received various samples which hopefully will be analysed later in this year. The Secretary reported that zircons have been extracted at the Potsdam Geoforschungszentrum from the additional Hasselbachtal bentonites sampled by D. Weyer (Magdeburg). R.D. Tucker (Washington University) has agreed to work on these zircons but samples have not yet been sent to him.

9. SDS Publications

The Chairmen drew attention to Courier Forschungs-Institut Senckenberg 199, "On sea-level fluctuations in the Devonian", edited by CM House and TM Ziegler, which includes the contributions to the 1994 SDS meeting in Moscow on "Devonian Eustatic Changes of the World Ocean Level". For the planned Devonian Correlation volume some manuscripts are still missing, such as contributions on the Eifelian, Givetian, and Frasnian stratotypes. There are also no reviews on the Devonian of Morocco, Germany, and of Western North Amerika. Some stratigraphically important fossil groups (e.g., acritarchs) are also not yet covered. [The decision to contact T. Servais proved to be succesful - a brief joint manuscript by several authors on Devonian acritarchs is promised for the end of 1998.] The Chairman gave the following list of current manuscript lengths:

Description of GSSPs	66 pp.
Regional reviews	423 pp.
Stratigraphically important fossil groups	366 pp.
total	832 pp.

TM Ziegler stated that this amount is much to high for a single Courier volume and proposed to divide contributions in two volumes. P. Königshof from Senckenberg explained the current difficult funding situation for Courier issues and said it was unlikely that all manuscripts could be published in one go. The Secretary suggested to go ahead with all completed manuscripts since several of them are waiting for so long that any further delay is unacceptable for authors. TM Ziegler stated that a contribution on the Wettelsdorf Richtschnitt could be finished within ten days after all other manuscripts had arrived at Senckenberg. The Chairman announced to visit the Senckenberg Institute this autumn [planned for November], to discuss the publication procedure with responsible staff, and to transfer manuscripts which have been submitted by then.

10. Future Meetings

10A. Meeting in 1999

A decision on a 1999 meeting was difficult since three different offers had arrived. The Chairman read a letter by TM Yolkin who invited SDS to hold a symposium in Novosibirsk and to visit sections in the Rudnyi Altai and Siberia. Since, unfortunately, no informed Russian colleague was present, no further details could be given. CM El Hassani gave a warm invitation to SDS to hold in spring 1999 a meeting in Morocco and to visit relevant sections for the current substage discussion in the Anti-Atlas and in the Moroccan Meseta. TM Talent informed about a planned meeting of IGCP 421 in Peshawar, Pakistan with possible excursions from Kashgar (Xinjiang, China) across the Karakoram to Pakistan (see SDS Newsletter 14: p. 26). The present SDS members voted strongly in favour of a symposium and excursion to Morocco. [The first circular has been distributed by e-mail and is also included in this Newsletter. The joint SDS and IGCP 421 meeting and excursions will take place from 24th April to 3rd May. For further details please contact CM El Hassani or the Secretary].

10B. Meeting in 2000

SDS is obliged to hold a meeting at the 31st International Geological Congress in Rio de Janeiro, from 6th to 17th August. The First Circular has been distributed widely and the SDS proposal for a symposium on "Devonian Paleogeography and Paleoclimatology of Western Gondwana" has been accepted (General Symposium 1-8). CM Isaacson promised to assist in the organisation. In addition, a number of planned field trips will visit South American Devonian section: Bft 27: Paleozoic of Western Gondwana active margin (Bolivian Andes), Aft 03: Paraná Basin records of Siluro-Devonian to Permo-Triassic biological and environmental changes, southern Brazil, Aft 04: Late Paleozoic glacial sedimentation in the eastern Paraná Basin, Aft 06: The Gondwana sequence in the eastern flank of the Paraná Basin, Southern Brazil, Aft 35: Paleozoic rocks of the Amazon Basin along the Tapajós River (Pará State) and around the city of Manaus (Amazonas State), North of Brazil. [Information can be obtained from the website: http://www.31igc.org]

Any other business

CM Mawson drew attention to the planned AUSCOS II meeting in 2000 which is planned just before or after the Sydney Olympic Games. It is intended to keep conference costs very low.

The annual meeting closed just in time for the ice-breaking party.

PROVISIONAL BALLOT

SDS decided during its Annual Meeting in Bologna, on 23rd of June 1998, to hold a provisional ballot in order to obtain the opinion of its membership concerning the future international subdivision of the Emsian, Famennian and Frasnian stages. Note that this questionaire is not binding for any future decisions. Please fill this form (or a copy of it) and send it to the chairman, P. Bultynck, **before the 15th of March 1999.** We expect an answer from all TMs and CMs. Additional opinions of other Devonian specialists, e.g. organized in national subcomissions, are welcomed to retrieve a broad background for the continuation of the discussion. If you have no opinion in some cases, please leave space open.

Name:

Address (to update our address file):

Country:

e-mail:

<u>Emsian Substages</u>

A. Preferred **substage names**:

Lower/Upper Emsian	yes	no
Zlichovian/Dalejan	yes	no
other name for lower substage	yes	no
	proposed name:	
Dalejan for upper substage	yes	no
other name for upper substage	proposed name:	
completely different proposals:		

B. Lower/Upper **substage boundary**

level near the entries of *Now. cancellata, Po. inversus, Po. laticostatus,* or *Gyro. gracilis*	yes	no
entry of *Now. richteri*	yes	no
other level:		

<u>Famennian Substages</u>

A. **Number of substages**

Three substages:		
Lower, Middle and Upper Famennian	yes	no
other substage names:		
Four substages:		
Lower, Middle, Upper, and Uppermost Famennian	yes	no
other substage names:		

B. Substage levels (you may give your opinion both for three and four substages)

Threefold division

base of Middle Famennian:

(e.g., base of *rhomboidea, marginifera*, or *velifer* Zone; other proposals)

base of Upper Famennian:

(e.g., base of *expansa* Zone; other proposal)

Fourfold division

base of Middle Famennian:

(e.g., base of *rhomboidea, marginifera*, or *velifer* Zone; other proposal)

base of Upper Famennian:

(e.g., base of *velifer* Zone, near *Annulata* Event level, or base of L. *expansa* Zone; other proposal)

base of Uppermost Famennian:

(e.g., base of Upper *expansa* Zone; other proposal)

Frasnian Substages

A. Three Substages yes no

different proposal:

B. Substage names

Lower, Middle, and Upper Frasnian yes no

different proposal:

C. Substage levels

base of middle substage:

base of *punctata* Zone (MN 5 zone) yes no

different proposal:

base of upper substage:

near "*semichatovae* transgression" yes no

near base of Lower Kellwasser Lst. (base do Iδ) yes no

different proposal:

I. U. G. S. SUBCOMMISSION ON DEVONIAN STRATIGRAPHY (SDS)
And
INTERNATIONAL GEOLOGICAL CORRELATION PROGRAM (IUGS/UNESCO) IGCP Project 421 :
North Gondwana Mid-Palaeozoic Bioevent/Biogeography Patterns in Relation to Crustal Dynamics

Under the Collaboration and Organization of:
The Scientific Institute of the Mohammed V University Rabat,
The Geological Direction of the Ministry of Energy and Mine,
The Faculty of Sciences and Techniques, Moulay Ismail University, Errachidia

SDS/IGCP 421 Morocco Meeting , 1999 - April 24th - May 3rd

FIRST CIRCULAR

The next international meeting of IGCP 421 will be held in connection with the SDS Annual meeting and will take place in Errachidia/Rabat, Morocco, on April 24th - May 3rd 1999. The field excursion connected with the joint meeting will focus primarily on Silurian to Early Carboniferous sequences in the Eastern Anti Atlas (Tafilalet and Maoder basins) and in the Moroccan Western Meseta, with special emphasis on Devonian sequences. This excursion will start at Errachidia and finish at Rabat. The opening ceremony and sessions are scheduled in the Faculty of Sciences and Techniques in Errachidia (500 km SE of Rabat).

PROGRAM:

Saturday April 24th

Arrival of participants to Errachidia.
Registration of the Participants
Night in Errachidia

Sunday April 25th

Opening ceremony and scientific sessions:
Night : in Errachidia
N.B. other scientific sessions can be arranged in Erfoud at the conference room after dinner. Otherwise this hotel have important spaces in the hall, that will allow to small groups to discuss comfortably.

PART I : The Atlas Anti (Tafilalet and Maider basins)

Monday 26th

8h00 Departure for the excursion. Eastern Tafilalet
The Boutchrafine section
The Hamar Lakhdad mud mounds
Guide: Coordinator Prof. BULTYNCK (Belgium)
Night : hotel El Ati (in Erfoud)

Tuesday 27th

Western Tafilalet or SE Maider (Mrakeb section)
The jbel Amelane section and/or The Mech Irdane section
The Mrakeb section
Guide: Coordinator Dr. Thomas BECKER (Berlin)
Night : hotel El Ati (in Erfoud)

Wednesday 28th

Erfoud - Msissi - Erfoud
The Jbel Issemour section.
Guide: Coordinator Dr. Eberhard SCHINDLER (Frankfurt)
Night : hotel El Ati (in Erfoud)

Thursday 29th

Journey crossing of the High Atlas : Erfoud-Khinifra
Night : Hotel Zayani in Khenifra

PART II : The north-western Meseta.

Friday 30th

The Mrirt sections
Guide: Coordinator Prof. Ahmed ELHASSANI (Rabat)
Night : Hotel Zayani (Khenifra)

Saturday May 1st

Khenifra- Oulmes
The Ziar section
The Moulay el Hassane section
Guide: Coordinator Prof. Abdelfatah TAHIRI (Rabat)
Night :Hotel des Thermes (in Oulmes)

Sunday May 2nd

Oulmhs - Rabat
The Rabat Tiflet zone
Tiflet area : the Tiflet river section. Eo-variscan conglomerates and Tournaisian transgression.
Rabat area : sections of the Bou Regreg. We shall show the Late Silurian and Lower Devonian, with Bohemian facies and fauna.
Guide: Coordinator Prof. Ahmed EL HASSANI (Rabat)
Night : hotel Terminus in Rabat.

REGISTRATION FEE: 8100 DH (= 900 $ at present exchange) Registration forms will be included with the second circular, which will be sent to all who respond to this first circular. The registration fee for participants covers admission to all scientific sessions, a guidebook copy, accommodations and participation to the excursion. N.B. Registration fees will be reduced for those who participate with their own car (exclusively 4WD). Details will be sending in the second circular.

ACCOMMODATION: Rabat and Oulmes are 3 stars hotels. Errachidia, Erfoud and Khenifra are 4 stars hotels
More details for the accommodation will be sent to all who respond to this first circular.

DEADLINES: Inscription to the meeting: January 10th 1999. Registration fee : March 10th 1999. Note: Places for the meeting and the excursion are limited. Registration after March 10th (10% extra), because hotels should be booked by the organizing committee early.

ORGANIZING COMMITTEE:
Leader : Prof. Ahmed EL HASSANI, Head of the Geological Department, Institut Scientifique RABAT
Co-Leaders: 1) Othmane FADIL, Head of the Geological Survey in Midelt Til and Fax : +212 5 58 21 63; 2) Abdellah EL MANSOUR, Vice Dyne of the Faculty of Sciences and Techniques, Errachidia. Fax: +212 5 57 44 84; Responsible of the excursion: Prof. Abdelfatah TAHIRI, Geological Department, Institut Scientifique, Rabat; Technical program: Dr. Lahcen BAIDER, Geological Department, Faculty of Sciences, Casablanca.

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Leader: Prof Ahmed ELHASSANI, Head of the Geological Department,
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REGISTRATION FORM FOR IGCP 421-SDS MEETING
Morocco, 1999

First name:
Surname:
Title:
Address:

(City)	(State)
(Post or Zip code)	(Country)

Phone: (office)	(home)

E-mail address:
Fax:

I will attend the IGCP421-SDS meeting in Morocco:	Yes	No
I will present a paper:	Yes	No
I will present a poster:	Yes	No
I intend to publish the paper (s) in the meeting volume:	Yes	No
I am interested in participating in the excursion:	Yes	No
I shall travel with my own car (4WD)	Yes	No

If YES please indicate :
1. Registration number of the car (if it's known),
2. Names of colleagues who are going to travel with you in the same car.

<u>This form should be returned as soon as possible (before January 10th 1999) to:</u>
Prof. Ahmed EL HASSANI
Institut Scientifique
B.P. 703 RABAT-AGDAL
10106 RABAT, MOROCCO

FAX: + 212 7 77 45 40
e-mail: hassani@emi.ac.ma

N. B. the Bank account Number for transferring registration fees will be provided in the second circular.

Second circular information for the field trips in South China

Adjustment of Fees

We have tried our best to minimize the expenses for the field trips as possible. The adjusted expenses for the field trips are:

1. Paleozoic to Triassic biostratigraphy in Guizhou Province, southwestern China

   Dates: August 31-September 6 (7 days)

   Cost: US$550.00

2. Stratigraphy and Paleobiology in Devonian reef complexes and Lower Carboniferous in Guilin, South China

   Dates: September 7-11(5 days)

   Cost: US$450.00

3. Field trips 1 + 2

   Dates: August 31-September 11 (12 days)

   Cost: UD$960.00

The payment will include access to the visit localities, a guidebook, the accommodations of stars-level hotel, all meals, traffic tools in the course of field excursions, etc; For the participants joining in the Field trips 1+2 the payment will include the fees for the inter-provincial traffic tool by overnight train or by flight.

Payment

Payment should be made only in US Dollar no later than 31 March 1999 by bank transfer to:

Bank of China

Nanjing Branch

Bai Zhi Ting Office

Account No.4447839-0188-004512-8

Account Name: HUI ZHEN YU

Cancellation

In case of cancellation, the cancellation charges are

On or before 31 march,1999 ················US$50

After 31 March ··························US$100

Refund will be made after deducting bank service charges and the above cancellation fees after the field trips.

Application form

Surname: Given name: Citizenship:
Sex: Date of Birth:
Participating

1 Field trip 1 Guizhou Province with payment of $
2 Field trip 2 Guilin with payment of $
3 Field trips 1 + 2 with payment of $

Please fill it and return to the following address no later than March 31 1999 (by the postmark)
Prof.Yu Chang Min
Nanjing Institute of Geology and Paleontology, Academia Sinica
No.39 Beijing Dong Road
210008 Nanjing, China
E-mail: yucm@jlonline.com (not yucm@njnet.nj.ac.cn as mentioned in the information from Sendai)

The third circular information will be issued and sent only to the participants who have returned the application form and notice of the bank receipt.

Minutes for the German SDS

The yearly meeting of the German SDS took place at the Senckenberg Museum in Frankfurt on February, 14 with 31 members and two guests being present. Brief comments are given on those topics not dealing exclusively with commission affairs. Main topics have been the working groups for the subdivision of the Emsian stage (coordinated by Ulrich Jansen, Frankfurt) and for the subdivision of the Late Devonian stages, namely the Famennian (coordinated by Matthias Piecha, Krefeld); addresses of the coordinators and further informations see previous SDS Newsletters. Details can also be obtained from the contributions to the SDS meeting in Bologna, elsewhere in this newsletter.

The members of the working group for the Emsian subdivision gathered in Göttingen on May, 11, 1998 for a 'theory meeting' where future activities have been proposed and discussed. Besides notes for the Bologna meeting, two excursions have been considered in detail; one on a national scale and an international field trip of a selected number of participants. The first has already been undertaken to some of the classical localities of the German neritic facies in the Rhein-Mosel area of the Rhein. Schiefergebirge. In cooperation with the Spanish colleagues from Oviedo (namely TM Jenaro Garcia-Alcalde), a small group (Carls, Jahnke, Jansen) will visit Emsian sections in the Cantabrian Mountains with its intermediate neritic/pelagic facies (planned for 1999). A similar trip to the sections of the classical pelagic Barrandian area is under discussion with the Czech colleagues.

The working group for the subdivision of the Late Devonian stages met two times in the field. During the first meeting in the Thüringisches Schiefergebirge on May 16 and 17, 1998, classical sections of this area have been visited. As one of these localities "won" new sections due to active quarrying (Kahlleite E Quarry, SW of Rödersdorf near Schleiz), detailed research will be arranged on the whole Upper Devonian sequence, present in hemipelagic to pelagic cephalopod limestone facies. The second field meeting has been held in the Harz Mountains on October 24 and 25, 1998. Late Devonian sections of different facies (siliciclastic basinal, condensed cephalopod limestones on submarine rises as well as turbiditic 'Flinz' facies with reworked material present) have been visited and vividly discussed. The sections are located in both parts (E and W) of the Harz Mountains; among them the type locality for the widely distributed 'Kellwasser Limestone' situated in the Kellwasser valley close to Altenau in the Northwestern Harz Mountains.

Briefly, I want to give some short notes on other matters: Sorry to say that about the bentonites, mentioned in the SDS Newsletter No. 14, which have been sent to dating labs, we can not yet tell anything due to lacking data. The new (and substancially expanded) issue of the 'Devonian Correlation Chart' (Devon-Korrelationstabelle, DK) is published in volume 77 of the Senckenbergiana lethaea (1998). Requests should be directed to TM Karsten Weddige. Finally I want to mention that members of the German SDS have been present numerously and very active in discussions of SDS matters and joint IGCP 421 affairs and contributions at the joint meeting of the IGCP 421 and SDS held together with the ECOS VII Conodont Symposium at the universities of Bologna and Modena (Italy).

For addresses, phone/fax numbers, and e-mail addresses of mentioned persons see previous SDS Newsletters.

Eberhard Schindler (Frankfurt)

DOCUMENT SUBMITTED TO THE INTERNATIONAL SUBCOMMISSION ON DEVONIAN STRATIGRAPHY
Annual Meeting at Bologna, 1998

PROSPECTS FOR AN INTERNATIONAL SUBSTAGE SUBDIVISION OF THE FAMENNIAN

R. Thomas Becker (Berlin)

Introduction

Most of the Famennian succession in the Belgium type area consists of shallowwater deposits with predominantly neritic or poor faunas. Conodont faunas are often sparse, and to a large extent they represent nearshore, peritidal or even restricted marine biofacies (Dreesen et al., 1986) with partly regional signatures. Ammonoids are restricted to very few faunal levels and localities. This limits the potential of the classical area for the establishment of substages that can be correlated internationally. In addition, the former Strunian stage has been incorporated by SDS into the Famennian and, as a consequence, the classical subdivision into a Lower Famennian (Fa 1, Pa. *triangularis* and *crepida* Zones, Famenne Shales) and an Upper Famennian (Fa 2, *rhomboidea* to parts of the expansa Zone, Condroz Sandstone Group; see Thorez & Dreesen, 1986) cannot be transferred easily to the Famennian of current international usage. This may require somewhat confusing changes to the meaning of terms which are entrenched in the Belgian literature. If, for example, the Strunian is redefined in the future as the Upper Famennian substage (currently Uppermost Famennian; e.g., Conil et al., 1986), readers must realize that there has been a complete change in the timespans associated with the term before and after an assumed formal recognition (see Sartenaer, 1997). SDS must either accept such alterations of the undestanding of the Lower and Upper Famennian as chronostratigraphic units in the type region or should choose new names free of potential misunderstanding.

Generally, it is recommended that preference is given to subdivisions in pelagic successions which have the best potential for world-wide correlation. Historically, the first pelagic Famennian sequences that were studied in detail, and which were given regional stage names, were the basinal shale and cephalopod limestone sequences of the Rhenish Massif and Thuringia. Moreover, the German "Oberdevonstufen", based on ammonoids, have been succesfully applied to other widely seperated regions such as Devon and Cornwall (House, 1963), the Carnic Alps (Gaertner, 1931), North Africa (e.g., Petter, 1959, 1960), former Soviet Union (e.g., Bogoslovskiy, 1971, 1981) and Western Australia (Teichert, 1949; Petersen, 1975). Ruan (1978) compiled evidence that correlation with Chinese pelagic successions is also possible.

The terms Strunian and Etroeungt have been used widely and internationally in a chronostratigraphic sense for late Famennian deposits (Sartenaer, 1997). However, definitions of authors differed significantly, may be vague, and there is still limited information about the conodont age of the Strunian base in sections of the type region and in other basins where the name has been applied (Milhau et al., 1997). According to Dreesen et al. (1993) and Maziane & Vanguestaine (1997), the shaly Strunian (s.l.) base at Chanxhe falls in the Upper *expansa* Zone (top Lower to basal Middle *costatus* Zone). This level correlates roughly with the base of the *Wocklumeria*-Stufe (Upper Devonian VI) of the eastern Rhenish Massif (Korn & Luppold, 1987; Becker in Weddige, 1997). The "Strunian Transgression", therefore, postdates by far the base of depophase IIf of Johnson et al. (1985). A substage boundary at this position would leave a rather short period for an upper substage. The typical biostromal Strunian (Calcaire d'Etroeungt s.s.) is even younger (*?praesulcata* Zone; Milhau et al., 1997).

It seems more desirable to divide the Famennian into periods of about equal length. This, however, is not necessarily indicated by the number of conodont zones as suggested by Sandberg & Ziegler (1996) and Ziegler & Sandberg (1997). House (1995), for example, has provided good evidence for large differences in zone durations in the Middle Devonian. Anyway, the author does not favour the recognition of the Strunian as an international substage. This should not discourage others from establishing more precise definitions of it as a regional stage in order to improve correlations with other terminal Devonian shallow-water regions.

Historical subdivision of the German Famennian

In the last century, Kayser (1873) first provided detailed evidence that (cheiloceratid) faunas from the famous "Nehden-Schiefer" differ from those of the goniatite shales of Budesheim in the Eifel Mountains. Consequently, he established a subdivision of the upper part of the Upper Devonian (now Famennian) with the Nehden fauna followed by faunas with clymenids. Frech (1887) recognized the Nehden faunal level as the middle part of the Upper Devonian ("Stufe des *Goniatites curvispina*", "mittleres Oberdevon") below his "Clymenien-Stufe". Later, Denckmann & Lotz (1900) and Frech (1902) separated two successive clymenid levels, a lower level with platyclymenids, and an upper level with *Cl. laevigata* and gonioclymenids. At the turn of the century, therefore, a threefold subdivision of Famennian strata, as currently envisaged by SDS, was already proposed for pelagic successions. Later it became clear (review in Becker, 1993) that two distinctive faunal overturns, the extinction of cheiloceratid and of platyclymenid faunas separate the three levels at a global scale giving two "natural boundaries" which are here proposed for future substage definition.

Already Denckmann (1901) introduced a further refinement of the ammonoid stratigraphy and distinguished faunas with cheiloceratids, *Goniatites* [now *Prolobites*] *delphinus*, *Cl.* [now *Platyclymenia*) *annulata*, the Dasberg Limestone with *Cl. laevigata*, and the Wocklum Limestone with *Cl.* [now *Kalloclymenia] subarmata*. Frech (1902) included *Pseudoclymenia* faunas in his lower part of clymenid limestones with platyclymenids and prolobitids. This formed the background when Wedekind (1908, 1913, 1914) both erected the principle Upper Devonian ammonoid zonation and an ammonoid "Stufen" (=

stage) succession (Upper Devonian I-VI) which was correlated with lithostratigraphic units. Stufen 11 (Cheilocerasstufe) and III (Prolobitesstufe) were part of the Enkeberg Limestone, Stufe IV was represented by the *Annulata* Limestone, Stufe V (Gonioclymenienstufe) equaled the Dasberg Limestone, and Stufe VI corresponded to the Wocklum Limestone. The basinal "Fossley" facies was not yet recognized as a lateral deeper-water equivalent of the fossiliferous cephalopod limestones. The original tripartite Famennian gave way to five biostratigraphic units. Based on faunal similarities, however, Schmidt (1924) not only combined Stufen III and IV in a single *Platyclymenia*-Stufe, he also merged Stufen V and VI, re-establishing a threefold upper part of the Upper Devonian.

Schmidt (1924) also correlated his ammonoid zones and stufen with partly new lithostratigraphical units: the *Cheiloceras* Stufe with the Nehden Beds ("Schichten"), the *Platyclymenia* Stufe with his Hemberg Beds, and the *Gonioclymenia* Stufe with the Dasberg Beds (including the Wocklum Beds). The base of the Dasberg Beds was drawn above a black shale marker unit representing a regional and global hypoxic event (Becker, 1992), the "*Annulata*-Schiefer". Without precise definition and selection of type sections for these formations (see Ziegler & Sandberg, 1997), the Prussian Geological Survey turned these lithostratigraphical units into five regional chronostratigraphical stages: Adorf-, Nehden-, Hemberg-, Dasberg- and Wocklum-Stufe (Matern, 1929, 1931). These were thought to equal Wedekind's ammonoid Stufen I to VI and were used widely in German post-war literature. However, in the meantime (e.g., House & Ziegler, 1977; Becker, 1992) it has become clear that lithological boundaries mostly do not coincide with stufen boundaries and it remains open whether a revision of the regional chronostratigraphical stages (Stufen) should follow the ammonoid biostratigraphy (ammonoid StUfen I to VI) or the lithostratigraphical units bearing identical names as the stages. For example, the *Annulata*-Schiefer is now known to lie at the base of Stufe IV (Kom & Luppold, 1987), not at the top of the *Platyclymenia* Stufe (Paproth, 1986: Tab. 4), which assigns a large part of the Dasberg Beds to the Hembergian (Becker, 1992, 1993a) if the common equation of the Hemberg- and *Platyclymenia*-Stufe (Stufen III-IV) is followed.

Proposed substage boundary names and levels

Conflicts between German lithostratigraphical, biostratigraphical and chronostratigraphical terminologies currently do not support their use as names for international Famennian substages. Revision by the German SDS, however, is underway.

Despite the potential of misunderstanding reading old and future Belgian geological literature, it is proposed to recognize Lower, Middle and Upper Famennian as future substage names. The Strunian should be kept as a defined regional term for the uppermost part of the Famennian in the Ardennes. Future substage definitions should distinguish periods of roughly equal duration and should be based on sequences with rich pelagic faunas that allow easy long distance correlation. Stratotype decisions, however, should await correlation with shallow-water successions.

It is proposed to follow the classical three-fold division of the upper part of the Upper Devonian of the German pelagic (ammonoid) sequence whose subdivision has been successfully applied on a world-wide scale. Substage definitions, of course, should concentrate on the most useful fossil groups such as conodonts, ammonoids, miospores and ostracods.

The significance of major eustatic changes for potential subdivision (Ziegler & Sandberg, 1997) is acknowledged but problems arising from associated facies changes and faunal discontinuities have to be considered. The same applies to short-termed hypoxic incursions such as the *Annulata* Event which, anyway, is not in an appropiate stratigraphic position.

The boundary between Lower and Middle Famennian substages should approximate to the classical boundary between the Upper Devonian II and III. Becker (1993b) discussed the originally vague definition of Stufe III and showed that only Lange (1929) defined a precise base in the Enkeberg section. His placing is not in conflict with the later understanding of other authors and, therefore, should be accepted. Both in the Rhenish Massif (Becker, 1993b) and in the Canning Basin (Becker & House, 1997), *Pemoceras* and *Protomoceras* spread slightly below the entry of *Scaphignathus velifer* In conodont terms, the base of the old velifer Zone (now Uppermost or Latest marginifera Zone) seems an acceptable level. The base of the (Lower = Early) *marginifera* Zone, as proposed by Ziegler & Sandberg (1997), lies much too low in the succession and falls in Germany, Morocco and Western Australia in the top part of the classical Upper Devonian IIa (Becker, 1993b; Becker & House, 1997). The main phase of an international eustatic rise, marked by the spread of early sporadoceratids (base of the classical 119), does not coincide with the base of the *marginifera Zone* but correlates with a level within the lower zone part.

The boundary between Middle and Upper Famennian substages should approximate to the faunal overturn and extinctions between the Upper Devonian IV and V. Unfortunately, the ammonoid zonation of this boundary interval still needs further revision (Becker, 1993a) and the extinction of platyclymenid faunas is still insufficiently documented. In Southern Morocco, there is a clear faunal break between the fossiliferous *Sporadoceras orbiculare* Marker Bed (with last *Platyclymenia)* and subsequent limestones with mass occurences of *Cl. laevigata, Cymaclymenia striata,* "imitoceratids" and kosmoclymenids. In Germany, faunas from the *Franconiclymenia serpentina* Zone need further investigation. In conodont terms, the faunal overturn took place within the Lower (Early) *expansa* Zone (Upper *styriacus* Zone; Kom & Luppold, 1987). Therefore, the base of the *expansa* Zone, as proposed by Ziegler & Sandberg (1997), may represent an acceptable level. However, it is suggested that the conodont succession is further revised in order to find .and test more detailed conodont sequences and to search for possible alternatives that can be widely correlated and which fit closely the entry of typical Stufe V ammonoids such as *Cl. laevigata,* early gonioclymenids and kosmoclymenids.

Potential stratotype regions and sections

Despite the overall regressive trend of long parts of the stage, fossiliferous Famennian pelagic sequences have been described from many regions: Rhenish Massif, Harz Mountains, Thuringia, Saxony, Holy Cross Mountains, South Devon, Carnic Alps, Montagne Noire, Pyrenees, Cantabrian Mountains, Southern Morocco, Algeria, Mugodzhar Mountains, Urals, Novaya Zemlya, Kazakhstan, South China (Guizhou), Northern China (Great Khingan), and Western Australia. All these regions have potential type sections. However, some regions (e.g., Pyrenees, Urals, Novaya Zemlya, Taimyr, Great Khingan) are still poorly studied and others (Algeria, Novaya Zemlya) are currently rather inaccessible. Regions such as the Holy Cross Mountains and SW England do not have good permanent outcrops. This diminishes the number of potential areas.

Fossiliferous prime candidates for the definition of the base of the Middle Famennian, at a level proposed here, are currently as follows (the list may be incomplete):

Rhenish Massif: Beringhausener Tunnel section (Clausen et al., 1991; Becker, 1993b), Burgberg (Stritzke, 1989), possibly more basinal section such as the Nie Brickwork Quarry (e.g., Becker & Schreiber, 1994).

Southern Morocco: Bou Tchrafine, Hamar Laghdad (Becker, 1993b), Rich Bou Kourazia (Becker, 1995).

Western Australia: Casey Falls (Becker & House, 1997), "Straight Gully".

An Upper Famennian base (as proposed here) could perhaps be defined at the following places:

Rhenish Massif: Effenberg Quarry (Korn & Luppold, 1987), Kattensiepen Quarry (Korn & Luppold, 1987); more basinal sections such Reitenberg (Becker, 1992) and Oese (Paproth & Streel, 1982). Problems arise from the fact that quarries are still in work and sections might not be preserved.

Thuringia: rather basinal sections such as the Bohlen (Schindewolf, 1952) and Kahlleite-East Quarry (Bartzsch et al., 1995).

Cantabrian Mountains: Horcada del Oro (Montesinos & Arbizu, 1987).

Carnic Alps and Montagne Noire: potential not yet fully exploited.

Southern Morocco: Bou Tchrafine, Hamar Laghdad, Ouidane Chebbi, Jebel Erfoud, Mrakeb (Becker, 1993b, 1995, unpublished data).

Mugodzhar Mountains (Kazakhstan): Kia River Section (Simakov et al., 1983).

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PROPOSALS FOR AN INTERNATIONAL SUBSTAGE SUBDIVISION OF THE FRASNIAN

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Introduction

Due to the global sealevel maximum of the Frasnian (House, 1983; Johnson et al., 1985), outer shelf sediments with pelagic faunal elements have a wider distribution than in any other part of the Devonian system. This, and the associated decline of endemism, should make the Frasnian the best Devonian stage for precise interbasinal correlation and should provide good opportunities for international stage subdivisions. However, as a consequence of the new definition of the Middle/Upper Devonian boundary by SDS (Klapper et al., 1987), classical subdivisions into lower, middle and upper parts cannot be transferred easily. This applies both to the Belgian type area and to other areas of long research such as Germany and eastern North America. In the current literature, terms such as Lower and Upper Frasnian are used without any precision, are subjective, and usages differ widely. We, therefore, will review briefly common past usages, identify suitable faunal and sequential levels, recommend potential stratotype regions, and propose levels that should be considered for a three-fold stage subdivision. Ultimately, we hope that a rigid substage definition will aid future identifications of evolutionary, tectonic, paleobiogeographic and paleoceanographic trends within the Frasnian on a world-wide scale. This will require serious improvements of pelagic-neritic and marine-nonmarine correlations.

Classical Frasnian Subdivisions

Belgium

In the Belgian type area, the base of the Frasnian historically has been placed in different positions, but the majority of authors (House, 1982) used the base of the Assisse de Frommelennes rather than the Assisse de Frasnes. The F1 to F3 divisions, widely applied until recent time, go back to this understanding and gave a classical tripartition. By redefinition of the Middle/Upper Devonian series boundary, the base of the Frasnian now lies close to the base of the F2a or of the Nismes Formation (e.g., Bultynck et al., 1987), and F1 is relegated to the Givetian. There is no current agreement about the range of a Lower Frasnian or a Middle Frasnian. Tsien (1989), for example, even gave up a Frasnian tripartition and employed only Early and Late Frasnian divisions with a boundary at the base of the poorly-defined *Ancyrognathus triangularis* Zone. The F3 or Matagne Shales and equivalents have always been assigned to the "Frasnien superieur' but the lower boundary of the formation is not isochronous in different regions (e.g., Helsen & Bultynck, 1992; Bultynck et al., 1988). Therefore, there is no precise agreement on the definition of the F3 or of an Upper Frasnian. Gatley (1983) provided evidence that *Archoceras*, the indicator of UD II-K (Becker et al., 1993), enters near the base of the Matagne Formation. This is in accordance with oldest conodont faunas suggesting a Lower Kellwasser age for the initial Matagne transgression. In summary, the Frasnian of the type area does not give clear evidence for international definition and the terms Lower, Middle and Upper Frasnian seem not to be endued with common historical understanding.

Germany

Kayser (1873) regarded the unusually multilobed *Goniatites* [now *Synpharciceras*] *clavilobus* as a faunal element of the upper Middle Devonian, and the overlying lower part of the Upper Devonian was named as "Intumescensstufe", following the widespread occurrence of *Goniatites* [now *Manticoceras] intumescens*. Frech (1887, 1988) recognized the significance of a level with multilobate "Devonian prolecanitids" (now pharciceratids) in the German pelagic sequences and placed it at the base of the Upper Devonian. This was subsequently confirmed by Denckmann (1900, 1901, 1903) who mostly studied more basinal, shaly successions in the northern Rhenish Massif. Wedekind's (1913) classic goniatite zonation of the lower Upper Devonian (Manticocerasstufe or Oberdevonstufe 1) included three zones above the Pharcicerraszone (Ia), characterized by *Gephyroceras* [now *Costamanticoceras*] *nodulosum* (IB), *Manticoceras cordatum* and *Mant. carinatum* (Iy), and by *Crickites holzapfeli and Mant.* [now *?Sphaeromanticoceras*] *crassum* (15, including and ending with the Upper Kellwasser Limestone). Just below *Crick. holzapfeli*, and in the Lower Kellwasser Limestone of some localities (Martenberg, Beul), a fauna with *Mant. adorfense* was found which (Wedekind, 1913: p. 31) was loosely attached to 18 or said (p. 55) to have been found "above Iy". Apart from pharciceratids and pseudoprobeloceratids (following redefinition of the Frasnian base now typical late Givetian groups), Wedekind regarded the following species as characteristic representatives of Ia (taxonomy updated): *Sandbergeroceras costatum, Koenenites lamellosus, Koen. sublamellosus, Hoeninghausia hoeninghausi* (Archiac & d'Verneuil) [= *Hoen.* archiaci Gurich, non *Koen hoeninghausi* (v. Buch)], Pont. aequabile, *Acanthoclymenia forcipifera, Acantho. planorbe,* ?Gen. nov. *triphyllus, Timanites keyserlingi* (= acutus Keyserling non Munster). Most of these species have since been recorded from or are likely to have come from the lower part of Frasnian strata. Only *Acantho. forcipifera* was recorded very rarely from the higher, main part of the Frasnian. Wedekind (1918) added *Pont kayseri* and *Epitornoceras mithracoides* from Ia. Without explanation, *Mant. adorfense* was assigned to zone Iy.

Matern (1929, 1931) tried to revise Wedekind's zonation and did not accept the distinction between III and Iy, creating a combined to I(B)y. He also added records of *Manticoceras* [now *Archoceras*] *bickense* from the Lower Kellwasser Limestone but due to the lack of *Crickites*, the latter was regarded as the top part of I(B)y. His chronostratigraphic Adorf-Stufe, an abstraction from the lithostratigraphic term Adorf Limestone in conjunction with the biostratigratigraphically defined *Manticoceras*-Stufe, had a clear tripartition which became widely accepted in subsequent German literature. Rabien (1954), for example, used it in his classic ostracod monograph. The Middle Adorf-Stufe was correlated with the base of the cicatricosa Zone whilst, following Matern (1931), the base of the Upper Adorf-Stufe was drawn above the Lower Kellwasser level (*cicatricosa/materni* Interregnum; see also Schindler, 1990). The German Adorf-Stufen division and ammonoid zonation was also succesfully transferred to other widely separate regions such as North America (House, 1960), SW England (House, 1963), and, partly, to former Soviet Union (Bogoslovskiy, 1969) and South China (Ruan, 1978). This system forms the oldest precise Frasnian threefold division with international application and should be seriously considered for formal substage definition.

In more recent years, House & Ziegler (1977) have re-established Wedekind's (1913) separation of III and Iy. A much refined ammonoid zonation (Becker et al., 1993; House & Kirchgasser, 1993) with twelve international zones has replaced Wedekind's succession. It has been shown that nearly all the lower half of the Frasnian is very poorly represented by goniatite faunas in Germany; proper ammonoid sections are lacking now completely. Also, and rather unfortunately, the definition of the base of the Upper Devonian by SDS has pushed most of the classical Ia (*Pharciceras* Stufe of House, 1985) into the Givetian leaving no clear understanding on the use of a Lower *Manticoceras*- *or* Lower Adorf-Stufe. Becker (1986), therefore, proposed to include all those faunal levels left in the Frasnian which are characterized by former typical Ia goniatites (especially members of the Koenenitidae) in a "Lower. Frasnian". The Upper Frasnian was used by Becker (1993) in the sense of Wedekind's (1913) vague understanding of 18, which is the interval from the base of the Lower Kellwasser Limestone (base of UD I-K, characterized by the spread of Archoceras and with *Mant. adorfense*) to the top of the Upper Kellwasser Limestone (UD I-L with crickitids). It should be noted that this closely correlates with the maximum extent of the Belgian F3 interval and with the extented Kellwasser Crisis of Schindler (1990).

North America

The well-studied Frasnian of eastern North America was divided in the last century more into facies realms .(Naples, Portage and Chemung) rather than into clear successive bio- and lithostratigraphical units. This problem was addressed by the famous paper of Chadwick (1935), and subsequently, a detailed picture of clastic wedges with intercalated transgressive, black shale tongues emerged (Rickard, 1975) which was recently summarized by House & Kirchgasser (1993). Traditionally, and until 1942 without disagreement (House, 1982), the base of the Upper Devonian was placed in North America at the base of the Tully Limestone which correlates well with the base of the Belgian Assisse de Frommelennes. With the new SDS definition, the series boundary now lies within the Genesee Group, near the base of the Penn Yan Shale and just above the Lodi Limestone. Currently, the New York Frasnian comprises three divisions: the remaining upper half of the Genesee Group, the Sonyea Group (Middlesex and Cashaqua Shales), and the West Falls Group whose top seems to correlate precisely with the Frasnian

Famennian boundary (Over & Reynolds, 1997). The group boundaries might be considered as potential substage levels. However, the base of the Rhinestreet Shale, marking a eustatic deepening at the base of the West River Group, lies roughly (according to conodont and ammonoid zones) in the middle part of the Frasnian and would create a rather extended upper division that includes much of the vaguely defined middle stage parts of most other regions. The North American tripartition, at least the highest group boundary, is difficult to recommend for, international substage definition.

Proposal for the definition of the Middle Frasnian

Classical pelagic to hemipelagic sequences of both Germany and New York offer a possible level for a base of the Middle Frasnian which agrees with classical ammonoid biostratigraphy, lithostratigraphy and a global eustatic pulse that should allow easy international recognition and correlation: the base of Zone 5 (Klapper, 1989) or of the *punctata* Zone.

Characteristic Ia goniatites such as most Koenenitidae *(Koenenites, Hoeninghausia, Timanites)* disappear in North America (House & Kirchgasser, 1993), the Timan (House et al., in prep.) and in NW Australia (Becker et al., 1993) near the end of Zone *4 (transitans* Zone) and this global smallscale exctinction (initial phase of the Middlesex Event; "Domanik Crisis" of Kuz'min et al., 1997) provides us with an excellent marker that follows the tradition of Wedekind (1913, 1918). Only *Sandbergeroceras* ranges into much younger beds (House & Kirchgasser, 1993; Becker et al., 1997a) but it is likely that only the pharciceratoid sutures and shell form of the genus led to its former inclusion in la lists. No *Sandbergeroceras* has yet been recorded together with typical Koenenitidae. More data are needed to document the ammonoid faunal changes associated with the koenenitid extinction around the transition from UD I-C to I-D.

