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, 23 to honorary members, Chairmen of the Carboniferous and Silurian Subcommissions, ILGS 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://geology.uta.edu/geoeb/sds. The SDS anonymous ftp site at ftp://geology.uta.edu/incoming or ftp://129.107.18.20/incoming is maintained for the convenience of SDS members.

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EDITORIAL NOTES

Electronic SDS

The SDS web page is presently under construction and should be completed near the end of January 1997. The complete newsletter will be ready for viewing with a standard web browser (Netscape, Internet Explorer, or Cyberdog). If the web site does not appear properly with your current browser, you can download the most current versions of these browsers from the SDS Anonymous ftp site. The address of the SDS Anonymous ftp site remains geology.uta.edu if you use a standard file transfer program or ftp://geology.uta.edu/incoming if you use a web browser to connect to the site. If you have problems making a connection, contact me at crick@uta.edu.

I greatly appreciate all who used the ftp site to transfer contribution materials for the newsletter as well as those who have mastered the technique of attaching formatted text and graphics to e-mail messages. Your efforts greatly reduce my work load.

Registration Forms via E-mail

E-mail versions of the registration form for the IGCP 406 Warsaw Meeting and the registration form for the IGCP 421 Iran Meeting are available. The forms can be obtained automatically by sending an e-mail message to crick@uta.edu with the appropriate subject (WARSAW MEETING or IRAN MEETING) spelled as given here. See notes at the bottom of pages 23 & 28 for more information.

Digital Newsletter


MESSAGE FROM THE CHAIRMAN

On behalf of the SDS members attending the Symposium on Devonian Cyclicity and Sequence Stratigraphy at the University of Rochester last July, I thank the organizers Carlton E. BREIT and W.T. KIRCHGASSER especially for showing SDS members the applications of cyclicity and sequence stratigraphy in the Devonian of New York and for the hospitality given to our subcommission. The number of participants at the SDS annual meeting and the proposals made, clearly show the interest of SDS members in the subdivision of the 7 formally defined Devonian stages (see minutes enclosed in this Newsletter). Further discussion of the substage proposals will also be the main topic on the agenda of the next SDS business Meeting in Bologna, associated with the ECOS 7 conodont symposium (June 24-26, 1998). In order to have a successful discussion, please provide your proposals as soon as possible but no later than 31 May 1998, so they can be distributed in advance to participants. A last point of my message concerns SDS membership. At present there is no Canadian titular SDS member. Considering that Canada is a most important Devonian region, I am looking forward to receiving nominations for a Canadian titular membership.

P. Bultynck
E-mail: bultynck.pal@kbinirsnb.be
Minutes of the SDS Business Meeting, 21th July, Rochester

The annual business meeting was held during the evening of Monday 21th July, in the Susan B. Anthony Hall at Rochester University. The SDS meeting took place from 19th - 21th July in conjunction with the Amadeus Grabau Symposium on "Cyclicity and Bioevents in the Devonian System", organized by CM Carlton Brett et al. from Rochester and by TM Bill Kirchgasser from Potsdam. The symposium was followed from 22th to 27th July by exceedingly informative excursions to the splendid Devonian of western and eastern New York State and of northern Pennsylvania.


1. Introduction

The Chairman, P. Bultynck, opened the meeting and thanked CM Carlton E. Brett and TM William T. Kirchgasser for the invitation to come to Rochester and for the perfect organization of the symposium that attracted such a high number of active SDS members, sixteen years after the last New York State SDS conference. The chairman also gave the warmest thanks of the whole subcommission to the past chairman TM M.R. House who finished his term which saw the ratification of the last Devonian GSSP.


On various topics eight documents were distributed and these were numbered in the following order (texts included in this newsletter but not in the order presented below)


Document 2: Chlupac, I.: Comments to subdivision of the Emsian Stage.

Document 3: Carls, P. & Valenzuela-Rfos, J.I.: no title (concerning the kitabicus-boundary...).


Document 5: Sartenaer, P.: Is the term Strunian worth being properly defined, and thus kept?


2. Minutes of the Beijing Meeting 1996

The minutes of the Beijing meeting were circulated in SDS Newsletter No. 13. CM Susan Turner drew attention that her apologies had not been recorded and following suggestion of TM House, this correction is reported here.

3. Chairman's Business

The chairman reported the sad death of our former active SDS member Wolfgang Struve. Members held a minute of silence in honor of him. TM W. Ziegler gave a short review of his life and scientific work and an obituary shall be included in this newsletter. Also, the death of Curt Teichert had to be reported. His extraordinary contributions to geology, palaeontology and present day reef research, including many contributions to Devonian stratigraphy, was previously acknowledged in the Teichert-Festschrift published in Senckenbergiana lethaea.

4. Proposals for Devonian substages and additional stages

At the beginning there was a discussion on the formal procedure. It was suggested that substages should be defined in the same way as stages and official recognition of substages should be attempted. Doubts were raised whether the International Stratigraphical Commission would approve substages. However, there is no reason why the international scientific community should not recognize and follow unratified SDS substage recommendations. The secretary proposed to proceed first with certain stages where there is a common desire for subdivision.
4A: Results of the questionnaire

The chairman reported the results of the questionnaire but criticized that only thirteen forms were returned. These show the following ranking for the need of subdivision:

1. Emsian
2. Famennian
3. Givetian
4. Frasnian
5. Lochkovian

Nobody has yet suggested a subdivision of the Pragian and Eifelian.

4B. Proposals for a subdivision of the Emsian (Documents 1-3, Document 9)

TM Yu proposed to include the paper by Yu & Ruan (1989), Canadian Society of Petroleum Geology, Memoir 14, vol. III: 179-191 (vol. III of the 2nd Calgary Symposium on the Devonian System) in the discussion and submitted a copy to be recognized as Document 9. CM Schindler explained Document 1 and summarized that the German SDS recommends to investigate in more details levels close to the entry of Nowakia cancellata (in evolutionary transition from N. elegans) and of Polygnathus inversus. Studies of brachiopod faunas of this interval are under way by U. Jansen. Potential stratotype areas were outlined and data on Spanish sections were promised for to the newsletter. The chairman summarized Document 2 by TM Chlupac who considers both the base of the inversus Zone and of the serotinus Zone but gives preference to the first level. CM Sartenaer drew attention to the fact that G. Solle had already used a subdivision of the Emsian a long time ago. The base of the Ems Quartzite and the base of the Luchbach Schichten may correspond with the base of the N. richteri and serotinus Zones which may be regarded as a good alternative for subdivision. TM House emphasized that in former discussions of pelagic successions neritic faunas were not considered enough and this should not be repeated in the future. The secretary raised the problem that the lower part of the cancellata Zone seems to have in South China (Luofo section, see Document 9) and in Central Asia (Dzaus Beds) still typical "Lower Emsian" ammonoid faunas with anetoceratids and relatives (Erbenoceras, Teicherticeras, Mimosaphinctes). The base of the serotinus Zone, again, is too high and postdates according to current knowledge the entry of oldest anarcestids. TM Weddige commented that the serotinus Zone is present in the Lower Lahnstein Beds and the chairman added that Po. serotinus lies above the level of Solle's subdivision. CM Schindler proposed to look in the initial phase of more detailed investigation at a longer time span and CM Hadil urged SDS members to link conodont studies with studies of physical boundaries formed by sea level changes and with methods such as chemostratigraphy. Following a move by CM Oliver to finish the debate, the following declaration was agreed unanimously by all voting members. SDS decides to investigate for a twofold stage subdivision of the Emsian in detail, and using all available stratigraphical methods, the time interval from the start of the Dalejan transgression to the entry of N. richteri and of early anarcestids. Special attempts shall be made to correlate pelagic and neritic successions. All SDS members are asked to provide at the next meeting relevant data and detailed descriptions of sections, including potential stratotype candidates.

4C. Proposals for a subdivision of the Givetian

The chairman proposed to defer a Givetian subdivision for future meetings which was accepted.

4D. Proposals for a subdivision of the Famennian (Documents 4 and 5)

TM Ziegler gave a brief outline of the joint Document 4 with TM Sandberg and emphasized that the proposed levels for a threefold subdivision (boundaries at the base of the marginifera Zone and at the base of the expansa Zone) correlate with major transgressions. They would not recommend a possible alternative earlier level (base of Latest crepida Zone) since it would cut off a too short interval for a Lower Famennian. Attempts are being made to understand the classical German Stufen of the pelagic realm. The international Pa. semichatovae transgression is proposed as a possible level for the definition of an Upper Frasnian. CM Sartenaer explained Document 5 and stated that the Strunian has been, and still is, so widely used in the literature, that it cannot be ignored. He reminded SDS members that by giving up the Strunian, up to 2 ma have been added to the classical Famennian. He conceded that there are wide discrepancies in the international use of the term Strunian but the entry of Quasiendothyra may be a good time marker. TM House stressed that many other groups apart from conodonts still need detailed documentation in the Famennian. The secretary recommended to subdivide the Famennian into a lower, middle and upper part which follow to a large extent the classical pelagic German Stufen-subdivision (Nehden- and Cheiloceras-Stufe = Upper Devonian II = Lower Famennian; Hemberg- and Platyclymenia-Stufe = Upper Devonian III = Middle Famennian, Dasberg- and Wocklum- or Clymenia- and Wocklermeria-Stufen = Upper Devonian V + VI = Upper Famennian). In conodont terms, the Middle Famennian should start somewhat below the entry of clymenids and the base of the old Lower velifer Zone (now Latest marginifera Zone) should be considered. The base of the expansa Zone may be an acceptable level but it may still correlate with last Platyclymenia faunas; this problem needs to be resolved by future work. TM Sandberg commented that the velifer Zone is hardly recognizable in North America and therefore of limited value. CM Ginter remarked that the shark teeth zonation could have relevance in the future discussion. Following the proposal by CM Oliver to close the discussion, the following declaration was decided: SDS asks its members to present proposals for a threefold subdivision of the Famennian in the light of submitted
documents, with regards to the discussion reported here, and considering the Strunian as a potential upper Famennian substage. Investigations should pay special attention to the correlation with neritic and terrestrial successions.