In eastern North America, the Middlesex Shale marks the base of the Sonyea Group and this transgressive pulse has been used to define T-R-Cycle IIc of Johnson et al. (1985). There is still uncertainty about the age of the basal Middlesex Shale in conodont terms but more detailed work is under way. (J. Over, oral comm.). In the Timan, the same level seems to be represented by the Domanik deepening (Kuz'min et al., 1997; House et al., in prep.) and in NW Australia there is a similar spread of hypoxia (Becker et al., 1993; Becker & House, 1997) with rich haematized faunas. The eustatic pulse has been noted in Canada (Johnson et al., 1985), western North America (Johnson & Sandberg, 1989), Morocco (Becker et al., 1997a), Pomerania (Matyja, 1993), and in South China (e.g., Ji et al., 1992; Shen, 1995). In the Belgian type area, the development of the Arche Reefs is associated with the same global sealevel rise. In the boreal Amazon Basin of South America, black shales which transgressed over a paraconformity have been roughly correlated with the beginning of depophase IIc (Loboziak et al., 1996). If the base of the punctata Zone is accepted for subdivision, it will be important to sort out sedimentary effects such as condensations and gaps which are commonly formed during rapid sealevel rise.

Proposals for the definition of the Upper Frasnian

Depending on -whether preference is given to the classical German subdivision or to a more equal stage subdivision, two alternative levels are available and perhaps both should be studied in more detail before a choice is made. Classical German biostratigraphy as outlined above, suggests as a potential base of the Upper Frasnian levels near the Lower Kellwasser level, and the base of the latter is proposed here. Ostracod workers have drawn the base of the Upper Adorf-Stufe only slightly higher (Rabien, 1954). Equivalents of the Lower Kellwasser Limestone have enormous international distribution (Schindler, 1990, Becker & House, 1994) and in areas lacking hypoxic facies (e.g., Australia, Timan), the level can perhaps be identified as a transgressive pulse. In the old conodont terminology, such a base of the Upper Frasnian would correspond with the base of the Upper gigas Zone which is slightly above the base of the Late *rhenana* Zone sensu Ziegler & Sandberg (1990). At the Coumiac stratotype (Klapper et al., 1993) and other sections (e.g., Martenberg), Pa. *bogartensis (= rotunda),* the defining conodont of Zone 13 of Klapper (1989), enters above the Lower Kellwasser Limestone. In other sections (e.g., Bine Jebilet, Southern Morocco; Schmidt Quarry, Ziegler & Sandberg, 1990), it was found in the upper part of the latter. Conodont distributions may have been affected by biofacies changes associated with the Lower Kellwasser Event. This emphasizes the necessity of very precise studies and documentation before decisions are made. As mentioned above, the Lower Kellwasser Limestone contains in places marker goniatites of zone I-K (Wedekind, 1913; Matern, 1931).

An alternative that differs significantly from the classical German subdivision of the Adorf-Stufe was proposed by Ziegler & Sandberg (1997): the *semichatovae* Transgression. Its advantages lie in the fact that it seems to split off an Upper Frasnian part that has a similar duration as the lower two divisions as proposed here. Sandberg et al. (1992) have documented a transgressive episode leading to the spread of *Pa. semichatovae* in the Belgian type area, where it is linked with the drowning of F2h (Lion) reefs. Johnson & Sandberg (1989) earlier showed the same sealevel rise and an incursion of palmatolepids in shallow-water successions in western North America (see also Johnson & Klapper, 1992).

The relations between the *semichatovae* Transgression and the base of T-R-Cycle IId of Johnson et al. (1985), unfortunately, are complicated. These authors defined Cycle IId both by the base of the West River Group as well as by the base of Kellwasser Limestones and by the base of the Matagne Shales. Thus the original derfinition was exceedingly ambiguous. The base of the Rhinestreet significantly predates the entry level of *Pa. semichatovae* and is dated as top part of Zone 6 (House & Kirchgasser, 1993). The Belgian *semichatovae* level is well below the base of the Matagne Shale (Sandberg et al., 1992) which mostly belongs to Zone 13 (Bultynck et al., 1998). As a consequence, the understanding of T-R-Cycle IId has differed widely between authors (e.g., Becker, 1993: base of Lower Kellwasser level; Johnson & Klapper, 1992: base of Zone 9). A precise revision of the IId definition is needed and should involve a re-evaluation of faunas from Sweetland Creek (oral comm. G. Klapper).

Regardless of such revision, the *semichatovae* Transgression can be recognized internationally. It seems to correlate with the Syrachoi and Lyaiol (Member II), deepening of the Timan (House et al., in prep.), possibly with a short-termed hypoxic pulse of Kellwasser-type beds in S-Morocco (Becker et al., 1997a), and with transgressive cephalopod limestones yielding UID II-I1 goniatites of the Canning Basin (Becker & House, 1997). Wang (1994) documented in South China (Guilin area, Guangxi) the incoming of *Pa. semichatovae* near a facies change at the base of the Liujiang Formation. Problematic is the current correlation of the Belgian (and international) entry of *Pa. semichatovae* with the Early *rhenana* Zone of the so-called standard zonation of Ziegler & Sandberg (1990). Faunas from Martenberg and the main Lion acces road show that the Belgian *Pa. semichatovae*, dated as Early *rhenana* Zone (Sandberg et al., 1992), are accompanied by typical Zone 11 conodonts (Klapper & Becker, 1998 in press) whilst the base of the Early *rhenana* Zone at the Martenberg type section clearly falls in Zone 12. In other words, the *semichatovae* level projects to a position below the base of the Early *rhenana* Zone in the type section, where it can probably be correlated with solid limestones assigned to the *jamieae* Zone. This is supported by the dating of Pa. semichatovae faunas from the Timan as Zone 11 (Klapper et al., 1996) and by data from Western Australia (G. Klapper, pers. comm.). It is also important to note that there is a significant facies break within the basal part of the limestone (Bed q; Ziegler, 1971) which yielded Zone 11 conodonts (*jamieae* Zone) at Martenberg. Crinoidal limestones with sheet cracks indicating a discontinuity surface are overlain by micrites with goniatite mass occurences forming the main part of the bed. Similar transgression of Zone 11 (or *jamieae* Zone) micrites over unconformities are known from other condensed German seamount sections (Schrickel, 1988; Huneke, 1995).

In summary, the entry of *Pa. semichatovae* should be seriously considered as a level for the definition of the base of an Upper Frasnian substage, but conflicting conodont data, partly hidden in different taxonomic concepts, need to be resolved. The base of the *jamieae* Zone and of Zone 11 sensu Klapper (1989) should be included in the investigation of the critical timespan. Both *Pa. semichatovae* and *Pa. jamieae* are currently affected by some taxonomic problems. It also has to be emphasized that the semichatovae level correlates roughly with the base of ammonoid genozone 1-1 (Becker et al., 1993; Becker & House, 1997) which would transfer nearly all classical (not only German) Iy ammonoids, as well as a large part of ostracod and brachiopod faunas of the Middle Adorf-Stufe into a new Upper Frasnian.

Potential Stratotype Regions and Sections

Since Frasnian pelagic to hemipelagic sequences are so widespread, only selected sections will be recommended here which appear to have a good conodont, ammonoid or other faunal record. This list is, of course, somewhat biased, partly by personal experience, and incomplete. It is only meant to suggest areas and sections for further study and does not necessarily mean that all localities can eventually be shown to be suitable as stratotype sections. Knowledge of large areas such as the former Soviet Union, Middle Asia, Central Asia and SW Asia, is still so limited, at least on a bed-by-bed basis, that no sections are currently included. It is hoped that formal substage subdivision will encourage work in neglected regions. Other important Frasnian basins and basin parts such as in Spanish Sahara, Algeria, in the Kaukasus, Afghanistan and Arctic Russia are currently rather inaccessible.

Basal Middle Frasnian: punctata *Boundary*

Rhenish Massif: Burgberg (Stritzke, 1991).

Montagne Noire: Col de Puech de la Suque (House et al., 1985; Klapper, 1989), La Serre, trenches A and D (Feist & Klapper, 1985; Klapper, 1989).

Timan: Chut River (House et al., in prep.)

Southern Morocco: Hassi Nebech (Bensaid et al., 1985), Ouidane Chebbi (unpublished).

South China: Licun Section (Ji et al., 1992)

Basal Upper Frasnian 1: Semichatovae *Transgression (base Zone 11)*

Rhenish Massif: Beringhausener Tunnel (Clausen et al., 1991), Martenberg (House & Ziegler, 1977; Ziegler & Sandberg, 1990).

Belgium: Lion Access Road (Sandberg et al., 1992).

South China: Duongcun Section, Guangxi (Wang, 1994).

NW Australia: Horse Spring (Becker et al., 1993; Klapper, unpublished)

Basal Upper Frasnian: II: Lower Kellwasser Boundary

Rhenish Massif: Beringhausener Tunnel (Clausen et al., 1991), Schmidt Quarry (Schindler, 1990), Benner Quarry (Schindler, 1990), Silbecke-East (Schrickel, 1988; Klapper, unpublished). Harz Mountains: Huhnertal (Schindler, 1990).

Belgium: Nismes Section (Helsen & Bultynck, 1992), ?others described in Bultynck et al. (in press)

Montagne Noire: Upper Coumiac Quarry (Klapper, 1989; Klapper et al., 1993; Becker & House, 1994), Causses et Veyran S (Becker & House, 1994), La Serre C (Schindler, 1990).

Moroccan Meseta: Gara d'Mrirt (Lazreq, 1992; Becker et al., 1997b).

Nevada: Devils Gate (Ziegler & Sandberg, 1990).

South China- Longmen and Sihongshan Sections (Wang & Ziegler, 1985; Wang, 1994), Lali Section (Ji & Ziegler, 1993), probably some others.

NW Australia: Horse Spring (Becker et al., 1993), "Windy Knolls" (unpublished).

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Table 1: Late Givetian to Frasnian correlation of ammonoid and conodont zones with some classical regional subdivisions, the timing of eustatic pulses, and the position of proposed substage boundary levels. Shaded areas indicate intervals to be investigated in detail. The terminology of "standard" conodont zones of Ziegler & Sandberg (1990) is changed from Early and Late into Lower and Upper as in the current Givetian conodont scale. The correlation of Frasnian conodont zones follows preliminary data of Klapper & Becker (1998), based on German type sections, but should not be uncritically transferred to published zonal assignments in other regions. Diachroneity of the base of the *rhenana* Zone refers to discrepancies of its correlation with Montagne Zones in Belgium and at Martenberg (see p. 5). IIa1 etc. are subdivisions of international depophases of Johnson et al. (1985). Arrows to the right indicate transgressions, arrows to the left regressions. Small-scale eustatic changes, indicated by short arrows, have been discussed in recent publications such as Becker & House (1997) and Becker et al. (1993, 1997). F. = Frasne Event, Gen. = Genundewa Event, Tim. = Timan Event, M. = Middlesex Event, Rh. = Rhinestreet Event, sem. = semichatovae Transgression, LKW = Lower Kellwasser Beds, UKW = Upper Kellwasser Beds.

stage	proposed substages	Wedekind zones		ammonoid genozones		"standard" conodont zones		MN zones	classical regional subdivisions			eustatic pulses
FRASNIAN	UPPER FRASNIAN	*Crickites holzapfeli*	I delta	I-L	*Crickites*	*linguiformis*		13	F3	UKW, upper Adorf-Stufe	West Falls Group	
		Manticoceras adorfense	I delta	I-K	*Archoceras*	*rhenana*	Upper	13	F3	upper Adorf-Stufe	West Falls Group	IId3
		Mant. carinatum *Mant. cordatum*	I gamma	I-J	*Neomanticoceras*	*rhenana*	Lower	12	F2	LKW, middle Adorf-Stufe	West Falls Group	
		Costamanticoceras nodulosum	I beta	I-I	*Playfordites*	*jamiae*		11	F2	middle Adorf-Stufe	West Falls Group	IId2 = sem.
	MIDDLE FRASNIAN	*Costamanticoceras nodulosum*	I beta	I-H	*Beloceras*	*hassi*	Upper	10 9	F2	middle Adorf-Stufe	West Falls Group	
		[unzoned]		I-G	*Mesobeloceras* *Naplesites*	*hassi*	Lower	8 7	F2	middle Adorf-Stufe	West Falls Group	IId1 = Rh.
		[unzoned]		I-F	*Prochorites*	*punctata*		6	F2	middle Adorf-Stufe	Sonyea Group	
		[unzoned]		I-E	*Probeloceras*	*punctata*		5	F2	middle Adorf-Stufe	Sonyea Group	
		[unzoned]		I-D	*Sandbergeroceras*	*punctata*		5	F2	middle Adorf-Stufe	Sonyea Group	IIc = M.
	LOWER FRASNIAN	*Pharciceras lunulicosta*	I alpha	I-C	*Timanites*	*transitans*		4	F2	lower Adorf-Stufe	Genesee Group	Tim.
		Pharciceras lunulicosta	I alpha	I-B	*Koenenites*	*falsiovalis*	Upper Middle	3 2	F2	lower Adorf-Stufe	Genesee Group	Gen.
		Pharciceras lunulicosta	I alpha	I-A	*Ponticeras [Neopharciceras]*	*falsiovalis*	Lower	1	F2	lower Adorf-Stufe	Genesee Group	IIb1 = F.
GIVETIAN	UPPER GIVETIAN	*Pharciceras lunulicosta*	I alpha	III-E	*Petteroceras*	*falsiovalis*	Lower	*norrisi*	F1	lower Adorf-Stufe	Genesee Group	
		Pharciceras lunulicosta	I alpha	III-D	*Pseudoprobeloceras*	*disparilis*	Upper		F1	lower Adorf-Stufe	Genesee Group	
		Pharciceras lunulicosta	I alpha	III-C	*Synpharciceras*	*disparilis*	Lower		F1	lower Adorf-Stufe	Genesee Group	
		Pharciceras lunulicosta	I alpha	III-B	*Stenopharciceras*	*hermanni*	Upper Lower		F1	lower Adorf-Stufe	Genesee Group	IIa2
		Pharciceras lunulicosta	I alpha	III-A	*Pharciceras*	*latifossatus/ semialternans*	Upper *varcus*		F1			IIa1
	M. GIVETIAN			II-D	*Afromaenioceras*	*ansatus*	Middle *varcus*					

Comments on Pragian/Zlichovian and Zlichovian/Dalejan boundaries in the Barrandian area, Czech Republic

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Extract of the paper presented at the SDS Meeting in Bologna (June 1998) and submitted for press in *Newsletters on Stratiqraphy* in August, 1998

The Lower Devonian sequences of the Barrandian area of central Bohemia are distinguished by marine, mostly carbonate development. The carbonate facies persist here from the Upper Silurian up to the early Middle Devonian (Eifelian).

The dominant carbonate development is also characteristic for strata of the Zlichovian and Dalejan stages (or substages) which have here their type areas and proposed lower boundary stratotypes, as summarized by Chlupac (1976, 1982). The sections were visited by members of the Subcommission on Devonian Stratigraphy during field meetings in 1977 and 1986. These sections, however, should be newly discussed and studied according to recent data and principles established by the International Commission on Stratigraphy (Remane et al. 1996) and the International Stratigraphic Guide (Salvador, ed. 1994).

Selected examples of sections, which can be considered potential international stratotypes of the Zlichovian and Dalejan lower boundaries are here illustrated and the associated problems discussed.

The lower Zlichovian boundary

The original definition of the lower Zlichovian boundary, made in the Conclusion of the First Silurian-Devonian Symposium 1958 (Svoboda, ed. 1960:511) in the stratotype section below Praha-Barrandov, corresponds to the base of the Kaplicka (Chapel) "Coral Horizon" (now Kaplicka Member) which reflects the first effects of the Basal Zlichovian Event as defined by Chlupac &Kukal (1986, 1988). This level also corresponds to a marked influx of new forms particularly in benthic faunas (brachiopods, trilobites, ostracods, etc.), some of which can be used for interregional correlations with other facies realms, including the Rhenish Lower Emsian.

The wider than merely regional significance of the Basal Zlichovian Event was confirmed by confrontation with the sea-level curve elaborated especially by Johnson et al. (1985), and by studies of different authors, e.g. Talent and Yolkin (1987 - Australia and Siberia), Garcia-Alcalde et al. (1990), Garcia-Alcalde (1997, 1998 - Spain, NW France, NW Africa), Yolkin et al. (1997 - Siberia), Bai et al. (1994 - South China). Apparently, the impacts of the Basal Zlichovian Event were underestimated in time of its definition (Chlupac & Kukal 1986) and its influence on wide-range migrations and evolution, marked e.g. in trilobites (Chlupac 1994), brachiopods (Havlicek 1994), final extinction of graptolites (Jaeger 1983) and somewhat later appearance of goniatites (Chlupac 1976, House 1985, 1989, Becker & House 1994) illustrate the probable effects and consequences of this event. The original Zlichovian base lies substantially higher than the base of the *Polygnathus dehiscens* conodont Zone, which was accepted by SDS in 1989 as the lower Emsian boundary marker, and the same concerns the recently established *P. kitabicus* Zone (Yolkin et al. 1994). Both levels are projected within the original and traditional volume of the Pragian Stage, and even change the original concept of the Emsian Stage (comp., e.g., Carls & Valenzuela-Rios 1993, 1997, stratigraphic tables edited by Weddige 1996, 1998). Consequently, the bases of *dehiscens* or *kitabicus* Zones cannot be identified with the Zlichovian base, which lies higher than the newly officially redefined base of the Emsian (Yolkin et al. 1997).

In the tentaculite biostratigraphy, the original Zlichovian base lies in the Barrandian sections usually several metres above the first occurrence of the zonal index *Guerichina strangulata* Bouc. et Ptl, but within the range of this species, as evidenced in the sections at Stydle vody, Praha-Klukovice etc. Also forms belonging to the lineage of the globally distributed *Nowakia (T..) acuaria* overlap the lower Zlichovian boundary (comp. the section Praha-Klukovice in Chlupac et al. 1986, newly studied sections at Srbsko, see also Alberti 1982, 1997). It seems that especially the subspecies *N. (T.) acuaria posterior* Alberti may appear as stratigraphically useful. The type subspecies *N. acuaria acuaria* (Richt.), however, should be retained as the index species of the Pragian Stage where it enables world-wide and easy correlations.

The onset of *Guerichina strangulata,* though usually not far from the Zlichovian base, seems to be less advantageous indicator in biostratigraphy, as *G. strangulata is* hardly distinguishable from *G. infundibulum,* which starts its occurrence rather deep within the Pragian. The same concerns the genus *Peneauia* and its type species *P. biannulata* (Peneau) which was newly found in the *Barrandian also* deep in the Pragian, even below the Reporyje Limestone at Stydle vody. Among tentaculites, the closest level to the original Zlichovian base seems to be the onset of *Viriatellina exigua Mu.* The range and correlative value of this species, however, should be further studied.

The onset of *Nowakia zlichovensis* Bouc. cannot be used in drawing the lower Zlichovian boundary, as the first occurrence of this species falls at considerably higher level, and usually above the most marked effects of the Basal Zlichovian Event and the corresponding change in benthic faunas. The same concerns the onset of *Polygnathus gronbergi* Mapper et Johnson.

As for the stratotype of the lower Zlichovian boundary, the original stratotype section below Praha-Barrandov (road-cut at the Chapel quarry), approved by the First Silurian-Devonian Symposium in 1958 (Svoboda, ed. 1960), should be further studied by modern methods. The same should be applied to the sections Zbuzanska mramorka and Stydle vody which show advantage in persisting pelagic facies throughout the broader Pragian-Zlichovian boundary interval. once these studies are completed a qualified potential redefinition of the Zlichovian base might be realized.

This procedure will be in agreement with recent comments by Carls & Valenzuela-Rios (1997), Jansen & Schindler (1997),Walliser (1997) and Chlupac (1995, 1997).

The lower Dalejan boundary

The original lower Dalejan boundary was proposed at the limit between the tentaculite Zones *Nowakia elegans* and *N. cancellata* (Chlupac 1976, 1982). This level has not been changed since its introduction and even presently it seems to be the best level for the following reasons:

1. The junction between the *Nowakia elegans* and *N. cancellata* Zones is readily distinguishable in the tentaculite zonation and the index fossils show a worldwide distribution, being evidently members of the same lineage (cf., Lukes 1977, last version in Alberti 1997). Both index fossils are less dependent on facies and appear in diverse limestone and shale types of rocks.

2. The level seems to be close to the lower *Polygnathus laticostatus -P. inversus* conodont Zone boundary (comp. columns in Weddige, ed. 1996, 1998), which, however, needs to be more precisely established in individual sections.

3. The *elegans/cancellata* boundary is very close to (or even identical) with the lower limit of the *Gyroceratites gracilis* Range Zone, which has a wide correlative value in the goniatite biostratigraphy, and was in the past frequently used even as the internationally applied Lower/Middle Devonian boundary (Prague Symposium 1958, Bonn-Bruxelles Symposium 1960), before the correlation reform was made by Carls et al. (1972).

4. The advantages in the goniatite biostratigraphy are accentuated by facts that the acme-development of the typical *Anetoceras* fauna remains below this boundary (though some elements persist higher, e.g. *Teicherticeras),* and the onset of anarcestids falls above the boundary, being an important feature in the goniatite evolution (House 1985, Chlupac & Turek 1983, Becker & House 1994, etc.).

5. The boundary falls within the culmination of the widely recognizable and transgressive Daleje Event. This may be useful for interregional approximate lithostratigraphic correlations and geological mapping, though this event cannot be designated as abrupt and having a marked impact on pelagic faunas.

Disadvantages of this boundary level seem to be lesser than in other levels. For instance, transitional forms between Nowakia elegans and N. cancellata exist, and the same is true of *Gyroceratites laevis* and *G. gracilis*, in both cases indicating an uninterrupted evolution. This may cause difficulties in determination of less favorably preserved specimens. However, the same may be regarded as advantage, demonstrating absence of significant breaks in sedimentation and continuous evolution.

The original lower boundary stratotype of the Daleje Stage has not been defined during the establishment of this stage (Chlupac 1976), though later the Prokop Valley at Praha-Hlubocepy was proposed as the type area (Chlupac 1982). In the Barrandian sections, the effects of the Daleje Event, marked by gradual onset of calcareous shale sedimentation in most sections, caused gradual changes in facies. Among the sections with the Daleje Shale, the section at Cisarska rokle near Srbsko seems to be one of the best stratotype candidates, as tentaculites are continuously frequent, index conodonts and goniatites are present, and rich spore assemblages are promising for correlation with non-marine sequences.

The Pekarkuv mlyn section offers additional information on goniatites and other faunas and might be regarded as the potential auxiliary stratotype (parastratotype).

The sections in the Koneprusy area, where the elegans/cancellata interval is developed in the biomicritic or bioclastic facies with the Daleje Shale missing, seem to be less useful, since above the Pragian reef complex of the Koneprusy Limestone a marked break in sedimentation exists just below the broader boundary interval (the most part of the Zlichovian is missing), though the Dalejan sequence is otherwise ideal particularly from the viewpoint of the conodont biostratigraphy (see Klapper et al. 1978, Chlupac et al. 1979 etc.).

As is the case with the lower Zlichovian boundary, the Zlichovian-Dalejan boundary interval needs further studies and the Barrandian sections, all protected by law and situated in the vicinity of Prague, are readily accessible for international teams of workers.

Comments on the names Zlichovian and Dalejan

The names Zlichovian (1958) and Dalejan (1976) were originally formally defined as stages in the Bohemian (Hercynian) facies development of the Devonian. Consequently, they became a status of regional stages. However, the international usage of Zlichovian and Dalejan substantially grew and at present these names are obviously applied in different continents either as subdivisions of the Emsian, or as separate stages.

The volume of these units has remained stable since their establishment and practicability of them has been proved by the common stratigraphic usage in different areas of the world.

In case of the subdivision of the inadequately large Emsian into two separate formal units, the names Zlichovian and Dalejan are available. The establishment of Lower Emsian and Upper Emsian as formal subdivisions of the Emsian, would be in contrast with, recommendations of the International Stratigraphic Guide, where is stated , that " when a unit is divided into two or more formal component units, the geographic name of the original unit should not be employed for any of the subdivisions" (Int. Strat. Guide, *2nd.* ed., Chapter 3, page 21, column vi).

The same principle should be applied for the 5 proposed subdivisions of the Famennian, where the names Nehden Substage etc. are fully corresponding the nomenclature recommendations.

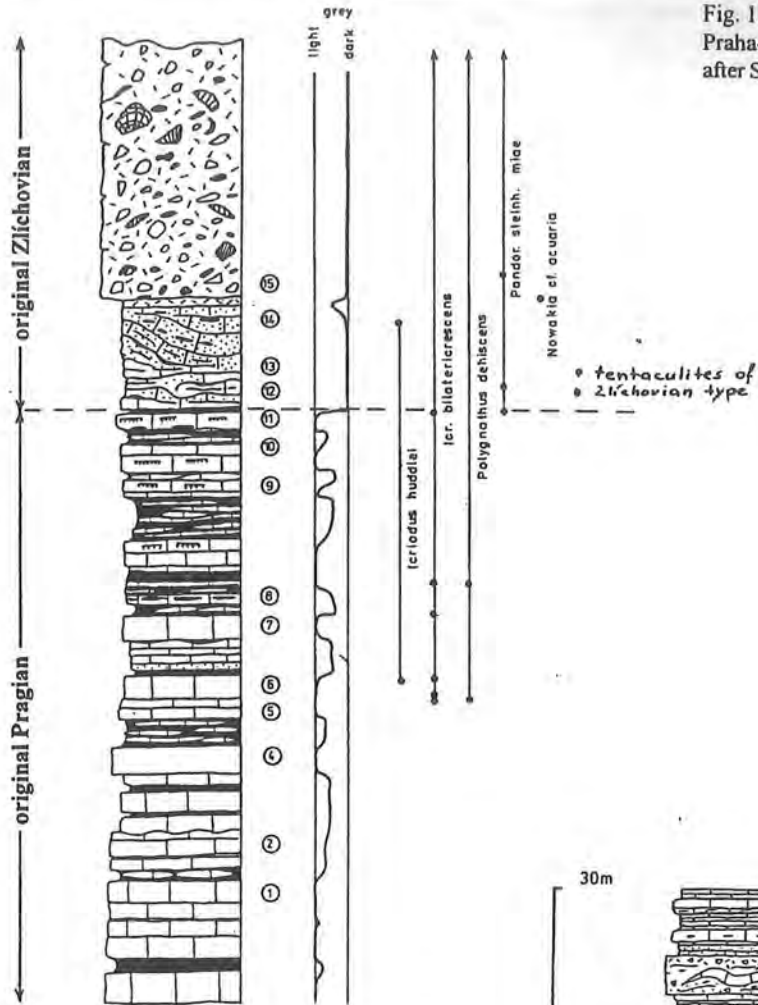

Fig. 1. The original Pragian-Zlichovian boundary stratotype below Praha-Barrandov (supplemented, Chlupac et al. 1986, conodonts after Schonlaub 1980 and Weddige 1986).

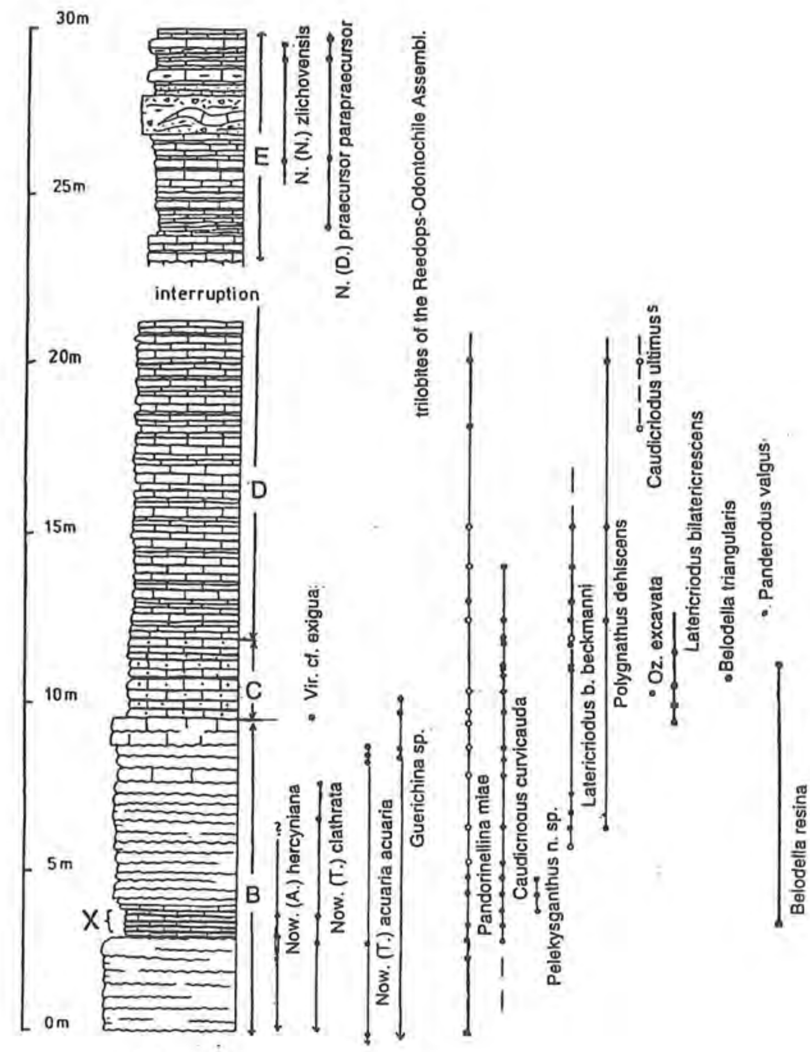

Fig. 2. The Pragian-Zlichovian boundary interval in the Zbuzanska mramorka quarry near Chynice (Chlupac et al. 1986, supplemented: tentaculites after Lukes - orig., conodonts after Weddige 1986 and Kalvoda 1995).

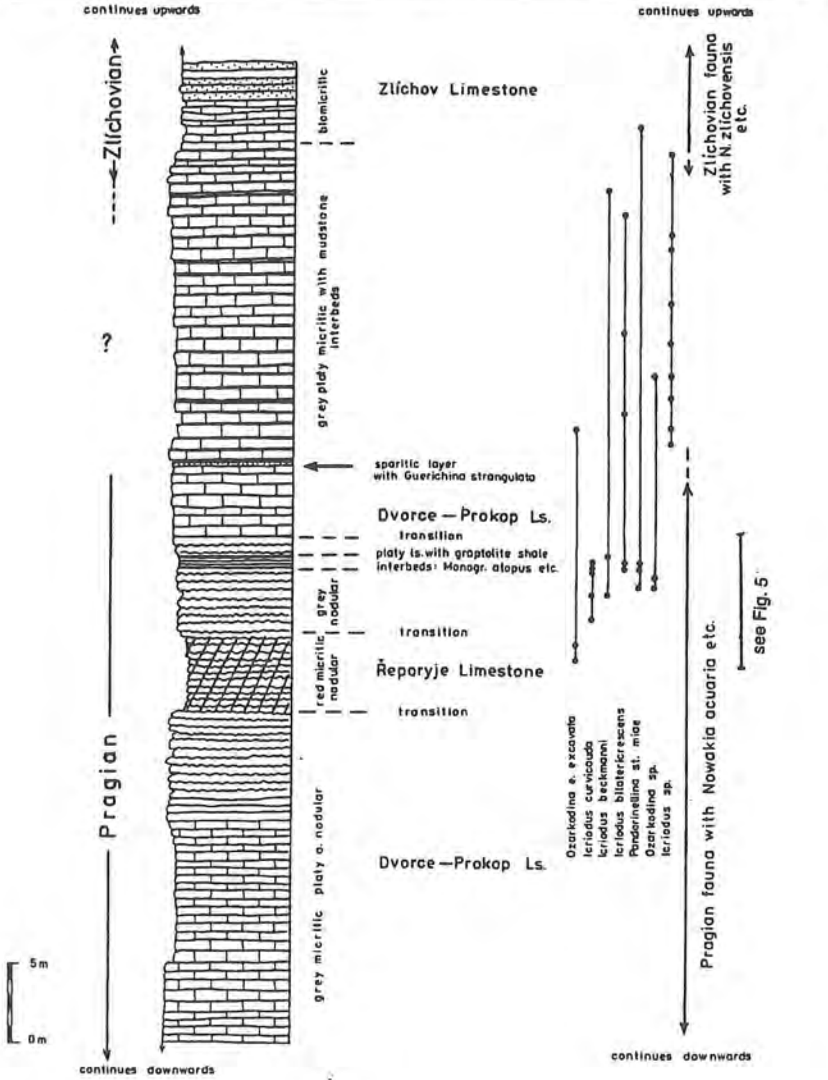

Fig. 3. The broader Pragian-Zlichovian boundary interval exposed in the Stydle vody quarry (Chlupac et al. 1986, conodonts after Schonlaub 1986).

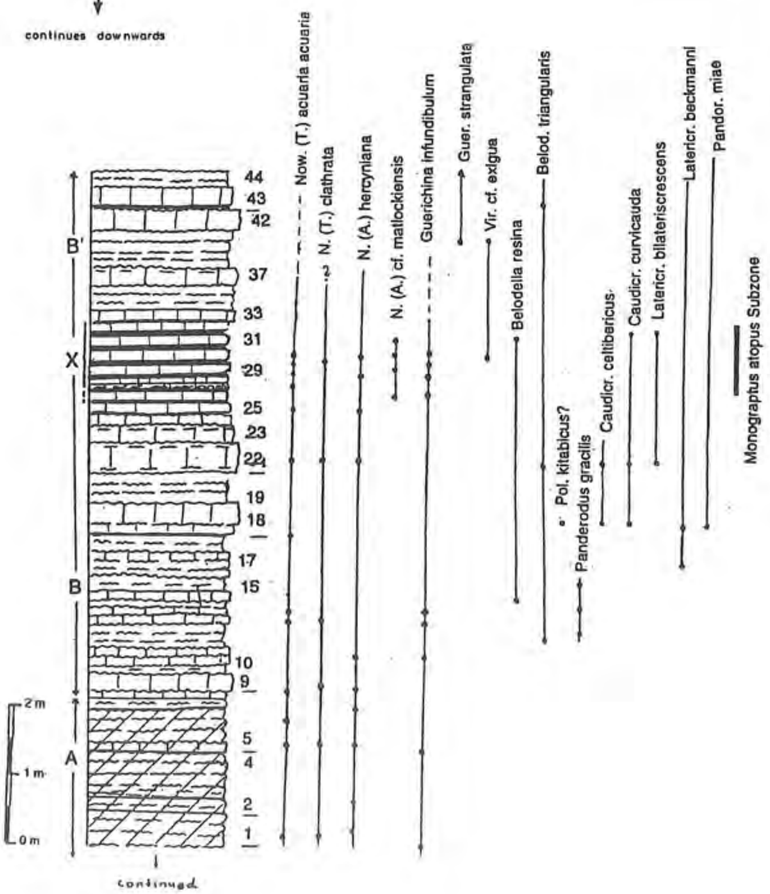

Fig. 4. The closer uppermost Pragian interval in the Stydle vody quarry. Tentaculites after Lukes (orig.), conodonts after Kalvoda (1995).

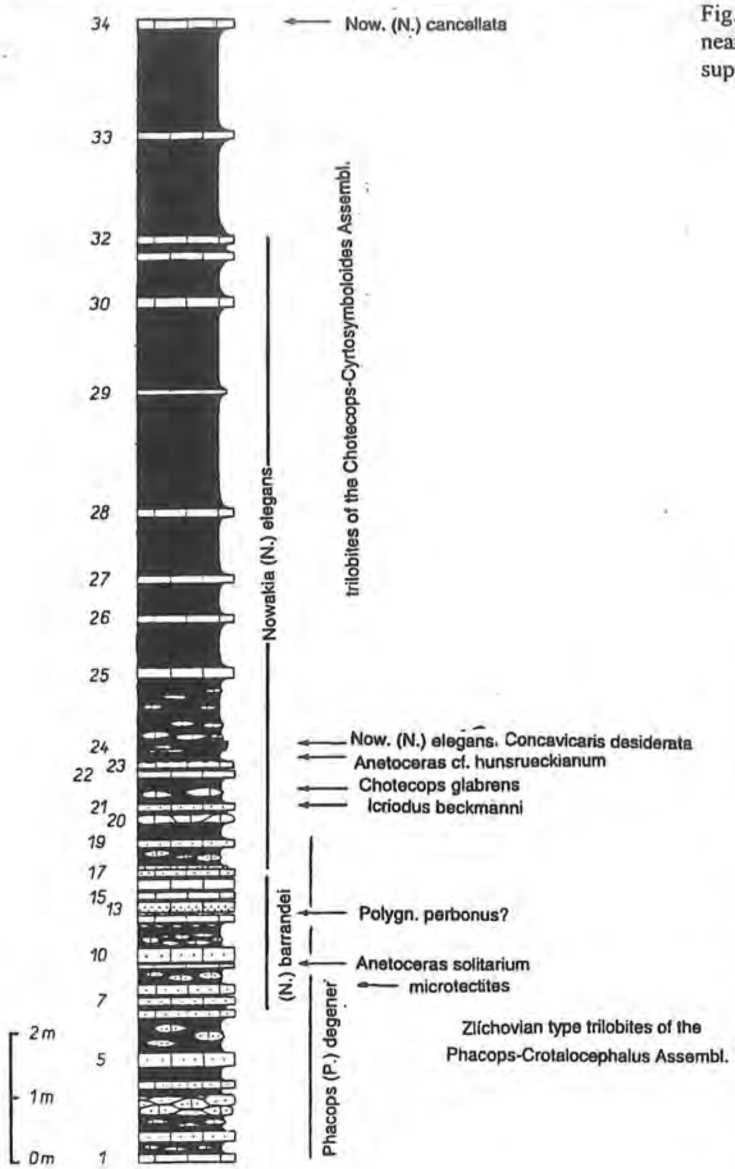

Fig. 5. The Zlichovian-Dalejan boundary interval in the old quarry near Pekarkuvv mlyn near Trebotov (Chlupac et al. 1986, supplemented).

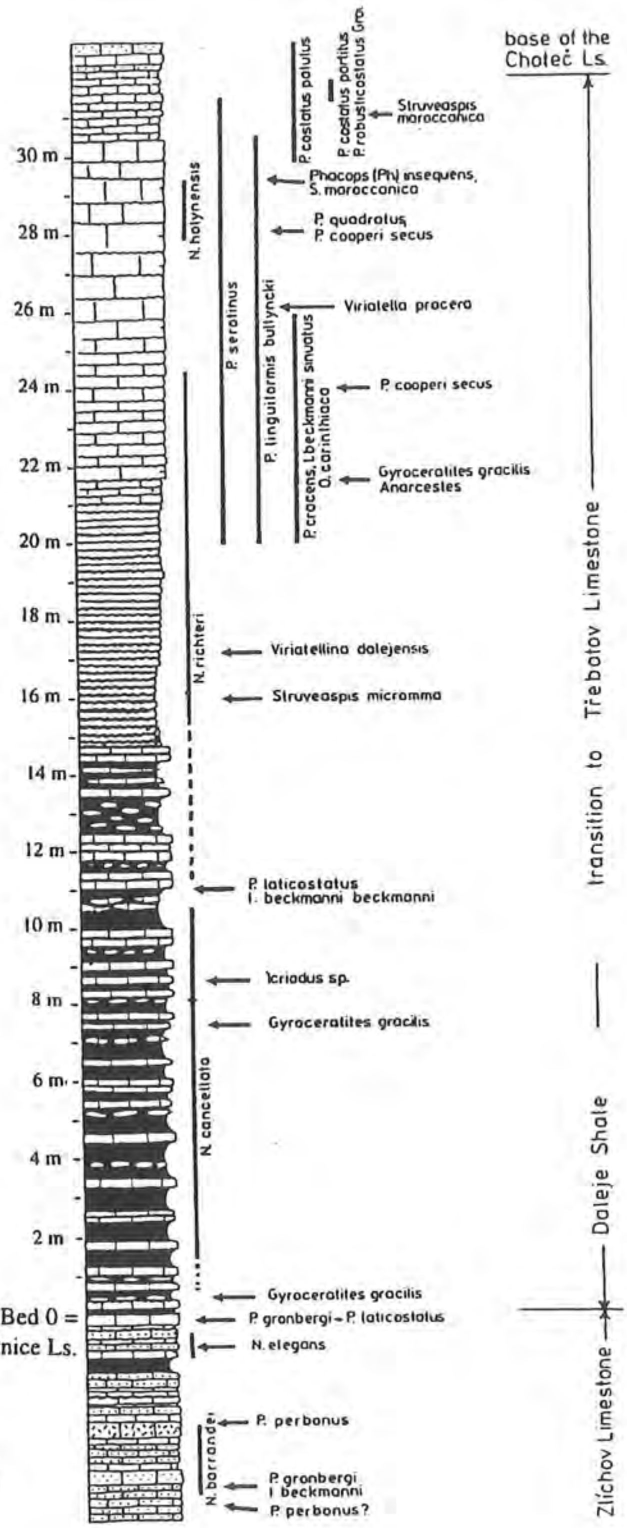

Fig. 6. The uppermost Zlichovian and the complete Dalejan sequence at Cisarska rokle near Srbsko (Chlupac et al. 1979, 1986, conodonts after Klapper et al. 1978, supplemented).

TM Rex E. Crick & Brooks B. Ellwood (Texas)

While we did not prepare a specific proposal to be considered, we urge the membership to adopt MagnetoSusceptibility Event and Cyclostratigraphy (MSEC) as a standard non-biostratigraphic method for the definition of stage and sub-stage boundaries. In consideration of our request, we urge members to reread the ICS revised guidelines for the establishment of global chronostratigraphic standards (Remane et al., 1996). In the revision the statement was made that *Magnetostratigraphy, sequence stratigraphy, cyclostratigraphy, analysis of stable isotopes should be given due weight in the selection of a GSSP. If a choice has to be made between candidates having more or less the same biostratigraphic qualities, the one offering the better applications of non-biostratigraphic methods should be preferred.* The progressive nature of the SDS and the fact that we (SDS) are embarking on the unprecedented path of formally establishing substage boundaries offers the SDS the opportunity of establishing substage GSSPs on the basis of both biostratigraphy and the magnetostratigraphy method established as MSEC. We respectfully request that the selection of GSSP candidate sections be chosen with the same care in developing MSEC profiles as they are in developing biostratigraphic zonation. We have shown numerous times that, in almost all cases, MSEC chronocorrelation offers an increase in resolution over coeval biozones and has the important added advantage of allowing high-resolution chronocorrelation between pelagic and neritic/hemipelaic sequences. It is highly unlikely that MSEC chronocorrelation or any other known form of non-biostratigraphic method will replace biostratigraphy as the premier correlation tool, this is particularly true for MSEC because of its reliance/dependence on biostratigraphy. However, in most instances, MSEC can add a degree of resolution to chronostratigraphy that is typically not available with biostratigraphic methods. We consider this to be a "win-win" situation for SDS and one that can be easily sampled for and applied. Examples of the application of MSEC appear under our authorship in the Reports from the Membership section.

Remane, J., Bassett, M.G., Cowie, J.W., Gohrbandt, K.H., Lane, H.R., Michelsen, O., and Naiwen, W., 1996, Revised guidelines for the establishment of global chronostratigraphic standards by the Internation Commission on Stratigraphy (ICS): Episodes, v. 19, p. 77-81.

LOWER EMSIAN/UPPER EMSIAN IN THE CANTABRIANMOUNTAINS (N SPAIN): STATE OF THE ART

J.L. Garcfa-Alcalde, M. Truyols-Massoni, F.M. Soto, S. Garcia-Lopez & J.R. Montesinos.

According to Garcia-Alcalde (1997), the best stratigraphical interval to select a GSSP for the Lower/Upper Emsian boundary would be the one in between the UZE (Upper Zlichovian Event) and DCE (Daleje-Cancellata Event) litho-events. Both global events can be rather well recognized and correlated in the Cantabrian Mountains (N Spain) in measured sections corresponding both to off-shore and near-shore facies. 'A project designed to contribute to the definition and worldwide correlation of the Lower Emsian/Upper Emsian boundary is being developed by the Oviedo Devonian paleontologists team headed by TM J.L. Garcia-Alcalde (brachiopods) and constituted by CM M. Truyols-Massoni (dacryoconarids), S. Garcia-Lopez (conodonts), F.M. Soto (corals) and J.R. Montesinos (ammonoids). For this. project four measured sections have been selected. Two of the sections correspond to different near-shore paleogeographical settings (La Vid and Villayandre sections). The other two sections correspond to different off-shore paleogeographical settings (N Vanes Lac and Arauz River sections) (Fig. 1).

Tectonics is always important everywhere in the Cantabrian Mountains. The selected sections have usually strong (sometimes even reversed) dipping that provokes at least bed sliding, which could cause loss of some of the softer and thinner rocky layers. However, they are essentially continuous, very well exposed, non-faulted sections.

Macro- and micropaleontological sampling has repeatedly been accomplished on the four sections, but new and more detailed sampling is being currently achieved. La Vid and Villayandre sections have been sampled for C and 0 stable isotope ratio analyses. Samples will be processed starting at the end of this summer. La Vid and the Arauz River sections will be sampled from next july for magnetosusceptibility and cyclostratigraphic (MSEC) analysis by TM Rex Crick and Brooks Ellwood (University of Texas at Arlington).

The UZE has been recognized in the off-shore facies domain of the Cantabrian Mountains in the lithological transition from the Requejada Lst Member of the Abadia Fm. to the overlying "Vanes beds" (Fig. 2) (Garcia-Alcalde, *1997). Erbenoceras filalense* and *Mimagoniatites tabuliformis,* the first representative of the *"Anetoceras* Fauna" in the Cantabrian Mountains, have been found 2-3 m. above the litho-event in the Vanes section. The first occurrence of this ammonoid fauna corresponds to the upper part of the *Nowakia barrandei* zone within the *Polygnathus gronbergi* zone (Garcia-Alcalde, et al., 1990). In the near-shore facies domain, the UZE has been identified, by indirect comparison based on conodonts and scanty occurrences of nowakids, from a modest brachiopod radiation (Faunal Interval *9;* Garcia-Alcalde, *1996),* mainly characterized by the first appearance of *Tetratomia* gr. *amanshauseri, Nucleospira* cf. *sirael, Spinatrypa* aff. *orba, Resserella sp. D, Tyersella tetragona,* and *Stenorhynchia briceae.* This fauna allows more or less accurate correlations with different North Gondwanan regions, and even with Euroamerican (Baltican) regions. The UZE litho-event in the La Vid and Villayandre sections could be a relatively important dark shale intercalation in the lower half of the La Pedrosa Fm. (Fig. 2). As outlined by Garcia-Alcalde (1997), the UZE would coincide very closely with the Lower Emsian/Upper

Emsian boundary as discussed in Garcia-Alcalde & Truyols-Massoni (1994) and in Truyols-Massoni & Garcia-Alcalde (1994).

The DCE is recognizable everywhere in the Cantabrian Mountains from the most clear onset of black and dark shales in all the known sections. The *Nowakia elegans/N. cancellata* zone transition is more or less represented everywhere both in the near-shore and in the off-shore facies domains (Fig. 2). *Polygnathus laticostatus* appears in the same beds or a bit higher and its phylogenetic derivation from *P. gronbergi is* even represented in the Arauz River section (Suarez-Diaz, 1993). Some ammonoids also occur in the offshore sections. For example, in the Arauz River section the first ammonoid fauna, with *Mimagoniatites spp.,* and *Mimosphinctes spp.* occur at the base of the *Nowakia cancellata* zone (Montesinos, 1991) at the P. *gronbergi/P. laticostatus* zone transition. In near-shore facies, thin bioclastic limestone lenses develop into the shales at the base of the *N. cancellata* zone. In these beds brachiopods of the Faunal Interval 10 (Garcia-Alcalde, 1996) occur. The brachiopod fauna comprises forms with mixed facies affinities as *Crinistrophia, Aesopomum, Reticulariopsis* cf. *indifferens, Straelenia* cf. *losseni, Triathyris, Brachyspirifer* aff. *carinatus, "Uncinulus" suborbignyanus, Arduspirifer arduennensis latronensis, Plicathyris collensis, Protodouvillina taeniolata, Anathyris phalaena* and *Struveina ferronesensis.* This fauna allows rather good correlations mainly within Northern Gondwana (Garcia-Alcalde, 1997).

Garcia-Alcalde, J.L. 1996. El Devonico del Dominio Astur-Leones en la Zona Cantabrica (N de Espana). Revista Espanola de Paleontologia, no extra, 58-71.

Garcia-Alcalde, J.L. 1997. North Gondwanan Emsian events. Episodes, 19 (1-2): 241-246.

Garcia-Alcalde, J.L., Arbizu, M., Garcia-Lopez, S., Leyva, F., Montesinos, R., Soto, F. & Truyols Massoni, M. 1990. Devonian stage boundaries (Lochkovian/Pragian, Pragian/Emsian, and Elfelian/Givetian) in the Cantabric region (NW Spain). Neues Jahrbuch Geologie Palaontologie Abhandlungen, 180(2): 177-207.

Garcia-Alcalde, J.L. & Truyols-Massoni, M. 1994. Lower/Upper Emsian versus Zlichovian/Dalejan (Lower Devonian) boundary. Newsletters in Stratigraphy, 30: 83-89.

Truyols-Massoni, M. & Garcia-Alcalde, J.L. 1994. Faune rheno-bohemienne (Dacryoconarides, Brachiopodes) A la limite Emsien inferieur (superieur au Cabo La Vela (Asturies, Espagne). Geobios, 27(2): 221-241.

Montesinos, J.R. 1991. Ammonoideos de las Capas de Vanes (Formacion Abadia, Devonico Inferior) del Dominio Palentino (Palencia, NO de Espana). Cuaderno Laboratorio Xeoloxico Laxe, 16: 193-201.

Suarez Diaz, J.R. 1993. El estudio de las biofacies de conodontos y su aplicacion a la Zona Cantabrica (Emsiense Inferior) y parte basal del Emsiense superior). Seminario Investigacion Departamento Geologia, Universidad Oviedo, 74 p.

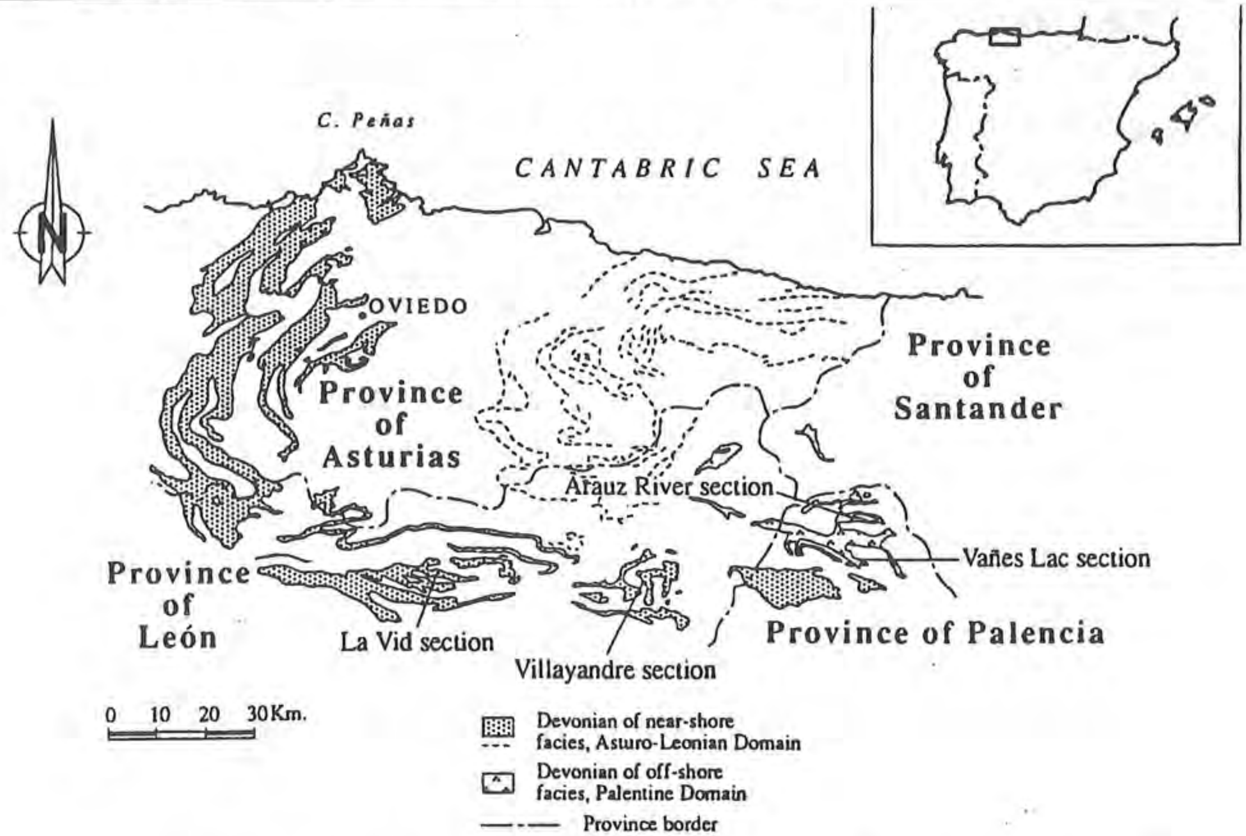

Fig. 1.- Geological and geographical setting of interesting Lower Emsian/Upper Emsian sections in the Cantabrian Mountains.

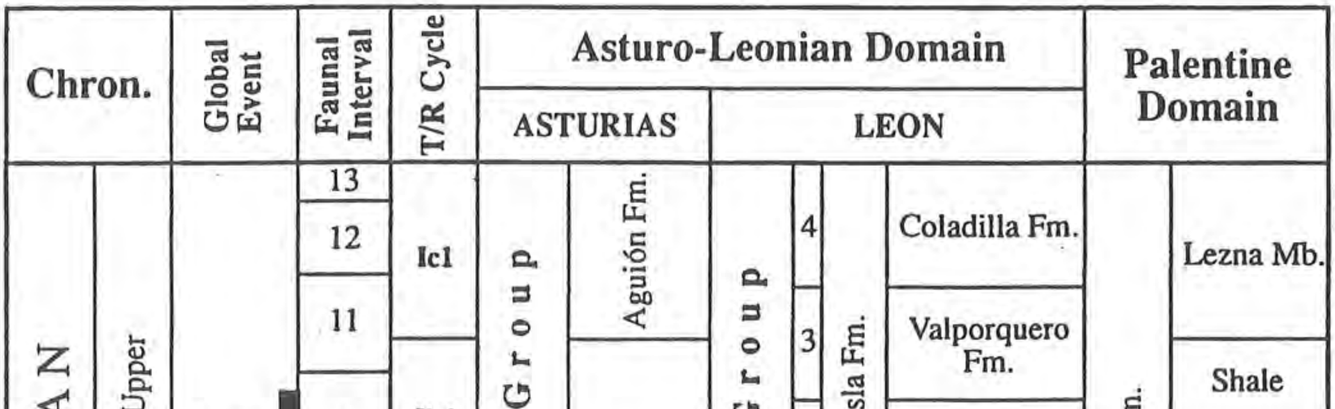

Fig. 2.- Stratigraphical situation of the global events, interesting for the definition of the Lower Emsian/Upper Emsian boundary, in the Cantabrian Mountains. (Modified from García-Alcalde, 1997).

Subdivision of the Emsian stage - compilation of sections in W-Europe and palaeontological remarks

H. JAHNKE (Gottingen) & U. JANSEN (Frankfurt)

The following description of sections in W-Europe was submitted to a meeting of the German Subcommission on Devonian Stratigraphy by the first author (JAHNKE 1994). The present translation from the original German version is supplemented by additional information. The subdivision of the Emsian stage into two parts should be adapted to the classical boundary between Early and Late Emsian in the type area of the Emsian, the Mosel/Middle Rhine area in the Rhenish Slate Mountains. Here the Late Emsian lithostratigraphically starts with the "Ems-Quarzit" and its equivalents.

On the right side of fig. 1. the ranges of important index fossils in this neritic succession are shown. On the left, stratigraphies of pelagic groups are figured, conodont and dacryoconarid zones as well as first ammonoid zones. Arguments for the correlation of pelagic and neritic subdivisions are shown in between and discussed in the remarks.

Fig. 1 shows that the boundary between Early and Late Emsian approximately coincides with the Zlichovian/Dalejian boundary of the Bohemian subdivision and therefore also with the Daleje Event or *cancellata* Event (HOUSE 1985, WALLISER 1985, CHLUPAC & KUKAL 1988). In many pelagic and hemipelagic successions, a gradual transition from pelagic limestones to pelitic and marly sediments can be observed. The lithological change is accompanied by a faunal change, especially expressed in the ammonoid evolution. Reflected by the lithological and palaeontological changes, there is a gradual sea-level rise beginning in the early Zlichovian.

The boundary interval is characterized by the transition from *Nowakia elegans* to N. *cancellata*. Tile transition may be not so clear as previously assumed - a reinvestigation of the two species with the help of statistical methods is urgently desired. Specimens resembling *N. cancellala* already occur in the Zlichovian together with *N. elegans* (ALBERTI 1998, written communication).

The conodont fauna of the boundary interval may be less distinctive because of its position within a conodont zone, the *inversus/laticostatus* Zone (CHLUPAC, LUKES & ZIKMUNDOVA 1979; KLAPPER, ZIEGLER & MASHKOVA 1978). However, after the new conodont zonation (CARLS & WEDDIGE 1996) the *inversus* Zone is situated slightly above the Zlichovian/Dalejian boundary. Further studies are requested.

In order to define an international boundary stratotype within the Emsian pelagic fossils are highly valuable, whereas neritic fossils are unsuitable due to frequent biogeographical and facies differences. In which sections should a definition be made.

The Barrandian has the clear advantage of continuously pelagic facies. The evolution of the conodonts and nowakiids can be observed entirely. However, the sections discussed below have aditionally the advantage of containing pelagic and neritic facies alternating in vertical direction. Therefore, they offer the chance to correlate the different facies. The correlation of sections in entirely pelagic facies with sections characterized by vertically changing facies seems to be an important point in the dicussions about the subdivision of the Emsian stage. In this document some of the sections interesting in this regard are figured.

Reun ar C'Hrank (Rade de Brest, Brittany) (Fig. 2)

The section Reun ar C'Hrank of the Rade de Brest contains an undisturbed succession from the high part of the "Formation du Faou" (Early Emsian) to the ,Formation Pen an Ero" (equivalent of the Kondel Substage, in German terminology). Biostrati graphical information is given in the following publications: RENAUD 1962, LARDEUX 1969, BULTYNCK & MORZADEC 1979, MORZADEC & WEYANT 1982, LE MENN et al. 1976, MORZADEC 1983a, 1983b, MORZADEC et al. 1988.

Probably because of the heterogenous state of investigation of the faunas there are some contradictions with regard to (1) the range of index fossils:the determination of *Icriodus latus* from the levels 48-52 *(serotinus* Zone), (2) the determination of *Euryspirifer paradoxus* from the levels 11 - 16 in the Formation Reun ar C'Hrank, and (3)the very early occurrence of *Rhenops lethaeae* in the levels 26-30 within the *laticostalus/inversus* Zone.

The boundary between Early and Late Emsian is placed by LE MENN et al. (1976) in the vicinity of the base of the Formation Reun ar C'Hrank (cf. BRICE & MORZADEC 1983, MORZADEC 1983).

The Fm. Beg an Arreun is assigned to the *laticostatus/ inversus* Zone; MORZADEC (1983) reported *Nowakiacancellata* from the highest layers of the formation whereas LARDEUX (1969) mentioned *Viriatellina hercynica.*

This would not be a contradiction if the boundary between Zlichovian and Dalejian is placed inside the transition interval between the Fin. Beg an Arreun and the Fm. Prioldi. The Kondel Substage, proven by the first occurrence of spiriferids of the *mosellanus* group, begins with the Fm. Pen an Ero representing a level that is above the levels 48-52 of the Fin. du Fret dated as *serotinus* Zone.

La Lezais (Syclinorium median Brest-Laval, Brittany) (Fig. 3)

The Devonian of this area consists of the following formations: Fm. de Gahard, Fm. de Bois-Roux, (corresponding to Fm. l'Armorique & Fm. du Faou), Fm. de la Foulerie (corresponding the Fm. Reun ar C'Hrank) and the Fm. des Marettes which is subdivided in three members: the Lower Member consisting of limestones with shaly intercalations, the Middle Member consisting of shales and the Upper Member, a nodular marl. The section, investigated by a French team in 1981, includes the top of the Fm. de la Foulerie, the Lower member and the Middle Member of the Fm. des Marettes (MORZADEC et al. 1981).

At level G 47, dacryoconarids of possible Zlichovian age were found: *Nowakia cf. praecursor* and *N. cf. zlichovensis.*

However, this interval is correlated with the Late Emsian (Wiltz Formation, Rhenish Slate Mountains) on the base of the joint occurrence of *Rhenops lethaeae, Schizophoria vulvaria* and *Arduspirifer arduennensis arduennensis.* This is contradictory to the data from the Celtiberian Chains. *Nowakia elegans is* reported from the layers G 122 and G 136, *N. cancellata* from the layer G 146. Therefore, the Daleje Event should be situated between the levels G 136 and G 145, consequently near the base of the Shale Member.

Palencia (E' Cantabrian Mountains, Spain) (Fig. 4)

Literature:

KULLMANN 1960, 1965, AMBROSE 1972, JAHNKE et al. 1983, SMEENK 1983, HENN & JAHNKE 1984, HENN 1985, FRICKE 1981, GARCIA-ALCALDE et al. 1990.

In the eastern Cantabrian Mountains, in the Pisuerga-Carrion Unit, there is a succession of Devonian strata, that is similar to the succession in the Asturoleonese Region, although many lithostratigraphical units were deposited in deeper water than their equivalents in the Asturoleonese Region. The Devonian in these areas is characterized by a repeated change of pelagic, hermipelagic and neritic facies. Unfortunately, the sections mostly have only a small vertical extent. Therefore one must be content with the investigation of short stratigraphical fragments that are to be connected afterwards by the usage of litho- and biostratigraphical criteria.

The Emsian is characterized by the succession of the Cortes, Arauz and Polentinos Formations. Within thehigh Cortes Fm. the Zlichovian Stage begins, proven by dacryoconarids. The start of the Zlichovian is situated not far above a faunal succession with *Arduspirifer prolatestrialus, Acrospirifer beaujeani, Acrospirifer fallax,Euryspirifer dunensis* and other taxa, that can be dated as Late Siegenian and Early Emsian (in the classical sense in Germany).

The Requada Member following above and dated as late *dehiscens* Zone contains spiriferids at its base resembling *Arduspirifer arduennensis antecedens,* which is an index fossil of the Early Emsian. The Requada Limestone corresponds to the middle and late parts of the Zlichovian; the late part of the *N. zlichovensis* Zone, the *barrandei* and *elegans* Zones are present. The beginning of the *cancellata* Zone is characterized lithologically by a decreasing frequency of layers of nodular limestones whereas shales become dominant to the top. *N. richteri* appears very early and is accompanied by *Nowakia cancellata.* The *N. richteri* Zone has a large vertical range - it ranges into the basal part of the Polentinos Formation. In the Lezna Member, approximately 15 m below the base of the Polentinos Fm. and within the *N. richteri* Zone there is a layer with a rich. neritic fauna containing *Arduspirifer arduennensis arduennensis, Euryspirifer paradoxus, Bojodouvillina morzadeci* (the same species occurs in the Fm. du Fret of the Rade de Brest). Because there are no spiriferids of the *mosellanus* group in this level, it may be older than Kondel time. The Kondel Substage is documented in the Polentinos Limestone.

Sections:

Pantano de Vanes, Arauz Celtiberian Chains (Fig. 5)

Literature:

CARLS 1965, 1969, 1979, 1988, CARLS et al. 1972, CARLS & GANDL 1967. GANDL 1972, CARLS et al. 1993.

CARLS (1988) gave a comprehensive description of the Devonian of Celtiberia. The Early/Late Emsian i.e. the Zlichovian/Dalejian boundary interval is situated within the Mariposas Formation following CARLS.

The sections in this stratigraphical succession are characterized by hemipelagic facies. On the one hand pelagic elements like dacryoconarids, pelagic trilobites and presumably epiplanctonic brachiopods are present, on the other hand also Asteropyginae, Homanoloticlae, neritic brachiopods like *Arduspirifer* and the Pleurodictyidae, typical of the hemipelagic and the neritic facies can be observed.

In the unit d4ba of the Mariposas Formation, *Anetoceras* and *Mimagoniatites zorgensis* occur together with *Nowakia barrandei. N. elegans* has not been determined yet but may be present in the highest layers of the d4ba. In the d4bß, predominantly consisting of a carbonatic shale, N. *cancellata* occurs together with *Rhenops lethaeae.* The Daleje Event is clearly documented lithologically and faunistically.

The predominantly pelagic and hemipelagic part of the d4b is overlain by an increasingly neritic facies called Castellar Formation that still contains neritic brachiopods of the Kondel Substage in the range of *Nowakia richteri (serotinus* Zone).

Section: road cut NE Nogueras, d4ba/d4bß with minor tectonic perturbations in the lower part.

Southern Cantabrian Mountains, Prov. Leon (Fig. 6)

Literature:

COMPTE 1959, RUPKE 1965, CARLS et al. 1972, GARCIA-ALCALDE et al. 1979, HENN & JAHNKE 1984,

KELLER 1988, GROTSCH 1988, TRUYOLS et al. 1990, GARCIA-ALCALDE 1996)

In the southern Cantabrian Mountains (province Leon) the Devonian is well exposed and not much disturbed by tectonics. Generally, the facies is more neritic than in the eastern Cantabrian Mountains, although in some parts of the sections pelagic facies predominates, e.g. in the Zlichovian/Dalejian interval.

Although the late Early Devonian sections in the southern Cantabrian Mountains generally show common features and similarities, there are lateral differences in the facies and the faunas. If sections with slightly different facies developments are correlated and put together to a synoptical section. it is possible to get more biostratigraphical time markers than it would be possible regarding only a single section. No description has been published yet of any of the sections under consideration. Some important time markers of the Villayandre section are figured here, that significantly represent the Zlichovian/Dalejian boundary interval.

Sections: road cut La Vid - Vegacervera Villayandre Adrados Grandoso W'Abelgas Caldas de Luna and others.

Remarks on the correlation of neritic and pelagic successions in the Early/Late Emsian boundary interval (Fig. 1)

(a) Occurence of *Anetoceras arduennensis* in the Stadtfeld Formation and the Hunsruck Shale on the one hand and the late Zlichovian *(barrandei* Zone) on the other hand. Dacryoconarids from the Hunsruick Shale correspond to the *praecur-*

sor Zone of the middle Zlichovian Stage. (e. g. ERBEN 1953, CARLS et al. 1972, ALBERTI 1993).

(b) *Rhenops lethaeae*, an index fossil of the early Late Emsian (Wiltz level), occurs in tile *cancellata* Zone of tile Celtiberian Chains. (GANDL 1972, CARLS et al. 1972).

(c) Rhenops lethaeae was described from the Reun ar C'Hrank section in the Rade de Brest, where it was found at a level that must be dated as late Zlichovian judging after the accompanying dacryoconarids. Slightly above, conodonts of the *laticostatus* Zone were determined. (MORZADEC 1983, LARDEUX 1969, BULTYNCK & MORZADEC 1979).

(d) The lower and middle parts of the Fm. de Hierge (Lahnstein and Laubach Substages) in Belgium belongs to the *laticostatus/inversus* Zone. (BULTYNCK & GODEFROID 1974, GODEFROID 1980).

(e) In Thuringia. spiriferids of the late Kondel Substage occur in the upper parts of the *cancellata* Zone and indicate like the co-occurring ostracodes a correlation with the Heisdorf Formation. (ZAGORA 1978, SOLLE 1953, 1972, CARLS et al. 1972, ALBERTI 1957). The representatives of the genus *Arduspirifer* recorded in Thuringia may not belong to the *Arduspirifer mosellanus* group, but represent *mosellanus*- like forms of the group of *Arduspirifer arduennensis latronensis*, whose onset is much earlier, e. g. in the Dra Plains (JANSEN, in prep.).

(f) A presumably new species of *Anarcestes* was found in strata belonging to the latest Laubach Substage (Rotelgallen-Schiefer) of the Olkenbach Syncline (Rhenish Slate Mountains). In Bohemia the onset of the genus takes place in the Trebotov Limestone. (WALLISER pers. comm.).

(g) Spore assemblages of the Bohemian Devonian allow the following correlations (MCGREGOR 1979): The top of the Pragian Stage corresponds to the Siegenian Stage and the Early Emsian Stage. The *barrandei-elegans* Zone ranges from the Early Emsian to the prae-Wiltz time. The base of the Daleje Shale is older than the base of the Wiltz Formation in the Eifel region.

(h) *Rhenops lethaeae* and and *Schizophoria vulvaria* have been reported from a level of the Zlichovian Stage from the ha Lezais and the Reun-ar-H'Crank sections, in the first case jointly with *Nowakia cf. praecursor* and *N. cf. zlichovensis*. *Rhenops lethaeae* from the Reun-ar-C'Hrank level seems to be different from the species (CARLS, pers. comm. 1998). *Schizophoria vulvaria*" described by MELOU (198 1) from the sections in Brittany does not belong to this species. It is a form that is much more primitive than the species from the Rhenish Slate Mountains (JANSEN, in prep.).

Remarks on index fossils of the neritic (Rhenish) Early Devonian

(1) Rhenops lethaeae is restricted to the early Late Emsian (after GANDL 1972).

(2) *Treveropyge rotundifrons* has its onset at the base of the Late Emsian (SOLLE 1972, GANDL 1972, R. & E. RICHTER 1943).

(3) *Treveropyge prorotundifrons:* SOLLE (1972): late Early Emsian, not passing over the Early/Late Emsian boundary; GANDL (1972): early Early Emsian.

(4) Kayserops kochi; occurring within the Late Emsian (WERNER 1969, SOLLE 1972, GANDL 1972, HAAS 1970).

(5) The following homanolotids just reach the Early/Late Emsian boundary: *Burmeisterella quadrispinosa, Burmeisterella armata, Burmeisterella vixarmata, Dipleura laevicauda, Digonus ornatus ornatus*. Others appear at the same boundary: *Parahomalonotus mutabilis, Trimerus crassicauda, Digonus intermedius*(WENNDORF 1990).

(6) Digonus gigas gigas: late Lahnstein Substage and Laubach Substage (WENNDORF 1990).

(7) *Tropidoleptus carinatus* is restricted to Late Siegenian and Early Emsian strata in the Rhenish Slate Mountains, but occurs in strata of Givetian age in the USA and Libya, in Morocco even in strata of early Late Devonian age (ISAACSON & PERRY 1977, BOUCOT et al. 1983, COOPER & DUTRO 1982, MERGL &MASSA 1992, HAVLICEK & ROHLICH 1987).

(8) Schizophoria provulvaria: records from strata of Middle Siegenian to latest Early Emsian age.

(9) *Schizophoria vulvaria:* Late Emsian, onset at the beginning of the Late Emsian (SOLLE 1972).

(10) Arduspirifer arduennensis anlecedens: Forms with highly projecting ‚Muskel-Zapfen" (= steinkern of thedeeply impressed ventral muscle field) are restricted to the late and latest Early Emsian (SOLLE 1972); after SOLLE (1953) the whole subspecies ranges from the Middle Siegenian to the latest Early Emsian. The Siegenian forms probably represent juvenile specimens of *Acrospirifer primaevus* (JANSEN, in prep.).

(11) Arduspirifer arduennensis arduennensis: Lahnstein to Laubach Substage, but many convergences in the Early Emsian. These may belong to the group of *Arduspirifer arduennensis latronensis*, which is frequent in western Europe and North Africa.

(12) *Arduspirifer mosellanus:* onset at the beginning of the Kondel Substage and ending at he Early/Middle Devonian boundary. In the Eifel region the *mosellanus* group appears with tile onset of the Wetteldorf Formation (SOLLE 1953, 1972, WERNER 1969).

(13) *Arduspirifer mosellanus dahmeri:* onset in the Late Kondel Substage and dissappearing little below the boundary between the Heisdorf Formation and the Lauch Formation (SOLLE 1953, 1972).

(14) Euryspirifer dunensis: ranging until the Early/Late Emsian boundary interval (SOLLE 1972, JAHNKE 197 1).

(15) Euryspirifer paradoxus: base of Late Emsian to late Kondel Substage.

(16) Alatiformia has Its onset at the beginning of the Wetteldorf level (STRUVE 1964).

(17) Paraspirifer praecursor: typical specimens appear at the base of the Laubach Substage, ranging from early to latest Late Emsian (SOLLE 197 1, 1972).

(18) Paraspirifer sandbergeri appears in the late Lahnstein Substage (SOLLE 1971).

(19) Paraspirifer cultrijugatus ssp.: Heisdorf Formation (Eifel region), main occurrence in the Lauch Formation (SOLLE 1971).

(20) Brachyspirifer ignoratus: Lahnstein Substage (SOLLE 1972, 197 1).

(21) Crinistrophia (Douvillinella) filifer: in the Rhenish State Mountains and North Africa the species is restricted to the late Kondel Substage (WERNER 1969, SOLLE 1976, JAHNKE 1981).

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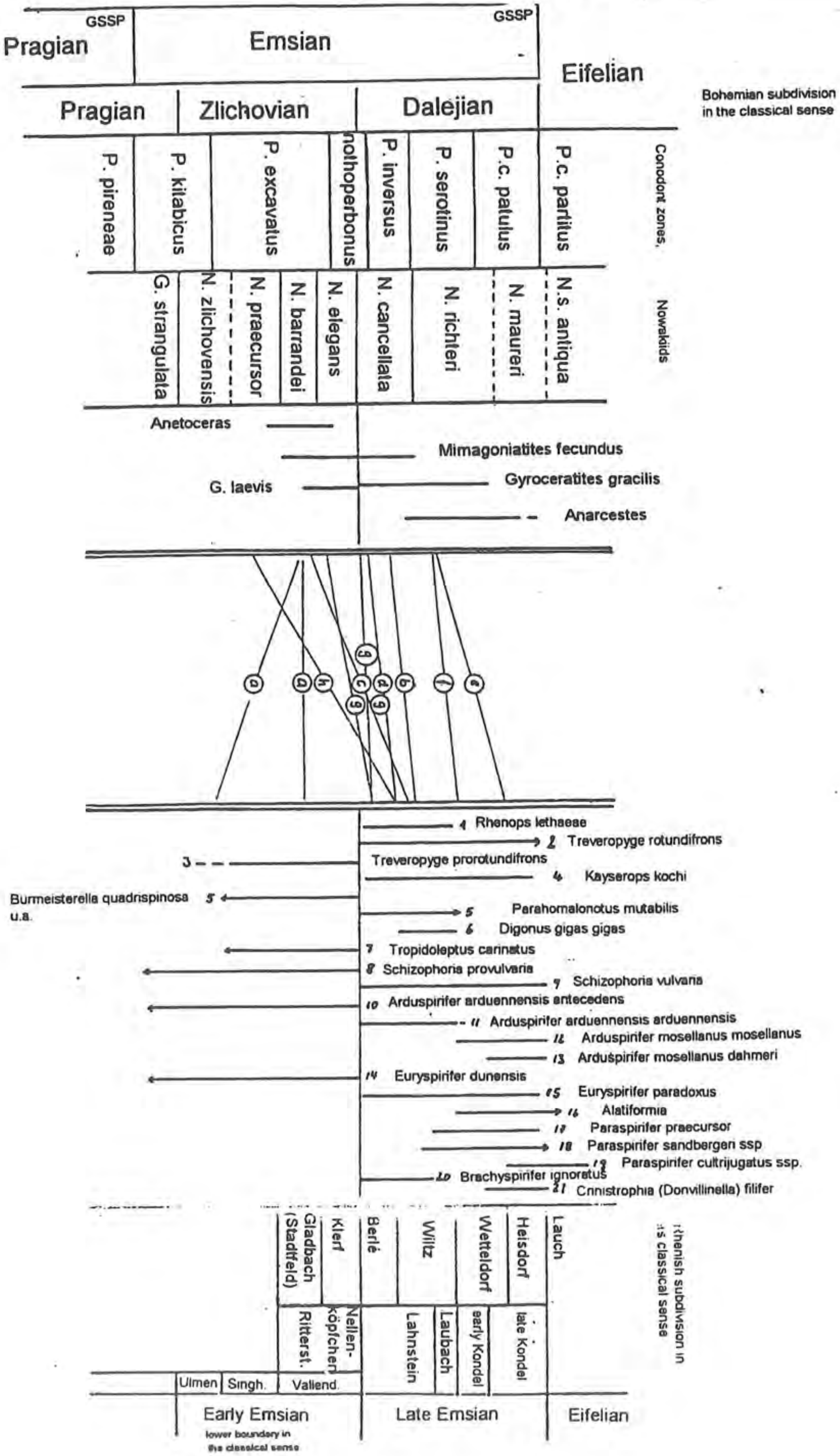
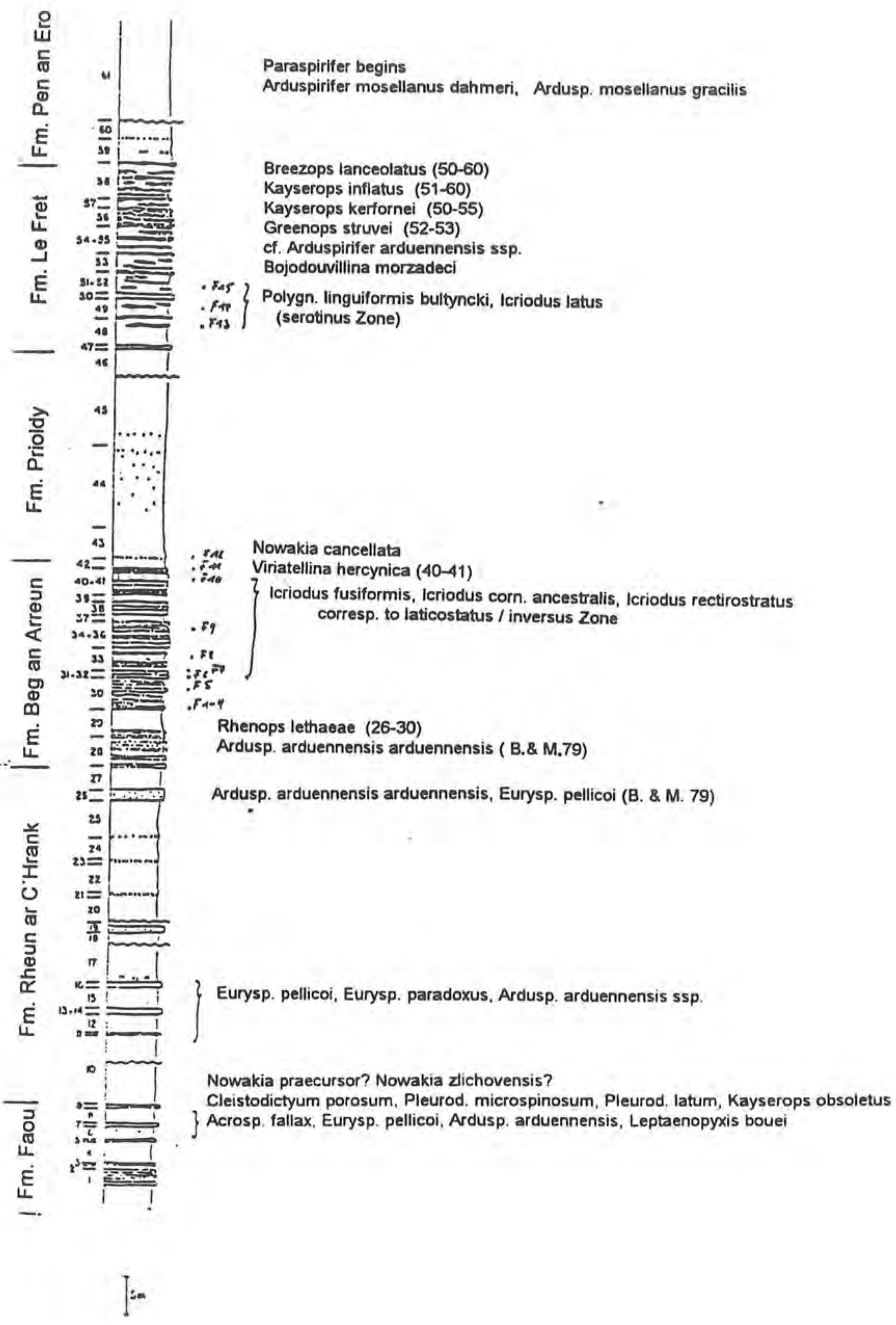
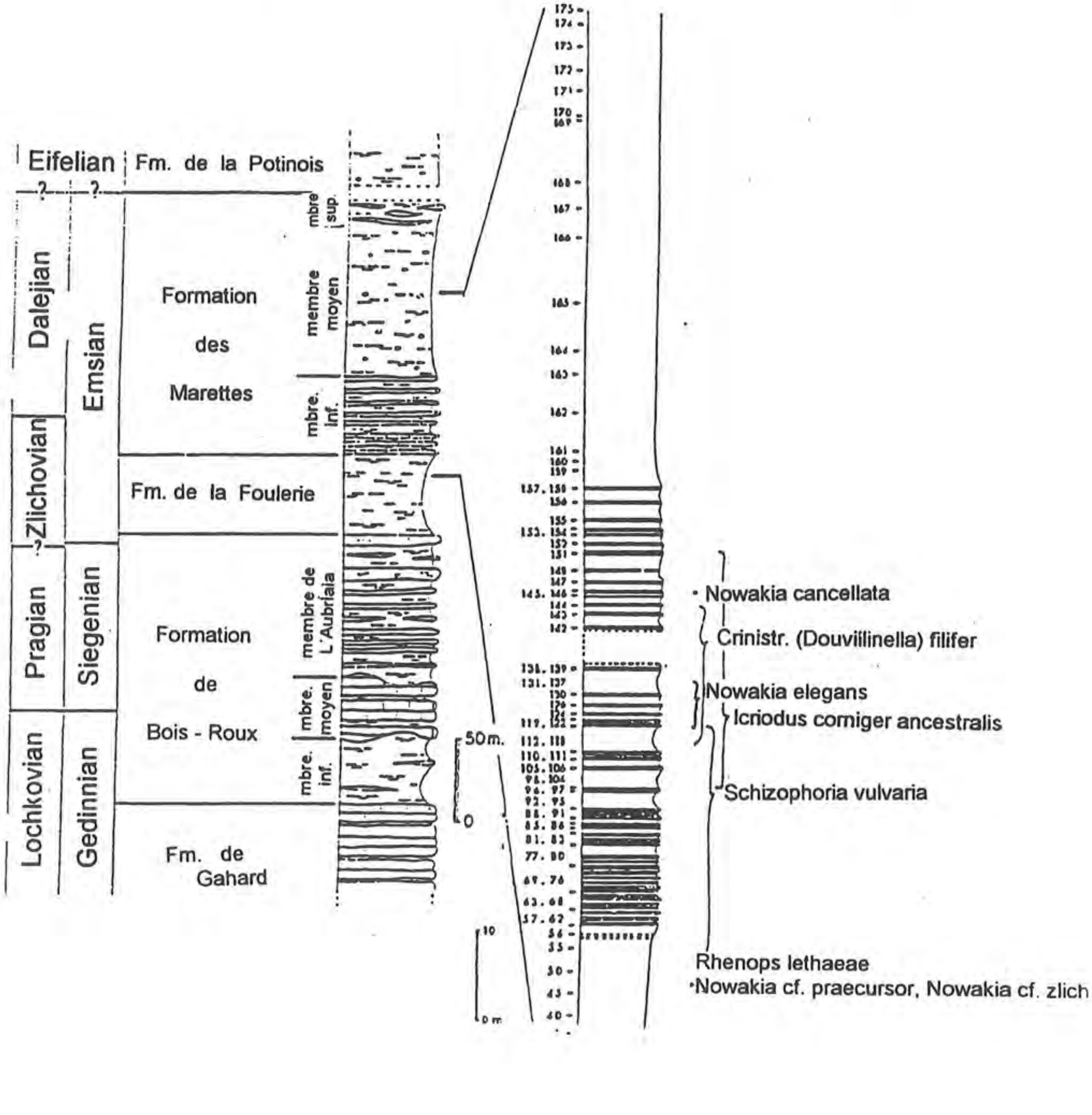