5. A formatted correlation table with coordinates as a standard medium for international Devonian stratigraphical communications (Document 6)

TM Weddige gave an introduction to the published correlation charts and invited all SDS members to contribute biostratigraphical and regional geological columns which will be published every year in the Senckenbergiana lethaea. CM Sartenaer congratulated TM Weddige for his large effort and it is hoped that many SDS members will cooperate.

6. Devonian Marine/Non-Marine correlation

A report by TM Biëck on the final year of IGCP 328 (Palaeozoic Vertebrate Biochronology and Global Marine/Non-Marine Correlation) has been submitted and will be published in this Newsletter. Devonian work will continue in the frame of IGCP 406 (Circum-Arctic Lower to Middle Palaeozoic Vertebrate Palaeontology and Biostratigraphy, proposed by M.V.H. Wilson and T. Marss).

7. IGCP 421 “North Gondwana Mid-Paleozoic Bioevent/Biogeography Patterns in Relation to Crustal Dynamics (Document 8)

TM Talent gave an introduction to the new IGCP 421 which is intended to cover the period from the Silurian to the pre-Variscan part of the Carboniferous. It is hoped to fingerprint Gondwana crustal blocks by faunal and biostratigraphical characteristics. Cooperation with palaeomagnetic and structural research will be essential to reach improved palaeogeographical and plate tectonic reconstructions. The inaugural meeting of IGCP 421 was announced to be held in September in Vienna. It is aimed that future IGCP symposia take place in connection with annual SDS meetings. Further details will be given separately (Document 8) in the SDS Newsletter. The chairman declared that SDS will support IGCP 421 as much as possible and asked members to take part actively.

8. IUGS matters

The chairman reported that new GSSPs have been decided for the base of the Ordovician, and for the Piacenzian (uppermost Neogen, Upper Pliocene). The new statutes and revised guidelines have been published by Remane et al. in Episodes. The IUGS will continue with financial support of ICS.

9. Membership

9A. Withdrawals

TMs Streel and House declared to withdraw from titular membership but both wish to continue as CMs. Thanks for the service of TM House by the chairman was underlined by long applause. CM Holland declared in a written statement to the secretary that he agrees to decline from formal membership but wishes to be kept on the mailing list of the newsletter. CM Freyer has withdrawn from the German SDS and it is suspected that this also applies to the International Subcommission.

9B. Election of CMs

Written nominations of Charles A. Ver Straeten (Department of Geological Sciences, Northwestern University, Evanston) and Jean LeMenn (Laboratoire de Paléontologie, Université de Bretagne Occidentale, Brest) were approved unanimously.

9C. Election of TMs

Written nominations (by TMs M.R. House and P. Bultynck) of the vice-chairman R. Crick and of the secretary R.T. Becker were approved unanimously.

10. Reports

10A. Financial Report

Income for 1997
- carried forward from 1996 144.05
- IUGS subvention for 1997 1,423.61
- 1,567.66

Expenditure for 1997
- attendance support Rochester meeting 355.00
- participation in costs associated with the Rochester Meeting 500.00
- secretary expenses 120.00
- Newsletter allocation for No. 14. 250.00
- 1,225.00

provisional balance July 1997 342.66
CM Schindler gave a summary of German SDS activities of the last year. The annual meeting on the 1st of March was attended by forty participants. A Devonian bibliography has assembled 1,600 references which were checked thoroughly. Current activities aim at holostratigraphic correlations of the German Devonian, and the integration of modern stratigraphical techniques was generally recommended. A working group has been founded to revise and re-define the classical German Oberdevon-Stufen. The chairman requested other national subcommissions to submit reports to the business meetings or to the Newsletter.

**10D. Progress in Radiometric Dating**

TM Talent reported that work on Eastern Australian ashbeds is in progress in cooperation with Greg Dunning (Memorial University). SHRIMP dating of two dozens of samples by J. Claoue-Long, unfortunately, has not become available since processing of Palaeozoic samples was stopped. Because of the significant shortcomings of the Harland et al. timescale, a new chart is currently planned by Cambridge Press. J. Ebert reported on a new, much older age than previously thought (418 ma) for a level in the woschmidt Zone at the base of the Pragian. The Tioga Bentonite of New York gave a 391.6 ma age (Uranium-Lead-date). Further radiometric dates were announced for the 1997 meeting of the Geological Society of America and the abstract with these is included in this Newsletter.

**11. SDS Publications**

**11A. Moscow Symposium Volume on “Devonian Eustatic Changes of the World Ocean Level”**

TM Ziegler presented the cover and content of the volume which will be published as Courier Forschungsinstitut Senckenberg, vol. 199. It is edited jointly by TMs House & Ziegler and dedicated to CM Maria Rzhonsnitskaya. TM House drew attention to the fact that she will celebrate her 85. birthday in 1997. [the volume with 146 pages has been published in the meantime]

**11B. Devonian Correlation Volume**

The chairman reported that most contributions had arrived since the last meeting. The secretary commented that papers on the Col de Puech de la Suque and Coumiac Stratotypes have been practically finished. The manuscript on Wetteisdorf was still missing but the regional summary of Australia had just arrived. Unfortunately, there is no review at all of the North American Devonian and yet no contribution for Morocco. The Correlation Volume will be printed as a volume of the Courier series in the next year.

**12. Future Meetings**

**12A. Meeting for 1998**

Since original plans to hold a meeting in Morocco, in conjunction with a field trip to more neritic successions of the Dra Valley, did not materialize, it was proposed to convene at the ECOS VII symposium, from June 24-26 in Bologna and Modena (see details in this Newsletter). In association with ECOS VII (25. June), there will be a working meeting of IGCP 421. The organizers of ECOS VII have agreed in the meantime to host the 1998 SDS Business Meeting which will take place in the afternoon of the 23rd June in Bologna. For any information, please contact Dr. Maria Christina Perri, Dipartimento di Scienze della Terra e Geologico Ambientali, Universita di Bologna, Via Zamboni 67, 1-40126 Bologna, Italy, Tel. 051-354569, Fax. 051-354522, e-mail perri@geomin.unibo.it

**12B. Meeting for 1999**

There is a previous invitation by TM Yolkin to hold a joint meeting with the Silurian Subcommission in Novosibirsk and to have an associated field trip to the Siberian Silurian/Devonian (see 1996 minutes). The chairman declared to inquire whether this offer is still valid. Alternatively, a business meeting can be linked in 1999 with IGCP 421 activities.

**13. Any other business**

Time had progressed considerably and no other business seems to have been regarded as urgent.

*R. Thomas Becker (Berlin)*
Conc: kitabicus-boundary; late original Pragian, Emsian, Zichovian; Pol. excavatus zone; intra-Emsian substage boundary.

CM Peter CARLZ (Braunschweig) & José Ignacio VALENZUELA-RIOS (Valenciana)

1. The installation of the pinezeit-Zone as the latest Pragian conodont zone was, though formally correct, the first one in a series of misleading procedures, because it only suggested the possible end of the original Pragian without having demonstrated that it covers only a really late interval of the original Pragian (as delimited by the beginning of the Zichovian). As a consequence, a succeeding zone is not necessarily close to posterior to the end of the original Pragian or to the beginning of the classical Emsian. Therefore, and combined to modify erroneous concepts of Polygnathus deliriens as a zonal index, the kitabicus-Zone could fall into a long interval of originally Pragian time.

2. Besides by the origin of its index Pol. kitabicus, the new kitabicus boundary of the Emsian is additionally correlatable by means of the following conodont occurrences slightly above the boundary in the Zinzilian Section (Yokim, et al. 1989):

Polygnathus pinezeit (final range)
P. elegans nov., sertus nov.
P. pedavis nov.
Polygnathus quahodina nov. excavae

To our knowledge, none of these conodonts has ever been reported from strata that were definitely Emsian in the classical sense of the Rhine region. In Celibers, Pol. sertusus and Q. excavae are in the same level as the Nogareaus Zone, which ends with about the middle of the original Pragian and about the classical Early Siegenian. However, sporadic reports of the other two taxa from other localities are also among the authors (e.g. Nevada, Pyrenees).

3. The official submission of the SDS to the JGS of June 1993 concerning the Pragian-Emsian boundary comprises, in its Appendix A, Fig. 3, graphitic ranges in the Zinzilian Section, given by KIN & ERNA. As we are not geologists, we will suggest to test how Monograptus thomasi, which is registered above the conodonts just mentioned and enters in 45 m above the kitabicus boundary, correlates with its records from Nevada and Yukon. In Nevada it is recorded close to and below some of the conodonts mentioned.

4. Final records of graphites in the Zinzilian Section are about 170 m above the kitabicus boundary. In Bohemia, the last graphites occur in a thin band within the dacryocarinoid zone of Goerichina strangulata. The latter was (almost?) final Pragian in its original scope. We ignore the position of the G. strangulata Zone in the Zinzilian Section, but we have been told that it is found somewhere above the kitabicus boundary. Is the originally Pragian about 170 m above the kitabicus boundary? (Some upper ranges of dacryocarinoids, identified in open nautiloid zones, would rather suggest late Zichovian age near that level.)