GSSP
Pragian
Emsian
GSSP
Eifelian
Pragian
Zlichovian
Dalejian
Bohemian subdivision in the classical sense
P. pireneae
P. kitabicus
P. excavatus
nothoperbonus
P. inversus
P. serotinus
P.c. patulus
P.c. partitus
Conodont zones,
G. strangulata
N. zlichovensis
N. praecursor
N. barrandei
N. elegans
N. cancellata
N. richteri
N. maureri
N.s. antiqua
Nowakiids
Anetoceras
Mimagoniatites fecundus
G. laevis
Gyroceratites gracilis
Anarcestes
Rhenops lethaeae
Treveropyge rotundifrons
Treveropyge prorotundifrons
Kayserops kochi
Burmeisterella quadrispinosa u.a.
Parahomalonotus mutabilis
Digonus gigas gigas
Tropidoleptus carinatus
Schizophoria provulvaria
Schizophoria vulvaria
Arduspirifer arduennensis antecedens
Arduspirifer arduennensis arduennensis
Arduspirifer mosellanus mosellanus
Arduspirifer mosellanus dahmeri
Euryspirifer dunensis
Euryspirifer paradoxus
Alatiformia
Paraspirifer praecursor
Paraspirifer sandbergeri ssp
Paraspirifer cultrijugatus ssp.
Brachyspirifer ignoratus
Crinistrophia (Donvillinella) filifer
Gladbach (Stadtfeld)
Klerf
Berlé
Wiltz
Wetteldorf
Heisdorf
Lauch
Rhenish subdivision in its classical sense
Rittersf.
Nellen-köpfchen
Lahnstein
Laubach
early Kondel
late Kondel
Ulmen
Singh.
Vallend.
Early Emsian
lower boundary in the classical sense
Late Emsian
Eifelian

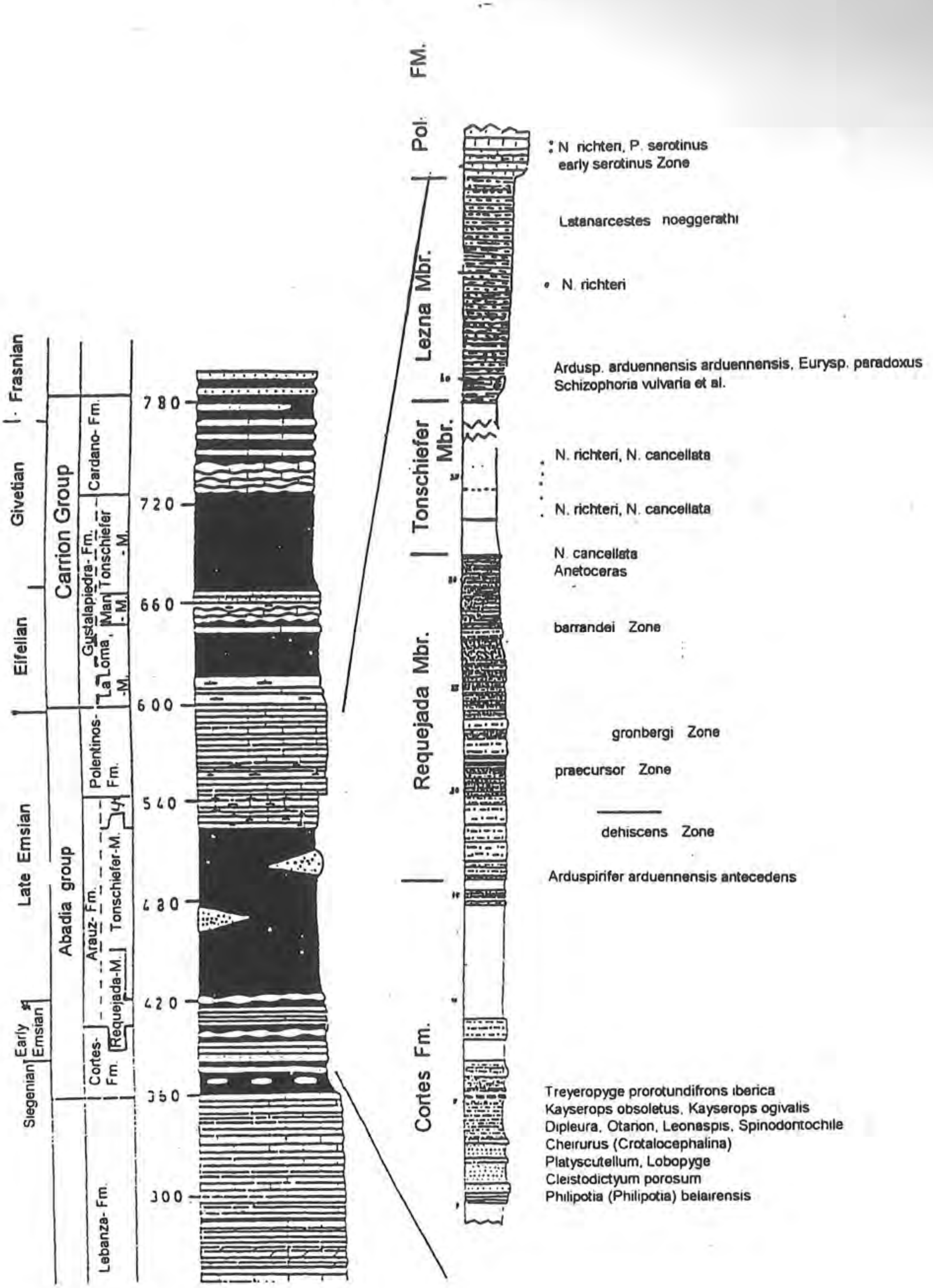
Reun ar C´Hrank
(Fig. 2)



La Lézais
(Fig. 3)

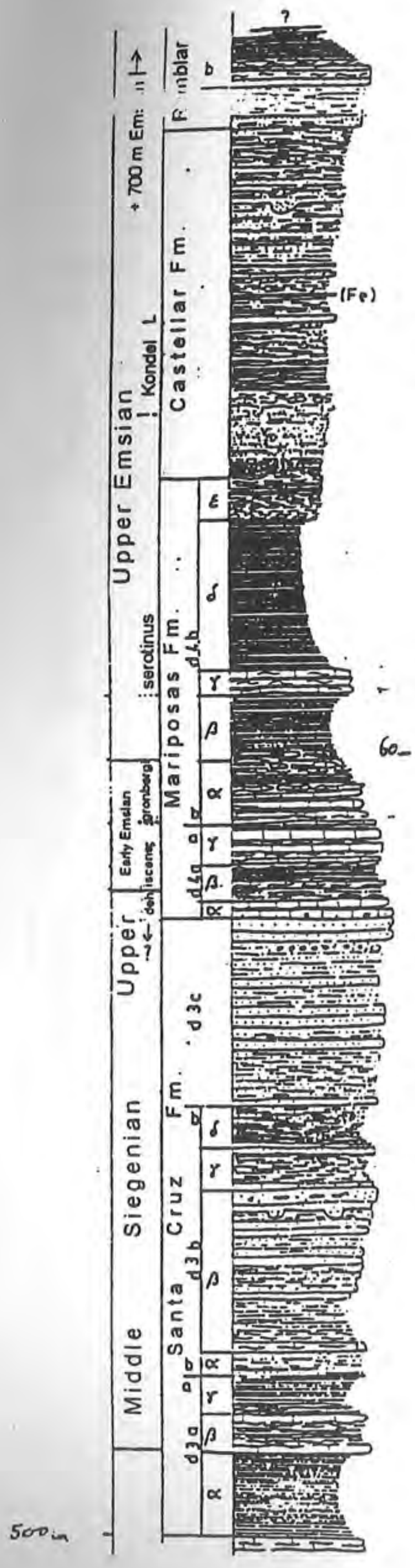


Palencia
(Fig. 4)



* lower boundary in the classical sense

Celtiberian Chains
(Fig. 5)



Schizophoria vulvaria, Alatiformia alatiformis
Brachyspirifer ignoratus, Arduspirifer mosellanus, Paraspirifer sandbergeri brevimargo
serotinus zone

Nowakia richteri, Alatiformia alatiformis, Eurysp. paradoxus
Arduspirifer mosellanus ssp., Ardusp. mosell. gracilis

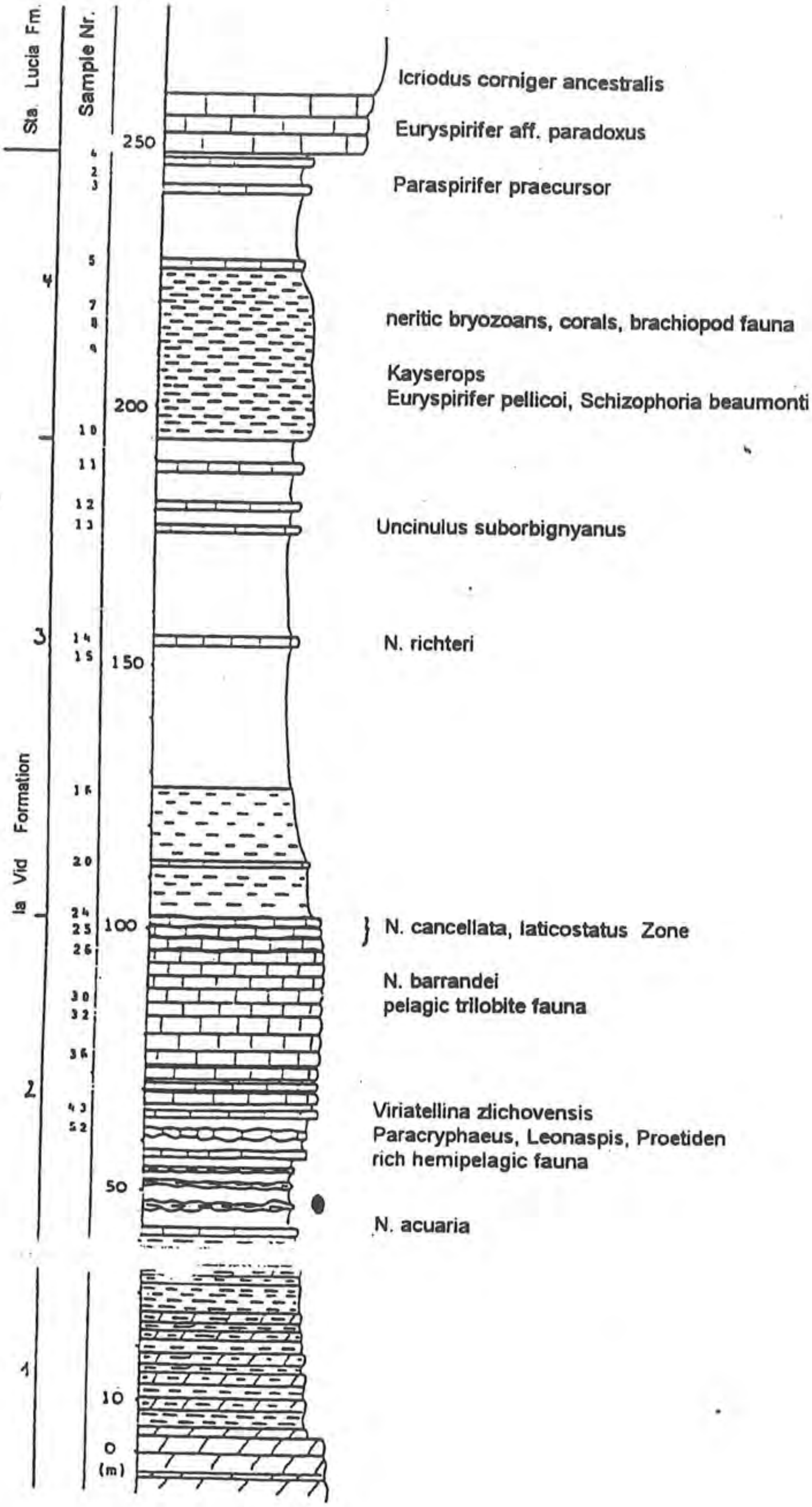
N. richteri, serotinus zone

N. cancellata, Rhenops lethaeae
N. elegans
N. barrandei, Anetoceras

gronbergi zone
dehiscens zone

Arduspirifer ard. antecedens - latestriatus, Acrosp. fallax, Eurysp. pellicoi
I. sigmoidalis, Polygnathus excavatus, Ardusp. prolatestriatus

Southern Cantabrian Mountains
Prov. Leon
(Fig. 6)



Subdivision of the Emsian stage - state of discussion in the German Subcommission on Devonian Stratigraphy

U. Jansen, Frankfurt (comp.)

The working group of the German SDS for subdivision of the Emsian stage (compare SDS Newsletter No. 14) held its second meeting this May in Gottingen. Among the participants, the stratigraphical levels under discussion *(elegans/ cancellata* and *inversus* boundaries) have still been considered to lie within the best interval. Discussions focused on distinct areas and sections that should be selected for future work. It has been stressed, that efforts must be carried out internationally. As concerning the target areas, the sections in the Cantabrian Mountains and the Celtiberian Chaines as well as the Barrandian area were regarded as key areas (e.g. Villayandre section, Nogueras section, Cisarska Rokle section near Srbsko) and shall be debated with respect to distinct plans for field-work during the present meeting. The type area of the Emsian, i.e. the German neritic sections, shall be considered, too.

The Rheinisches Schiefergebirge (especially the Middle Rhine area) with the classical boundary between Early and Late Emsian shall be reinvestigated and clearly documented. Correlations to other areas, e.g. the Armorican Massif, the Celtiberian Chaines, the Cantabrian Mountains and the Anti-Atlas have to be thoroughly checked. Such investigations should be based e.g. on brachiopods, trilobites, and palynomorphs of the neritic facies and compared with pelagic elements e.g. conodonts, nowakiids, goniatites. Areas where neritic and pelagic facies are co-occurring are of main interest.

The sections in the Barrandian area have to be reinvestigated with regard to the Zlichovian/Dalejian boundary interval. Systematic problems concerning the distinctive nowakilds *Nowakia elegans* and *N. cancellata* must be resolved quickly. Linkage to conodont data must be elucidated.

In tile Cantabrian/Celtiberian sections (see document by JAHNKE & JANSEN to this meeting) containing both neritic and pelagic facial elements, already existing investigations should be intensified by international cooperation. Due to the different facies developments, the chance for comparison of neritic and pelagic faunas is highly promising.

Investigations in the Moroccan Pre-Sahara are currently under way. Sections yielding both neritic and pelagic facies promise good possibilities for correlation.

Future aims/activities:

The transition from *Nowakia elegans* to *N. cancellata* should be clarified in the Barrandian area. Subsequently, conodonts from around the *Polygnathus inversus* level should be investigated in great detail The development of both faunal groups must be compared to other areas (e.g, in the Spanish sections). Palynological studies shall be integrated as much as possible. Correlations to areas with neritic facies (mainly based on brachiopods and trilobites) are required, especially to the type area of the Emsian. To clarify the position of distinct conodont and nowakiid evolutionary stages in the Zlichovian/ Dalejian boundary interval in comparison to the classical Early/Late Emsian boundary must be one of the main goals of future work. The newly defined upper part should be named Dalejian. If the lower part is named Zlichovian as favoured by some of the working group's members the base of the Emsian as presently defined would have to be reconsidered in order to leave the base of the original Zlichovian unchanged.

Redefinition of the German Late Devonian 'Stufen'

Matthias PIECUIA (Krefeld) & Eberhard SCHINDLER (Frankfurt)

At the annual meeting of the German Subcommission on Devonian Stratigraphy on March 1, 1997, a working group has been set up with the aim to redefine the traditional 'Stufen' of the German Late Devonian. Problems and misunderstandings of these 'Stufen' that historically arose, have already been stated by Willi ZIEGLER at the annual meeting of the internationalSDS in Rochester, July, 1997. These 'Stufen' have often been misleadingly regarded as chronostratigraphic units even though they neither have been biostratigraphically defined exactly nor did exist any reference sections. Therefore, a modern revision is required. The subdivision of the German Late Devonian into five 'Stufen' is strongly related to lithostratigraphic subdivisions used by the different German Geological Surveys which therefore have great interests in the redefinition of these 'Stufen'.

The German Late Devonian traditionally is subdivided as following ('Stufen); the boundary between the Adorf/Nehden and the Frasnian/Famennian correlates roughly, not precisely.

Recently, proposals also exist for subdividing the Frasnian and Famennian stages. At the annual meeting of the SDS in Rochester, July 1997, Willi ZIEGLER & Charles A. SANDBERG proposed a conodont-based subdivision of the Famennian into three substages and introduced the possibility of creating a Late Frasnian substage. For the 1998 SDS meeting in Bologna, R. Thomas BECKER & Michael R. HOUSE proposed a subdivision of the Frasnian based on cephalopods. A second proposal for subdividing the Famennian into three substages by R. Thomas BECKER is also based on cephalopods. A comment on the proposed Frasnian and Famennian subdivisions will be given by Charles A. SANDBERG and Willi ZIEGLER. Differences on the suggested boundaries between the conodont-based and the cephalopod-based proposals still have to be discussed in the future, the cooperation of further specialists will be required to solve the problems.

Since March 1997, the working group met three times. The following persons have participated:

Michael AMLER (Univ. Marburg), Konrad BARTZSCH (Saalfeld), R.Thomas BECKER (Mus. f.Naturkunde, Berlin), Peter BENDER (Univ. Marburg), Horst BLUMENSTENGEL (Geol. Survey Sachsen-Anhalt, Halle), Peter BUCHHOLZ (Univ.

Braunschweig), Claus-Dieter CLAUSEN (Geol. Survey Nordrhein-Westfalen, Krefeld), Helga GROOS-UFFENORDE (Univ. Gottingen), Heiner I HEGGEMANN (Geol. Survey I lessen, Wiesbaden), Dieter KORN (Univ. Tubingen),Matthias PIECHA (Geol. Survey Nordrhein-Westfalen, Krefeld), Karl-Heinz RIBBERT (Geol.Survey Nordrhein-Westfalen, Krefeld), Eberhard SCHINDLER (Forsch.-Inst. Senckenberg, Frankfurt), Immo SCHULKE (Univ. Hannover), Dieter WEYER (Mus. f. Naturkunde, Magdeburg), Willi ZIEGLER (Forsch.-Inst. Senckenberg, Frankfurt).

The first meeting took place at the University of Marburg on August 29, 1997. The historical problems of the 'Stufen' and the aims of the working group were discussed. The participants proposed field trips to different German areas with well known Late Devonian sections of the basinal facies with stratigraphically important faunal groups, such as conodonts, cephalopods, and ostracods.

The second meeting was field on October 18 and 19, 1997, in the area of the northern border of the Rhenish Massif, east of the river Rhine (Rechtsrheinisches Schiefergebirge), i.e. in the region from where the names of the traditional German 'Stufen' had been derived. The working group visited six classical Late Devonian sections guided by R. Thomas BECKER, Dieter KORN, Claus-Dieter CLAUSEN and Karl-Heinz RIBBERT. Two of these sections (i.e. Ziegelei Nie and Beringhauser Tunnel) were considered to be most interesting at present; detailed sampling for conodonts, cephalopods and ostracods has already been done in 1997. The samples are currently under investigation.

The third meeting was arranged in Thuringia (Thuringisches Schiefergebirge) on May 16 and 17, 1998, by Konrad BARTZSCH, Horst BLUMENSTENGEL, and Dieter WEYER in the area of the Schwarzburg Anticline and the Berga Anticline. The most important section of this area is situated at the Kahlleite quarry and ranges from the Frasnian up to the Lower Carboniferous. A revision of the conodont faunas and investigations on sedimentological features of the Late Devonian beds are provided.

The next meeting of the working group is planned for October 24 and 25, 1998. A field trip to Late Devonian sections in the Harz Mountains will be organized by Peter BUCHHOLZ und Heiko HUNEKE (Univ. Greifswald).

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Comments on Proposed Frasnian and Famennian Subdivisions

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Introduction

With great interest we have read advance copies kindly provided by T. Thomas BECKER of two documents to be submitted by him to the IUGS Subcommission on Devonian Stratigraphy (SDS) meeting at Bologna, Italy, on June 22, 1998: "Proposals for an International Substage Subdivision of the Frasnian," by R. Thomas BECKER & M. R. HOUSE and, "Prospects for an International Substage Subdivision of the Famennian," by R. Thomas BECKER. We are in agreement with some of the Substage boundaries suggested in these documents, as we have already proposed in our document (ZIEGLER & SANDBERG, 1997) submitted to the SDS meeting at Rochester, N.Y. on July 21, 1997. Therein, we proposed the *semichatovae* Transgression within the Early *rhenana* Zone as the boundary to separate out an Upper Frasnian Substage, with no opinion being given on a possible Lower Middle Frasnian Substage boundary. For the Famennian, we proposed a tripartite subdivision with the Lower-Middle Famennian Substage boundary placed at the start of the Early *marginifera* Zone and a Middle-Upper Famennian Substage boundary placed at the start of the Early *expansa* Zone. Now, we would strongly support the BECKER & HOUSE (1998) additional proposal of a Lower-Middle Frasnian Substage boundary situated at the start of the *punctata* Zone.

Following are our comments on the two Frasnian Substage boundaries proposed by BECKER & HOUSE (1998) and the two Famennian Substage boundaries discussed by BECKER (1998).

Lower-Middle Frasnian Substage Boundary

The start of the *punctata* Zone would be an ideal position for this boundary, even though the major worldwide transgression (IIc) takes place in the middle of this zone (JOHNSON et al., 1985; JOHNSON & SANDBERG, 1989, JOHNSON & KLAPPER, 1992). *Palmatolepis punctata* is an easily recognized pelagic species within a lineage between *Pa. transitans* and *Pa. jamieae* (ZIEGLER & SANDBERG, *1990).* Identification of this zone is supported in shallower water sequences by the appearance of *Ancyrodella gigas* s.s. A further aid to identification *is Ancyrodella gigas* sensu ZIEGLER. which SANDBERG et al. (1989b) showed to first occur just slightly before the start of the *punctata* Zone.

Middle-Upper FrasnianSubstage Boundary

BECKER & HOUSE (1998) discussed two possible boundary positions: (I) at the *semichatovae* Transgression, and (II) at the base of the "Lower Kellwasser interval." We previously advocated and still most strongly support their first choice at the start of the *semichatovae* Transgression for the Substage boundary. This position marks the transgression within the Late Devonian and within the entire Devonian (JOHNSON et al., 1985, i.a.) and is a natural boundary that can be readily used by biostratigraphers globally. In shallower water carbonate platform sequences, which are the most widespread of Frasnian deposits, the entry of the opportunistic species *Palmatolepis semichatovae* provides the only marker within an otherwise monotonous sequence of multitudinous species of *Polygnathus*, the morphotypes and relationships of which are presently not well understood. In fact, being a shallow water genus, *Polygnathus* includes many provincial species of limited utility for interregional or intercontinental correlation. *Palmatolepis semichatovae*, however, provides a unique tie, unparalleled in the Devonian, between pelagic and neritic conodont faunas. *Palmatolepis* faunas within carbonate-platform sequences may contain 70-100% *Pa. semichatovae*, whereas basinal or pelagic sequences contain <10% of this species (SANDBERG et al., 1989a).

Arguing against the entry of *Pa. semichatovae* at the start of the IId Transgression as a useful position, BECKER & HOUSE (1998) apparently were influenced by JOHNSON & KLAPPER (1992). That paper, in contrast to previous papers on the Devonian sea-level curve (JOHNSON et al., 1985; JOHNSON & SANDBERG, 1989; JOHNSON et al., 1991), interpreted that the IId Transgression did not coincide with, but was earlier than, the *semichatovae* Transgression. This interpretation, however, was based primarily on a condensed section at Sweetland Creek, Iowa, in which their conodont Zone 11 (= our *jamieae* Zone, according to BECKER & HOUSE, 1998, **but more likely our** Early *rhenana* Zone before the entry of *Pa. semichatovae,* see below) is thought to be represented by 73 cm of siltstone without conodonts. This interpretation is supported by a subsurface section in which their *Palmatolepis domanicensis* (= one of the morphotypes of our *Pa. hassi)* is succeeded about 4 m higher by *Pa. semichatovae.* They mentioned the same succession as occurring in the Martin Formation near Globe, Arizona. Both the Iowa and Arizona areas are located on the Transcontinental arch (SANDBERG et al., 1989, fig. 1), where there are many hiatuses and irregularities because the IId Transgression occurred through drowned valleys and over an uneven topography. In contrast, SANDBERG et al. (1989a) documented the coincidence of the *semichatovae* and IId Transgression at 14 carbonate-platform, slope, and basinal localities in the western United States. At many of these sections, and now at even more studied localities, *Pa. semichatovae* occurs in succession with its immediate ancestor, *Pa. rhenana brevis,* within the Early *rhenana* Zone, and **not** in the *jamieae* Zone. Moreover, KLAPPER et al. (1996) showed *Pa. semichatovae* as occurring only above Zone 11. However, this position is BELOW their first occurrence of *Pa. foliacea.* In contrast. we have recorded *Pa. foliacea* as first occurring much earlier, that is, at the start of the *jamieae* Zone. Consequently, it seems apparent to us, that these two first occurrences, as recorded by KLAPPER et al. (1996), are retarded biofacies entries.

It is also probable that BECKER & HOUSE (1998) employed different identifications of some of our species of *Palmatolepis* in equating the entry of *Pa. semichatovae* with the start of Zone 11, which **they** equate to our *jamieae* Zone. This position is not possible because we (ZIEGLER & SANDBERG, 1990) have shown that *Pa. semichatovae* first occurs within the Early *rhenana* Zone and does not range higher. Only a single specimen, which may have been reworked, has been recorded in the Late *rhenana* Zone in the extensive D/C Conodont Database (CHARPENTIER & SANDBERG, 1992). As shown by ZIEGLER & SANDBERG (1990, fig. 9), *Pa. semichatovae* evolved from *Pa. rhenana brevis* (e.g., their Pl. 13, figs. 1-2), which together with *Pa. rhenana nasuta,* marks the start of the Early *rhenana* Zone. Some transitional forms, which are difficult to assign, connect the two species. In turn, *Pa. rhenana brevis* evolved from long-lobed forms of *Pa. hassi* (e.g., ZIEGLER & SANDBERG, Pl. 2, fig. 7), which do occur within the *jamieae* Zone. Some workers may have confused these morphotypes of *Pa. hassi with Pa. rhenana nasuta* or with *Pa. rhenana brevis,* which commonly can be distinguished by their more strongly nodose carinas. Below *Pa. semichatovae,* KLAPPER et al. (1996, figs. 7.3, 7.5, 7.8) also recorded specimens that we would interpret as being ancestral to *Pa. semichatovae. Thus,* we do not find any evidence to agree with the BECKER & HOUSE (1998) interpretation that the *semichatovae* Transgression occurred at the start of the *jamieae* Zone.

At Steinbruch Schmidt, below the Lower Kellwasser Limestone, we have recorded *Pa. semichatovae (ZIEGLER & SANDBERG,* 1990, fig. 4 and table 2, key no. 21) at <1.25 m below the entry of *Pa. rhenana nasuta* (key no. 23) and < 2 m below the entry of *Pa. rhenana rhenana* (key no. 24/2), which marks the start of the Late *rhenana* Zone. If bed (key no. 21) were in the *jamieae* Zone, there would be too short a rock interval to record the entire Early *rhenana* Zone in comparison to the Late *rhenana* Zone, give the approximately equal length of these two zones and the comparatively equal rates of deposition at Steinbruch Schmidt. It should be noted that although beds (key no. 21 and 22) do not contain *Pa. rhenana nasuta,* they do contain *Pa. gigas gigas*, which first occurs within the Early *rhenana* Zone.

Furthermore, BECKER. and HOUSE (1998, p. 5) stated:

"Faunas from Martenberg and the main Lion access road show that the Belgian *Pa. semichatovae* dated as Early *rhenana* Zone (SANDBERG et al., 1992), are accompanied by typical Zone 11 conodonts ... whilst the base of the Early *rhenana* Zone at the Martenberg type section clearly falls in Zone 12. In other words, the *semichatovae* level **projects** (our emphasis) to a position below the base of the Early *rhenana* Zone in the type section, where it can probably be correlated with solid limestones assigned to *the jamieae Zone*."

The thick bed to which they refer is bed. "q" of ZIEGLER (1971), which was erroneously drafted as being assigned entirely to the *Ancyrognathus triangularis* Zone (now Late *hassi* and *jamieae* Zones). Although this bed was later shown by ZIEGLER & SANDBERG (1990, fig. 3, table 1), to belong entirely within the *jamieae* Zone, using a similar lithologic profile, this published section is only one of three profiles that we sampled for conodonts at this locality. The reason for sampling additional profiles is that Martenberg deposition occurred near a pelagic, deep-water hematitic smoker that produced hot, highly oxygenated waters. Whereas such an environment induced prolific growth of conodont organisms, it was also responsible for production of many minor submarine discontinuities or hiatuses due to different rates of strong current flow. The conodont faunas are so large that workers must search carefully to discern the incoming of the first few new zonal indicators. From two other nearby sections in the same 10-meter block, we have collected three and five sequential samples, respectively, from the same 38-centimeter bed ("q"). In these other two sections we found that bed "q" contains faunas of the Late *hassi, jamieae,* and Early *rhenana* Zones, thus enabling us to later correct the erroneous drafting in the original profile of ZIEGLER (1971).

The alternative position for the Middle-Upper Frasnian boundary, more strongly advocated by BECKER & HOUSE (1998), is at the base of the Lower Kellwasser interval. This position is not marked by the incoming of any species of conodont known to us. Hence, it would be a position difficult, if not impossible, to recognize globally merely on the basis of a facies change from lighter to darker limestone, such as occurs in Germany, France, Morocco, and south China. In the western United States, for example at Devils Gate and Coyote Knolls (SANDBERG et al., 1997), there is not generally a change in sedimentation within deposits of the Late *rhenana* Zone. However, a black shale may be present at this position at Little Mile-and-a-Half Canyon.

Lower-Middle Famennian Substage Boundary

As we have previously stated (ZIEGLER & SANDBERG, 1997), the best position for this boundary would be at the start of the Early *marginifera* Zone. This position, easily recognized by a major change in conodont faunas, coincides with an important eustatic rise that can be identified in North America, western Europe, Asiatic Russia, South China, and western Australia (HOUSE & ZIEGLER, 1997). The only other usable position, easily recognized in conodont faunas is the Latest *crepida* Zone, but this position. is too low for approximately equal subdivisions of the Famennian. The alternate position, the start of the former *velifer* Zone (= Latest *marginifera* Zone) as proposed by BECKER (1998) is not as well recognized as the Early *marginifera* Zone, because it is based on the incoming of a shallow water species. This incoming coincides with a major eustatic fall. For example, a major regression and continent-wide erosion begins with the Latest *marginifera* Zone in North America (SANDBERG et al., 1997, and references therein). The same regression can be recognized in many other regions (HOUSE & ZIEGLER, 1997).

Middle-Upper Famennian Substage Boundary

As we have previously stated (ZIEGLER & SANDBERG, 1997) and as BECKER (1998) has partially agreed with, this is probably an ideal position for a Middle-Upper Famennian Stage boundary. This position coincides with a major eustatic rise and is probably the best documented of all late Famennian positions. For example, SANDBERG (1976) initiated the recognition of interregional conodont biofacies extending between shallow-water and deep-water environments, based mainly on an extensive study of the former Lower *styriacus* (= Early *expansa)* Zone. The conodont faunas of this Zone in Germany and elsewhere in western Europe are equally well studied already (ZIEGLER, 1962; SANDBERG & ZIEGLER, 1979), so we foresee nothing that could be accomplished by additional conodont studies in order to discern a faunal change corresponding to the change in ammonoid faunas, as suggested by BECKER (1998).

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SDS Meeting, June 23, 1998, Bologna

Proposal of boundaries for subdivision of the Famennian Stage: miospore implications

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If subdivision of the Famennian Stage is to be based on the first occurrence of conodont zones that can be widely recognized not only by their zonal indicators, but also by their accompanying faunas (Ziegler & Sandberg, 1997), they should also calibrate with the floral zonations, particularly the miospore zonation, the unique tool for correlating the continental and marine realms in the Famennian.

Ziegler & Sandberg (1997) proposed the base of the Early expansa Zone as the lower boundary of an Upper Famennian Substage. However the base of this zone occurs stratigraphically well below one of the most useful biohorizons suggested for the base of the Strunian (Conil & Lys, 1980) i.e. that of the miospore Retispora lepidophyta which starts somewhere in the Middle or Late expansa Zones, most probably close to the base of the Late expansa Zone (Dreesen et al., 1993; Streel & Loboziak, 1996). In the Franco-Belgian basins, the Early expansa Zone is poorly known and the eustatic rise, if any, really begins higher, at the base of that Strunian i.e. the base of the Epinette Shales or the Comblain-au-Pont Beds (The base of the Fa2d sensu Bouckaert et al. 1969). R. lepidophyta probably derived from the older R. macroreticulata, noted for the first time from the Montfort Formation in a section which contains also the Latest marginifera Zone. R. lepidophyta is a very distinctive miospore, present worldwide, from subpolar to equatorial regions, and is certainly one of the most common biostratigraphical marker used in Palaeozoic palynology.

The base of the Early marginifera Zone, proposed by Ziegler & Sandberg (1997) as the lower boundary of a Middle Famennian Substage, is near the base of Grandispora famenensis, another distinctive miospore which first appears somewhere in the Late rhomboidea or in the Early marginifera Zones (Streel & Loboziak, 1996). G. famenensis var. minuta, a variety with reduced ornamentation, first occurs in the upper part of the Esneux Formation (Condroz Sandstone Group), immediately followed by the first occurrence of the typical variety (G. f. famenensis), a succession also observed at the Eletz / Petrikov limit in Byelorussia (Loboziak et al., 1997). Thus the first occurrence of G. famenensis appears to be a good marker for long distance correlation within the southern and northern provinces of Euramerica.

Significantly, the four Substages of the Famennian as proposed by Streel et al. in press, can also be characterized by the first occurrence of miospores as shown here on Fig. 1 which also indicates the range of uncertainty in the correlation of conodonts and miospores.

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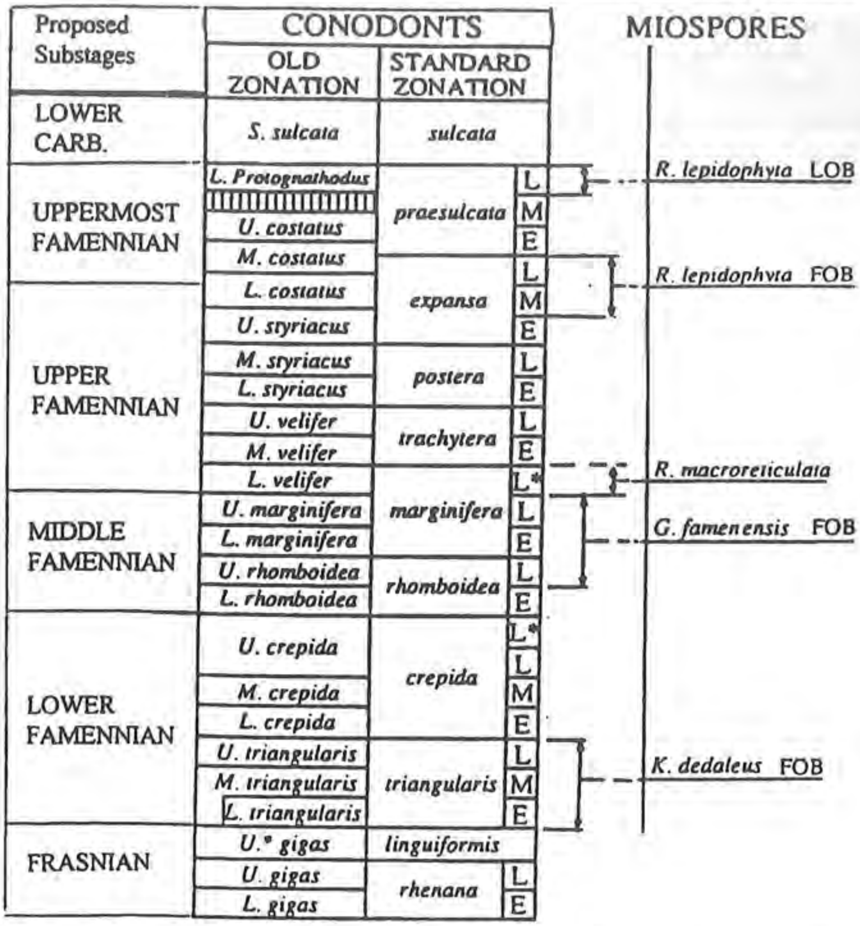

Fig. 1-Proposal for Famennian Substages after Streel et al., in press, their correlation with current and old conodont zones and the occurrence of a few selected miospores (FOB = well defined first occurrence biohorizon, LOB = well defined last occurrence biohorizon).

SDS Meeting, June 23, 1998, Bologna

Proposal for a Strunian Substage and a subdivision of the Famennian Stage into four Substages

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Strunian Substage

1. The Strunian is based upon the Etroeungt Limestone ("Calcaire d'Etroeungt") and was introduced by de Lapparent (1900, p. 860) and later considered as a Stage by Barrois (1913, p. 16) and Maillieux & Demanet (1929), This limestone was studied by Gosselet (1857) in the Parcq Quarry at Etroeungt near Avesnes (Department of the North, France) and has been updated by Sartenaer & Mamet (1964). The Strunian has been widely used, following Gosselet's guide-line, for beds containing a transitional fauna between the late Devonian and the early Carboniferous (as understood before the latest modification of the Devonian/Carboniferous boundary). The Strunian has been mentioned and investigated in almost one hundred sedimentary basins on most continents. Its faunas and floras have been studied by various authors and, in some regions,

the Strunian has even been subdivided into two or three parts according to their fossil content or sedimentary facies. The latter are concerned with the Velbert Anticline (Bergisches Land, Germany : Paul, 1939), North Devon (England : Goldring, 1957) or, in the type area, the Dinant Synclinorium (Conil, 1964).Strata assigned to the Strunian may reach a thickness of 180 m to 430 m in Algeria or 100 to 260 m in Armenia. We believe therefore that the term Strunian is worth being properly defined and retained (Sartenaer, 1997).

2. In this paper we do not intend to review the many interpretations of the term Strunian in the literature. We will focus on the relevant micro-faunas and -floras available in the type area, in Belgium and northern France. We shall keep in mind that all the Devonian Stages are characterized by the first occurrence of microfossils (basically conodonts). Consequently it would be important to use the same kind of criteria to define the Substages.