5. In the Nogareaus region of Celibers, there is the following succession:

a. Member d3b of the Santa Cruz Fm. with a succession of brachiopod faunas that just reach the level, where the classical Middle Siegenian fauna began. Conodonts are abundant Isorhidium curvicauda (late occurrence, reported at the Rade de Brest, France, in the same level). No Polygnathus has been obtained.

b. Over 100 m of barren detritic facies, member d3c of Santa Cruz Fm.

c. Top bed of Santa Cruz Fm. with Steilocariceras vermelii and Diamesoceratites foresti, correlative with top bed of unit F9 = 45 m, below the top of the Bele Fm. in the Seillow Section, Rade de Brest; also coinciding in revised trachipods. No exceptionally classical Emsian trachipods.

d. Basal limestone bed of Mariposas Fm., type stratum of Polygnathus excavatus; the true origin may have been older, corresponding to somewhere in the lower interval B1; the excavatus Zone begins late within the classical Siegenian - consequently, the entire conodont kitabicus-Zone is within the classical Siegenian. Goerichina is still absent.

1. m or 2 m above d. Goerichina sp. sp. and Penzaulis sp. are found as striatoids in conodont samples. Acraspis rufa is the first relevant post-Siegenian spirema and marks the oldest possible level for the beginning of the classical Emsian.

f. According to external morphology, Goerichina cf. funduliformis exists up to about 1 m above the limestone bed in the middle of submember d4b-beta. This still demonstrates the Goerichina strangulata Zone of the original (fossil) final Pragian. The uppermost tenth or so of the extension of this zone is, according to brachiopods (Acraspis rufa, Acraspis rubinensis), the equivalent of the Ereblochoceras fauna (see JAHRAE, 1971). Extension of conodonts, including those figured from Bohemia, results in this Icaridella bilaterecrinis multilocus-

1. The local range of Novakia elegans is not yet destined, but it passes from submember d4b-alpha to d4b-beta, and the basal 5 m or so of the latter overtops with faint Novakia cancellata. Consequences of the above conditions and biostratigraphic successions are as follows:

a. The kitabicus boundary cuts the original Pragian near its middle.

b. The excavatus Zone begins before the Goerichina strangulata Zone. Its beginning is too old to be connected anyhow with the range of the Zichovian. The range of its index ends rather early in the Zichovian.

c. The original Pragian and the classical Emsian of the Rhine region overlap is good approximation by the Guer. strangulata Zone.

d. The ammonoid zonae of the Bundesbacher shales correlate with the Late Emsian of Stuttgarden, Germany, through Anticoelurus. Both promote the beginning of the classical Late Emsian and the Rhine province.

f. Any alternative should concern the Zichovian, its original beginning should not be changed.

Comments to subdivision of the Emsian Stage

TM Ivoc. CHILUPAC, Prague

The Emsian Stage should be subdivided into two chronostratigraphic units of a lower rank. The necessity of such a subdivision is generally known (e.g. Seilacher 1971, CHILUPAC 1976) and is based especially on the following features:

1. The stratigraphic volume of the present Emsian Stage is markedly larger than that of all adjacent Devonian Stages. It includes 5 to 6 conodont Zones or 7 to 8 ecmatoid zones, which contrast with 3 conodont zones of the Pragian and four zones of Eifelian in both fossil groups.

2. The faunistic differences between the lower and the upper parts of the Emsian Stage are very conspicuous. The upper part contains many younger elements, which were in the past traditionally regarded as Middle Devonian. This concerns particularly ontogenies (onset of arcocystids), taeniocystids (broadly the same location of Novakia cancellata, later replaced by Novakia rohleri), changes in lines of brachiopods (particularly characteristic in the Rheinian faunas, e.g. Mittmeyer 1962, 1972).
Con: *kitacitus*-boundary; late original Pragian, Emsian, Zlichovian; *Pol. excavatus* Zone; Intra-Emsian substage boundary.

CM Peter CARLS (Braunweig, Niederbayern) & José Ignacio VALLENZUELA-RÍOS (Valencia)

1. The installation of the *pierneese*-Zone as the latest Pragian conodont zone was, though formally correct, the first in a series of misleading procedures, because it only suggested the proximality of the original Pragian without having demonstrated that it covers only a really late inter-val of the original Pragian (as delimited by the beginning of the Zlichovian). As a consequence, a succeeding zone is not necessarily close or posterior to the end of the original Pragian or to the beginning of the classical Emsian. Therefore, and combined to multiply erroneous concepts of *Polygnathus deletrix* as a zonal index, the *kitacitus*-Zone could fall into a long interval of originally Pragian time.

2. Besides the origin of its index *Pol. kitacitus*, the new *kitacitus*-boundary of the Emsian is additionally correlatable by means of the following conodont occurrences slightly above the boundary in the Zilinziia Section (Yolkin, et al. 1889):

*Polygnathus pierneese* (final range)
*Polygnathus serratus* *Polygnathus* nov. *Ozakodina exc. excavate*

To our knowledge, none of these conodonts has ever been reported from strata that were definitely Emsian in the classical sense of the Rhine region (cf. D.Calthrop). *Polygnathus serratus* and *Oc. excavate* too do not rise above the Noguerae Fm., which ends with about the early half of the original Pragian and amid the classical Early Emsian. Rather sporadically reports of the two taxa from other regions are also amid the unshortened Pragian (e.g. Nogačica, Pyrenees).

3. The official submission of the SIDS to the IUGS of June 1993 concerning the Pragian-Emsian boundary comprises, in its Appendix A, Fig. 3, graphitopic ranges in the Zilinziia Section, given by RIM & ERINA. As we are not graphitopic experts, we would suggest to test how *Monograptus rhombeus*, which is registered above the conodont just mentioned and enters 46 m above the *kitacitus*-boundary, correlates with its records from Nevada and Yakima. In Nevada it is recorded close to and even below some of the conodonts mentioned.

4. Final records of graptolites in the Zilinziia Section are about 170 m above the *kitacitus*-boundary. In Bohemia, the last graptolite records are found in the acroconoid zone of *Guecichiana stragulata*. The latter was (almost?) final Pragian in its original scope. We ignore the position of the *G. stragulata*-Zone in the Zilinziia Section, but we have been told that it is found there somewhere above the *kitacitus*-boundary. Is the originally final Pragian about 170 m above the *kitacitus*-boundary? (Some upper parts of *dacyroconoids* identified is open nomenclature; we would rather suggest late Zlichovian age near that level).

5. In the Noguerae region of Catalonia, there is the following succession:

a. Member d3b of the Santa Cruz Fm. with a succession of brachiopod faunas that just reach the level, where the classical Middle Siegenian fauna began. Conodonts are abundant *Icriodus curvicauda* (late part of range) and few *Icec. angustivalvis* (isolated last occurrence; reported at the Rade de Brest, France, in the same level). No *Polygnathus* has been obtained.

b. Over 100 m of barren deltic facies, member d3c of the Santa Cruz Fm.

c. Top bed of Santa Cruz Fm. with *Sallicurcianus vermisellii* and *Diacanthomcrura finnasius*, correlating with top bed of unit F3 at 44-55, 5 m below the top of the Le Fau Fm. in the Seilou Section, Rade de Brest; also coinciding in revised brachiopods. No exclusively classical Emsian brachiopods.

d. Basal*F*1*mestone* bed of *Maripopora* Fm., type stratum of *Polygnathus excavatus*; the true ooze of the ooze and mostly bore above its corresponding to somewhere in the -bracken interval b the excavatus Zone begins late above the classical Emsian. Consequently, the entire classical *kitacitus*-Zone is within the classical Siegenian. *Guecichiana* is still absent.

e. 1 m or 2 m above d, *Guecichiana* sp. and *Penicula* sp. and found as steinkerns in condont samples. *Acrorhiphiella* falkner is the first relatum post-Siegenian spirostris and marks the oldest possible level for the beginning of the classical Emsian.

f. According to exterior moulds, Chueurichia cf. *spanduliana* exists up to 1 m above the limestone set in the middle of submember d4a-beta. This still demonstrates the *Guecichiana stragulata*-Zone of the original (basically) final Pragian. The uppermost to the extent of this zone is, according to trachipods (*Acrotrichia* and *Aegirhiphia*), the equivalent of the *Ehbe* Gravurenschicht (Janka see JANHEK, 1971). Revision of conodonts, inclusive of those figured from Bohemia, results is *Icriodus bilatericiscus multicristis*.

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The local range of *Novakia elegans* is not yet clearly delimited, but it passes from submember d4b-alpha to d4b-beta, and in the basal 5 m or so of the latter it overlaps with the next. *Novakia* fenestralis.

Consequences of the above conditions and biostratigraphic successions are as follows:

A. The *kitacitus*-boundary cuts the original Pragian near its middle.

B. The *excavatus* Zone begins below the *Guecichiana stragulata*-Zone. Its beginning is too old to be connected to any how with the name of the Zlichovian. The range of its index ends rather early in the Zlichovian.

C. The original Pragian and the classical Emsian of the Rhine region overlap in good approximation by the *Guecichiana* Group Zone.

D. The ammonoid record from the *Buddenbach* shales correlates with the late Early Emsian of Southfield, Germany, through *Anactostoma*. Both predate the beginning of the classical Late Emsian of the Rhine region. The *Buddenbach* ammonoids indicate late Zlichovian (CHELUPAC, 1976), this can be tied in with the uppermost part of submember d4b-alpha of the *Maripopora* Fm. The latter is closely followed by the lower Emsian *Rhenosites* group (text GANDL, 1972) and by the initial Dalejan of the *Novakia*-Group. Therefore, the classical Early/Late Emsian-bounded by the Rhine region and the beginning of the Dalejan of Bohemia coincide imperfectly. A definition of an intra-Emsian substage boundary should define the Early/Late Emsian boundary so that a correlation by means of the index of *Novakia* fenestralis is possible.

E. The *kitacitus*-Zone is a good zone is a merely definitive sense, but the *kitacitus* boundary is at an undesired level. Useful early occurrences of its index are not widely available. The application of the Name of the *Novakia* to strata as old as the *kitacitus*-Zone causes confusion in the historical sense of the region. It converts some 4000 m of formerly Siegenian sediments into "Emsian." As soon as the rules permit, we will claim to redefine the beginning of the Emsian so as to be close to the classical boundary in the Rhine region and to the beginning of the *Guecichiana*-late Zone.