3. Foraminifers, miospores, and to a lesser extent, conodonts and ostracods have been discovered in many localities across the Dinant Synclinorium. However, it is in the eastern part of Belgium, notably in the Ourthe Valley, a classical area for the lithostratigraphy of the middle and late Famennian, that these biostratigraphical data are the most reliable. Correlation between the Chanxhe section and the Tohogne borehole using the first occurrence and biometric analysis of the populations of Retispora lepidophyta (Fig. 1 ; Streel, 1966 ; Bouckaert et al., 1978 ; Dreesen et al., 1993 ; Maziane et al. in press ; Maziane, unpublished) shows the following relevant biostratigraphical events. In ascending order these are : 1) first occurrence of R. lepidophyta, 2) foraminifers of the Df3d Zone, associated with conodonts belonging to the Late expansa Zone including Bispathodus ultimus, 3) first occurrence of Quasiendothyra kobeitusana (Df3e Zone)

4. The same sequence of miospores and foraminifers is observed in the type area (Avesnois, northern France), at levels situated more than 100 m below the Etroeungt Limestone, i.e., near the base of the Epinette Shales (Fig. 2). For this reason Conil & Lys (1980) have defined the Strunian in the Avesnelles and Saint Hilaire sections (France), at the first occurrence (in unit i) of R. lepidophyta, followed by bilaminated Eoendothyra (E. communis radiata and E. radiata), characterized by a radial inner layer. Many carbonate microproblematica (Kamaena spp, Menselina spp, ...) occur at the same levels.

5. If the Df3d foraminifer Zone obviously belongs to the Late expansa Zone (see 3 above), it is still unknown whether the base of the R. lepidophyta Zone also belongs to the same conodont Zone, or better to the uppermost part of the Middle expansa Zone. The latter zone is found in the nearby Esneux railway section some 55 m below the Late expansa Zone. Therefore, unlike Conil & Lys (1980), we do not propose to define the lower boundary of the Strunian Substage in the Franco-Belgian shelf area by foraminifers or miospores, but instead we recommend that boundary be defined at the base of the Late expansa Zone in a pelagic facies. The various sections of the reference Franco-Belgian area should thus be used as either "parastratotypes" or "auxiliary reference sections".

6. Ziegler & Sandberg (1997) proposed the base of the Early expansa Zone to define the base of the highest Substage of the Famennian. However this would be well too below the base of the Strunian and would prevent any possibility of correlating this Substage in the shelf areas around the world, due to the scarcity of stratigraphically significant foraminifers or miospores at this level. On the contrary, the successive appearances of R. lepidophyta and double-walled Eoendothyra, which approximate the base of the Late expansa Zone, have been found in shelf facies in many places around the world, particularly in central and eastern Eurasia. R. lepidophyta probably evolved from R. macroreticulata. The double-walled Eoendothyra evolved from single-wall Eoendothyra (Df3g Zone) and gave rise to true Quasiendothyra which are typical of the uppermost Devonian Df3e Zone. Elements of these sequences of bioevents have been controlled worldwide (Fig. 3). Other paleontological groups display major changes at this level, such as the Rugosa which radiate after their decline during the late Frasnian (Poty, in press). We now have a precise correlation between conodont and ichthyolith Zones in the pelagic facies. The Phoebodus limpidus Zone equates with the expansa + praesulcata Zones (Ginter & Ivanov, 1995, and in press).

Other Substages of the Famennian

7. Ziegler & Sandberg's (1997) suggestion to subdivide the Famennian Stage into three Substages only, would significantly change the current usage of the Middle Famennian in the Belgian type area. Sartenaer (1969) has reemphasized a longstanding (Mourlon 1882) Middle Famennian subdivision corresponding to the "Macigno de Souverain-Pré", i.e., approximately to the Late and Latest marginifera Zones. A subdivision of the Famennian Stage which took into account this widely used "Middle Famennian" subdivision would be appropriate to avoid confusion. However a Substage corresponding to only two conodont zones would unbalance the subdivisions of the Stage, therefore we recommend the definition of a Middle Famennian Substage between the base of the Early rhomboidea Zone and the base of the Latest marginifera Zone (Fig. 4).

8. Consequently, we propose that the Famennian Stage be subdivided into four Substages, Substage 1 (Lower Famennian), defined at the base of the Early triangularis Zone and composed of 7 conodont zones, Substage 2 (Middle Famennian), defined at the base of the Early rhomboidea Zone and composed of 4 conodont zones, Substage 3 (Upper Famennian), defined at the base of the Latest marginifera Zone and composed of 7 conodont zones and Substage 4 (Uppermost Famennian or Strunian), defined at the base of the Late expansa Zone and composed of 4 conodont zones. The base of the Middle Famennian is nearly coincident with the Condroz Event (Thorez & Dreesen 1986 and in press, Dreesen et al. 1988, Becker 1993). The base of the Middle Famennian and the base of the Upper Famennian, would more or less correspond respectively to the two major falls of sea-level noted in IIe by Johnson et al. (1986). The base of the Uppermost Famennian corresponds to a new transgressive system which, in the Franco-Belgian area, brings limy sediments containing foraminifers.

9. In conclusion, a subdivision of the Famennian into four Substages as proposed here above appears appropriate for the following reasons:

· a more accurate definition of the Strunian allows the retention of this historical concept which has been widely used for about one century;

· the Substage boundaries based on conodonts will allow long-distance correlation tto be made and facilitate correlation between shelf carbonates and deeper water facies;

· the classical "Middle Famennian" of the type area in Belgium becomes a Substage in the new subdivision;

· the proposed pattern appears rather well balanced in terms of conodont zones.

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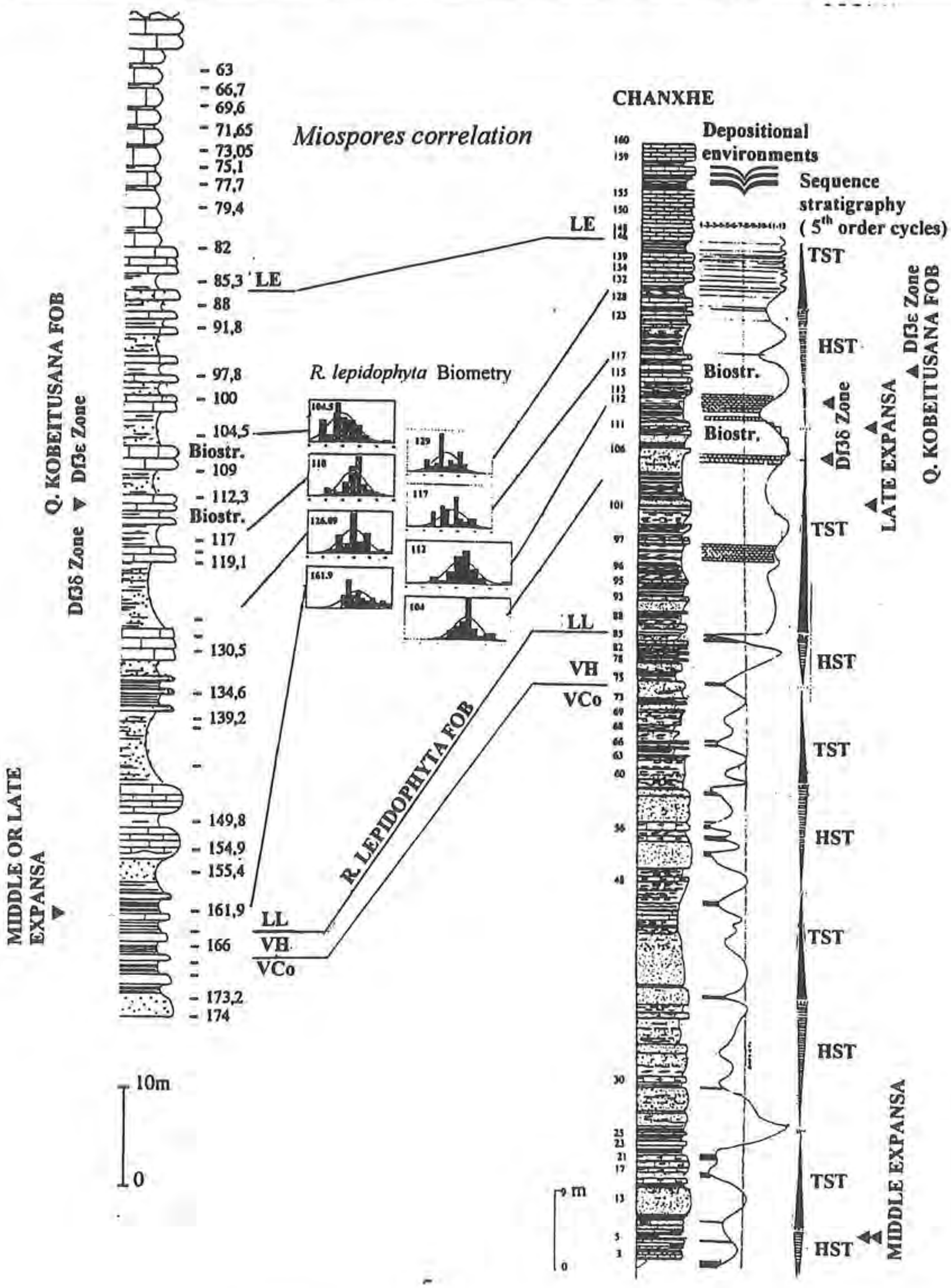

Fig. 1. Correlation between the Chanxhe section and the Tohogne borehole in eastern Belgium.
R. lepidophyta FOB = Retispora lepidophyta first occurrence biohorizon
Q. kobeitusana FOB = Quasiendothyra kobeitusana first occurrence biohorizon
Biostr. = biostrome
LE = lepidophyta explanatus Zone
LL = lepidophyta – literatus Zone
VH = verrucosa – hystricosus Zone
VCo = versabilis – cornuta Zone
Depositional environments: 1.distal alluvial, 2.supratidal, soil, evaporite, 3.intertidal, 4.subtidal, evaporitic lagoonal, 5.back barrier, tidal lagoonal, 6.barrier, 7.backshore, 8.foreshore, 9.upper shoreface, 10.lower shore face, 11.transitional, 12.lower offshore
TST = Transgressive Systems Tract
HST = Highstand Systems Tract
= faunal occurrence level in the section
= faunal occurrence level in a nearby section

FIG. 2

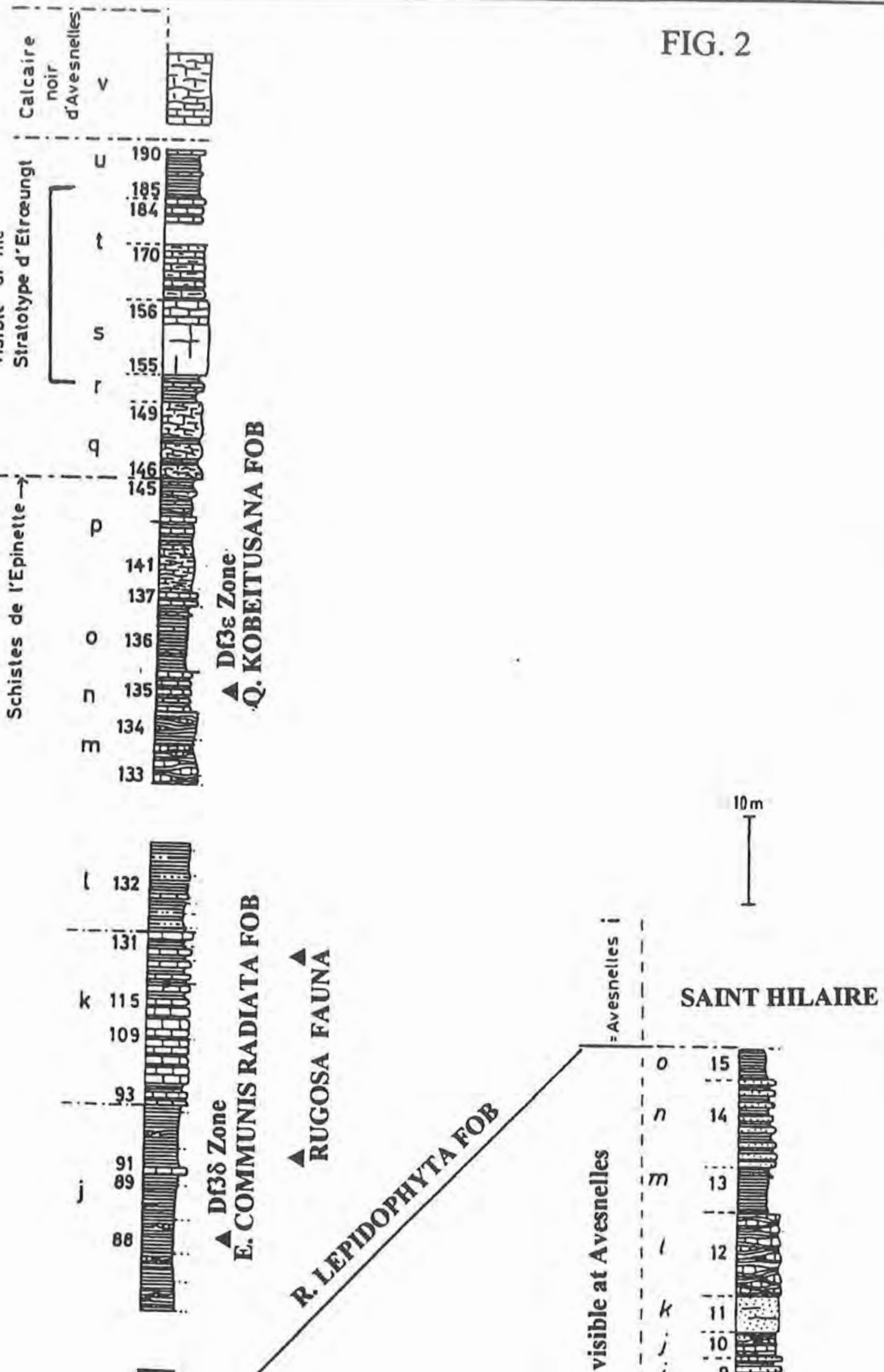

Fig. 2. Correlation between the Avesnelles and Saint Hilaire sections in northern France. (Data from Conil et al. 1974)

R. lepidophyta FOB = *Retispora lepidophyta* first occurrence biohorizon

Q. kobeitusana FOB = *Quasiendothyra kobeitusana* first occurrence biohorizon

E. communis radiata FOB = *Eoendothyra communis radiata* first occurrence biohorizon

Fig. 3. Geographical distribution of characteristic foraminifers and miospores of the Strunian Substage.
▲ = *Retispora lepidophyta* Zones
★ = *Quasiendothyra kobeitusana* Zone

FIG. 3

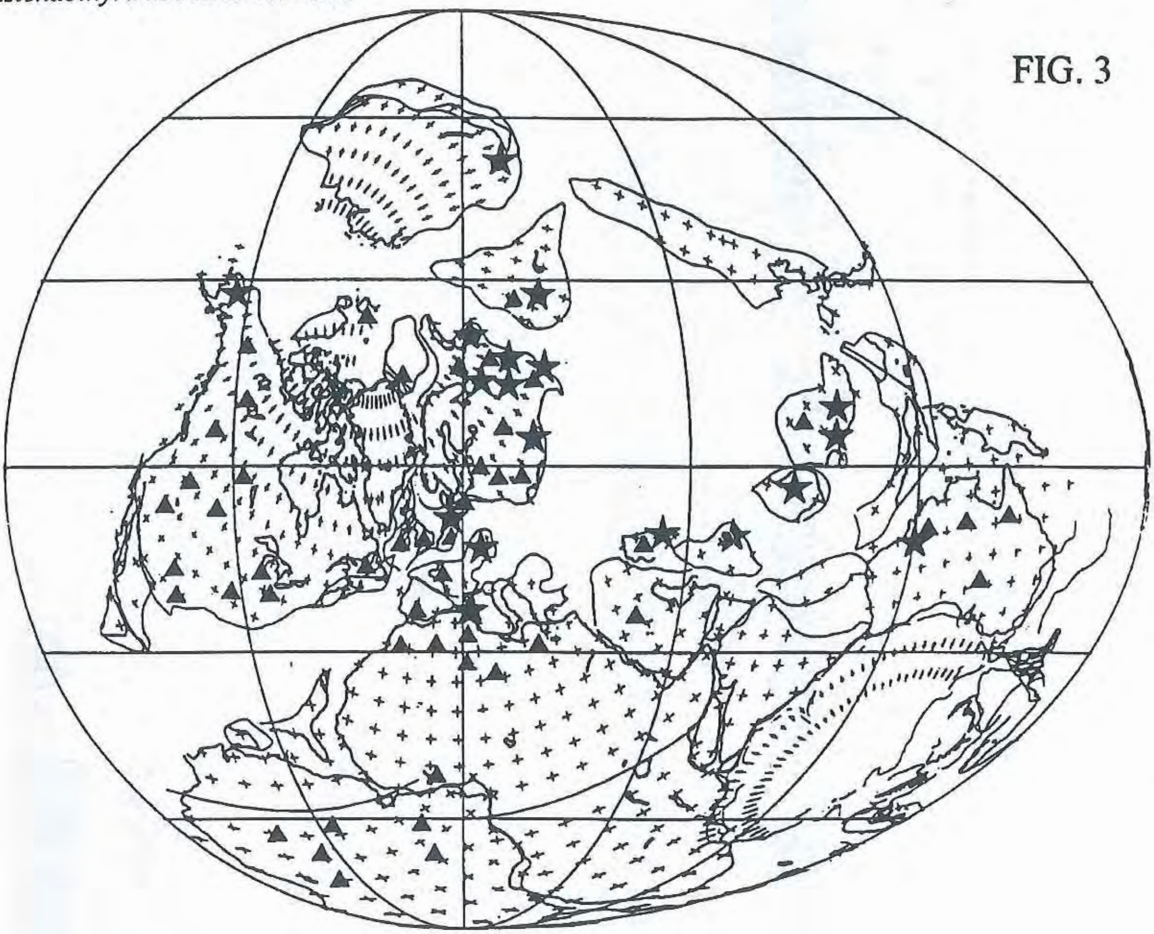

Fig. 4. Proposal for Famennian Substages and their correlation with current and old conodont zones.

FIG. 4

Proposed Substages	CONODONTS: OLD ZONATION	CONODONTS: STANDARD ZONATION	
LOWER CARB.	*S. sulcata*	*sulcata*	
UPPERMOST FAMENNIAN	*L. Protognathodus*	*praesulcata*	L
	U. costatus		M
	M. costatus		E
	L. costatus	*expansa*	L
UPPER FAMENNIAN	*U. styriacus*		M
	M. styriacus		E
	L. styriacus	*postera*	L
	U. velifer		E
	M. velifer	*trachytera*	L
	L. velifer		E
		marginifera	L*
MIDDLE FAMENNIAN	*U. marginifera*		L
	L. marginifera		E
	U. rhomboidea	*rhomboidea*	L
	L. rhomboidea		E
LOWER FAMENNIAN	*U. crepida*	*crepida*	L*
			L
	M. crepida		M
	L. crepida		E
	U. triangularis	*triangularis*	L
	M. triangularis		M
	L. triangularis		E
FRASNIAN	*U. * gigas*	*linguiformis*	
	U. gigas	*rhenana*	L
	L. gigas		E

Proposals for an International substages subdivision of the Devonian stages.

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Introduction

In the present materials there are given suggestions of the Devonian Commission of ISC ofthe Russia about the substage subdivision of stages of the Devonian system. In so doing the boundaries of stages were taken by us in accordance with the solutions of International Subcommission on Devonian stratigraphy (SDS) and are governed by selection of chronostratigraphic standard determining the boundaries of stages in GSSP's. In spite of the fact that we do not agree with many boundaries (especially Emsian, Eifelian and Frasnian) because they are not in line with earlier historically traditionally taken boundaries of stages in stratotype region of their evolution we decided not to revise the bases of stages suggested by SDS. However inside of some stages it is necessary to mark additional stages. It is mainly true for Emsian having great volume and clearly divided into two additional stages – Zlichovian and Dalejan divided by large inter stage biotic events. Besides the Emsian stage with the lower boundary in the base of kitabicus zone probably also embraces the upper part of the Pragian stage. Eifelian stage may be subdivided into three substage as in the Eifel Mount.Givetian stage on at basis of evolution of ammonoidea (with the lower boundary taken in the base of hemiansatus conodont Zone) may be subdivided into 3 substages: 1/ Lower Givetian in the volume of goniatite Zone – Maenioceras undulatum and conodont Zone – hemiansatus; 2/ Middle Givetian – in the volume of goniatite Zones – Maenioceras molarium, M. terebratum and Sellagoniatites and conodont Zones – Lower and Middle varcus; 3/ Upper Givetian, which may be determined as independent Fromelennian stage, corresponding to the great part of Pharciceras Genozone according to ammonoidea (in Weddekind,1918, is understanding). This stage is subdivided by T.Becker [Becker, Hause, 1998] into the following Zones (from the bottom upwards): Pharciceras amplexum, Synpharciceras clavilobus – Stenopharciceras lunulicosta, Pseudoprobeloceras pernai, Petteroceras pernai and P.errans. These zones according to conodonts are correlated with the Zones: Upper varcus, hermanni-cristatus, disparilis and norrisi (=Lowermost asymmetricus).

In relation to substages subdivision of the Upper Devonian stage now at present there are some different opinions besides that of the decides of the Devonian stratigraphic commission of the Russian [Resolution, 1990].

Lower Devonian

Lochkovian stage. The Lochkovian stage may be subdivided by graptolites into two substages. The lower boundary of the Upper Lochkovian is drawn at the base of the Monograptus hercynicus Zone;according to tentaculites, it corresponds to the base of Homoctenonowakia bohemica Zone and to the appearance of the genus Paranowakia and according to conodonts – to the base of pedavis pesavis Zone.

In the carbonate sections of the Urals this Upper Lochkovian boundary may be correlated by brachiopods with the base of the Karpinskia vagranensis Zone. Late Lochkovian time is characterized by the appearance of the bivalve genus Hercynella /Kulikova, 1977/ and the trilobite genus Lochkovella.

Stratotype of the lower boundary of the Upper Lochkovian: Barrandian, Czech Republic – the Cerna rocle gorge near the village Kosor, Radotin Limestone [Chlupac, 1958, 1977].Key section of the North Urals / East slope /, Russia – the Sauma horizon with Karpinskia vagranensis Zone. [Early Biostratigraphy and fauna of the East slope of the Urals,1977].Key section of Central Asia: Kyk Mountain with Graptolites and Dacrioconarides [Koren'et al.,1982].

Pragian stage. The Pragian stage according to SDS is not subdivided into substages. But this question should be defined more accurately because graptolites: thomasi, yukonensis, craigensis Zones were earlier considered as the Late Pragian. The lower boundary of the Upper Pragian substages may correspond to the base of Polygnathus pireneae conodonts Zone and possible to the base of Guerichina strangulata tentaculites Zone. By brachiopods the Upper Pragian substages may be defined in the Uralian section at the base of the Toschemka horizon [Kulikova, et al, 1978], with Leviconchidiella tenuiplicata venusta Breiv., Cymostrophia stephani / Barr. /, Glossinotoechia princeps / Barr./, Karpinskia consuelo Gort., Nymphorhynchia pseudolivonica / Barr. /, etc. In Upper part of the Pragian stage in the Carnian Alps in the pireneae conodont Zone tentaculites of the genus Guerichina /G. africana Alb./ also occur in the Upper Pragian [Schonlaub, 1985].

Stratotype section possible of the Upper Pragian, Czech Republic – at Kaplicky

and this vicinity, beds with Monograptus yukonensis and guerichina strangulata [Chlupac, Barrandian,1977].

Emsian stage. The Emsian stage is established by Dorlodo /1900/ with its stratotype in Rheinisches Schifergebirge near the little town of Ems near Koblenz town, Germany, it is subdivided into two substages. The lower boundary of the Upper Emsian is drawn at the base of the Emsquarzit with brachiopods and trilobites of the Ardennian- Rhine types: Euryspirifer paradoxus /Schloth/, Arduspirifer arduennensis /Schnur/, Paraspirifer auriculatus /Kayser/, Homalonotus gigas /Roem./ etc.

In the carbonate section of the Barrandian, Czech Republic, stratigraphic analogy by the Emsian is subdivided also into two the stages : Zlichovian and Dalejan , which it is necessary take to as independence stages.

The faunistic differences between this Stages very conspicuous. The Zlichovian /Lower Emsian/ contains more early of the complex of the faunas brachiopods, Anetoceras fauna on ammonoidea, tentaculites /Nowakia zlichovensis, N.barrandei, N.elegans/, trilobites etc. The Dalejan stage /Upper Emsian/ contents many younger middledevonian elements of the faunas: Anarcestes lateseptatus, Gyroceratites gracilis from ammonoidea; Nowakia cancellata, N.richteri, N.holynensis, N.procera from tentaculites; Zdimir pseudobaschkiricus, Z.baschkiricus, Carinatina signifera , Kransia parallelepipeda etc. from brachiopods. This deposits were traditionally regarded as Middle Devonian.

The global Daleje Event and the eustatic sea level variation on the Zlichovian / Dalejan boundary with the occurrence of dark shells /Walliser,1985/, also support this subdivision of the Emsian stage.

International Subcommission on Devonian Stratigraphy / SDS/ decided to determine the Global Stratotype Section and Point /GSSP/ for the base of the Emsian stage in Zeravshan mountain range in Central Asia [Yolkin,ct al.,1997]. Lower boundary of the Emsian is drawn here along Zinzilban Gorge into the base of the kitabicus conodont Zone – in lower part of the Zinzilban beds.

The Emsian stage in this region is determined in volume of the Kitab horizon, which may be subdivided into four parts : Zinzilban, Kim, Dzhaus and Obisafit beds.

The Zinzilban beds are characterized by a rich assemblage Graptolites : Monograptus

thomasi Jaeger , M. telleri Lenz et Jackson, M. yukonensis Lenz et Jackson, M. aequabilis notaequabilis Jaeger et Stein; tentaculites – Nowakia /Turkestanella/ acuaria /Richter/, N./T./ recta Klisch.[Koren',Klischevich,1982]; brachiopods, except local forms, there are species – Gorgostrophia gorgo Havl., G. neutra /Barr./ etc., known from the Pragian stages of the Barrandian. Emong conodonts found here are: Pandorinella miae, Pedavis mariannae, Polygnathus pannonicus, P.pireneae, P. kitabicus, P. sokolovi, P.tamara.[Yolkin et al.,1997].

It is possible the Zinzilban beds may be regarded as Upper Pragian substages. The Kim (=Norbonak) beds and Lower part of the Dzhaus bed with zlichovian goniatites /Anetoceras kimi Bogosl., Mimosphinctes tripartitus Eichenb., M. erbeni Bogosl., Theicherticeras rudicostatus Bogosl. etc/ ; tentaculites – Nowakia zlichovensis Bouc.,

N. barrandei Bouc. et Prantle and conodonts – Polygnathus dehiscens, P.gronbergi, P.perbonus may be regarded as the Zlichovian stage or the Lower Emsian, Upper part of the Dzhaus beds with Gyroceratites laevis , Nowakia cancellata and Obisafit beds are correlated with the Dalejan of the Czechia or the Upper Emsian.

GSSP – Lower boundary of the Emsian stage; Zeravshan mountain range, Uzbekistan, the section at the Zinzilban Gorge in the Kitab State Geological Reserve –170 km SSE of Samarkand, near the base of Zinzilban beds.[Yolkin et al,1997].

Stratotype of the lower boundary of the Upper Emsian / Dalejan/: Barrandian, Czech Republic - the sequences of Dalejan stage exposed particularly at the North slope of the Procop vallei at Praho-Hlupacepi.[Chlupac,1959,1977,1982].

Middle Devonian

Eifelian stage. The Eifelian stage should be subdivided into three substages as it is adopted in the stratotypical Eifelian region, Germany [Struve,1982,1996, /in Weddige/]. In this region lower boundary of the Lower substage should be drawn at the base of partitus conodont Zone. This substage here includes: the Uppermost part of the Heisdorf beds, Lauch and Nohn Formation.

The Middle substage boundary of Eifelian stage shoud be drawn at the base of the australis conodont Zone.Middle Eifelian substage in the Eifelian region corresponds to Ahrdorf and Yunkerberg beds, whiches contain the brachiopods fauna of the Spinocyrtia ostiolata Zone and Bornhardtinoid brachiopods of the genus Gerothyris and Yeothyris. From the conodonts this substages correlated with australis and lower part kockelianus conodont Zone [Weddige,1996].From the coralls there are many Calceola sandalina subsp.subsp.; from the Tentaculites here founded – Cepanowakia pumilio, Nowakia chlupaciana.

Lower boundary of the Upper Eifelian substage is drawn at the base kockelianus conodont Zone. This substage includes the Freilingen Formation and of lower part of the Ahbach Formation (Maiweiler beds). The Upper substage of the Eifelian stage is comprises Nowakia chlupaciana and Now. otomari Zones on Tentaculites, and Agoniatites Genozone from ammonoidea; Primipilaria primipilaris group and Spinatrypa /Isospinatrypa/ aspera aspera from brachiopods. Stratotype section Eifel Mount, Prumer Mulde, Germany [Struve,1982,1996].

Key sections of the Russia: in the Salair, Gurjevsk region, the sections of the Akarachkino and Malaya Salairka quarries [Rzhonsnitskaya and al.,1985].

The Lower Eifelian substage boundary here is drawn in the Uppermost part of the Shanda horizon with brachiopods Zdimir pseudobaschkiricus sibiricus, Megastrophia uralensis and conodonts of partitus Zone : Polygnathus linguiformis bultyncki, P.ex gr.costatus,P. partitus. Lower boundary of the Middle substage at this region is drawn in the basement of Malaya Salairka beds with Pinacites jugleri and conodonts Polygnathus costatus Zone and Urella asiatica and Lazutkinia mamontovensis Zone from brachiopods.

The Lower boundary of the Upper substage of the Eifelian stage is drawn in base of the Akarachkino horizon with conodonts of the kockelianus Zone.[Rzhonsnitskaya and al.,1985,Gagiev and al.,1987].

The key sections the Transcaucasus: Nakhichevan Republic Earli of the USSR Velidag Mount, the south slope; the Karaburun Mount; the left bank of the Arpachai River near Danzik village etc [Mamedov et Rzhonsnitskaya,1985].

The lower boundary of the Lower substage of the Eifelian here is drawn at the Upper part of the Sharur Formation – beds with Zdimir rossicus /Karp./ and conodonts Eognathodus bipennatus montensis Weddige, Icriodus struvei Weddige, Polygnathus costatus costatus Klapp.

The base of the Middle substage of the Eifelian stage is drawn at the lower boundary of the Danzik Formation with australis conodonts Zone and Spinospirifer araxicus – Emanuella takwanensis brachiopods Zone.

The lower boundary of the Upper Eifelian substage is drawn in the base: of the Volchie Vorota Formation with kockelianus conodonts Zone; Spinatrypa (Isospinatrypa) aspera aspera – Undispirifer rzhonsnitskayae brachiopods Zone and with Nowakia otomari from tentaculites in the Uppermost part of this Formation [Mamedov, Rzhonsnitskaya,1985].

The sames Russian specialists are proposed Eifelian stage are subdivided into two substage with lower boundary of the Upper Eifelian substage at the base australis Conodont Zone. [Gagiev,1996; and other].

Givetian stage. This stage, in the range adopted SDS [Walliser et al.,1995] at the base of the hemiansatus conodont Zone, may be subdivided into three substages on conodonts, ammonoids and brachiopods.

Lower boundary of the Lower Givetian substage is drawn at the base of the hemiansatus conodont Zone, Maenioceras undulatum Zone on Goniatites and the beds with Invertatrypa kelusiana on brachiopods [Weddige,1996].

Lower boundary of the Middle Givetian is drawn at the base of Lower varcus conodont Subzone, Maenioceras molarium on the Goniatites Zone and Stringocephalus burtini – Uncites gryphus on brachiopods.

The Upper Givetian substage is drawn at the base of Pharciceras Genozone /=Ph.amplexum/ on Goniatites [T.Becker, House,1996;1998], the Upper varcus and lower part of Middle varcus conodont Zone. On brachiopods in the Rheinisches Schiefergebirge and Eifelian muldes at the base of Upper Givetian substage is drawn at the lower boundary Parastringocephalus Genozone [Struve in Weddige,1996].

This boundary by W.Struve is corresponded to the base Middle varcus conodont Zone. In the Altai-Sajan area of the Russia lower boundary of the Upper Givetian substage is drawn at the base of Euryspirifer cheehiel brachiopods Zone.[Rzhonsnitskaya,1968, Rzhonsnitskaya et al.,1985]. This Zone correlated with Upper part of the Middle varcus, with Upper varcus and possible with hermanni – cristatus conodont Zones [Krasnov, et el,1992; Karaulov, 1992].

The Stratotypes for International Givetian substages are proposals of the Belgium types Sections of the southern borders of the Dinantian basin, Fromelennes Formation.

Key sections pelagic Ammonoid Zone, Rheinishes Schiefergebirge, Germany [T.Becker in Weddige,1996; Becker et House,1998].

Key sections neritic in stryngocephaloid Facies, Germani – Rheinishe Schiefergebirge [Venn, Bergische Landes, Eifel].

Key sections of the Russia and the Early USSR :

1/ SW margin of the Kuznetsk basin /NE slope of the Salair ridge/: the Section of the Zarechnaya village along Bachat River [Rzhonsnitskaya, 1968, Gagiev et al, 1987].

Here Lower boundary of the Middle Givetian substage there are at the base of the Safonovo Formation with Ammonoidea-Maenioceras terebratum and Sellagoniatites discoides, brachiopods – Indospirifer pseudowilliamsi, Spinatrypina praebodini etc. and at the base of the Lower - Middle varcus conodont Zones [Rzhonsnitskaya and al,1985].

2/ North margin of the Kuznetsk basin, Anzhero-Sudzhenka region, Lebedyan quarry in Lebedyan village. Here there are lower boundary of the Upper Givetian substage is drawn in the base of the Alchedat Form. with Euryspirifer cheehiel /Stuckerberg sensu/, Uncinulus group goldfusi, Upper part Middle varcus and Upper varcus conodont Zones. [Rzhonsnitskaya,1968;Types sections of the Middle - Upper Devonian and Frasnian – Famennian boundaries deposits of the Kuznetsk basin,1992].

Key sections of the Transcaucasus /Nakhichevan Republic, the Early of the USSR/.

In this region there are very good sections of the Givetian stage in neritic Facies /with many brachiopods, corals, stromatoporoids etc./. One from this sections are as more typical are the section along the left bank of the Arpachai River in region early Danzik village [Mamedov,Rzhonsnitskaya,1985; Rzhonsnitskaya and al.,1984]. In this section the lower boundary of the Middle Givetian substage is drawn into at the base of the Lower Arpachai subformation with Spinocyrtia transcaucasica = Sp.mediotextus sensu Frech [Mamedov et al].This deposits may be correlated with the Terres d'Haurs Member of the Middle Givetian substage of the Dinantian basin of the Belgium [Tsien,1974].

The lover boundary of the Upper Givetian substage in the Transcaucasus on conodonts is drawn at the base at the Chrakhana Formation, which correlated with Fromelennes Form. of the Belgium. The Chrakhana Form. of the Transcaucasus is consisted of the Fauna Cyrtospiriferoides brachiopods such as this had take place in the Fromellennes of the Belgium.

Upper Devonian

Frasnian stage. The Frasnian stage may be subdivided into two substages. The lower boundary of the Upper substage should be drawn at the base of gigas conodont Zone. In the interval from Upper asymmetricus Zone to gigas Zone there are great regressive and transgressive Event and biotic Event. Among brachiopods, numerous the Cyrtospiriferdaethe groups Cyrtospirifer disjunctus – C. schelonicus disappear and Spiriferids of the genus Theodossia of the group Theodossia anossofi /Vern./ appear. Among ammonoids appear numerous forms of the group Manticoceras cordatum – M. intumescens by B.J.Bogoslovsky /1991/, which it possibly corresponds to Neomanticoceras paradoxum and Archoceras varicosus by T.Becker, 1996 and Crickites holzapfeli. This lower boundary of the Upper Frasnian substage is drawn at the Russian Platform [Rzhonsnitskaya,1988; Rzhonsnitskaya et al.,1991].

In the Stratotype of the Frasnian stage in Belgium this stage is subdivided into two substages with the lower boundary Upper Frasnian at the base of Ancyrodella triangularis zone [Tsien,1974]. V.A.Aristov and A.Zhuravlev also suggest to distinguish the lower boundary of Upper substage at the base of the Ancyrognathus triangularis Zone.

Stratotype section of the Frasnian Stage and its the lower boundary Upper substage at the southern border of the Dinantian basin /Tsien,1974/.

Key section of the Upper Frasnian substage at the base of gigas zone – in the Russian Platform - at the base of the Petino Formation (Correlation table, sheet 1).

On the Interdepartmental of Stratigraphic Conference by Devonian of the Russian Platform [Resolution, 1990] the Frasnian stage were proposed subdivision into the three substage. The lower boundary of the Middle substage drawn into the base Sargaevo horizon (Lower asymmetries conodont Zone). But this boundary necessary more accurate definition.

Fammenian stage. Famennian stage may be subdivided into three substages in stratotype section of Belgium /where these deposits are represented by neritic facies/, as well as one in the pelagic ammonoid facies of Germany.

In Belgium, the lower boundary of the Middle substage is drawn at the base of Esneux /Fa 2a/ beds /with Septatournayella rauserae, Sporadoceras latiloba, rhynchonelloids of the group Centrorhynchus letiensis/ and its partial equivalents Souverain Pre' /Fa 2c/ beds with Septatournayella rauserae, Polygnathus rhomboidea etc.

The lower boundary of the Upper substage of the Famennian is at the base of the Fa 2d and is included into Comblain au – Pont /Tn 1a/ with Quasiendothyra kobeitusana , Sphenospira julii, "Spirifer"strunianus, Spinocarinifera niger, Cymaclymenia euryomphala , miospores – Retispora lepidophyta, R.pussilites etc.

In Germany the lower boundary of the Middle substage is drawn at the base of the Hembergian with Pernoceras dorsatum of the Genozones Prolobites – Platyclymenia and accordingly, at the base of velifer conodont Zone. Lower boundary of the Upper substage is at the base of Kalloclymenia subarmata Zone and Middle costatus conodont Zone.

W.Ziegler [1997] proposed lower boundary for Upper substage of the Famennian is drawn into the base expansa conodont zone on conodonts and Dasberger stage of the Germany.

Key sections of Russia and the Early USSR. In neritical facies are: Transcaucasus /Nakhichevan Republic/ the lower boundary of the Middle substage of the Famennian is drawn at the base of the Schamamidzor Formation /= Enchondrospirifer ghorensis Zone/ it is accordingly velifer conodont Zone. The lower boundary of the Upper Famennian substage is at the base of Arshakiakhpur Formation with Sphenospira julii, Araratella araratica, Spinocarinifera niger etc. This boundary corresponds to the lower boundary Etroeungt beds of Famennian in Belgium.

In the pelagical facies: the Southern Urals, western slope (sections along the rivers: Sikasa, Rjauzak, basin of the Zigan, Zilim, Inzer Rivers) the lower boundary of the Middle substage of the Famennian is drawn at the base of the Murzakaevo Formation with Platyclymenia annulata Prolobites delphinus, Pseudoclymenia sandbergeri and Zigania ursa [Bogoslovsky, 1991]. The bas of the Upper Famennian substage is drawn here at the Lytwa horizon (Abuskan and Zigan beds) of the Wocklumeria – Kalloclymenia Zones, correlated with Quasiendothyra kobeitusana Zone on foraminifera, Sphenospira julii on brachiopod Zone and Retispora lepidophyta on miospores Zone. The same specialists of the Russia [A.Zhuravlev,M.Gagiev, V.Krasnov et al.,1998] proposed for the lower boundary Upper Famennian substage is drawn into the base expanse zone on conodonts also as [W.Ziegler,1997].

Correlation Table (sheets 1-4) demonstrating the position of the Devonian stage boundaries (it is advisable SDS) in the Devonian sections of the Russia and proposals for an Substages subdivision of the Devonian system from Russian commission on Devonian Stratygraphy.

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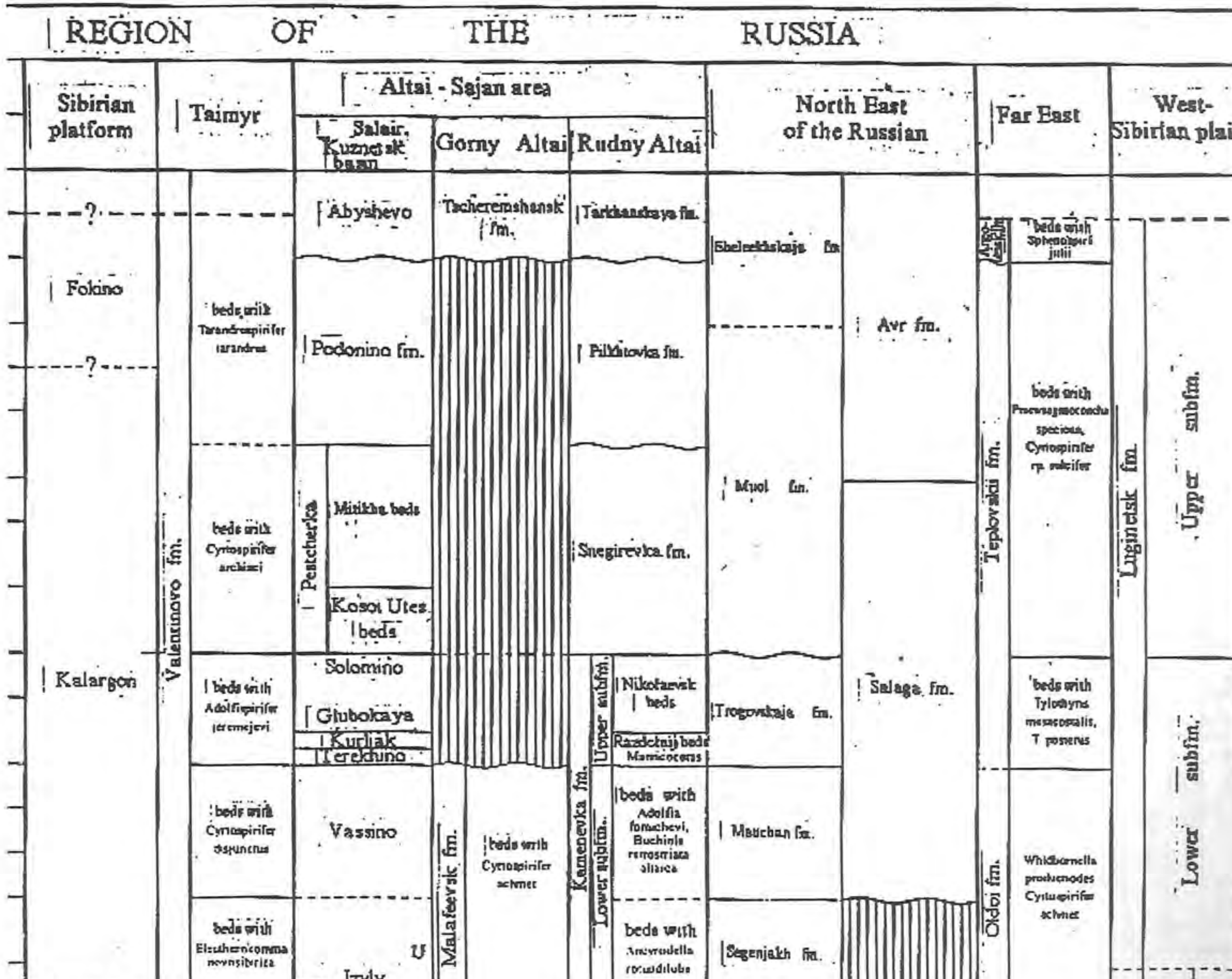
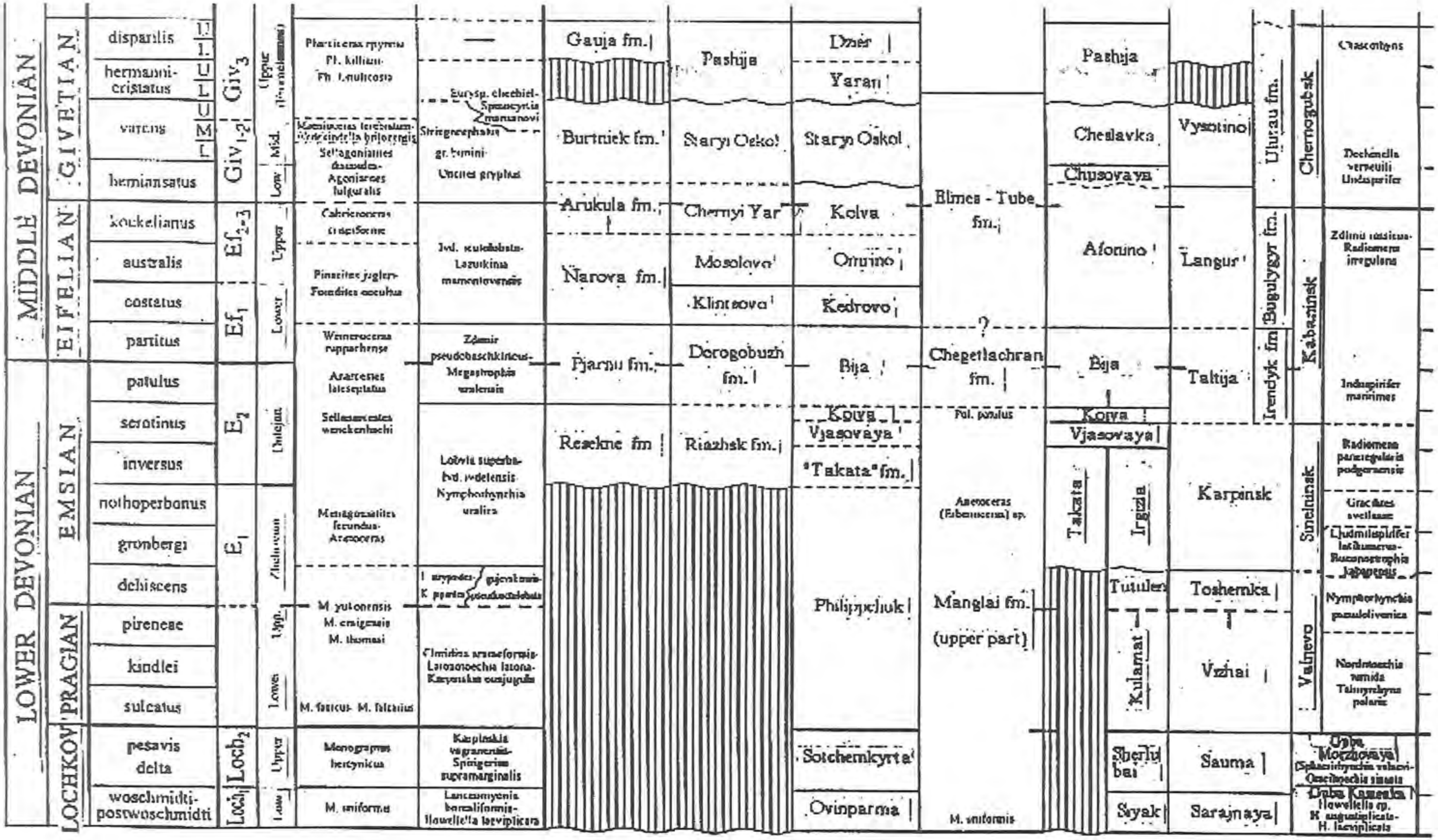
Devonian standard stratigraphic scale: Series	Stage	Standart conodont zonation		Proposed substages		THE MAIN DEVONIAN — ZONES: Ammonoids graptolites	Brachiopods	Russian platform: The Main Devonian Field (East part)	Central area	Timano-Pechora area	North Caucasus	The Urals: West slope	East slope		Novaja Zemlja
CARBON						Acutimitoceras prorsum			Kupavino beds	Sotchemshor		Gumerovo			
UPPER DEVONIAN	FAMENNIAN	praesulcata		Fm_3	Upper	Cymaclym. euryomphala; Paratornoceras paradoxa	Sphenospira julii	Raevskaja	Khovanstchina	Nimylga (Dzhebol)	Bogoslovsk	Lytva	Civonchovo	Zilair fm.	?
		expansa	U			Kalloclymenia subarmata			Ozerki	Zelenetskii					
			M, L	Fm_2		Gonioclym. speciosa; Gonioclym. hoevelensis	Dzieduszyckia baschkirica-Planovatirostrum planoovalis	L'njan	Plavsk; Optukha			Kushelga			Kharlovskii (Tarandrospirifer tarandrus-Zigania ursa)
		postera	U, L		Middle	Platyclymenia: Platyclymenia annulata	Zigania ursa-Cyrtospirifer lebedjanicus	Bilovo fm.	Lebedian	Ust'Pechora	Volchaya fm.	Murzakaevo	Chepchugovo		
		trachytera	U, L			Prolobites delphinus									
		marginifera	U			Ps. sandbergeri									
			M, L	Fm_1	Lower	Sp (Maeneceras) pompeckji	Mesoplica meisteri-Cyrtospirifer tschernyschewi	Tuder fm.	Bletz	Bletz	Uzhum fm.	Makarovo	Shamei		Sokhanino (Dmitria subrotunda-Cyrtospirifer archiaci)
		rhomboidea	U, L												
		crepida	Um, U, M, L			Cheiloceras curvispina	Cyrtospirifer sjasiakensis-Zilimia polonica	Chimaevo fm.	Zadonsk	Zadonsk (Izhma fm.)					
		triangularis	U												
			M, L			?	"Pugnoides triangularis"			beds with Palm. triangularis		Barma	Ust'Kolpak		
	FRASNIAN	linguiformis		F_2	Upper	Crickites holzapfeli-Cr. expectatus	Theodosia anossofi-Hypothyridina zuboides	Kunino fm.	Livny	Ukhta fm.		Askyn	Irikdy	Koltuban fm.	Menshikovskoi (Theodosia anossofi-Cyrtospirifer tenticulum)
		rhenana	U, L			Manticoceras cordatum (M. intumescens)		Smotino-Lovat fm.; Prilovat fm.	Evlanovo; Voronezh; Petino	Sirachoi; Vetlasian		Mendym	Tashtugai		
		jamieae		F_1	Middle	Manticoceras ammon-Ponticeras uchtense-Probeloceras domanicense	Cyrtospirifer (Tenticosp.) tenticulum-Cyrtosp. disjunctus	Snezha fm.		Domanik	Kardzhurt fm.	Domanik	Kiltin fm.	Mukasovo fm.	Zhandrovsk: Cyrtospirifer disjunctus
		hassi	U, L				Cyrtospirifer schelonicus	Semiluki	Semiluki						
		punctata				Koenenites stuckenbergi									
		transitans			Lower	Timanites keyserlingi	Ladogia meyendorfii Hyp. calva-Eleutherokomma novosibirica	Sargaevo	Sargaevo	Ust'yarega fm.		Sargaevo	Solonchak fm.	?	Eleutherokomma novosibirica
		falsiovalis	U, L			Hoeninghausia uchtensis-K. nalivkini	Uchtospirifer murchisonianus	Amat fm.	Timan	Timan		Kyn			Uchtospirifer murchisonianus

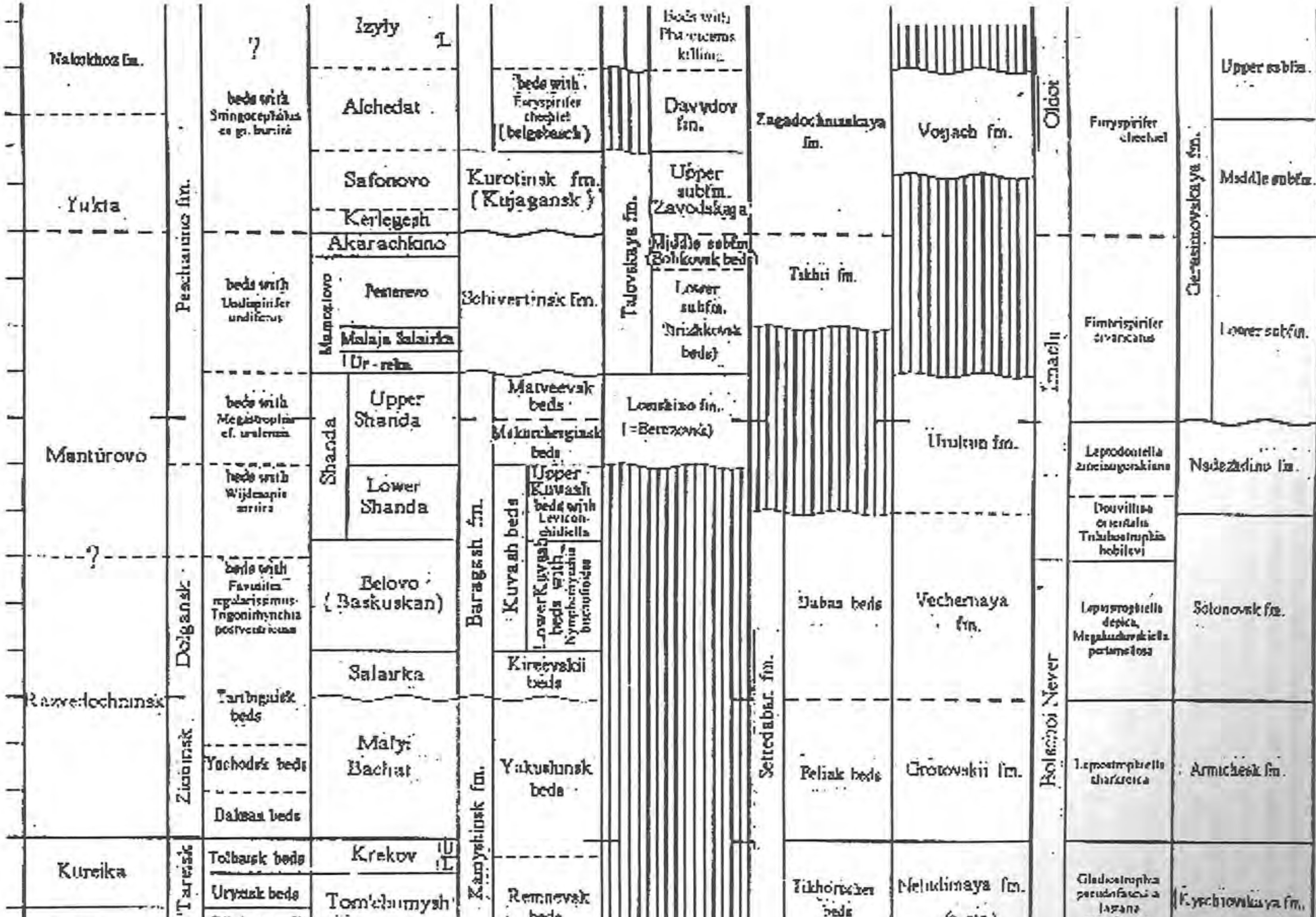
boundaries in the Devonian deposits of the Russia.

Sheet 2





LOWER DEVONIAN
MIDDLE DEVONIAN
LOCHKOV
PRAGIAN
EMSIAN
EIFELIAN
GIVETIAN
disparilis
hermanni-cristatus
varcus
hemiansatus
kockelianus
australis
costatus
partitus
patulus
serotinus
inversus
nothoperbonus
gronbergi
dehiscens
pirenеae
kindlei
sulcatus
pesavis
delta
woschmidti-postwoschmidti
Giv3
Giv1-2
Ef2-3
Ef1
E2
E1
Loch2
Loch1
Upper
Mid.
Low.
Upper
Lower
Dalejan
Zlichovian
Upp.
Lower
Upper
Low.
Ph. killiani
Ph. lunulicosta
Sellagoniatites
Agoniatites fulguralis
Cabrieroceras crispiforme
Pinacites jugleri
Foordites occultus
Werneroceras ruppachense
Anarcestes lateseptatus
Sellanarcestes wenkenbachi
Mimagoniatites fecundus
Anetoceras
M. yukonensis
M. craigensis
M. thomasi
M. fanicus - M. falcarius
Monograptus hercynicus
M. uniformis
Stringocephalus
gr. burtini
Uncites gryphus
Zdimir pseudobaschkiricus
Megastrophia uralensis
Lobvia superba
Nymphorhynchia uralica
Karpinskia vagranensis
Spinigerina supramarginalis
Lanceomyonia borealiformis
Howellella laeviplicata
Gauja fm.
Burtniek fm.
Arukula fm.
Narova fm.
Pjarnu fm.
Reackne fm
Pashija
Staryi Oskol
Chernyi Yar
Mosolovo
Klintsovo
Dorogobuzh fm.
Riazhsk fm.
Dzer
Yaran
Staryi Oskol
Kolva
Omrino
Kedrovo
Bija
Koiva
Vjasovaya
"Takata" fm.
Philippchuk
Sotchemkyrta
Ovinparma
Blimes - Tube fm.
?
Chegetlachran fm.
Pol. patulus
Anetoceras (Erbenoceras) sp.
Manglai fm.
(upper part)
M. uniformis
Pashija
Cheslavka
Chusovaya
Afonino
Bija
Koiva
Vjasovaya
Takata
Irgizla
Tutulen
Kulamat
Sherlubai
Siyak
Vysotino
Langur
Taltija
Karpinsk
Toshemka
Vzhai
Sauma
Sarajnaya
Uluzau fm.
Bugulygyr fm.
Irendyk fm.
Chernogubsk
Kabaninsk
Sinelninsk
Valnevo
Cheiloceras
Dechenella verneuili
Zdimir
Radiomena irregularis
Indospirifer
Radiomena
Gracilites
Nymphorhynchia pseudolivonica
Nordotoechia
Oppa
Morzhovaya
Dolba Kamenka
Howellella sp.
H. laeviplicata


Nalotkhoz fm.
Yukta
Manturovo
Razvedochninsk
Kureika
Peschaninno fm.
Dolgansk
Zmininsk
Taresk
?
beds with Stringocephalus ex gr. burtini
beds with Undispirifer undiferus
beds with Megastrophia cf. uralensis
beds with Wijdeaspis arctica
beds with Favosites regularissimus Trigonirhynchia postvestricosa
Tarbagatsk beds
Yachodsk beds
Daksan beds
Tolbarsk beds
Urynsk beds
Izyly
Alchedat
Safonovo
Kerlegesh
Akarachkino
Mamontovo
Pesterevo
Malaja Salairka
Ur-reka
Shanda
Upper Shanda
Lower Shanda
Belovo (Baskuskan)
Salairka
Malyi Bachat
Krekov
Tom'chumysh
Kurotinsk fm. (Kujagansk)
Schivertinsk fm.
Baragash fm.
Kamyshinsk fm.
beds with Eurysprifer cheehiel (belgebasch)
Matveevsk beds
Makarchergiask beds
Kuvash beds
Upper Kuvash beds with Leviconchidiella
Lower Kuvash beds with Nymphorhynchia bicuspidoides
Kireevskii beds
Yakushinsk beds
Remnevsk beds
Tulovskaya fm.
Beds with Pharciceras killing
Davydov fm.
Upper subfm. Zavodskaja
Middle subfm. (Bobkovsk beds)
Lower subfm. (Brizakovsk beds)
Lomshino fm. (=Berezovsk)
Zagadochninskaya fm.
Takhtui fm.
Setredabar fm.
Dabas beds
Peliak beds
Tikhorechen beds
Vojach fm.
Ulukun fm.
Vechernaya fm.
Grotovskii fm.
Neludimaya fm.
Oldoi
Imachi
Bolshoi Never
Eurysprifer cheehiel
Fimbrispirifer divaricatus
Leptodontella zuevi
Douvillina orientalis Trahubostrophia hobilevi
Leptostrophiella depica, Megakozlowskiella pertumelosa
Leptostrophiella tharkensis
Gladiostrophia pseudofascia lagana
Gerasimovskaya fm.
Upper subfm.
Middle subfm.
Lower subfm.
Nadezhdino fm.
Solonovsk fm.
Armichesk fm.
Kyschtovskaya fm.

Devonian substages in West Siberia sequences.

TM E.A. Yolkin (Novosibirsk)

Substage units are traditionally used in the regional stratigraphical scales of Siberia. Two or three such subdivisions are recognized within individual Devonian stages. They are indicated as "lower-upper" or "lower-middle-upper". All seven stages, defined by the SDS, are identified in the Devonian successions of West Siberia with acceptable accuracy. As in the other regions of the World, only Pragian and Eifelian stages could not be subdivided here into substages.

The Lochkovian Stage is subdivided into two substage units. The base of the upper Lochkovian coincides with the Kyk (*praehercynicus*) Event (Yolkin et al., 1993). This level corresponds to the beginning of clear expressed transgressive event in Siberia, Central Asia and other regions near the base of the *delta*-Zone (Talent et Yolkin, 1987; Yolkin et al., 1997).

Equivalents of the Emsian Stage within a territory of the Former USSR, as it is known, were included up to 1989 into the Elfelian. This stratigraphical interval is located between the Zinzilban (*kitabicus*) Event and Chotec (*c.costatus*) Event (Yolkin et al., 1993; Yolkin, 1998) and is named as the Telengit Suprahorizon (Yolkin et al., 1982). By the benthic fauna and cyclicity, it is subdivided into three equal parts that are considered as substages with their boundaries at the bases of *excavatus* and *nothoperbonus* zones (Yolkin, 1968, 1983; Yolkin et Izokh, 1988). However within this interval there exist most sharp transgressive as well as evolutionary level in a developing of polygnathids (Yolkin et Izokh, 1988; Yolkin et al., 1994), that divides the Emsian into two parts (substages). It is situated at the base of the *nothoperbonus*-Zone, just below the Dalejan Stage of Barrandian, and corresponds to the start (not "to the culmination of the transgressive Daleje Event": see Chlupac, 1997, p.8). So, there are two versions of the substage division of the Emsian Stage. Now two-fold division has obvious preferences because of clear correlations. At the same time, three-fold division should be considered as well. it also has the historic usage and evidences, at least within the territory of the Former USSR.

The Givetian Stage is traditionally subdivided in West Siberia into two substages. The base of the upper Givetian corresponds to the large-scale transgression that could be aligned with the Taghanic onlap in North America. This substage is characterized by so-called "chehiel-fauna".

The Frasnian Stage in West Siberia is subdivided into two substages. Delimitative level for these substages is expressed by a sharp T-R event (up to the stratigraphical discontinuity) that is situated near the base of the rhenana-Zone.

For the Famennian Stage in West Siberia it was applied two-fold division. However, new standard position of the D/C boundary compels to consider three-fold substage division of this Stage.

Notes to discussion

The SDS Newsletter No.14 includes a half of submissions that are devoted to the Emsian Stage. They show a clear tendency to a replacing the Emsian Stage by two new ones: Zlichovian and Dalejan. Obviously the main task of these proposals is to exclude the stage name Emsian. I believe that we should keep the Emsian Stage in the Devonian standard scale dividing the Emsian Stage into two or three substages without specific names. Discussed reasons and evidences to exclude the Emsian Stage are really in a contradiction with SDS guidelines and leads to a re-consideration of Subcommission decisions.

Chlupac I.1997. Comments to subdivision of the Emsian Stage Subcomission on No.14, p. 7-8. Devonian stratigraphy, Newsletter,

Talent J.A. and Yolkin E.A. 1987. Transgression-regression patterns for the Devonian of Australia and Southern West Siberia. - Cour. Forsch.-Inst. Senckenberg, v. 92, p. 235-249, 5 text-figs.; Frankfurt am Main.

Yolkin E. A. 1968. Trilobity (dekhenellidy) i stratigrafiia nizhnego i srednego devona yuga Zapadnoi Sibiri. Nauka, Moskva, 156 p. [in Russian].

Yolkin E.A., Gratsianova R. T., Zheltonogova V. A. and Kim A. I. 1982. Osnovnye biostratigraficheskie rubezhy i podrazdeleniya nizhnego i srednego devona na zapade Altae-Sayanskoi oblasti i ikh korelyatsiya. In: Biostratigrafiya pogranichnykh otlozhenii nizhnego i srednego devona. Trudy polevoi sessii Mezhdunarodnoi podkomissii po stratigrafii devona, Samarkand, 1978, Nauka: 65-80, 2 tabs.; Leningrad.

Yolkin E. A. 1983. Zakonomernosti evolutsii dekhenellid i biokhronologiia silura i devona. Nauka, Moskva, 116 p. [in Russian].

Yolkin E.A. and Izokh N.G. 1988. Zonal'nie vidy konodontov v tipovykh vykhodakh telengitskogo nadgorizonta (devon, Salair). - In: Yolkin E.A. et Kanygin A.V. (Eds.), Fauna i stratigrafiya paleozoya Srednei Sibiri i Urala, Nauka: 3-17, 2 text-figs., 2 pls.; Novosibirsk.

Yolkin E.A., Izokh N.G., Sennikov, N.V., Yazikov A.Yu., Kim A.I. and Erina M.V. 1993. Vazhneishie global'nye sedimentologicheskie i biologicheskie sobytiya devona yuzhnogo Tyan' Shanya i yuga Zapadnoi Sibiri. - Stratigrafiya. Geologicheskaya korrelyatsiya, 2 (3) : 24-31, 3 text-figs., Moskva.

Yolkin E.A., Weddige K., Izokh N.G. and Erina M.V. 1994. New Emsian conodont zonation (Lower Devonian). - Cour. Forsch.-Inst. Senckenberg, v. 168, p.139-157, 4 text-figs., 1 tab., 1 pl.; Frankfurt am Main.

Yolkin E.A., Gratsianova R.T., Bakharev N.K., Izokh N.G. and Yazikov A.Yu. 1997. Devonian sea-level fluctuations on the south-western margin of the Siberian continent. - Cour. Forsch.-Inst. Senckenterg, v. 199, p. 83-98, 5 figs., Frankfurt am Main.

Yolkin E.A. 1998. Silurian-Devonian trilobite evolution and depositional cyclicity in the Altai - Salair region (western Siberia, Russia) - The N.Y. State Museum Bulletin, v. 491.

REPORTS FROM THE MEMBERSHIP

CM G.K.B. ALBERTI (Grosshansdorf)

I. Continued study of planktonic tentaculitids concerning systematic and biostratigraphical aspects with special regard to taxa (and their ranges) from the Pragian/Emsian boundary interval of several sections particularly in North-Africa, among them the relevant sections of "Marhouma/Ougarta- Km 30" and of "Ben Zireg" (both of them: SW-Algerian Sahara).

1. Within the "Marhouma - Km 30" Section there is the following (partial) succession:

a) The siliciclastics (beds of sandstone/greywacke, embedded in sandy marls) in the upper part of the "Dkhissa Formation" (LEGRAND 1968, ALBERTI 1993,1998) contain rich successive brachiopod faunas of Rhenish character. The uppermost beds of this sandstone/greywacke contain the post-Siegenian *Acrospirifer fallax* assemblage (LE MAITRE 1952, LEGRAND 1968, ALBERTI 1993, 1998), which is underlaid by beds with *Hysterolites* aff. *Hystericus*, *Cleistopora geometrica* and rare specimens of *Icriodus* sp. A few m below this level very rare thin limestone lenses/beds with *Nowakia* sp. gr. *acuaria*, remnants of *Guerichina* sp. gr. africana (?) and with *Asteropyginae* occur, underlaid by limy beds with *Nowakia anteacuaria* and *Nowakia acuaria acuaria*.

b) The "Dkhissa Formation" overlying "Formation of Teferguenite" (LEGRAND 1968, ALBERTI 1993) starts with the morphologically clearly elevated limestone-bar (n° A) of the "Muraille de Chine" with abundant *Guerichina strangulata strangulata* (in addition *Guerichina africana africana*, *Nowakia* sp. gr. *acuaria* etc., trilobites and conodonts such as *Polygnathus* gr. "*dehiscens*", *Pelkysgnathus* sp., *Ozarkodina* sp.) approximately in its basal and its top bed. See here in Fig.1.

c) Above the "Muraille de Chine" siliciclastics come again with spiriferids such as *Euryspirifer hercyniae* and *Brachyspirifer carinatus carinatus* (teste W. STRUVE 1985)from a bit different stratigraphical levels, suggesting an age of lower Upper Emsian (STRUVE 1985).

Only a bit higher in the sequence (in the limestone/dolomite-bar n° B) late Lower Zlichovian age indicating planktonic tentaculitids (with co-occurring conodonts) have been found.

2. Within the Pragian/Emsian boundary interval of the "Ben Zireg Section" (ALBERTI 1981:Fig.2, 1982:Fig.2 and 1998:Fig.8) which is of deeper neritic or hemipelagic biofacies (marly limestones and silty marls) the successive entries and ranges of *Guerichina africana africana*. *Guerichina strangulata strangulata* (with different morphotypes, among them those ones with remarkable strongly curved tubes/shells at a very small percentage of the "populations"), *Nowakia clathrata arctoafricana*, *Nowakia* cf. *hercyniana* and *Peneauia* in comparison with the ranges of conodonts (*Polygnathus* gr. "*dehiscens*", *Pelkysgnathus* etc.) are currently studied in detail. By means of recent finds of *Guerichina strangulata strangulata* and of *Guerichina africana* from new samples these taxa enters earlier-than demonstrated in ALBERTI 1998:Fig.8. The Lowermost Zlichovian indicating rich planktonic tentaculitid faunas from the "Ben Zireg Section" co-occur with conodont faunas similar to those ones from the "Jbel Amlane Section" (Tafilalt).

II. Completion of our knowledge of the planktonic tentaculitids (and their ranges) from the "Tentaculitenknollenkalk reference Section of Ebersdorf" (Upper Franconia), see here in Fig.2.

III. Continued study of planktonic tentaculitids (and a bit on conodonts too) from the Givetian styliolinid/goniatite sections east of the "mole d'Amguid" (central Sahara) (ALBERTI 1997b,1998). The goniatites from here are currently studied by Dr.T.R. BECKER, Berlin.

IV. Taxonomic study of recently found complete tubes/shells of real species (new taxa) of Homoctenus, but of reliable Lower Devonian age (paper submitted to press).

V. Continued trilobite study, concerning now the biogeographic distribution of several groups of Hercynian taxa, starting with that of the *Struveaspis micromma/Eopalpebralia hermanni* assemblage (ALBERTI 1981) of Late Dalejan age (paper in press).

Recent publication

ALBERTI, G.K.B. (1998):Planktonische Tentakuliten des Devon.III. Dacryoconarida FISHER aus dem Unter-Devon und oberen Mitteldevon.- Palaeontographica,Abt.A.,250(1-3): 1-46,9 fig., 12 pls.; Stuttgart.

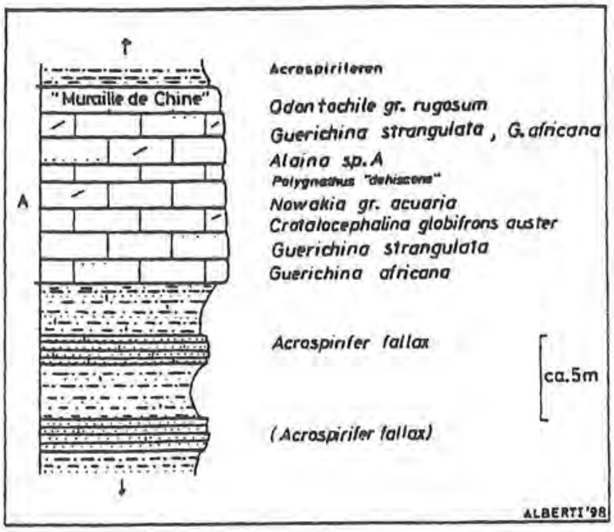


Figure 1 - Table showing the observed occurrences of taxa in the Lower Emsian sequence of the "Marhouma- Km 30 Section" (SW Alerian Sahara). Modified and completed from Alberti 1998.

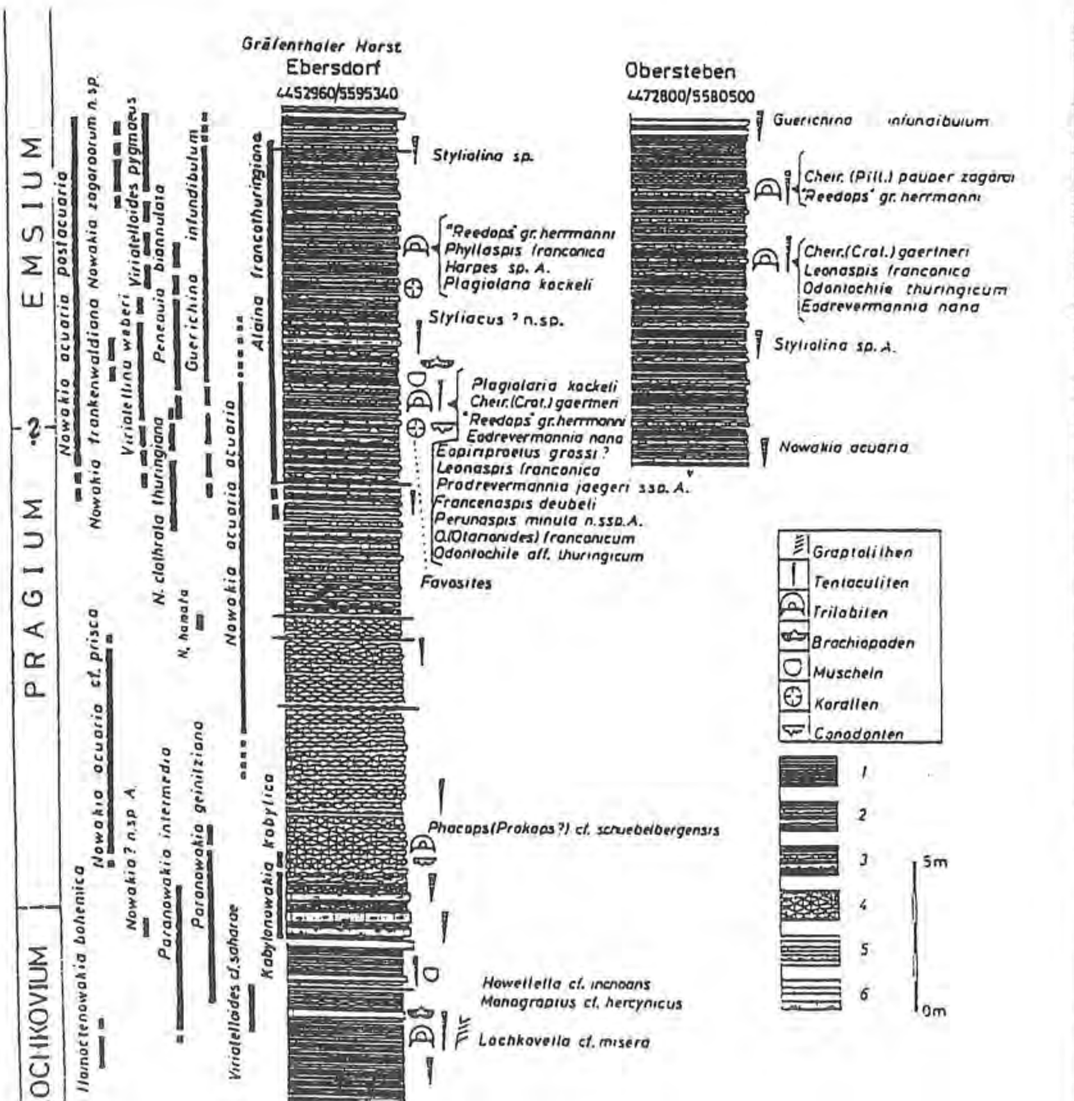


Figure 2 - Table showing the (tentative) ranges of planktonic tentaculitid taxa from Upper Lochkovian up to the Lower Emsian of the "Ebersdorf reference Section" through the uppermost "Graptolite Shales" and the "Tentaculitenknollenkalk" (Upper Franconia). Modified and completed from Alberti 1997.

TM R. Thomas Becker (Berlin)

Various research programmes were continued intensively in 1998. To complete the joint project on the Timan Upper Devonian, large new ammonoid collections were studied during a stay in Moscow which was made very pleasant by our hosts V. Menner and N. Ovnatanova. Outcrop conodont samples and the regional conodont-goniatite correlation were revised together with G. Klapper and A. Kuz'min. It turned out that there were serious discrepancies in the use some marker species, e.g. *Pa. domanicensis* and *Pa. jamieae*, which require future revisions. Generally, there are no difficulties to apply the Montagne Noire zonation to the Timan Frasnian but recently published Timan conodont accounts will need to be further revised. Rich goniatite collections by S. Yatskov showed that *Nordiceras* is indeed a good regional zonal marker for the Middle and Upper Domanik formations, and additional species were first found. The enigmatic *Goniatites strangulatus* of Keyerling (1844) was re-discovered and turned out to be a close but older relative of the German *Lobotornoceras ausavense*. Other new species (*Hoeninghausia*) come from sections in the Northern Timan/Polar Urals. Results hopefully will be published next year.

At ECOS VII, the correlation of Montagne Noire and so-called "Standard" Frasnian conodont zones, based on the German type-sections, was introduced as a joint contribution by Gil Klapper. There is an important, so far overlooked sedimentary break in the Martenberg succession, followed by a transgression which might be the "*semichatovae* transgression".

In the second half of July, field work in the Canning Basin was continued together with J. Reitner from Göttingen. This time, special emphasis lay on microbialites, stromatolites and sponge-rich limestones but additional goniatite samples were taken as well. Ammonoid coquinas yielded some proetid trilobites from younger levels than previously known from the region (Feist & Becker, 1997). Canning Basin conodont and ammonoid data have been prepared for a joint Geological Survey of Australia Bulletin. A manuscript on buchiolids from the area is in preparation together with M.C. Grimm from Mainz.

Sampling also continued at Hasselbachtal, where digging with Thomas Steuber (Erlangen) allowed to free some 1.5 m of section below the oldest parts known so far. Of special interest are peculiar redbeds in the lowest part of the Wocklum Beds. Carbon isotopes of D/C boundary sections give a distinctive small shift from the Devonian to the Carboniferous, which cannot be explained by diagenetic alteration. A revision of wocklumeriid evolution is close to completion. More than 1.500 specimens have been examined, including the Richter and Schindewolf types. Unfortunately, all holotypes of Schindewolf (1937) have been lost and neotypes had to be chosen.

Together with V. Ebbighausen and J. Bockwinkel, morphometric analyses of Moroccan ammonoid populations from single beds are under way. A revision of *Alpinites* has made progress. Work on pharciceratid taxonomoy, stratigraphy and phylogeny was continued together with Michael House. A new Ph.D. student, Mrs. Sarah Abousalam, has started with detailed work on the Taghanic Event in Germany, Belgium, Southern France, and Morocco. Distinctive sedimentary breaks were sampled in late Oktober in Harz and Kellerwald sections. Two masters students have finished mapping thesis in the Sötenich Syncline of the Eifel Mountains. Another masters student is about to start with studies on the pathology of the well-preserved Lower Famennian goniatites from Bergisch Gladbach. G.H.K. Alberti has supplied lower Emsian goniatites from the Harz Mountains and Givetian goniatites from the NW of Tassili-n-Ajjer (Southern Algeria) for joint publication. There are also new early Eifelian goniatites from the Ardennes (leg. G. Schraut, Senckenberg, and E. Edinger, Leverkusen).

References for 1998

Klapper, G. & Becker, R.T.: Comparison of Frasnian (Upper Devonian) conodont zonations. - Seventh Internat. Con. Symp., ECOS VII, Abstr.: 53-54.

Becker, R.T.: Palaeobiogeographic aspects of Australian Upper Devonian ammonoid faunas. - Abstr. IGCP 421 Meeting, Isfahan.

Annual Meeting of the Deutsche Paläontologische Gesellschaft 1998

This years annual meeting was part of the largest geoscientific congress Germany has seen in decades. Geo-Berlin '98 was organized at the Technical University (TU Berlin) to celebrathe the 150[th] anniverary of the Deutsche Geologische Gesellschaft and was attended by more than 1.400 paricipants who gave more than 500 talks and presented more than 240 posters. It brought together the German Geophysical Society, the German Mineralogical Society, the German Geological Society, the Society for Geo-Sciences, the Palaeontological Society and the German Pedological Society. Paleontological topics were organized in symposia on black shales, palaeogeography, isolated Eocene deposits, palaeobotany, micropalaeontology, vertebrate palaeontology, reef systems, and on climatic change. As usual, abstracts and excursion guides were published in *Terra Nostra*, vol. 98/3 and 98/4. The following Devonian contributions (titles here translated) were made:

Talks:

Brühl, D.: First record of *Nowakia (Nowakia)* ex gr. *otomari* BOUCEK & PRANTL 1959 (Dacrycoconarida) in the lower Freilingen Formation (Middle Devonian, Eifelian) of the Dollendorf Syncline in the Eifel (Rhenish Slate Mountains).

Kerp, H. & Hass, H.: Plants and substrate in the Lower Devonian: examples from the Rhynie Chert, Scotland.

Korn, D.: Phylogeny of Lower and Middle Devonian ammonoids.

Jansen, U.: Brachiopod stratigraphy in the Lower Devonian of the Dra Plain (Morocco, southern Anti-Atlas).

May, A.: The reef in the Pragian (Lower Devonian) of Koneprusy (Bohemia) and its stromatoporoid fauna.

Schmid, D.U.: Palaeoecology of incrusting microorganisms: Palaeozoic and Mesozoic in comparison.

Schröder, S.: Rugose corals and stratigraphy of the upper Eifelian and lower Givetian of the Dollendorf Syncline/Eifel (Middle Devonian; Rhenish Slate Mountains).

Schultka, S.: New finds of *Sporogonites exuberans* in the Rhenish Lower Devonian.

Tragelehn, H.: Facies development, stratigraphy and palaeogeography in the Devonian and Carboniferous of NE Bavaria and South Thuringia.

Posters:

Otto, M.: Brachiopods with soft body preservation in the Hunsrück Slate?

Pohler, S.: Facies development of Devonian carbonates in an intra-oceanic island arc system, Tamworth Belt, N.S.W., Australia.

Schöne, B. & Basse, M.: New stratigraphic subdivision of the marine Middle Devonian at the Eifel/Givet transition (eastern Rhenish Slate Mountains).

TM Ivo Chlupac (Praha)

Continued study of Devonian of the Barrandian and metamorphic Paleozoic of the northern part of the Bohemian Massif (Jested Mts. etc.)