F. If any alternative should concern the Zlichovian, its original beginning should not be changed.

Comments to subdivision of the Emsian Stage
TM Iv ČELUPAC, Praha

The Emsian Stage should be subdivided into two chrono-stratigraphic units of a lower rank. The necessity of such a subdivision is generally known (comp. e.g. Bolle 1972, Chlapek 1976) and is based especially on the following features:

1. The stratigraphic volume of the present Emsian Stage is markedly larger than that of all adjacent Devonian Stages. It includes 5 to 6 condont Zones or 7 to 8 ostracod faunal stages, which contrast with 3 zones of Pragian and 4 zones of Elfeian in both fossil groups.

2. The faunal differences between the lower and the upper parts of the Emsian Stage are very conspicuous. The upper part contains many younger elements, which were in the past traditionally regarded as Middle Devonian. This concerns particularly goniatites (onset of anascerids), tuntunculines (start of the wide distribution of *Novakia* cancellata, latest replaced by *N. riceri*), changes in lineages of brachiopods and particularly characteristic in the Rheinisches Faules, cf. e.g. Mittwieser 1982, new data also in Garcia-Al
3. The eustatic sea level variation and the global event-stratigraphy also support the subdivision (the Daleje Event, e.g. the recent SDS Devonian stratigraphic scheme of TM R. Crick, 1994).

As for the limit between the both Emsian subdivisions, this should be in accordance with the conodont, and, if possible, also with other biostratigraphic zonations. In my view, two alternatives do exist:

1. The base of the *Polygnathus inversus* conodont Zone which may be roughly correlated with the base of the *Nowakia cancellata* or possibly *N. elegans* tentaculite Zones and is close to the culmination of the transgressive Daleje Event. This level is also supported by the goniatite biostratigraphy as the upper boundary of the *Anetoceras* fauna lies in close proximity.

2. The base of the *Polygnathus serotinus* Zone which is close to the base of the *Nowakia richteri* tentaculite Zone, and also close to the first worldwide distribution of anarcestid goniatites.

If compared the two candidate levels, the first choice, i.e. the base of the *Polygnathus inversus* conodont zone seems to have preference: it is easily distinguishable in different faunal groups and subdivides the Emsian into two substages of comparative volume.

When naming the Emsian subdivisions, the names *Zlichovian* and Dalejan in slightly redefined sense may be adopted. They are widely used in international correlations of different parts of the world and the *Zlichovian/Dalejan* boundary remained without substantial changes since its establishment.

The use of the names Lower and Upper Emsian as separate formal units is not advisable, as it would contradict the practice in naming chronostratigraphic units lower in rank than the Series: These should have specific names different from other units (comp. The International Stratigraphic Guide).

**Subdivision of the Emsian stage - German Subcommission on Devonian Stratigraphy**

U. JANSEN & CM E. SCHINDLER, Frankfurt (comps.)

After the 21st meeting of the German 'Subkommission für Devon-Stratigraphie' (SDS) a working group for a possible subdivision of the Emsian has been established. This group recently met for the first time. Besides the compilers, the following persons were participating at the meeting, held at Göttingen University on July 2, 1997: H. GROOS-UFFENORDE, O.H. WALLISER, W. RIEGEL, H. JAHNKE (Univ. Göttingen), P. CARLS (Univ. Braunschweig), H.-G. MITTMEYER, J. GAD (GLA Rheinland-Pfalz, Mainz), G. SCHRAUT (FIS, Frankfurt). - G.K.B. ALBERT! (Hamburg), G. BECKER and K. WEDDIGE (FIS Frankfurt) were not present, but had given statements in advance. The results shall be briefly presented and are open for discussion.

With regard to an international subdivision of the Emsian, the working group stated to favour the pelagic facies when discussing boundary proposals, due to the worldwide distribution of pelagic organisms. The classical pelagic sections (yielding dacryoconarids and conodonts as most important index fossils) are situated in the Barrandian area (Bohemia). The area of the Rheinisches Schiefergebirge, representing the type area of the Emsian, is developed in neritic facies. The classical subdivision of Lower and Upper Emsian strata (mainly based on brachiopod development) should be referred to as well. For it should be the aim to correlate the different biostratigraphic successions (based on different faunal groups in different facies), areas with interfingering facies developments are regarded as highly valuable in respect to future investigations (e.g. Armorican Massiv, Cantabrian Mountains, Cetinean Chains, ? Moroccan Presahara).

Dacryoconarids, conodonts, brachiopods and goniatites have been considered as very important for subdividing the Emsian. On a worldwide scale, the dacryoconarids *Nowakia elegans* and *N. cancellata* have been proven as most useful. The evolutionary transition from the first to the latter can easily be identified (almost in the field). It represents the boundary between the *Zlichovian* and the Dalejan of the Barrandian succession and more or less matches the facies shift known as Daleje Event. Even in sections with dominating neritic facies, corresponding pelagic incursions documented by dacryoconarids-bearing rocks, can often be observed. Therefore, this level is especially suitable in respect to subdividing the Emsian and should be seriously considered. Despite minor taxonomic problems concerning the two nowakiid taxa - a revision has been proposed (G.K.B. ALBERT!, written comm., and O.H. WALLISER, oral contr.) - they may be candidates for the boundary definition. The conodonts, up to now applied for defining the Devonian stage boundaries, are not yet investigated in greater detail around this level. Therefore, the working group proposes to examine this level with regard to a phylogenetic transition in polygnathid conodont development. At the regular meeting of the German SDS earlier this year, K. WEDDIGE had already proposed to focus on the onset of *Polygnathus inversus*. Other faunal groups (e.g. brachiopods, goniatites, trilobites, ostracodes, etc.) or palynomorphs show increasing potential in biostratigraphy and therefore should also be taken into account in the future. This is of special interest when correlating between different facies. Concerning such correlations, first promising attempts are made within the brachiopods (relationships between Moroccan Presahara and the Rheinisches Schiefergebirge, U. JANSEN) as well as in the palynomorphs (e.g. STREEL et al. 1987). Regarding the goniatites, the proposed boundary level would lie closely to the disappearance of substantial parts of the anarcestid goniatites. The trilobite succession is rather spotty up to now, but may also offer additional information (e.g. G. SCHRAUT, Presaharan sections). Ostracodes are not considered as highly valuable to date, but have not been satisfyingly studied so far.

With regard to an Emsian subdivision the working group favours the following regions:
Pelagic facies:

- Barrandian area (Czech Republic), being predominantly pelagic.
- Southern Cantabrian Mountains (Spain), e.g. the Villayandres section showing pelagic facies in the boundary interval.

Intercalation of pelagic and neritic facies:

In the following areas, the sections show faunal elements belonging to both, the neritic and pelagic facies. The state of investigation is different to date.
- Presahara (Morocco).
- Brittany (France).
- Celtiberia (Spain).

Neritic facies:

Type area of the Emsian in the Rheinisches Schiefergebirge (Germany) as well as in the above mentioned areas.

In the course of the working group meeting, there have been discussed several problems of the late Early Devonian, particularly of the Pragian and the Emsian stages as well as the Zlichovian and the Dalejian (and of their boundaries, respectively). Especially the recently defined base of the Emsian has been strongly discredited by P. CARLS. For this part of the discussion only touches the subdivision of the Emsian with respect to nomenclature, this topic is referred to in a separate handout by P. CARLS & J.I. VALENZUELA-RíOS.

In the discussion about the youngest stage of the Early Devonian, the question arose whether there should be established two formally new stages (instead of the Emsian) or if there should be a subdivision on the substage level. Independently of this question, the problems of the Pragian/Emsian boundary definition at the Zinzilbian section have to be considered. As stressed by P. CARLS, the actual base of the boundary lies well down in Pragian strata of Barrandian stratigraphy. In case of a formal subdivision of the Emsian into two separate stages (and in the light of the 'basal problems'), the working group has been discussing possible names for the new stages. A suggestion of preliminarily naming the upper part "Dalejian" and leaving the lower part unnamed for the moment (until the problems concerning the base are solved) has been raised and declared to put forward. If there will be no support for this suggestion, the creation of new names would be another alternative.

Literature (mainly SDS proposals):


Is the term Strunian worth being properly defined, and thus kept?

CM Paul SARTENAER (Bruxelles)

No month, no week, passes without the Etroeungt beds or the Strunian being mentioned in a publication, and still it is customary among geologists to state that nobody knows what the Strunian is. Some even call it a regional stage. This negative attitude is wrong and right at the same time.

It is wrong, because the Strunian rests upon solid foundations, the Etroeungt Limestone ("Calcaire d’Etroeungt"), of which the stratotype is the Parcq quarry in Etroeungt near Avesnes (Department of the North, France). The 24.05 m thick Etroeungt Limestone has been described bed by bed by GOSSELET (1857), - although formally named by the same author only in 1860, and updated by SARTENAER & MAMET (1964). GOSSELET never used the term Strunian, which was introduced by de LAPPARENT (1900, p. 860), and later considered as a stage by BARROIS (1913, p.16).

It is wrong, because the Strunian has been widely used, following GOSSELET’s lead, for beds containing a transitional fauna between the late Devonian and early Carboniferous beds (as understood before the latest modification of the Devonian/Carboniferous boundary), i.e. beds containing species, part of them being declared Devonian, and the other part Carboniferous.

It is right, because the lack of an internationally accepted definition has been counterbalanced by such a great "plasticity" in the usage of the term Strunian that it makes it impossible for any geologist to prove that "his" Strunian is better than that of another geologist. Having become vague the term has become convenient. As a result there are quite a few dozens of Strunians.