The works in the Barrandian were concentrated on the broader Pragian-Zlichovian boundary interval at the type and other localities with emphasis on tentaculite and trilobite faunas (together with P. Lukes , report in press). Cyclostratigraphic studies, started in 1987, continued after an interruption and reached the final stage (report presented for publication).

The quarrying in the Koneprusy Reef Complex exposed new phenomena (especially neptunian dykes of different generations) and offered some new materials which allowed to complete former observations (see the recent papers).

Due to financial difficulties of the Geological Survey, the edition of the completely ready joint monograph (Chlupac, Havlicek, Kriz, Kukal, Storch) on the Paleozoic of the Barrandian (Cambrian to Middle Devonian, in English), which is in the state of the 2nd proof, was stopped and a new publisher is searched.

Recent publications

Chlupac, I. (1996): Neptunian dykes in the Koneprusy Devonian: Geological and palaeontological observations. - Bull. Czech Geol Surv., 71: 193-208, Praha.

- (1998): Comments on facies and stratigraphy of the Lower Devonian Reef Complex at Koneprusy (Barrandian area, Czech Republic, in Czech, Engl. summary). - Bull. Czech Geol. Surv.

73: 1-13, Praha.

Chlupac I., Ferrer E., Magrans J., Mane R. & Sanz J. (1997): Early Devonian eurypterids with Bohemian affinities from Catalonia (NE Spain). - Batalleria, 7: 9-21, Barcelona.

Chlupac I. & Lukes P.: Examples of Pragian/Zlichovian and Zlichovian/Dalejan boundary intervals in the Lower Devonian of the Barrandian area, Czech Republic. Newsl. Strat. (submitted).

Chlupac I. (partly with Kukal Z., Lukes P.): Barrandian chronostratigraphy, Barrandian goniatites, Barrandian planctonic tentaculites, Barrandian graptolites, Barrandian trilobites, Barrandian events, Barrandian formations and members. In Weddige, K. (ed.): Devon-Korrelationstabelle. Senckenbergiana lethaea 77: 289-326, Frankfurt a. M.

TM Rex E. Crick & Brooks B. Ellwood (Texas)

An Update on MSEC and Its Applications

The global MSEC framework required for acceptance and utilization of MSEC for chronocorrelation magnetostratigraphy cannot be developed without the creation of MSEC CRSs. In the following sections we describe work completed on the Anti-Atlas MSEC CRS and how these data can be used to investigate and better understand the 47 Ma represented by the CRS. We also briefly illustrate the established MSEC signature for the Eifelian-Givetian GSSP and demonstrate chronostratigraphic correlation between the GSSP and a neritic sequence from the Iowa Basin. We also illustrate work recently submitted to establish MSEC signatures for the Frasnian-Famennian GSSP and for the Pridoli-Lochkovian (Silurian-Devonian) GSSP.

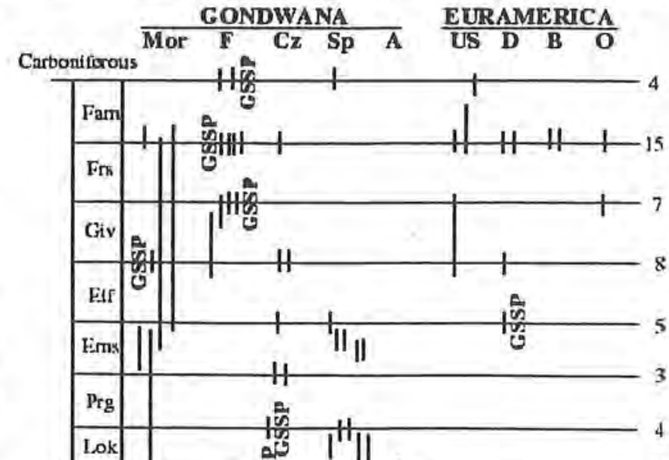


Figure 1 – Arrangement in time and space of the 52 stratigraphic sections sampled for magnetic susceptibility since 1996. The vertical lines are an accurate representation of the geologic time covered in each section. Concentration on stage boundaries has resulted in MSEC profiles across 52 boundary sequences with the Frasnian-Famennian boundary receiving the most attention (15 profiles) and the Pragian-Emsian and Famennian-Tournaisian the least attention with 3 profiles each. The Pragian-Emsian GSSP in Uzbechistan has not been studied.

Anti-Atlas MSEC Composite Reference Section (CRS)

Figure 1 summarizes the work completed thus far in our pursuit of establishing MSEC as a valid means of chronocorrelation. Figure 2 shows the MSEC CRS for the Devonian of the Moroccan Anti-Atlas exclusive of the upper two-thirds of the Famennian, and based mostly on section in the Tafilalt. The positioning of conodont biozone boundaries for the Pragian and Zlichovian is only approximate and awaits completion of identifications by TM Weddige and CM Schindler and their colleagues at Forschungs-Institut Senckenberg. We eagerly look forward to matching the MSEC with qualified biozones. The construction of an MSEC CRS differs little from the construction of a CRS based exclusively on biostratigraphy except that the greater frequency of MSEC events generally provides for greater chronostratigraphic control. We have compensated for the higher rates of sediment accumulation during the Emsian in the Anti-Atlas (Fig. 2A) by normalizing the CRS to the stage durations of the revised Devonian time scale (Tucker et al., 1998) (Figure 2B).

The large number of data points provides considerable detail about the variability in the depositional system and serves to document general trends on the 47 Ma time scale of the CRS, especially in regards to eustasy. The position of bioevents relative to the MSEC signature lend support to the interpretation of high and low MS magnitudes as being indicative of low and high stands of sea level (Crick et al., 1997; Ellwood et al., 1998). Two of the 13 events, Basal Pragian Event and Condroz/*Cheiloceras* Event correlate with peaks of high MS magnitude (Fig. 2B) and these two bioevents have been described by various authors as occurring during peri-

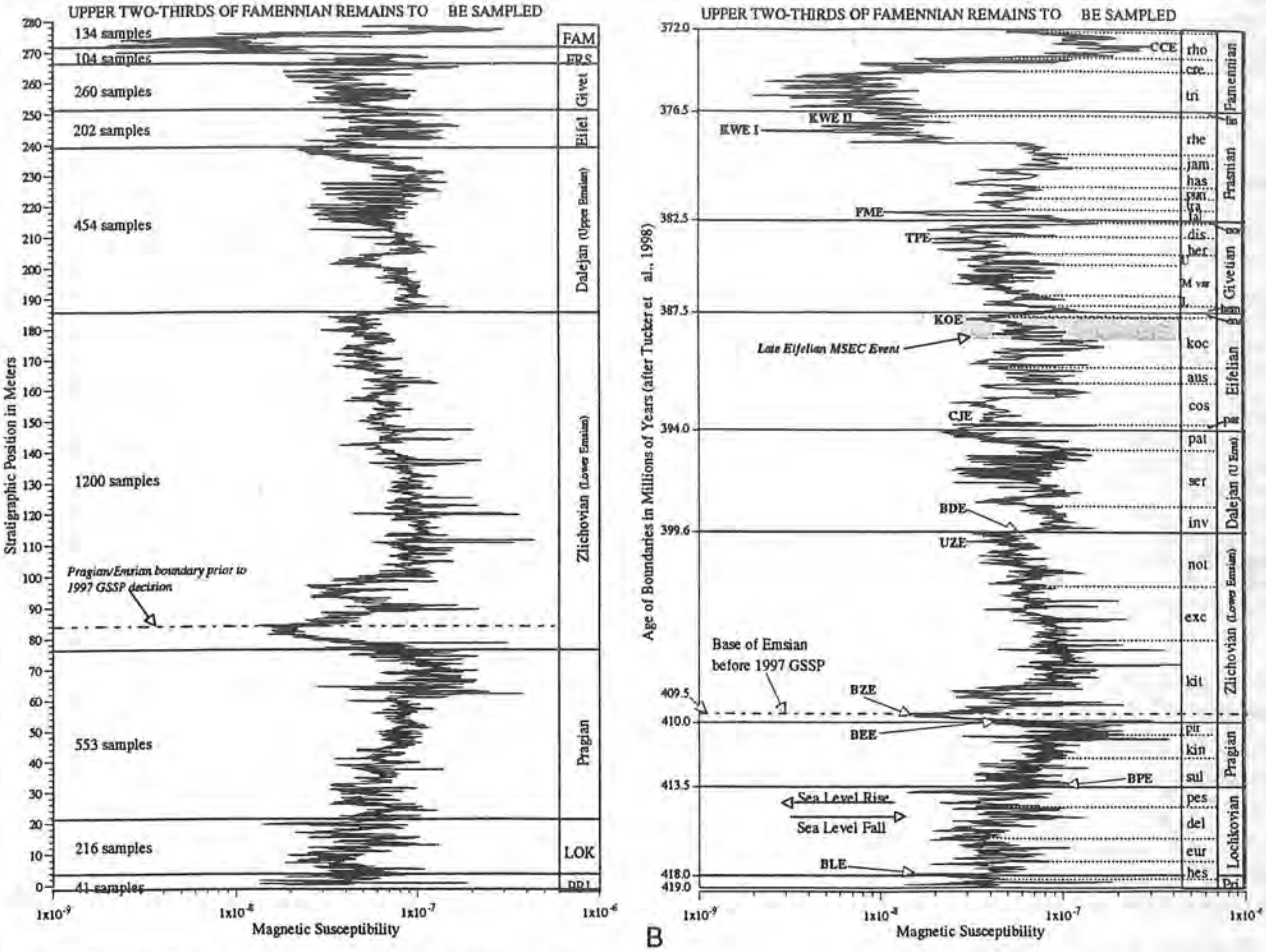


Figure 2 – MSEC CRS for the Devonian of the Anti-Atlas of eastern and central Morocco. The CRS is complete, in terms of conodont zones, from the latest Pridoli through the *Palmatolepis rhomboidea* CZ of the Famennian and covers 280 m in composite form. The MSEC data are shown first at the scale of outcrop thickness (A). The thicker Emsian (60% of the exposed Devonian) distorts a CRS scaled to outcrop thickness. The CRS was constructed from 3164 data points using a combination of overlapping MSEC curves and biozones from several sections in two adjacent basins, the Tafilalt and the Maider (western Sahara, southeastern Morocco). The dashed line above the Pragian-Emsian boundary marks the unofficial position of this boundary prior to the IUGS/ICS acceptance of the SDS proposal to place it lower (Yolkin et al., 1997). Figure 2B shows the same data with the ordinate scaled to account for differences in the duration of Devonian stages. Stage durations are from Tucker et al. (1998). The position of the Late Eifelian MSEC Event (Crick et al., 1997) is shown along with the Devonian bioevents through the Early Famennian. See Fig. 4 for the key to these and other abbreviations.

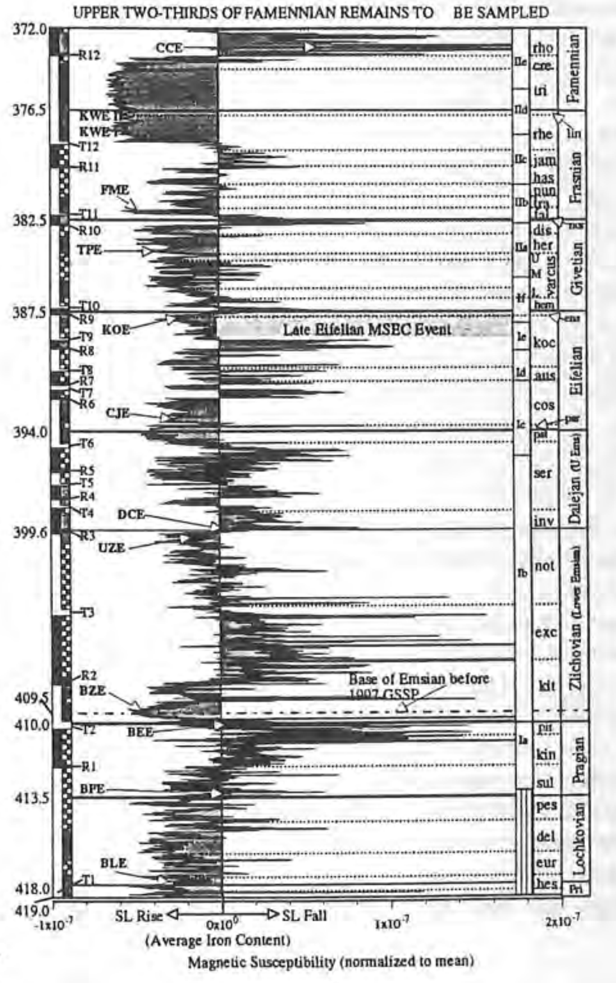


Figure 3 – The approximation of mean sea level (MSL) and indentification of transgressive and regressive events. The MSL reference was determined by subtracting the mean of the MSEC data from all data points. Values that fall to the right of MSL have MS values indicative of lower stands of sea level (higher concentration of iron minerals susceptible to magnetization) while those that fall to the left of MSL have MS values indicative of higher stands of sea level (lower concentration of iron minerals susceptible to magnetization). The duration of transgressions and regressions following T and R events is measured either in terms of stratigraphic thickness or duration of T or R trends. Reversals in a trend related to single, isolated data points are ignored. This allows the plotting of the data of Figure 5 from the perspective of MSL. While it is clear that the position of the vertical line defining MSL will change somewhat with different data sets, its position relative to major high and low peaks is quite stable, at least within the region of the Anti-Atlas. Included along the left margin is a graphic interpretation of the transgressive and regressive character of the MSEC data. See Fig. 4 for details.

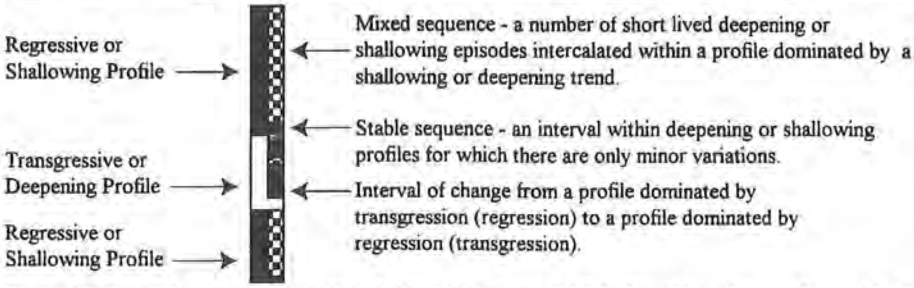


Figure 4 – Key to bio-events (in order of oldest to youngest): BLE–Basal Lochkovian Event, BPE–Basal Pragian Event, BEE–Basal Emsian Event, BZE–Basal Zlichovian Event, UZE–Upper Zlichovian Event, DCE–Dalejan/*cancellata* Event, CJE–Chotec/*jugleri* Event, KOE–Kacak/*otomari* Event TPE–Taghanic/*Pharciceras* Event, FME–Frasne/*Manticoceras* Event, KWE I–Kellwasser Event I (Lower Kellwasser), KWE II–Kellwasser Event II (Upper Kellwasser), CCE–Condroz/*Cheiloceras* Event. Key to conodont zonation: **hes**, *Icriodus woschmidti hesperius*; **eur**, *Ozarkodina eurekaensis*; **del**, *O. delta*; **pes**, *Pedavis pesavis*; **sul**, *Eognathodus sulcatus sulcatus*; **kin**, *E. s. kindlei*; **pir**, *Polygnathus pireneae*; **kit**, *Po. kitabicus*; **exc**, *Po. excavatus*; **not**, *Po. nothoperbonus*; **inv**, *Po. inversus*; **ser**, *Po. serotinus*; **pat**, *Po. costatus patulus*; **par**, *Po. co. partitus* **cos**, *Po. co. costatus*; **aus**, *Tortodus kockelianus australis*; **koc**, *T. k. kockelianus*; **ens**, *Po. ensensis*; **hem**, *Po. hemiansatus*; **varcus**, *Po. varcus*; **her**, *Schmidtognathus hermanni*; **dis**, *Klapperina disparilis*; **nor**, *Po. norrisi*; **fal**, *Mesotaxis falsiovalis*; **tra**, *Palmatolepis transitans*; **pun**, *Pa. punctata*; **has**, *Pa. hassi*; **jam**, *Pa. jamieae*; **rhe**, *Pa. rhenana*; **lin**, *Pa. linguiformis*; **tri**, *Pa. triangularis*; **cre**, *Pa. crepida*; **rho**, *Pa. rhomboidea*

ods of regression (Walliser, 1995). It is generally accepted that the remaining 11 bioevents occurred during times of elevated sea levels (Walliser, 1995) and all correlate with peaks of low MS magnitude or intervals of sustained low MS magnitudes (Fig. 2B). Work proceeding in Spain with TM Jenaro Garcia-Alcade, CM Montserrat Truyols-Massoni, and their Universidad de Oviedo colleagues promises to fine tune the biostratigraphic and MSEC boundaries of the CRS.

A general point of reference for the position of high and low peaks of MS magnitude, relative to mean sea level (MSL), is not easily determined from Fig. 2. One method of illustrating MSL is shown in Fig. 3 with details in the figure caption and Fig. 4. Using these data, the Anti-Atlas Devonian CRS consists of 12 major R events (R1-R12) and corresponding episodes and 12 major T events (T1-T12) and corresponding episodes. Fig. 3 also shows the position of the T-R Cycles for North America (Johnson et al., 1985). It is necessary to combine adjacent T and R events to approximate T-R Cycles. It is perhaps not too surprising that there is little correspondence between MSEC R and T events and T-R Cycles. T-R Cycles are defined on different criteria and the exact character of T-R Cycles does not always agree with events outside North America. The temporal spacing of MSEC T & R episodes cluster into three distinct patterns over the course of 47 Ma. T and R durations for the CRS are summarized in Fig. 5.

The type of graphical analysis of MSEC data illustrated in Fig. 3 is also helpful in revealing the relationship between MSL and the timing of bioevents. Comparison of the position of the bioevents to the MSEC MSL reveals that 11 of 13 bioevents occurred during periods when sea level was stable (gray bars of Fig. 3). Of the two bioevents that do not occur during stable sequences, the Basal Pragian Event (BPE) has been interpreted as representative of conditions consistent with a relatively quick but non-drastic global lowering of sea level (Chlupac and Kukal, 1986), and the Basal Emsian Event (BEE) has been interpreted as the beginning of a prominent sea level rise in the type area, the effects of which lead ultimately to the Basal Zlichovian Event (BZE), a well documented and major transgressive event at the base of historical Zlichovian (Walliser, 1995). At the time of the submission of the GSSP proposal in 1995 and its acceptance in 1997(Yolkin et al., 1997), it was not known if the effects of the Basal Emsian Event could be found outside the region of the GSSP (Zeravshan Range, Uzbekistan). The position and character of these two events are best seen on Figure 3 where the Basal Pragian Event occurs near MSL during transition from a T trend to a R trend, while the Basal Emsian Event occurs during a transition from a R trend to a T trend. We can document that the Basal Emsian Event does occur in at least one additional geographic region (Anti-Atlas Morocco) outside the stratotype area.

A close look at the Givetian

Fig. 6 illustrates the Givetian portion (including latest Eifelian and earliest Famennian) of Figs. 2 & 3. The Givetian portion is a composite of Jbel Mech Irdane, Jbel Amelane, and Bou Tchrafine sections. The conodont zonation of the Givetian

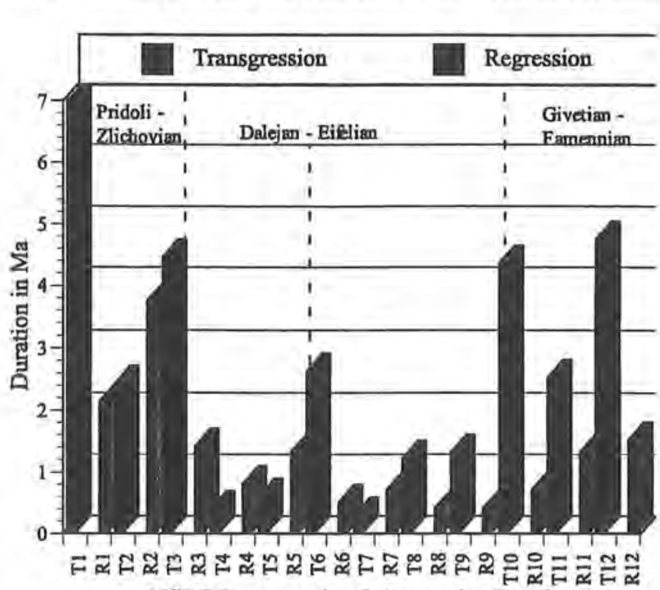


Figure 5 – Summation of transgressive and regressive events and trends contained within the MSEC CRS of Fig. 6. The 19.4 Ma spanning the interval latest Pridoli through Zlichovian (Note: Zlichovian and Dalejan are used for the Early and Late Emsian respectively) consists of only 3 T and 2 R events with average durations on the order of 4.6 and 2.9 Ma, respectively. With exception of the rather long T1 events that begins earlier in the Pridoli the T and R events are of roughly the same duration. The succeeding 12.1 Ma of the Dalejan through Eifelian interval consist of 6 T (T4-T9) and 7 R (R3-R8) events. Although the Dalejan and Eifelian are alike in exhibiting a high number of T and R events and episodes, they differ in that R events account for 78% of Dalejan time but only 27% of Eifelian time. The 15.5 Ma interval for the Givetian, Frasnian, and early Famennian consists of 3 T (T10-T12) and 3 R (R10-R12) events with average durations on the order of 3.9 and 1.2 Ma, respectively. Transgressions are three times the duration of regressions, although regressions do increase in duration over the 15.5 Ma. Duration from Tucker et al. (1998).

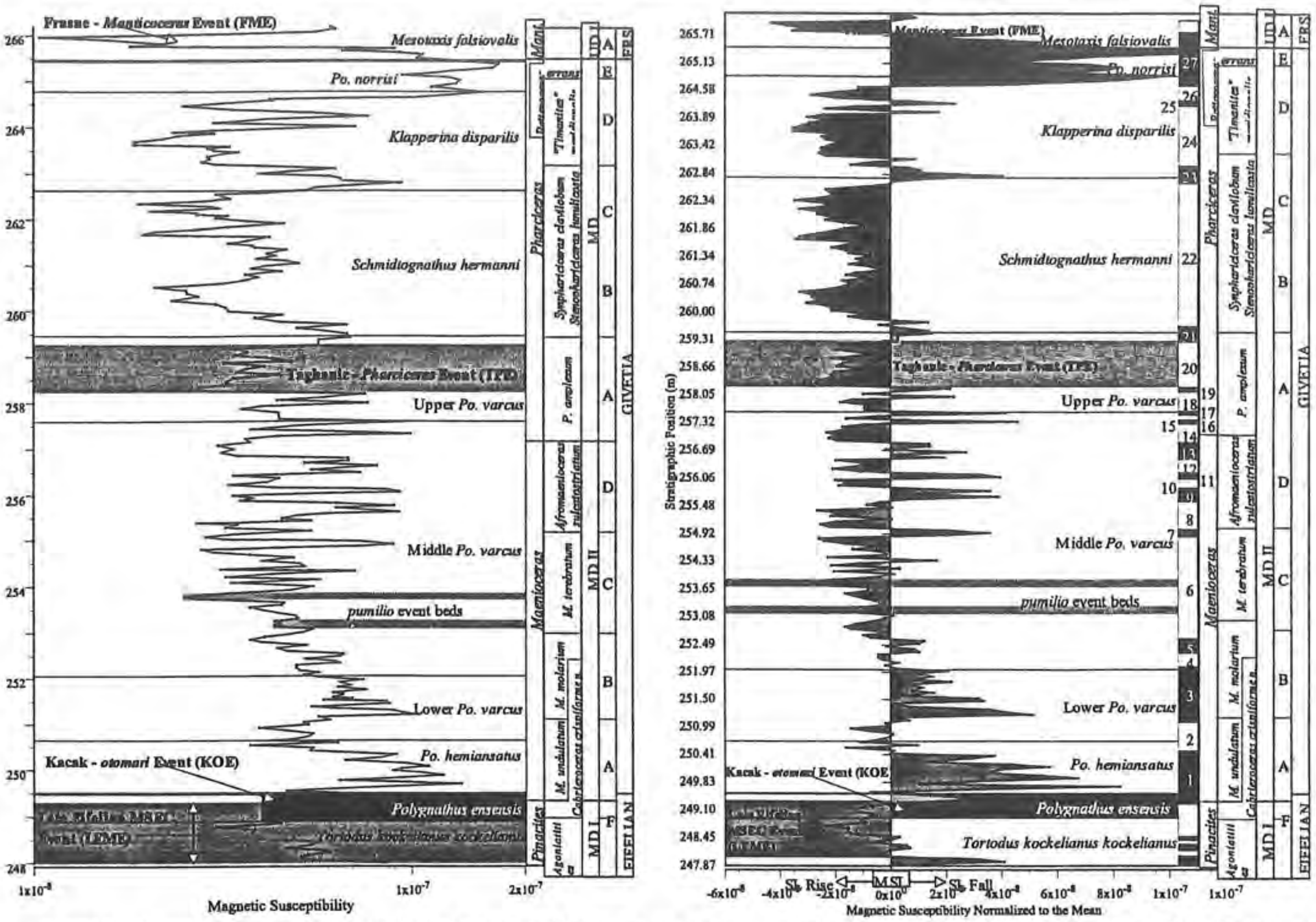


Figure 6 – Givetian portion of the CRS (including latest Eifelian and earliest Famennian). Shown is the stratigraphic position of the *Terebratula pumilio* event beds that extend from Germany to the Anti-Atlas of Morocco and considered to be individually isochronous as a result of deposition by tsunami (Lottmann, 1990). A, values of MS plotted in stratigraphic position as they occur in the 16 m represented by the Givetian. B, the data of A with the mean subtracted from each value to provide an approximation of mean sea level (MSL) and a better illustration of the position and duration of MSEC events at the scale of the Givetian.

is mature but roughly 50% of Givetian time falls into the *Polygnathus varcus* CZ. Plotting the MSEC curve at the scale of the Givetian greatly increases the resolution of the data and permits the definition of 27 Givetian MSEC chronozones for high-resolution chronocorrelation (Fig. 6B). Fourteen chronozones occurred during R events and 13 during T events. Of the 13 T events, only events 6 & 22 are equal to or longer that associated ammonoid or conodont zones. The greatest increase in chronocorrelation resolution occurs in the Middle *Po. varcus* CZ where 5 T events and 6 R events subdivide the Zone.

MSEC events are not of equal duration. Longer duration events occur in the Early and Late Givetian and shorter duration events occur in the Middle Givetian, specifically in the late Middle *Po. varcus* CZ and the early Upper *Po. varcus* CZ. This pattern strongly suggests that events controlling either climate or sea level or both were constantly changing immediately prior to the biotic Taghanic/*Pharciceras* Event. MSEC events of the Early Givetian (*Po. hemiansatus* and Lower *Po. varcus* CZs) were generally of longer duration and developed under regressive conditions. Long duration MSEC events following the Taghanic/*Pharciceras* Event were developed under transgressive conditions with only short regressive events through the latest *Klapperina disparilis* CZ.

Using a Givetian duration of 5 Ma (Tucker et al., 1998) it is possible to derive a first order estimation for the duration of MSEC chronozones. The summation of these data appears in Fig. 7. It is interesting that 18 of the 27 events are high frequency events with durations of 25 Ka, 50 Ka, and 100 Ka. The 50 Ka and 100 Ka events correspond well to the 54 Ka and 106 Ka eccentricity orbital forcing cycles. The 25 Ka events may represent one or more of the shorter obliquity cycles or longer precession cycles when adjusted for Middle Devonian time. Of the remaining nine events, 3 and 24 occur with a duration close to the 413 Ka eccentricity cycle and others fall close to orbital forcing cycles of lesser magnitude. The stability of eccentricity cycle durations and changes to precession and obliquity cycle durations over geologic time is discussed in Berger (1989) (Berger et al., 1989). There is also the distinct possibility that unidentified MSEC events belong to tectonic events.

Eifelian –Givetian boundary sequence (eastern-central Iowa)

Fig. 8 shows the MSEC chronostratigraphic relationship between the Eifelian-Givetian GSSP (Crick et al., 1997) (Fig. 8A) and the MSEC profile for equivalents of the upper Spillville/Otis Formation and the lower Pinicon Ridge Formation contained in core from eastern-central Iowa (Fig. 8B). This work is

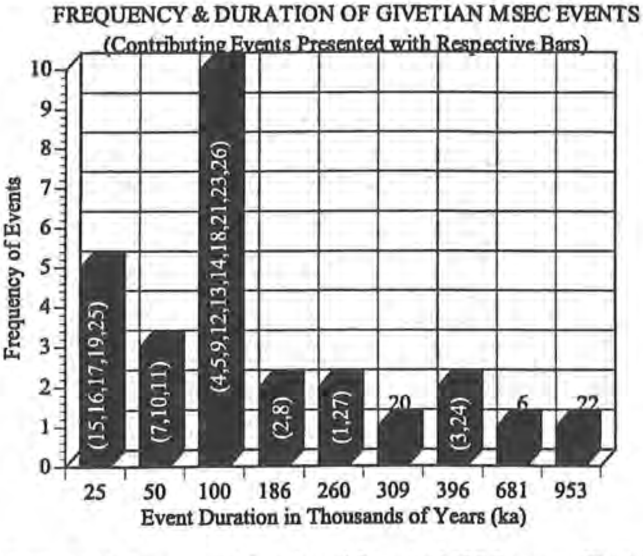
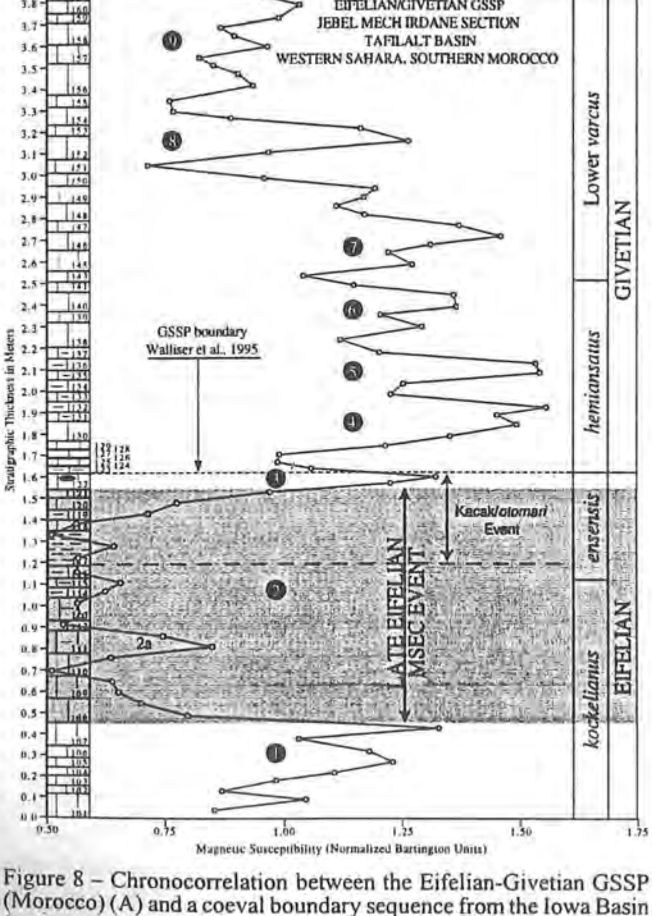


Figure 7 – Frequency and duration of Givetian MSEC events. The 16 m represented by the Givetian in Fig. 8 is also considered to represent 5 Ma on the revised Devonian time scale (Tucker et al., 1998). The duration of the 27 MSEC events was read directly from Fig. 8 and the frequencies of durations were used to construct the height of bars.

in collaboration with CM Jed Day. The lithology of the Iowa sequence ranges from oolitic grainstones to dolomitic mudstones to mudstones. Many units are brecciated, all or in part. What fauna exists (few brachiopods – mostly assigned to *Emanuella* - and gastropods) is impoverished and decidedly not pelagic (Day and Koch, 1994). Conodonts are rare in the Spillville/Otis of east-central Iowa and nonexistent from most portions of the overlying Pinicon Ridge Formation (Klapper and Barrick, 1983). Lower portions of the sequence were thought to be Late Eifelian on the basis of a probable correlation between endemic Eifelian conodont faunas, described from the lower part of Spillville/Otis Formation in northern Iowa and southern Minnesota, and the standard *Polygnathus ensensis* CZ as it was then defined (Klapper and Barrick, 1983).

Correlation of the Iowa MSEC profile with the GSSP signature allows (1) clear identification of the Late Eifelian MSEC Event (event 2), (2) the description of the interval corresponding to the Kacak/*otomari* bioevent previously unreported from the mid-continent Devonian, and (3) the determination of the position of the Eifelian-Givetian boundary in unit 8 immediately above the base of the Pinicon Ridge by virtue of the position of MSEC Event 3. The MSEC signature between MSEC Events 5 and 7 is not resolvable due to an interval of brecciated dolomudstone from the upper half of unit 9 through the lower half of unit 11. A similar lithology leaves the MSEC signature unresolved from the interval thought to contain MSEC Events 8 and 9.



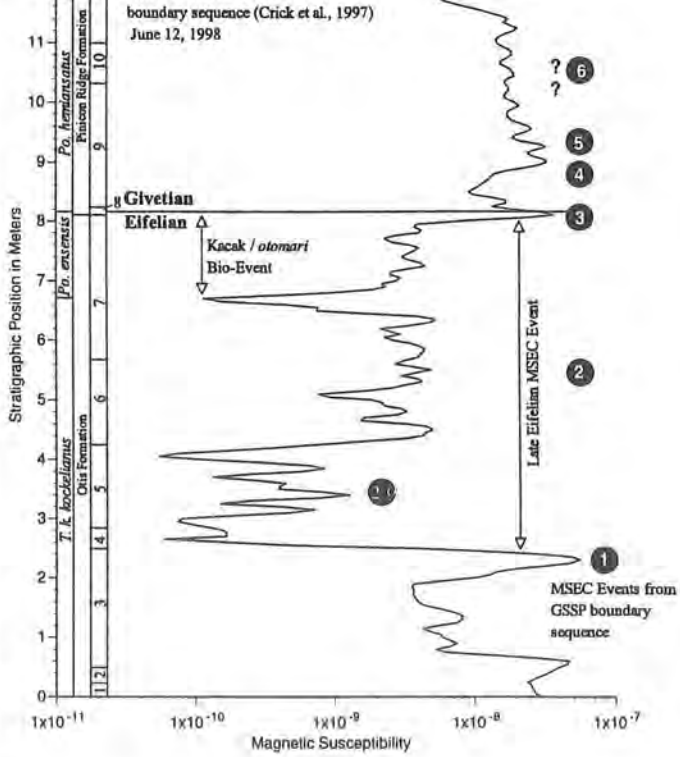


Figure 8 – Chronocorrelation between the Eifelian-Givetian GSSP (Morocco) (A) and a coeval boundary sequence from the Iowa Basin (eastern-central Iowa) (B). The MSEC profile for the Eifelian-Givetian boundary sequence from the Iowa Basin (B) is part of a 60 meter core sampled for MS at 5 cm intervals. The work is part of an ongoing project directed by CM Jed Day (Illinois).

MSEC signature for the Frasnian-Famennian GSSP

The MSEC signature for the Frasnian-Famennian GSSP has been completed in collaboration with TM Raimund Feist and Catherne Girard (Lyons) (Fig. 9). A paper has been submitted to EPSL describing the MSEC signature for the F-F GSSP, correlations with three other Montagne Noire sequences, and the relationship between the MSEC profile and proportional changes in the makeup of the conodont fauna. Details of Fig. 9 are given in the figure caption. Preliminary work in Belgium, Germany, Morocco and southern Oklahoma (Woodford Shale) indicates that the GSSP MSEC signature has correlative power outside of the Montagne Noire.

MSEC signature for the Pridoli-Lochkovian (Silurian-Devonian) GSSP

In collaboration with TM Chlupac, CM Hladil, and Frantisek Hrouda (Jecna, CZ) we have completed the MSEC signature for the Pridoli-Lochkovian GSSP (Fig. 10). A paper describing the MSEC signature and demonstrating correlations with Pridoli-Lochkovian boundary sequences in the Tafilalt and Maider Basins has been submitted to Palaios. Nine MSEC events are identified in the GSSP MSEC signature, two of which are described as boundary events (Fig. 10). Five of the events are defined by peaks of low magnitude and four events are defined by peaks of high magnitude. Large-scale transgressive and regressive patterns in the MSEC data establish that the Silurian-Devonian boundary falls between a short-lived transgressive pulse in the latest Pridoli and an equally short-lived regressive pulse in the earliest Lochkovian (Fig. 11). Several first and last appearances of Late Pridoli and Early Lochkovian species are coincident with transgressive or regressive events.

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Chlupac, I., Jaeger, H., and Zikmundova, J., 1972, The Silurian-Devonian boundary in the Barrandian: Bulletin of Canadian Petroleum Geology, v. 20, p. 104-174.

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Ellwood, B.B., Crick, R.E., and El Hassani, A., 1998, The MagnetoSusceptibility Event and Cyclostratigraphy (MSEC) method used in geological correlation of Devonian rocks from Anti-Atlas Morocco: American Assoication of Petroleum Geologists Bulletin, v. (in press).

Girard, C., and Feist, R., 1996, Eustatic trends in condont diversity across the Frasnian/Famennian boundary in the stratotype area, Montagne Noire, Southern France: Lethaia, v. 29, p. 329-337.

Hladil, J., 1991, Evaluation of the sedimentary record in the Silurian/Devonian boundary stratotype at Klonk (Barrandian area, Czechoslovakia): Newsletter in Stratigraphy, v. 25, p. 115-125.

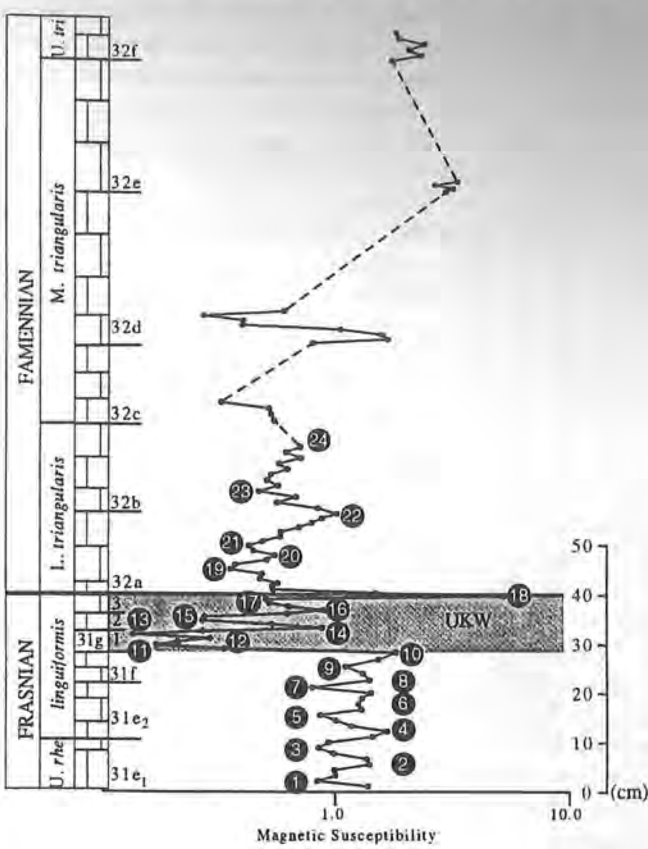

Figure 9 – MSEC signature for the Frasnian-Famennian GSSP. The ordinate is stratigraphic thickness in cm and the abscissa represents MS magnitude in units of MS normalized by the mean of the signature. Each small black dot is 1 sample. Numbered black circles identify MSEC events used for chronocorrelation. Intervals over which samples were not collected are dashed. The UKW interval is shaded. Unit designations and biozone boundaries are from Girard & Feist (1996).

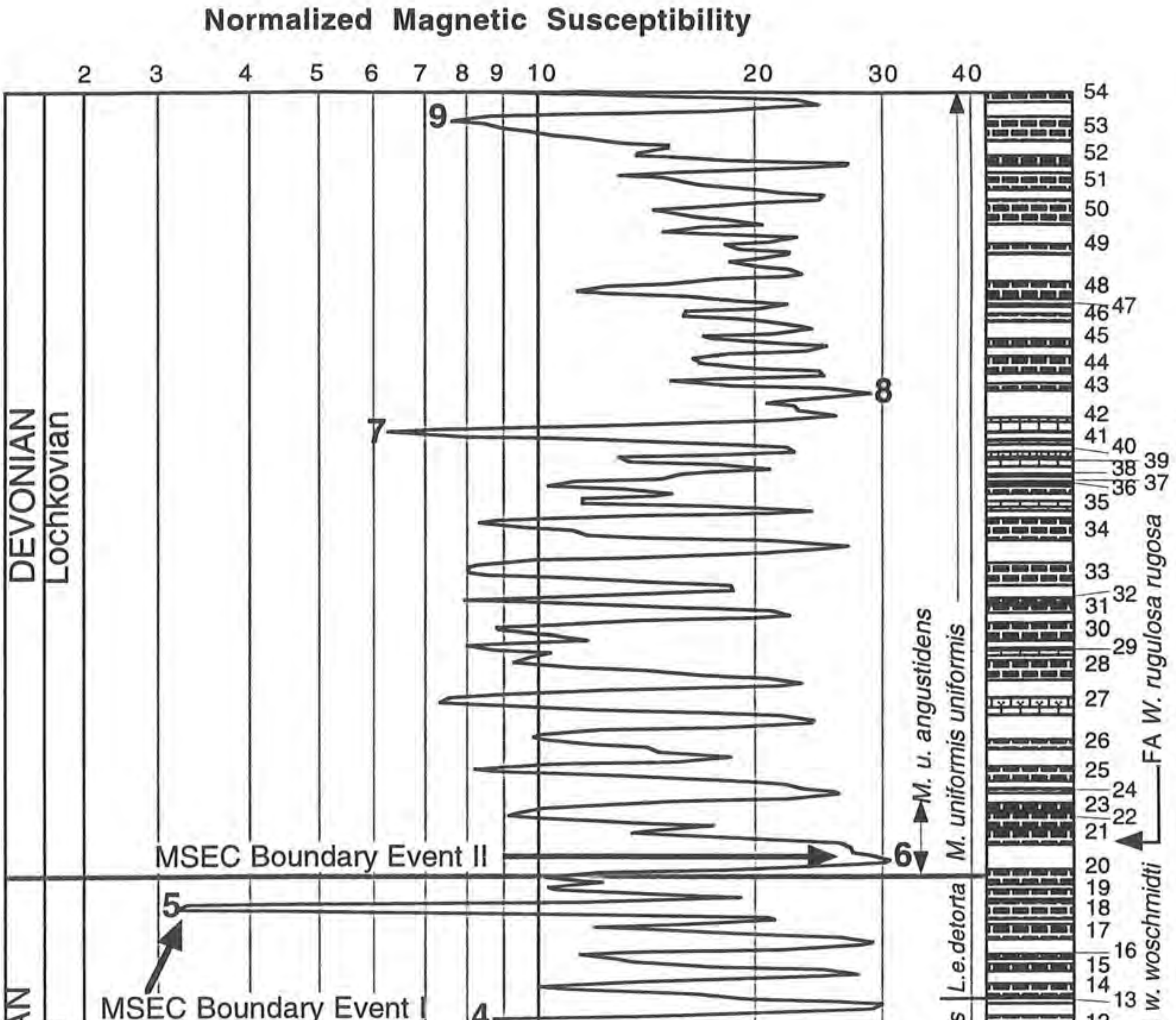

Figure 10 – MSEC signature for the Pridoli-Lochkovian GSSP. The signature is based on 320 data points from the same number of samples taken at approximately 5 cm intervals over the boundary sequence. The lithologic determinations and bed numbers are those of Chlupac et al. (1972) with later modifications by Hladil (1991). The magnetic susceptibility scale was normalized to the value of the lowest magnitude. The position shown for the Silurian-Devonian boundary in the upper one-third of Bed 20 is that determined by biostratigraphic data (Chlupac and Kukal, 1977). It should be noted that *Icriodus woschmidti woschmidti* has not been recorded from the GSSP. *I. w. woschmidti* is placed within the GSSP on the basis of its occurrence at nearby Certovy schody. Biostratigraphic information for all taxa but *Ligonodina elegans detorta* (Jeppsson, 1988, 1989)) came from Chlupac et al. (1972). 1, Bituminous Limestone; 2, Crinoidal Limestone; 3, Calcareous Shale.

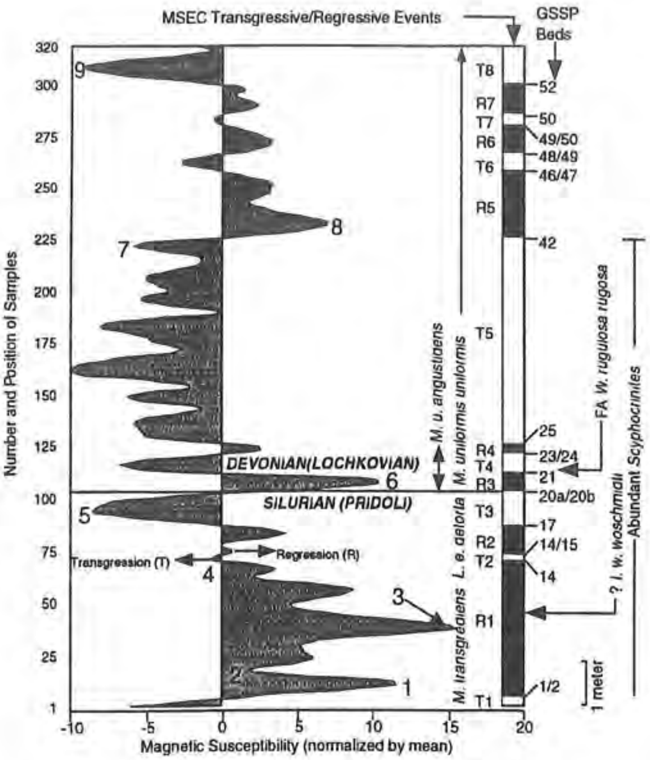

Figure 11 – Transgressive/Regressive Events and conditions within the Pridoli-Lochkovian GSSP boundary sequence. The position of MSEC magnitudes relative to the profile mean provide illustration of the general environmental and sea level conditions for the boundary sequence. Ranges of important taxa are from Chlupac et al. (1972). FA, first appearance. See Figure 10 for other details.

CM Jed Day

I am currently engaged in a number of projects that might be interest to SDS members and are briefly summarized below.

High-resolution Middle-Late Devonian neritic stable carbon and oxygen isotope profiles.— Goals are to characterize isotopic signatures of platform carbonates spanning Devonian T-R cycles Id-IIf and document records associated with intervals of known Middle-Late Devonian sea level changes, bioevents, and climate changes. Detailed sampling of the late Givetian and Frasnian of the Iowa Basin carbonate platform was completed as of October of 1998 with Michael Jochimski and Robert VanGeldern (University of Erlangen). Future sampling of the Eifelian-early Givetian of central and northern Ohio and Michigan are planned with Chuck Ver Straeten and Carl Brett in 1999.

North American Neritic Magnetic Susceptibility Records.—Work was initiated to develop and test the utility of high-resolution magnetic susceptability profiles for enhanced correlations of North American Middle-Late Devonian neritic (carbonate platform) and pelagic successions. Sampling of cores and surface exposures the Eifelian-early Frasnian of the Iowa Basin was completed with Brooks Elwood and Gretchen (Univ. Texas-Arlington) in June of 1998. Initial MS profiles generated from measurements in well preserved platform carbonates and dolomites through the late Eifelian and early:Givetian are comparable to profiles generated from a variety of Eifelian-Givetian boundary sections in pelagic facies from Europe and Africa. Additional MS sampling through the remainder of the Iowa Basin Frasnian is planned for 1999-2000. Detailed lithologic sampling for development of MS profiles for the Eifelian-early Givetian of central and northern Ohio and Michigan are planned with Chuck Ver Straeten and Carl Brett in 1999-2000.

Devonian Eustasy-Proposed subdivision of Frasnian T-R cycle IId.—In a study of the distribution of Frasnian atrypid brachiopods of central and western North America (Day, 1998) informal division of Devonian T-R cycle IId (Johnson et al., 1985; later revised by Johnson and Klapper, 1992) is proposed. The two divisions consist of a lower T-R cycle IId-1 and upper T-R cycle IId-2. The base of the former corresponding to a position at or near the base of M.N. Zone 11 of Klapper (1989), and the base of the latter corresponding to the deepening event correponding the Lower Kellwasser Horizon at or near the base of M.N. Zone 13 of Klapper (1989). Formal proposal of subdivisions of T-R cycle IId in North America will be published in 1999 or 2000.

Biostratigraphic and Sequence Stratigraphic Investigation of Late Givetian-Famennian-Western Canada.—Substantial progress was made this field season on biostratigraphic and sequence-stratigraphic investigation of the Miette and Ancient Wall reef platforms with Michael Whalen (Univ. Alaska-Fairbanks) We completed lithologic sampling at 50 cm intervals through neritic and platform-to basin transition sections spanning the late Givetian-early Famennian at Ancient Wall and Miette, as well completing sampling of Frasnian and Famennian brachiopod and conodont faunas. The new lithologic sample suite (approx. 2500 samples) are suitable for MS measurement that will be used to develop MS profiles through the late Givetian-Early Famennian interval to test the utility of MS profiles for intrabasinal correlation, and comparison of neritic profiles generated from the Frasnian of the subtropical Iowa Basin and coeval pelagic sections.

Nertitic Brachiopod Records-U.S.—Development of detailed biological records of Middle-Late Devonian carbonate platforms in central and western North America. Work continues on the biostratigraphy, biogeography and taxonomy of the Eifelian-Famennian brachiopod faunas of central and western North America. A number of recent papers feature revisions or descriptions of elements of the the Iowa Basin Devonian brachiopod fauna. Work continues with collaborators on Middle and Late Devonian faunas from the Michigan, Illinois, and Appalachian basins in the central and eastern U.S. and the Great Basin (Famennian). A focus of current work in New York with Jeff Over (SUNY-Geneseo) is to document pre- and post

F-F extinction shelly faunas. Work with John Bratton (USGS-Woods Hole) is intended to refine biostratigraphic range data and the revise the brachiopod systematics of early Famennian post-extinction platform faunas from carbonate debris flows in the Pilot Shale and West Range Limestone.

Neritic Brachiopod Records-Western Canada.—Work began in 1997 in the NWT and Alberta and continued in 1998. Work in Alberta is intended to develop detailed data on brachiopod and conodont sequences and faunas in and around the Miette and Ancient Wall detached carbonate platforms aiding correlation of major sequence packages comprising the main platform architectural units of the buildups in collaboration with Michael Whalen (Univ. Alaska-Fairbanks). Data on the brachiopod sequence is also intended to develop information on extinction patterns of tropical shelly platform faunas through the Frasnian and early Famennian. Conodont systematics and zonal correlations are being handled by Gil Klapper. Work in Frasnian-early Famennian of the Mckenzie Shelf in the NWT began in 1997 and is intended to recongnizeand characterize sequence boundaries and refine correlations of sequence packages deposited during Late Devonian T-R cycles IIc-IIe and document the Frasnian-early Famennian brachiopod sequence and extinction record of near equatorial-tropical platform shelly faunas.

Devonian brachiopod systematics.—Recent studies were completed on biostratigphic and biogeographic distribution of late Givetian and Frasnian atrypids of central and western North America, and systematic revision of late Givetian and Frasnian atrypids of central North America with Paul Copper. Bill Koch (Oregon State Univ.) and I are making progress on two papers describing the late Eifelian-early Givetian faunas of T-R cycle Ie from the Michigan Basin (Rogers City and Lake Church formations) and Iowa Basin (Spillville Formation). Related work on the Eifelian faunas of Ohio are in early stages of development with C. Ver Straeten and C. Brett. Dr. Xueping Ma (Univ. Peking, Beijing) is in the middle of a year-long visit and we have completed the first of four papers focused on systematic revision, biostratigraphy, and biogeography of the Frasnian and Famennian species of the cyrtospiriferid brachiopod genera *Cyrtiopsis, Cyrtospirifer*, and *Tenticospirifer* from North America and south China. Work continues on completion of two other papers describing late Devonian brachiopod and conodont faunas from the Hanover Shale of New York (with Jeff Over) and the Chattanooga Shale of Tennesee (with J. Over and Juergen Schrieber, Univ. Texas-Arlington). Work will begin in early 1999 on systematic revision of late Givetian and Frasnian rhynchonellid brachiopods of the Iowa Basin with Paul Sartenaer.

New Frasnian Trilobite from North America.—Frasnian trilobites are extremely scarce in North America. I recovered a very handsome specimen of a scutellid trilobite from the late Frasnian Arcs Member of the Southesk Formation in western Alberta in July. This material was forwarded to Raimund Feist for study and a brief report on its taxonomic and biogeographic significance is planned for sometime in 1999.

Publications in 1998.

Day, J. & Copper, P., 1998, Revision of latest Givetian and Frasnian Atrypida (Brachiopoda) from central North America. Acta Palaeontologica Polonica, v. 43, no. 2, p. 155-204

Day, J. , 1998,Distribution of latest Givetian-Frasnian Atrypida (Brachiopoda) in central and western North America. Acta Palaeontologica Polonica., v. 43, no. 2, p. 205-240.

CM Peter E. Isaacson (Idaho)

The principal news for Andean Devonian work is expansion of the areal and temporal extent of the glaciations. Combined with Brazilian data (principally from Mario Caputo), evidence for the glaciation is very convincing. Albeit primarily dated in the latest Famennian, 1998 work has shown that there were dropstones significantly lower in the section. These are being palynologically dated at this time. We suggest that the glacial drawdowns had worldwide impact. We have a paper in press, with the Geologische Bundesanstalt (Vienna), whose abstract follows:

Authors: Peter E. Isaacson, Jindrich Hladil (Prague), Shen Jian-wei (Nanjing), Jiri Kalvoda (Brno), and George Grader (Idaho)

Famennian events present a more significant timespan than earlier acknowledged. It has recently been shown that Gondwana's well-known Carboniferous glaciations began in Late Devonian time. The Devonian glaciation event occurred over a broad area, including much of Brazil (Parna!ba, Amazonas, and Solim"es basins) and Bolivia (Madre de D!os an Altiplano areas of the Paleozoic foreland basin), and this initial glaciation continued into earliest Carboniferous (Tournaisian) time. It is dated within at least the LE, LN and VI palynozones. Bolivian glaciation events include unbedded and poorly bedded diamictites with striated and faceted clasts of sedimentary and granitic rocks sourced from the adjacent foreland fold- and thrust- belt. Some evidence suggests that at least two major ice advances occurred within Devonian time. Coeval with the Gondwanan glacial event is a geologic record in North America, central Europe and southern China that suggests a very rapid sea- level fall that exhumed and eroded carbonate platforms, deposited siliciclastics, and generated lacunae in the Famennian record. The lowstand resulted in extensive carbonate breccias, shoal-deposits and evaporites in western U.S.A. and Canada. Widespread early Famennian and older carbonate breccias located in Idaho and western Montana may manifest coeval subaerial exposure and interaction with a fluctuating phreatic weathering zone related to varying sea-levels. Possible similar breccias occur also in Nevada. Lowstand clastic-wedges were deposited in a major forced regression in black shales (eastern U.S.A.). The glaciation was apparently responsible for lacunae in the Famennian rock-record in many places. In Moravia, Famennian physil and siliclastic influx increased as a result of weathering in newly- emergent highs that resulted from sea-level drop. Partial sea level drops were manifested by ferruginous oolites, which developed in near-shore environments and were subsequently dispersed onto adjacent slopes by storm resedimentation. In southern China (Guilin), aggradation, siliciclastic influx, dolomitization from evaporation, and shallow-water carbonates resulted from Famennian sea-level lowering. The coupling of glacial and lowstand events explains the sudden appearance of shallow-marine, as well as subaerially-affected features within a generally transgressive sea that breached the North American craton during Late Devonian (Frasnian) time.

We are pursuing palynological dating of the lower dropstones, investigating extent of diamictite outcrops in Peru, and we are working with colleagues on consequences of the glaciation on Famennian events elsewhere.

We welcome any comment.

CM Ruth Mawson & TM John Talent (New South Wales)

News from Macquarie University Centre for Ecostratigraphy and Palaeobiology (MUCEP)

Ruth Mawson and John Talent report that at last their paper on allochthonous carbonates of the Tolga "Calcarenite", Nubrigyn Fmn, Jesse Limestone and Cunningham Formation of the Dripstone-Euchareena area of central New South Wales is in press and that another paper on Early Carboniferous conodonts from the Ruxton Formation of the Clarke R. Basin of northern Queensland will be sent off to Italy as a contribution to the ECOS VII volume. Another paper on Ordovician, and Devonian conodonts from Chitral, Pakistan is nearing completion. The manuscript in collaboration with Covadonga Brime, University of Oviedo on patterns of illite crystallinity and conodont colour-alteration indices in relation to Ordovician-Early Carboniferous tectonic events in the Townsville hinterland (Broken River, Burdekin and Clarke River Basins) of northeastern Queensland will be completed when John visits Oviedo in late November, 1998. A manuscript on the Silurian of Australia has been completed; it will probably see the light of day even prior the Devonian summary paper submitted early in 1997!

Radiometric dating for improving the mid-Palaeozoic time scale is progressing slowly because of time-lags in accessing the SHRIMP at Curtin University and commitments our collaborator in TIMS dating of zircons, Greg Dunning from Memorial University, Newfoundland. Preliminary dates, however, are looking good.

Most of our other activities have been connected with IGCP 421 "North Gondwana mid-Palaeozoic bioevent\biogeography patterns in relation to crustal dynamics" (coordinators Raimund Feist and John Talent). The edited volume emanating from the inaugural meeting of the project held in Vienna is now in press (North Gondwana Terranes, Stratigraphy and Biota. Bah. Geol. Bund. Wien, Vol. 54, 415 pp., 20 contributions). IGCP activities for the year included a highly successful session held in conjunction with ECOS VII in Bologna and Modena (19 June-2 July, 1998). The fourth meeting of IGCP421 is scheduled for 5-20 December in Isfahan, Iran. Attendance indicated to date includes 70 Iranians and 40 non-Iranians.

Glenn Brock, Lecturer in Palaeontology at Macquarie, has undertaken a study of Late Devonian brachiopod biogeography with emphasis on the northern Gondwana margin. He continues to edit Alcheringa as well as continuing work on Cambrian and Ordovician faunas. Theresa Winchester-Seeto continues her work on Ordovician to Devonian chitinozoan faunas. Zerina Johanson successfully completed her PhD and is now an ARC-supported Fellow at the Australian Museum. Alison Baseden nears the completion of her PhD on Early Devonian fish faunas from eastern Australia. Margaret Anderson and John Klyza both completed MSc dissertations during the year and Ken Bell's PhD on Devonian foraminifers is close to submission.

Visitors to MUCEP include Charles Harper (University of Okalahoma) who has been working on a manuscript for the Struve memorial volume and probing the use of computers in field studies. We very much enjoyed showing him our sections at the Broken River. Daniel Drygant from the Ukraine and Igor Bardashev from Tajikistan spent 2 months with us during working on their conodont faunas. Rose Toni (University of Alexandria) was with us for 12 months as a Visiting Adjunct Professor.

Plans for AUSCOS 2 to be held in conjunction with an IGCP421 meeting to be held in Australia are firming up. Please keep aside some of your well-earned dollars or whatever to make the trip to the antipodes.... We'll certainly make you welcome!

Jeff Over (Geneseo, New York)

Myself and students continue to concentrate our work on the Middle and Upper Devonian black shales in eastern and central North America. Samples from numerous sections of the New Albany and Chattanooga shales were collected and are currently being processed for conodonts. These samples, and conodonts collected by F. Ettensohn, R. Norby, and J. Scheiber, will document ranges of taxa in the shales. Other notable studies are precise biostratigraphic placement of the Center Hill Ash from the Appalachian Basin in MN Zone 13 (uppermost Frasnian) and description of a post-Frasnian (Lower *triangularis* Zone) brachiopod fauna from the upper Hanover Shale in New York State (w/J. Day).

CM Eberhard Schindler (Frankfurt)

Research concentrated on various continuing projects and on the start of new investigations in the Russian Urals. Among ongoing work, the Sessacker Trench section in the Rhein. Schiefergebirge shall be mentioned. The extremely detailed investigations of the Frasnian/Famennian boundary interval have been published together with Immo Schülke and TM Willi Ziegler (Senckenbergiana lethaea, vol. 77; also orally presented at the ECOS VII/IGCP 421/SDS meeting in Bologna and Modena, Italy). Activities in the Eifel Hills area also continued – especially cooperative work on an early Late Devonian section at 'Steinbruch Reichle' near Loch and a core (drill hole 'Büdesheimer Bach') from the center of the Prüm Syncline, yielding Frasnian to Famennian strata in siliciclastic (younger) and partly calcareous (older) rocks. Joint work on this core with different researchers is under way. Work on Albanian samples from the Korabi-Unit also continued. A paper on an isolated graptolite locality is already in press (Maletz, Königshof, Meco & Schindler: Senckenbergiana lethaea, vol. 78). In the frame of the cooperation program in the Moroccan Anti-Atlas between the Forschungsinstitut Senckenberg (FIS) and the University of Marrakech (additional cooperations with CM Ahmed El Hassani, Rabat, and the geomagnetic group at Arlington, i.e. TM Rex Crick and Brooks Ellwood), investigations on mainly Lower Devonian strata continued. New sections of Lower and Middle Devonian rocks in the SE Maider have been measured and sampled during recent field work.

New cooperations started with the stable isotope group from Erlangen University (Buggisch, Joachimski, van Geldern) in order to get a very detailed record of stable isotopes in well preserved brachiopod shells from biostratigraphically well-dated strata.

A new project between the FIS and the Academic Institute at Ekaterinburg (Russia), granted by the 'Deutsche Forschungsgemeinschaft', started with a joint field campaign to Western Uralian areas. Own investigations in this project will focus on homoctenids and facial/sedimentological phenomena from two Upper Devonian sections in close cooperation with the other participants of the project (i.e. TM Willi Ziegler, TM Karsten Weddige, Peter Königshof, Gunnar Schraut, Gerhard Becker, Gerhard Plodowski, Ulrich Jansen from FIS; Alexander Bikbaev, Maria Snigireva, Kirill Ivanov, Larissa Mizens from Ekaterinburg).

Finally, there shall be mentioned the participation at the joint ECOS VII/IGCP 421/SDS meeting in Bologna and Modena (Italy) as well as the contribution to both working groups (Emsian and Late Devonian subdivisions) of the German SDS.

Short note:

At the Forschungsinstitut Senckenberg (Frankfurt, Germany) palynological investigations have started recently on sections in the Moroccan Anti-Atlas and in the Rheinisches Schiefergebirge (Germany). The aim of the studies is to compare both regions and to contribute to refinement of their biostratigraphy. The material will be dealt with by Rainer Brocke (address: Dr. Rainer Brocke, Paläobotanik, Forschungsinstitut Senckenberg, Senckenberganlage 25, D-60325 Frankfurt/M. - phone ++49-69-97075189, fax ++49-69-97075137, e-mail rbrocke@sngkw.uni-frankfurt.de). There will be a close cooperation with the newly elected CM Christoph Hartkopf-Fröder (Krefeld, Germany)

CM Streel, M. (Liège)

IGCP 421 round table, June 25, 1998, Bologna

Quantitative palynology of latest Famennian events in the Sauerland

During the late and latest Famennian, quantitative palynology allows to recognize four continental ecological niches, three marine megaenvironments and two contrasting palynofacies (oxic / anoxic). Miospore analysis recognises a recurrence of high sea levels developing downstream "coal" swamps and a recurrence of wet climates developing upstream swamp margin plant communities.

Applied to a sequence around the Hangenberg Event in Sauerland, Germany, where the changes in sea level are known to have been severe, miospore analysis suggests a high rate of sedimentation and short cycles involving climatic changes and sea-level changes probably of the 6th order i.e. of less than 100 ka by comparison with other, but similar, researches conducted in the late Famennian in N-E Belgium.

Continental vegetation has not been affected by the Hangenberg Event sensu stricto (the base of the Hangenberg Black Shale). On the contrary, younger "continental Hangenberg Events", corresponding to the peak of the regression, probably associated with a much wetter climate, have strongly modified the contemporaneous "upland" and "coastal"plant communities. The "coastal" one has not recovered after that peak, probably as a consequence of a colder climate (Brand 1993).

The duration of the Hangenberg Events (corresponding to the miospore LN Zone) was probably less than 100 ka as also suggested by Sandberg & Ziegler (1996). The consequence is that the glacial episode known in Brazil, which is characterized by the same miospore Zone, had also a very short duration. Latest Famennian climate was probably unstable with quick oscillating glacial and interglacial phases in the high latitudes.

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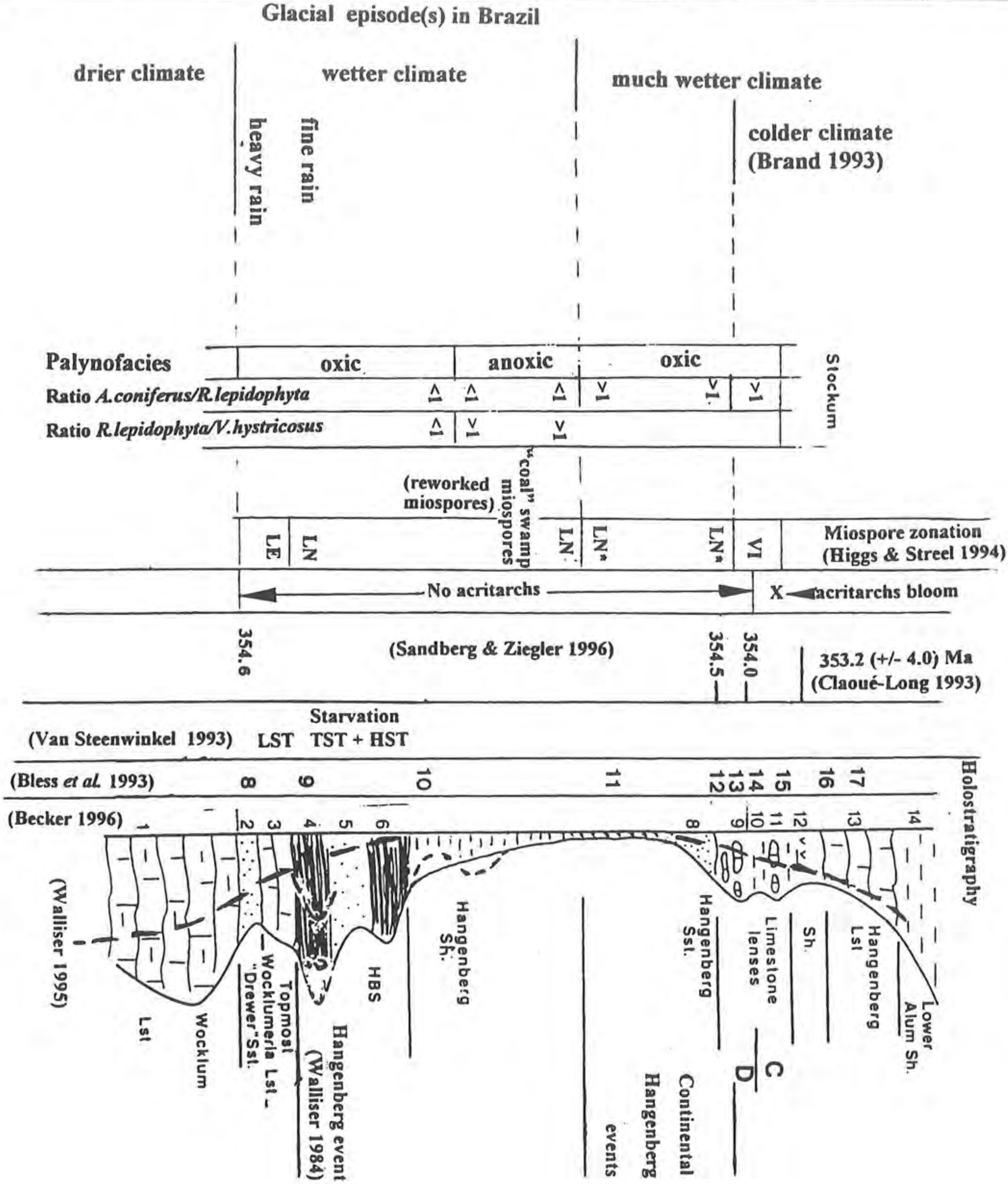
Glacial episode(s) in Brazil
drier climate
wetter climate
much wetter climate
heavy rain
fine rain
colder climate (Brand 1993)
Palynofacies
oxic
anoxic
oxic
Stockum
Ratio A.coniferus/R.lepidophyta
Ratio R.lepidophyta/V.hystricosus
(reworked miospores)
"coal" swamp miospores
LE
LN
LN
LN*
LN*
VI
Miospore zonation (Higgs & Streel 1994)
No acritarchs
X acritarchs bloom
354.6
(Sandberg & Ziegler 1996)
354.5
354.0
353.2 (+/- 4.0) Ma (Claoué-Long 1993)
Starvation
(Van Steenwinkel 1993)
LST
TST + HST
(Bless et al. 1993)
8
9
10
11
12
13
14
15
16
17
Holostratigraphy
(Becker 1996)
(Walliser 1995)
Lst
Wocklum
"Drewer" Sst.
Topmost Wocklumeria Lst.
Hangenberg event (Walliser 1984)
HBS
Hangenberg Sh.
Continental Hangenberg events
Hangenberg Sst.
Limestone lenses
Sh.
Hangenberg Lst
Lower Alum Sh.
C
D

SDS Meeting June 23, 1998, Bologna

Quantitative palynology in late and latest Famennian swamp environments, an accurate tool for Marine / Non-marine correlation

Coal seams do not become common until the Middle and Late Devonian. However these coals are either algal or only questionably of vascular plant origin. Coal-bearing sediments of the Late Famennian Hampshire Formation (West Virginia and Virginia, USA), dominated by the prefern *Rhacophyton*, are the first widespread occurrence of true swamp-adapted plant communities in the Paleozoic (Scheckler 1986). Miospore assemblages from these coals and associated sediments allow to distinguish **upstream** from **downstream** (coastal) **marginal swamp** environments (Streel & Scheckler 1990).

Coastal "coal" swamp development is known to depend mainly on the sea-level : higher the sea-level, higher the fresh-water table near the coast and therefore, wider the swamp. Upstream swamp environment development only depends on climate : more rainy the climate, higher the water table and wider the swamp environment, but also more important the river run-off and its discharge into the sea.

Miospores produced by their (often unknown) mother-plants are dispersed mainly in the corresponding environment but also in the neighbourhood. Their quantitative analysis in non-marine sediments gives a mean picture of the regional vegetation. But, in marine sediments, a distorted picture is obtained. Indeed, if the miospores from coastal environments are directly recorded, through the wind, in the neighbouring marine sediment, those from upstream environments are mainly transported to the sea through the rivers.

In the late Famennian marine facies of the Ourthe Valley in N-E Belgium, miospore quantitative analysis recognises a recurrence of high sea levels developing downstream "coal" swamps and a recurrence of wet climates developing upstream swamp margin plant communities.

Applied to a sequence around the latest Famennian Hangenberg Event in Sauerland, Germany, where the changes in sea level are known to have been severe, miospore analysis suggests short cycles involving climatic changes and sea-level changes probably of the 6th order i.e. of less than 100 ka by comparison with the researches conducted in the late Famennian in N-E Belgium.

Dreesen, R., Poty, E., Streel, M. & Thorez, J. - 1993: Late Famennian to Namurian in the eastern Ardenne, Belgium. I.U.G.S. Subcom. on Carb. Strat., guidebook : 60 p. Liège University.

Jarvis, D.E. - 1992: The stratigraphic palynology, palynofacies and sedimentology of the Devonian-Carboniferous Kiltorcan Formation of Southern Ireland. Ph. D. Thesis, Cork (Unpublished).

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Miospores dominating a specific continental environment during the late Famennian (after Streel & Scheckler 1990, Jarvis 1992, Dreesen *et al.* 1993)

Well drained alluvial plains:

Aneurospora greggsii

(probably *Archaeopteris* microspores)

"Coal" swamps:

Diducites plicabilis-Auroraspora varia Complex

(*Rhacophyton* isospores)

Upstream swamp margins:

Grandispora gracilis

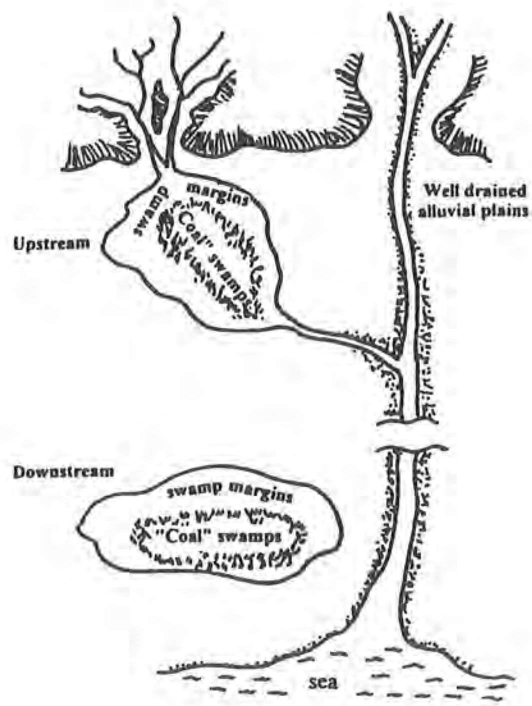
Apiculiretusispora coniferus

Downstream swamp margins:

Vallatisporites hystricosus

Auroraspora asperella

Retispora lepidophyta



CM Chuck Ver Straeten

I recently completed a two year Post-doctoral Fellowship at Northwestern University (Evanston, Illinois; with Dr. Bradley Sageman), examining Eifelian to Famennian mudrock-dominated facies from the Appalachian Basin. The work integrated sedimentologic, paleobiologic, and geochemical (elemental, carbon, and stable isotopes of carbon) data with statistical analyses in an examination of: the delineation of stratigraphic sequences and foreland basin evolution in the Devonian mudrock facies; the role of biogeochemical dynamics/productivity in the ecology and evolution of Devonian marine communities; controls on organic carbon burial during the late phases of the Mid-Paleozoic greenhouse episode. A summary paper of the work is presently in preparation.

In an offshoot of that work, we are utilizing the elemental data to examine provenance of Devonian mudrocks and unroofing history of Acadian Orogeny. Results will be presented at the Northeastern Geological Society of America meeting (March 1999) in a session I am organizing entitled "Dynamics and Events in the Acadian Orogeny: Foreland Basin and Mountain Belt Perspectives".

An ongoing interest in bentonites contributed toward the newly published Devonian time scale (Tucker, R.D., Bradley, D.C., Ver Straeten, C.A., Harris, A.G., Ebert, J.R., and McCutcheon, S.R., 1998, New U-Pb ages and the duration and division of Devonian time: Earth and Planetary Science Letters, v. 158, p. 175-186). Results include more highly-refined estimates for the duration of stages and moving the base of the Devonian from 408 to 419 Ma.

At present, I have papers in preparation on: 1) a new, more highly refined synthesis of Emsian-Eifelian strata across the Appalachian Basin and their tectonic and sequence stratigraphic frameworks (based on Ph.D. work under Carlton Brett); an interval of early Emsian K-bentonites from the Appalachian Basin, their tectonic implications, and potential plutonic and volcanic sources in the remnant Acadian mountain belt.

In other work, Gil Klapper and I have begun to examine conodont biostratigraphy of less well documented Emsian and Eifelian intervals in the Appalachian Basin, and Carlton Brett (Univ. of Cincinnati) Jed Day (Illinois State Univ.) and myself have been examining Eifelian carbonates on the western margin of the Appalachian Basin in Ohio. Brad Sageman (Northwestern Univ.) and I have also been working with Rex Crick and Brooks Elwood (Univ. of Texas at Arlington) on magnetosusceptibility of the Eifelian-Givetian and Givetian-Frasnian stage boundaries in a core from the Appalachian Basin.

I'm presently in a one year academic position at Gustavus Adolphus College in Minnesota, teaching Sedimentary Geology, Paleontology, Historical Geology, and Global Environmental Change.

CM Tony Wright (New South Wales).

Like a lot of Australian palaeontologists, I "retired" after taking a package in September 1997. I am now an "Honorary Principal Fellow" which means that I enjoy the privileges of an office, full access to facilities and the opportunity to carry out full time research.

Chores in hand are dominantly editorial, as John Talent, Gavin Young and I are editing 2 publications flowing from our very successful PAFF ("Palaeobiogeography of Australasian Faunas and Floras") conference in December 1997. These 2 include: (1) a volume in the Oxford University Press Biogeography series and (2) a special issue of *Historical Biology*. Submissions for these 2 volumes are steadily reaching the final stage of review. Watch for these important volumes.

Current research is focussed on several fronts;

I am collaborating with Barrie Rickards on NSW graptolites of Silurian age (the Barnby Hills Shale (part II), the Yass sequence [submitted], the Spring-Quarry Creek area, the Bungonia area) and Early Devonian age from the Limekilns area. A general paper on the evolution of *Bohemograptus* has also been submitted for publication.

In addition to these Australian faunas, manuscripts (with Rickards and M.A. Hamedi) dealing with Arenig graptolites from east-central Iran, and another on Late Ordovician and Early Silurian of the Zagros are in preparation. A paper with June Ross and Hamedi on Ordovician bryozoans from east-central Iran is in press.

Devonian studies are concerned with operculate corals. Having divested myself of years of accumulated *Goniophyllum* in the Jess Johnson volume [Geol. Soc. America Special Paper 321], I am now homing in on *Calceola* and its close relatives. A paper describing a new genus from the Early Devonian Garra Formation of NSW is in preparation, and studies of various other calceoloids will hopefully appear in the near future, based on global collections. Some of this story was given at the Mary Wade Symposium at the 1998 Australian Geological Convention in Townsville. A joint paper with Yongyi Zhen and John Jell will appear in the PAFF Special Issue of *Historical Biology*.

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Rickards, R.B. & Wright, A.J., (in submission). Evolution and biostratigraphy of the late Ludlow and PÍRdolR (Late Silurian) graptolites of the Yass district, New South Wales. *Records of the Australian Museum.*

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TM Yolkin reports a new address:

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My current Ordovician-Devonian projects were outlined in previous issues.

This year I am focusing on Silurian stratigraphy and paleogeography of the Altai-Sayan area. A long paper already is sent to editors. Devonian results are connected with relationships of sea-level fluctuations and trilobite evolutionary stages. The first attempt was made to compare trilobite and conodont evolutionary rates using their Emsian lineages (Poster for the ECOS VII). Much time was paid to editorial works with the first issue of a new journal "News of Paleontology and Stratigraphy" that is considered now as a supplement to journal "Russian Geology and Geophysics" [or "Geologiya i Geofizika"] (see "Contents" of first issue).

Recent papers:

Yolkin, E.A., Sennikov, N.V., Bakharev, N.K., Izokh, N.G. and Yazikov, A.Yu. 1997. Periodicity of deposition in the Silurian and relationships of global geological events in the Middle Paleozoic of the southwestern margin of the Siberian Continent. Russian Geology and Geophysics (Geologiya i Geofizika), 38(3):636-647.

Yolkin, E.A., Gratsianova, R.T., Izokh, N.G., Yazikov, A.Yu., and Bakharev, N.K. 1997. Devonian sea-level fluctuations on the south-western margin of the Siberian Continent. Cour.Forsch.-Inst. Senckenberg, 199:83-98.

Yolkin, E.A., Kim, A.I., Weddige, K., Talent, J.A., and House, M.R. 1997. Definition of the Pragian/Emsian Stage boundary. Episodes. 20(4):235-240.

Yolkin, E.A. 1998. Silurian-Devonian trilobite evolution and depositional cyclicity in the Altai-Salair region (Western Siberia, Russia), p. 215-226.

In Ed Landing and M.E. Johnson (eds.) Silurian Cycles Linkages of Dynamic Stratigraphy with Atmospheric, Oceanic, and Tectonic Changes. James Hall Centennial Volume. New York State Mus. N.Y. Geological Survey, Bulletin 491.

Yolkin, E.A., and Sennikov, N.V. 1998. Paleogeograficheskie i paleoklimaticheskie obstanovki v pozdnem llandovery na territorii Altae-Sayanskoi oblasti i ikh geodynamicheskaya interpretatsiya. Geologiya i Geofizika, 39(8):1151-1154. [In Russian]

Yolkin, E.A., Kirda, N.P., Gratsianova, R.T., Izokh, N.G., Kanygin, A.V., Timokhin A.V., and Yazikov, A.Yu. 1998. O pozdnedevonskoi i pozdneordovikskoi faune iz kerna skvazhiny Zapadno-Novogodnyaya-210 (Nadym-Tazovskoe mezhdurech'e, Zapadno-Sibirskaya plita). In Aktual'nye voprosy geologii i geografii Sibiri. T. 1. Materialy nauchnoi konferentsii 1-4 aprelya 1998, Tomsk. Tomsk: Tom. Gos. Univ., pp. 207-209.

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INFORMATION FOR CONTRIBUTORS

There are several ways to provide contributions to the Newsletter. Listed in order of preference, they are:

1. **Computer file on disk** — Text files in any DOS, WINDOWS or MACINTOSH word processing format are acceptable (Microsoft Word is the preferred option). Graphic files are acceptable in any standard format **BUT** if the desire is to retain the image's original appearance, image files should be created with Adobe Illustrator or if created by another graphic package, they should be submitted in encapsulated postscript (eps) format.

2. **E-mail** — Text material is acceptable when contained within the body of the e-mail message. In most cases, however, this results in the loss of italics, etc. To prevent the loss of such formatting, it is suggested that contributors attach formatted text material and graphics to e-mail messages after being archived (ZIP or SIT). Check with your systems administrator or computer specialist if you are unsure how to accomplish the attachment of text or graphics.

3. **Anonymous ftp** — Contact the Editor for details.

4. **Original typewritten copy** — Please keep the number of pages to a minimum since this material will have to be either retyped into a computer file or scanned.

REPORTS FROM THE MEMBERSHIP