The Strunian has been mentioned and investigated in 85 sedimentary basins, 25 countries, and 5 continents. Its fauna has been studied by various authors, and the expression “Etroeungt fauna” is commonly used in literature. GOSSELET (1879), DEHEE (1929), LE MAITRE (1933), LETHIERS (1974), to quote only some of the authors who worked in the type area, described brachiopods, stromatopores, and ostracods. Two recent publications by MISTIAEN (1997) and by BRICK et al. (presented at the 30th International Geological Congress in Beijing, 1996, in press) indicate that endeavour is not fading out. Beds assigned to the Strunian may reach great thicknesses, e.g. 180 to 430 m in Algeria or 100 to 260 m in Armenia, and in some regions they have been subdivided into two or three parts according to their faunal contents, e.g. in the Velbert Anticline (Bergisches Land, Germany) by PAUL (1939) or in N Devon (England) by GOLDRING (1957). Some scientists have even recognized a shaly, a sandy, and a limy Strunian in the type area.

Should we keep the Strunian for historical reasons? Certainly not for historical reasons alone, although we must not disregard them and forget that the Strunian, the central point of discussions during a few international congresses, was an important Devonian component until 1928, and then again since 1937.
The purpose of this brief submission is not, at this stage, to recommend the acceptance of the Strunian as a formal sub-stage. What is considered as highly desirable is, first, to start an open discussion leading to a clarification and a definition of the Strunian (MAMET, MORTEL MANS & SARTENAER suggested, in 1965, to accept the first appearance of Quasien- dothyra kobetitana as the base of the Strunian), secondly, to face reality in accepting the fact that the Strunian, depending on the accepted definition, is not just a quiet period corresponding to a full recovery from the Dasberg event, but also an event in itself, including the Hangenberg event. The worse thing to do would be to pursue an ostrich policy - anyhow, research scientists would not - and to adopt a "ça va de soi" ("c'est la vie") attitude towards the some 2,000,000 years that have been added to the Famennian in increasing its span of time by about 30%. We have switched overnight from the late Famennian (i.e. the late "late" Famennian) to the late Famennian (i.e. the late "new" Famennian). It means that we have not changed our vocabulary although the contents of what we refer to have been drastically modified. In the time interval at stake, more than in the preceding and succeeding time intervals, the correlation between most of the "magic" zones are still rough approximations, the "correlation" between the conodont and foraminifer zones deserving a special mention.

As a concluding remark, it must be borne in mind that the words "to keep" and "acceptance" have been used in this short note, because, the Strunian existing already for a long time, no new name has to be eventually adopted.

References


Comments on the revision of the Emsian Stage
CM O.H. WALLISER (Göttingen)

Ongoing discussions of the status of the Emsian Stage should consider not only a subdivision of the stage, but rather the possibility of dividing it into 2 stages. If this suggestion is followed we must also evaluate the position of the base of the lower of the two new stages.

The number of faunal changes and length of the Emsian Stage suggest that it would be appropriate to divide it into two stage-level stratigraphic units. If we do this, two new stage names are required. It would be advantageous to use Zlíchovian and Dalejan as the upper two stages of the Lower Devonian, the logical next step is to choose boundary stratotypes for the new stages in the Barrandian, which action has the advantage that then all Lower Devonian boundary stratotypes are defined within a single magnificacies.

The base of the above proposed Dalejan Stage should coincide with the base of the regional Dalejan Stage as it is employed in recent publications, i.e. the appearance of Nowakia cancellata. The regional Dalejan basal boundary, also known as the gracilis (after Gyrococeratites gracilis) or cancellata boundary, coincides with the global Dalejan Event which terminates the interval (N. elegans Zone) where most of the early goniastite lineages became extinct. Of course, intensive investigations of dacryocystid and conodont faunas around the proposed boundary is needed before any decision is reached. For example, the transition from N. elegans to N. cancellata should be pinned down because N. cancellata, evolving from N. elegans, occurs already in faunas still dominated by N. elegans. The cancellata boundary then has to be integrated with the conodont stratigraphy. This boundary is within the Po. latistatus-Po. inversus Zone, most likely at the appearance of Po. giberti or at the boundary of Weddige's (1996) Po. nothoporus and Po. inversus Zones, respectively.

If we divide the Emsian Stage, the logical procedure would be to continue to use the appearance of Po. citabicus as the boundary criterion for the lower stage. However, this boundary is much lower than the subcommission assumed when it selected the Po. dehiscens criterion. Half, or perhaps more, of the classical Pragian has been transferred to the Emsian, thus totally changing the meaning of the regional Pragian Stage. Therefore, inspite of the rules, we should revise the lower boundary. I propose that we use the base of the regional Zlíchovian as the lower boundary of the proposed Zlíchovian Stage.
Proposal of boundaries for a Late Frasnian Substage and for subdivision of the Famennian Stage into three Substages

TM Willi ZIEGLER (Frankfurt) and TM Charles A. SANDBERG (Denver)

If subdivision of the Frasnian and Famennian Stages is to be achieved, the most appropriate boundaries should be based on conodonts and on the start of conodont zones that can be widely recognized not only by their zonal indicators, but also by their accompanying faunas. Such widely recognized zones are invariably related to major eustatic rises, as shown on the Devonian sealevel curve (Johnson, Klapper, and Sandberg, 1985). It seems appropriate to subdivide the Famennian Stage, which has a generally accepted duration of ~10 m.y., into three parts (see accompanying chart). The two globally most recognizable zones are the Early marginifera Zone and the Early expansa Zone. Such a tripartite subdivision would assign 9 zones having a duration of 4.0 m.y. to the Lower (Early) Famennian, 7 zones having a duration of 3.5 m.y. to the Middle Famennian, and 6 zones having a duration of 2.5 m.y. to the Late Famennian. The only equally recognizable zonal boundary, which might be substituted for the start of the Early marginifera Zone, is the start of the Latest crepida Zone.

The base of the Famennian Stage, of course, has already been defined by the SDS at the start of the Early triangularis Zone.

For the Frasnian Stage, which has a duration of only ~5 m.y., there is only one major eustatic rise that is recognized in shallow as well as deep environments. This is the Palmatolepis semichatovae transgression, which occurred within the Early rhenana Zone. We are unaware of any other Frasnian eustatic rise that is so widely recognizable.

Remarks on the German Late Devonian Stages (Stufen)

Willi ZIEGLER

The German Stages (Stufen) of the Late Devonian were developed between the late 19th century and the middle of the 20th century during the exploration of the Variscan Rhenish Mountains. Many famous German paleontologists were involved, for example, Kayser, Frech, Denckmann, Wedekind, Paekelmann, H. Schmidt, and Schindewolf.

Although these Stages served as the stratigraphic frame for mapping projects of the former Prussian Geological Survey and later State Geological Surveys, none of them (except the Wocklum Stufe) were originally based on a single measured section but rather on partial sections from different facies realms, slates in the basinal and nodular cephalopod lime-stones of the submarine rises, which the authors thought would best represent their concept of the respective units. By about 1950, these Stufen were used officially in stratigraphic work and resulting maps, and despite the lack of good reference sections or stratotypes they represented an acceptable umbrella for Upper Devonian rock sequences, stratigraphy, facies, and paleontologic content.

The Stufen and their rocks from the beginning on were searched for fossils and hand in hand with the geological reconnaissance work a cephalopod succession came into usage. A correlation between the Stufen and the ammonoid development was accepted as follows:

- Adorf Stufe: Manticoceras Stufe
- Nehden Stufe: Cheiloceras Stufe
- Hemberg Stufe: Platycheimenia - Prolobites Stufe
- Dasberg Stufe: Clymenia Stufe
- Wocklum Stufe: Wocklumeria Stufe

This correlation was rarely based on bed-by-bed and fossil successions, but rather on single tie points, perhaps with the exception of Wedekind’s and Schindewolf’s studies on ammonoids. Serious errors and miscorrelations resulted, as shown for the Adorf-Manticoceras Stufe by House and Ziegler (1977).

Since the 1950’s, however, entomozoan ostracodes provided a refined biostratigraphic zonation for the basinal slates (Rabien, 1954, 1956) and conodonts were found to be the ultimate tool for high precision biostratigraphy (Bischoff, 1956; Ziegler, 1958, 1962). The previous classification was helpful for tie points, but the refining studies revealed that many old sections had gaps (Hemberg Stufe), were incomplete (Nehden Stufe), or even overlapped (Adorf and Nehden Stufen; the top of the former Adorf Limestone is within the Famennian Middle crepida Zone).

The presently known conodont ages of the boundaries of the German Stages (Stufen), which are still in use, are indicated on the accompanying chart. This positioning is the result of post-1960’s studies, during which many of the older sections for all Stufen were revised and some new sections were excavated in type areas (Dasberg and Hemberg Stufen).

It is expected that the German Geological Surveys will continue using the old Stufen, therefore the German Subcommission on Devonian Stratigraphy has recently set up a Working Group to reevaluate and/or newly establish their reference sections.

I would like to thank M. Murphy for help in formulating this comment with which he agrees.
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PROPOSED BOUNDARIES FOR FOUR UPPER DEVONIAN SUBSTAGES

(Conodont biochronology from Sandberg and Ziegler, 1996, Fig. 1a; German Stufen by Willi Ziegler)
The German SDS group gathered for their yearly meeting at the Senckenberg Museum in Frankfurt on the 1st of March. 40 colleagues working on the Devonian system participated. Various topics were discussed during the meeting; among those, the following were of major importance: further subdivision of the Devonian stages, holostратigraphic aspects, Devonian correlation chart. Because some of these aspects have been already dealt with in the last newsletter and in a brief submission to the SDS meeting in Rochester, only a few main topics are reported where new developments have progressed.

Two main aspects of German SDS activities are the subdivisions of the Emsian and the Famennian stages. As already reported before (Newsletter No. 13), there has been set up a working group of the German SDS on the boundary between the Lower and the Upper Emsian. During a first meeting of this working group, it had been agreed to search for a boundary close to the *cancelatula elegans* boundary in terms of the dacyroconarid zonation or to look for a suitable 'conodont boundary' as close as possible. These suggestions have been presented in a submission to the SDS meeting in Rochester (U. Jansen & E. Schindler [comps.]), where the search for a suitable conodont boundary had been favoured (but also close to the dacyroconarid boundary). Connections concerning international efforts are under way by the coordinator of the German subgroup Ulrich Jansen (address see Newsletter No. 13). Any suggestions on that topic should be directed to him.

A second working group, concerned with a possible subdivision on the Famennian stage has been established during our yearly meeting. Matthias Piescha from the Geological Survey of Nordrhein-Westfalen in Krefeld (address at the end) took the coordination. In the meantime, there have already been held two meetings (one 'theoretical' gathering and one 'practical' field-trip). Briefly summarized, a division of the Famennian into three parts - similar to suggestions in a submission to the Rochester meeting by Willi Ziegler and Charlie Sandberg - have been taken into consideration. Most intense research shall be focused on detailed correlation between the sections, such as the GSSP section at the Lower/Middle Devonian boundary) have been forwarded; cooperations with colleagues working on these datings are in progress.

Two other examples for cooperations between biostratigraphers and other stratigraphers briefly shall be mentioned:

There is a new project (roughly translated as 'Evolution of the system Earth during the late Palaeozoic in the light of sedimentary geochemistry', supported by the German Science Foundation [DFG]) to which some SDS members are attached. CM's Wolfgang Buggisch and Michael Joachimski (both Erlangen) are mainly involved in this project; strongly involved are a group of chemists (organic chemistry) from Jülich and Jan Veizer (Bochum). Questions should be directed to the Erlangen workers (address at the end).

A very fruitful and active cooperation has started between German SDS members and the magnetic susceptibility workers (Brooks Ellwood and Rex Crick) from Arlington, Texas. Biostratigraphically well-known sections have been investigated; research will go on.

Many of the above mentioned activities may be regarded in the frame of the new IGCP project 421 on 'North Gondwana mid-Palaeozoic biodynamics' (leaders: John Talent and Raimund Feist). German SDS participants at the initial meeting of the project in Wien have been Willi Ziegler, Thomas Becker, Dieter Korn, Gunnar Schraut, Eberhard Schindler. As an example for projects connected with the IGCP 421, TM Willi Ziegler gave a report about an already running cooperation project on the Devonian (mainly Lower Devonian) of the western Anti-Atlas in Morocco between the University of Marrakech and the Senckenberg Institute, Frankfurt. During recent field work, additionally the Arlington magnetic susceptibility group and the colleagues from Rabat, Morocco have been working jointly on a Lower Devonian section together with the teams mentioned above.

At the end of 1996, the first issue of the 'Devonian correlation chart', edited by TM Karsten Weddige (comp. SDS Newsletter No. 13), has been published in Senckenbergiana lethaea, 76: 267-286; Frankfurt/M. The next issue of the chart (updated and enlarged) is in press (Senckenbergiana lethaea, vol. 77). The chart should be checked, applied, and corrected by any interested colleagues. Suggestions should be directed to Karsten Weddige (address see SDS Newsletter No. 13).

Briefly, I want to announce a recent volume of the 'Courier Forschungsinstitut Senckenberg' (CFS) resulting from the SDS meeting on sea-level changes three years ago in Moscow. The volume dedicated in honour of Maria A. Rhzonitskaya (St. Petersburg), contains twelve articles on that topic, mostly from regions of the former Soviet Union and other eastern countries; two contributions are dealing with Australian examples. All articles are written in English. Citation of the volume: House, M.R. & Ziegler, W. [eds.] (1997): On sea-level fluctuations in the Devonian—Cour. Forsch.-Inst. Senckenberg, 199: 146 pp., 70 figs., 3 tabs.; Frankfurt/M. For copies of the volume, the following address should be contacted: Mrs. Sabine Jessel, Forschungsinstitut und Naturmuseum Senckenberg, Schriftenausch, Senckenberganlage 25, D–60325 Frankfurt/M., Germany; Fax: ++49-69-746238; e-mail: sjessel@sng.uni-frankfurt.de

List of addresses of colleagues mentioned in the minutes—and not mentioned in the SDS Newsletter No. 13:

Wolfgang Buggisch and Michael M. Joachimski, Institut für Geologie und Mineralogie, Schloßgarten 5, D–91054 Erlangen, Germany; phone: ++49-9131-852615 (W.B.), ++49-9131-852699 (M.J.), fax: ++49-9131-859295, e-mail: joachimski@geol.uni-erlangen.de
Report of the German Subcommission on Devonian Stratigraphy SDS meeting at Rochester, N.Y.; July 1997

Currently, the German SDS has 64 members. 40 gathered at our last meeting in Frankfurt on the 1st of March.

The participants discussed various topics; among those the most prominent were: subdivision of Devonian stages, holostatigraphic aspects, Devonian correlation chart, monograph of the German Devonian, database of Devonian (and additional Rhenohercynian) literature.

Starting with the last: There exists a collection of more than 1,600 citations of Rhenohercynian (mainly Devonian) literature. Karsten Weddige initiated it and takes care of it. For the future it is planned to provide it online (to date it is saved on diskettes).

About the valuable Devonian correlation chart we have already heard by K. Weddige.

One of the main aspects in the German SDS is (and will be) the application of holostratigraphic methods. Obviously, the base has to be intensive biostratigraphic work, but other "stratigraphies" must also be taken into account. The following ones have been discussed in greater detail and may surely enhance stratigraphic knowledge.

Isotope and organic matter geochemistry: There are active working groups (e.g. M. Joachimsk! from the Univ. of Erlangen, who is present) or the group at the KFA in Julich.

Event stratigraphy already has - and will continue - to play a major role in Devonian stratigraphy. Many colleagues are working with this method for several years.

Graphic correlation and sequence stratigraphy have to be considered in the future. Discussion of this topic has been showing, that the application of these methods has to be conducted critically, and must be referred to basic biostratigraphic data wherever possible.

Magnetostatigraphy - where possible - will also be conducted (e.g. P. Buchholz, Braunschweig).

Radiometric dating shall be one of the focuses in the future. There are many bentonites in the German Devonian and - not known to some people - there are already studies from years ago that could be reactivated due to the modern methods (e.g. SHRIMP). I'd like to mention Prof. J. Winter at the Univ. of Frankfurt, who worked (differently from today) with bentonites and zircons e.g. in the Eifel area. First efforts from well-dated sections by myself are under way together with TM J. Talent and other colleagues.

Concerning the subdivision of Devonian stages there are interests namely for the Famennian and for the Emsian stages.

There has been set up a working group for the subdivision of the Famennian of which M. Piecha (Geol. Survey in Krefeld) will be the convertor.

A similar group - as we already have shown earlier - exists for the subdivision of the Emsian, were U. Jansen (FIS, Frankfurt) is the convertor.

Eberhard Schindler
Senckenberg Institute, Frankfurt/M.
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Revised guidelines for the establishment of global chronostratigraphic standards by the International Commission on Stratigraphy (ICS)

by Jurgen Remane, Michael G Bassett, John W Cowie, Klaus H Gohrbandt, H Richard Lane, Olaf Michelsen and Wang Naiwen, with the cooperation of members of ICS

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2 Aims and principles

2.1 Aims of the revision

The original Guidelines were issued by the Bureau of ICS (Cowie and others, 1986) and summarised by Cowie (1986) in Episodes, the official publication of IUGS, and by Cowie (1990, 1991). They have guided uniformity of definition for 20 chronostratigraphic boundaries during ten years of successful application. The experience gained in this process has confirmed the basic principles of the original Guidelines. Nevertheless, a cautious revision of the Guidelines appears useful for different reasons:

1. The Precambrian Subcommission of ICS has proposed a global stratigraphic subdivision for the Proterozoic where boundaries are defined in terms of absolute ages (see section 2.2), with entirely new names for the nine Proterozoic systems created on this basis. The resultant new subdivision of the Proterozoic was voted by ICS and ratified by IUGS at the 28th IGC in Washington, 1989: it is thus formalized (and should therefore not have been omitted in the 2nd edition of the ISG).

2. During the last years, great progress has been made in the field of non-biostratigraphic methods of correlation (see section 3.1). These should therefore be given more weight in the choice of boundary levels and type-sections.

3. Certain problems concerning the philosophy of boundary definition came up repeatedly in recent discussions of GSSP candidates, such as the necessity to respect priority, to have natural boundaries (see section 2.4), the role of fossils in boundary definition (see section 3.1), and the degree to which global correlation has to be exact before defining a boundary (see section 2.3).

4. Since the publication of the original Guidelines (Cowie et al., 1986), important publications on the principles of stratigraphy have appeared, especially the 2nd edition of the International Stratigraphic Guide (ISG) (Salvador, 1994), or Harland (1992). The position of the Guidelines in this new context had to be clarified.

The role of the Guidelines remains, however, unchanged. They regulate the procedures of boundary definition, the selection of an appropriate boundary level, and the corresponding voting procedures (also partly dealt with in articles 3 and 7.1 of the statutes of ICS). They further define the requirements to be fulfilled by the stratotype-section housing the boundary point.

2.2 The Precambrian Standard

The new boundary-type definition, first introduced for the Proterozoic in 1989, was necessitated by the lack of adequate fossils in most of the Precambrian. It is termed herein the Global Standard Stratigraphic Age (GSSA). Defining boundaries in terms of absolute ages means that the numerical value of the boundary age is a theoretical postulate, independent of the method applied to obtain numerical ages. But, as in the case of boundaries defined by a GSSP, an explicit motivation for the choice of the proposed numerical value should be given, clarifying, at the same time, its relation to traditional boundary definitions. GSSAs have the same status for boundary definition in the Precambrian as GSSPs have in the Phanerozoic.

2.3 Correlation precedes definition

Except for the Precambrian, this principle is still valid. To define a boundary first and then evaluate its potential for long-range correlation (as has been proposed in some cases) will mostly lead to boundary definitions of limited practical value. On the other hand, it would be unrealistic to demand that a given boundary be recognisable all over the world before it can be formally defined. In each case we must find the best possible compromise, otherwise the search for the Holy Grail of the perfect GSSP will never end.

2.4 Priority and natural boundaries

Our main task for a number of years will be to develop precise boundary definitions for traditional chronostratigraphic units. Most of them were defined in the last century by their characteristic fossil contents, and their boundaries coincided with spectacular biostratigraphic and lithologic changes. These were "natural" boundaries, in perfect agreement with the catastrophist philosophy of that time. In reality, rapid faunal turnovers are to a certain extent artefacts due to stratigraphic gaps or condensation. Most of the classic type-localities are thus unsuitable for a precise boundary definition: we have to look for new sections where sedimentation is continuous across the boundary interval; but then boundaries will rarely correspond to a lithologic change.

The idea that chronostratigraphic boundaries should always correspond to something "visible" has also led to conflicting regional definitions of international chronostratigraphic boundaries, which were adapted to regional lithostratigraphic boundaries of different ages.

There is no formal priority regulation in stratigraphy. Therefore, in redefining boundaries, priority can be given to the level with the best correlation potential. The redefinition will give us the opportunity to use fossil groups (such as conodonts) and methods of chronocorrelation (such as magnetostratigraphy) which were unknown or poorly developed at the time of the original definition. This does not mean that priority should be totally neglected. Practical considerations will incite us to limit changes to the necessary minimum. If, however, the interregional correlation potential of a traditional boundary does not correspond to the needs of modern stratigraphy, its position has to be changed.

Chronostratigraphic boundaries are conventional boundaries. They are a matter of normative science and can be decided by a majority vote (Cowie and others, 1986). To a certain degree, this principle can be reconciled with the demand for natural boundaries. As stated above, most of the classical boundaries are not clear cut but correspond to critical biotic and/or climatic transitions. Placing a boundary within such an interval will preserve the advantage of having successive units which are distinguished by their contents. But where exactly the boundary is to be placed, are matters of convention and practical considerations.

Once a boundary is (re-)defined by a GSSP or a GSSA, it should be used in all published figures and tables. Such an obligation will not hinder any authors from expressing their personal opinions.

2.5 Boundary-stratotypes instead of unit-stratotypes
If chronostratigraphic units were defined by unit-stratotypes, the boundary between two adjacent units would be defined by two separate GSSPs: as the upper boundary of the lower unit in one unit-stratotype and as the lower boundary of the succeeding unit in the other. The Global Chronostratigraphic Scale must, however, comprise strictly contiguous units, without overlaps and with no gaps between them. But there is no method of correlation which would guarantee a perfect isochrony of two separate boundary points, even at a short distance apart (Harland, 1992).

This problem was already recognised in the first edition of the ISG (Hedberg, 1976), but unit-stratotypes for chronostratigraphic units were still admitted as an alternative possibility. In the second edition (Salvador, 1994), boundary-stratotypes are given a stronger preference, but as a whole, the position remains ambiguous: "Since the only record of geologic time...lies in the rocks themselves, the best standard for a chronostratigraphic unit is a body of rocks formed between two designated instants of geologic time." (Salvador, 1994: 88).

The Guidelines of ICS are unambiguous: Chronostratigraphic units of the Phanerozoic Global Standard can only be defined through boundary stratotypes. Even should the situation arise (e.g. as in the Silurian stratotypes in Britain) that the GSSPs defining the lower and upper boundaries of one-and-the-same unit are located in the same section, this does not imply that the stratigraphic interval and its biota between the two GSSPs represent a unit stratotype.

For several systems, upper and lower boundaries are now defined by GSSPs. Following the choice of the best type-section these are located in distant regions: the base of the Silurian in Scotland, UK; that of the Devonian in the Czech Republic; that of the Carboniferous in the Montagne Noire, France; of the Permian in Kazakhstan; and the base of the Quaternary in Italy.

The lower boundaries of chronostratigraphic units of higher rank (series, systems etc.) are automatically defined by the base of their lowermost stage. In other words: the lower boundary of a system is always also a series and it stage boundary.

A GSSP cannot be compared to the holotype of Zoological Nomenclature; it corresponds rather to a standard of measure in physics (Harland, 1992). The use of terms like holostratotype, parastratotype etc. should therefore be avoided (Cowie and others, 1986). If reference sections and points seem necessary in order to give a better understanding of the boundary in another facies or paleobiogeographic context, an auxiliary stratotype point may be defined. Such auxiliary points are subordinate to a GSSP.

3 The choice of the best boundary level

3.1 Some general considerations about chronostratigraphic methods

Chronostratigraphy and chronocorrelation have been discussed at length in the ISG (Salvador, 1994). We may thus limit the following discussion to selected topics which are of particular importance for the choice of the boundary level.

Considerable progress has been made in the last few years in developing and improving methods of non-biostratigraphic chronocorrelation. Some of them are based on geochemical signals, like the famous Ir-spike used as guidance for the definition of the Cretaceous-Paleogene boundary, or on shifts of stable isotopes which should be helpful in the definition of the Permian-Triassic boundary (Baud and others, 1989).

Reversals of the Earth's magnetic field are important, because they are a worldwide phenomenon and practically instantaneous, thus providing a precise and reliable means of chronocorrelation. Late Jurassic to Recent reversals have been calibrated to the Magnetic Polarity Time Scale based on oceanic anomalies (Hailwood, 1989).

Geophysical and geochemical events are, however, repetitive and do not allow an unequivocal determination of the age. They need calibration through radioisotopic or biostratigraphic dating. Unfortunately, radioactive isotopes are rarely available where needed so that stratigraphic routine work depends mostly on other methods. But radioisotopic datings are very important for the quantitative calibration of relative ages.

Biostratigraphic boundaries, i.e. the boundaries of the material stratigraphic occurrence of species, are diachronous (ISG). This fact has, however, been overstated. A species exists for a finite span of time and is therefore characteristic of a certain geologic interval. In rapidly evolving lineages this may be less than one million years, so that most biostratigraphic datings attain a higher degree of resolution than the use of radioisotopes.

The use of fossils for calibrating chronostratigraphic units does not only involve tracing of biostratigraphic boundaries. It is indeed less a matter of correlation than of determining relative ages within a biochronologic standard of reference. Biochronology is the reconstruction of the succession of species in time through the synthesis of local and regional biostratigraphic data (for a recent overview, see Remane, 1991). The chronostratigraphic reliability of biostratigraphic boundaries can thus be tested by comparing data from different species. In this process, mathematical approaches (Quantitative Stratigraphy) play an increasingly important role (Gradstein and others, 1985; Guex, 1991; Mann and Lane, 1995).

Fossil species depend on the environment and are biogeographically limited. An appropriate choice of widespread species may diminish but never totally eliminate these shortcomings. Radioactive isotopes do not suffer from these geographical restrictions; but their resolution diminishes with increasing age. Therefore, non-biostratigraphic markers like magnetic reversals and stable isotopes have gained increasing importance in long-range lateral correlation.

3.2 The best boundary level

With the above considerations in mind, the correlation potential of any boundary level should be tested through a detailed study of several continuous successions covering the critical interval, if possible on different continents. The most suitable of these sections can then be selected for definition of the GSSP. If two boundary levels of equal correlation potential are available, the better candidate (see chapter 4) will decide the choice of the boundary level.

This implies the integration of data from different facies and paleogeographic provinces in a global synthesis. The per-
4.2 Biostratigraphic requirements

- Abundance and diversity of well-preserved fossils
- Favourable facies for long-range biostratigraphic correlation
- Exposure over an adequate thickness of sediments is one requirement necessary in order to make a timely decision.
- Absence of horizontal and vertical facies changes at or near the boundary level.
- The rate of sedimentation should be sufficient that successive events can be easily separated.
- Absence of synsedimentary and tectonic disturbances.
- Absence of metamorphism and strong diagenetic alteration (identification of magnetic and geochemical signals).

4.3 Other methods

- Radioisotopic dating. Whenever possible, it is important to achieve direct quantitative calibration (numerical age) of a chronostratigraphic boundary at the GSSP.
- Magnetostratigraphy. A reproducible magnetic reversal stratigraphy is a desirable requirement in order to know where in the magnetostratigraphic sequence the GSSP is located.
- Chemostatigraphy, including the study of vertical changes of the proportions of stable isotopes, which may be indicative of global events.
- The regional paleogeographical context and the facies relationships of the stratotype-section should be clarified.

4.4 Other requirements

- The GSSP should be indicated by a permanently fixed marker.
- Accessibility: candidate sections in remote regions which can only be visited by organizing costly expeditions should normally be excluded from the selection.
- Free access for research to the type-section for all stratigraphers regardless of their nationality.
- When making a formal submission to ICS, the concerned Subcommission should try to obtain guarantees from the respective authority concerning free access for research and permanent protection of the site.

5 Procedure for the submission of a GSSP

5.1 Editing of the submission

Submissions must be in English. In order to provide a clear picture of the qualities of the proposed GSSP candidate, the formal submission to ICS or to the concerned Subcommission should give the following information:

1. name of the boundary;
2. indication of the exact location (coordinates) of the stratotype-section on a detailed topographic map or aerial photograph, if possible at a scale not less than 1:50,000;
3. location on a detailed geologic map;
4. detailed description of the stratotype-section including a litholog and photos of the section, indicating the bed in which the boundary-point is defined and the key-levels for all physical and biostratigraphic markers;
5 motivation for the choice of the boundary level and the stratotype-section, with a discussion of failed candidates and their ease of intercontinental correlation;
6 any comparison with former usage should be discussed fully;
7 discussion of all markers used in the determination of the boundary level;
8 illustration of important fossils;
9 results of radiisotope dating, indicating clearly what method has been used;
10 results of all votes within the Working Group and the Subcommission.

Note: Within these procedures, only items 1, 6, 7, 9, 10, and the motivation for the choice of the boundary-level are relevant to the establishment of a GSSA.

Following acceptance of the submission within these Guidelines, the Chairperson or the Secretary of ICS will arrange a vote by the full Commission within a period of no more than 60 days.

5.2 Voting procedure
In accordance with the ICS statutes, all formal voting must be conducted by post, giving a deadline of 60 days for the receipt of votes. Voting members of the Working Group, Subcommission or full Commission may vote 'YES', 'NO', or 'ABSTAIN'. The last step in the selection of a final candidate for a boundary level and/or a GSSP should always be a vote on one single candidate (Cowie et al., 1986).

In outline, this procedure includes the following steps:
1 Successive voting by members of the concerned Working Group leading to the choice of a boundary level and the final selection of a single GSSP or GSSS candidate.
2 If this obtains the statutory working majority in the Working Group, members of the respective Subcommission will vote on whether or not the candidate be approved.
3 In the case of a statutory majority being in favor, formal submission of the candidate to ICS for approval.
4 Again, in the case of a statutory minority, submission of the GSSP or GSSS candidate to the IUGS Executive Committee for ratification, together with an abstract of the submission prepared by the responsible ICS body.

ICS should attempt to finalize, within three years after IUGS ratification, any remaining official steps for the protection of the site with the authorities of the country in which the GSSP is located.

6 Revision of a GSSP
A GSSP or GSSS can be changed if a strong demand arises out of research subsequent to its establishment. But in the meantime it will give a stable point of reference. Normally, this stability should be maintained and the practical value of the boundary definition tested for a minimum period of ten years. Revisions for other reasons should be made only in exceptional circumstances, such as:
1 The permanent destruction or inaccessibility of an established GSSP;
2 a violation of accepted stratigraphic principles discovered only after the ratification of a GSSP.

7 Selected references
The 2nd edition of the ISG (Salvador, 1994) contains a comprehensive list of publications dealing with the principles and techniques of stratigraphy. The present list of references is therefore limited to papers providing further information on the principles underlying these Guidelines, adding some titles not mentioned in the ISG.


This year's Annual Meeting took place in the heart of the Eifel Mountains and, therefore, much of the program and the excursions was devoted to Devonian topics and localities. The conference was held in the modern conference centre next to the GEO Zentrum Vulkaneifel (Leopoldstr. 9, D-54550 Daun) which focuses on the Tertiary and Quaternary basaltic volcanism but the Deutsche Palaeontologische Gesellschaft was exceedingly well hosted by the organizers I. Eschghri and Mrs. H. Rudolf. A reception was held on the evening of the 24th in the Natural History Museum of Gerolstein which displays a good collection of the famous local Devonian fauna.

Seven excursions led to the Lower Devonian clastic sequences of the southern Eifel Mountains and of the Hunsruck as well as to the fossiliferous Eifelkalkmulden. Two excursions dealt with the industrial exploitation of Middle Devonian carbonates and with hydrogeological aspects of the southern Eifel synclines. Stratigraphy and regional palaeontology were during tours to:

Excursion B: Stratigraphy and facies in the Lower Emsian of the Manderscheid Uplift (led by H.-G. Mittmeyer).

Excursion C: The Lower Devonian of the Ostefel-Hauptsattel (led by W. Meyer).

Excursion D: Middle Devonian Eifelkalkmulden, I and II (led by W. Haas & A. Braun).

Excursion H: Biostratigraphical stage boundaries and events in the Pr1m and Hillesheim Synclines (led by G. Pladowski & K. Weddige).


All excursion guides are published in Terra Nostra, 97/7: 202 p., ISSN 0946-8978.

During the sessions the following Devonian talks and poster contributions were presented (titles translated, all published in Terra Nostra, 97/6; page numbers given in square brackets).


Meeting of the IGCP 406 project “Circum-Arctic Lower-Middle Palaeozoic Vertebrate Palaeontology and Biostratigraphy”

The meeting: “Palaeozoic Strata and Fossils of the Eurasian Arctic” was held from 23 to 26 September 1997 at the St. Petersburg University, Geological Faculty, Department of Palaeontology. The meeting was organised by A. Ivanov, I. Evdokimova, T. Modzalevskaia, S. Snigirevskiy and A. Zhiravlev. More than 35 participants from 12 countries (Australia, Estonia, France, Germany, Ireland, Latvia, Lithuania, the Netherlands, Poland, Russia, Sweden, UK) have attended with various contributions. They embraced the studies of the whole Palaeozoic but most oral and poster presentations were associated with the Devonian biostratigraphy: the stratigraphic position of reefs and the vertebrate and conodont assemblages in the Timan-Pechora Province; ostracod, bivalves and fossil plant distribution and palaeogeography of the Eurasian Arctic region; vertebrates and other fossils of Severnaya Zemlya; vertebrate microremains from the Canadian Arctic. The project business meeting and workshop on Severnaya Zemlya monographs took place during the meeting. Dr Peep Mannik (Tallinn, Estonia) was elected as a third co-leader of the project apart from Tiit Marss and Mark Wilson. The meeting of the project are planned for next year in Warsaw, Poland. As well the project is going to finish the preparing of two monographs on Severnaya Zemlya. The first of them concerned the Silurian-Devonian stratigraphy of the archipelaog will be pub-
lized in Russian, in Novosibirsk Press, R. G. Matukhin & V. V. Menner, eds.; a second one with the palaeontological descriptions will be printed in English, in Geodiversitas, Paris, D. Goujet & H. Lelièvre, eds.

The abstract volume published by the St. Petersburg University as Ichthyolith Issues Special Publication 3 (A. Ivanov, M.V.H. Wilson & A. Zhuravlev, eds.) are available on the Web site:

http://www.wplus.net/pp/Stratigr

Contents of Ichthyolith Issues Special Publication 3:


ABUSHIK, A. F. & EVDOKIMOVA, I. O.: Key intervals for ostracod correlation in different facies of the lower Devonian of the Eurasian Arctic

ANTOSHKINA, A. I.: Stratigraphic position of reefs in the Lower Paleozoic succession of the Timan-Pechora region

BURROW, C. J., VERGOOSSEN, J. M. J. & TURNER, S.: Microvertebrate assemblages from the Late Silurian of Cornwallis Island, Arctic Canada

ERMOLAEOV, W. & IVANOV, A. O.: Middle Devonian vertebrates from the Mimer Valley Basin of Vestspitsbergen

FEDOSEYEV, A. V.: Biostratigraphic trilobite-based subdivision of Cambrian deposits of Sukhobika River (Igarjka Region)

GINTER, M. & TURNER, S.: New Early Famennian phoebodont shark from Melville Island, Arctic Canada

GOUJET, D. F.: Placoderms from Lower Devonian borings of Timan-Pechora

ISAKOVA, T. N. & AGAFONOVA, G. V.: Fusulinid biostratigraphy of Lower Permian deposits of the Kolva swell, north Timan-Pechora province

KARATAJUTE-TALIMAA, V. N. & MARSS, T.: Thelodonts from the Silurian and Lower Devonian of the Severnaya Zemlya Archipelago, Russian Arctic

KARATAJUTE-TALIMAA, V., VALIUKHEVIUS, J., JURIEVA, Z. & MENNER, V.: Vertebrate assemblages and correlation of Lower Devonian deposits of different facies in the northern Timan-Pechora province

KISSELEV, G. N.: Brief review of Silurian cephalopods of Severnaya Zemlya Archipelago and Novosibirsk Islands

KOROVNIKOV, I. V.: Lower Cambrian trilobite assemblages from the northeastern Siberian Platform

KOSSOYVA, O. L.: Upper Paleozoic rugose coral biostratigraphy of northern European Russia: key reliable levels

KULIKOV, V. F. & SINITSINA, I. N.: Silurian - Devonian bivalvia from the Eurasian Arctic

KURSS, V. & PULILS, M.: On paleogeography of eastern blocks of the Devonian Euramerican supercontinent

KUZMIN, A. V.: Aspects of the Frasnian conodont stratigraphy of the Timan-Pechora province


LUKSEVICS, E.: Preliminary report on Middle/Upper Devonian fishes from Severnaya Zemlya (Placodermi, Bothriolepididae)

MANNIK, P.: Silurian conodonts from Severnaya Zemlya


MILLER, C. G. & ADRAIN, J. M.: Conodonts from the Cape Phillips Formation (Wenlock, Silurian) of Arctic Canada

MODZALEVSKAYA, T. L.: Ordovician and Silurian brachiopod succession of the Timan-Pechora region


PATRUNOV, D. K.: Southern Novaya Zemlya basin in the Middle Palaeozoic: from Yapesus system to Paleo-Uralian ocean system

SIPIN, D. P.: Small shelly fossil zonal assemblages of the Tommotian - Atdabanian on the northwestern Siberian Platform

SNIGIREVSKY, S. M.: Some Lower Carboniferous floras of the Arctic

SNIGIREVSKY, S. M.: Upper Devonian floras of the Arctic

STUKALINA, G. A.: Correlation of the Lower Silurian in Arctic regions and the Siberian Platform


TURNER, S.: Late Silurian microvertebrates from Cresswell Bay District, Somerset Island, Canada

TURNER, S. & BURROW, C. J.: Lower and Middle Devonian microvertebrate samples from the Canadian Arctic

VERGOOSSEN, J. M. J.: Revision of paraconodont acanthodians

YOUNG, V. T.: Early Palaeozoic acanthodians in the collection of the Natural History Museum, London

ZHURAVLEV, A. V.: Environmental control on conodont microornamentation: preliminary results from the Upper Devonian and Lower Carboniferous

ZHURAVLEV, A. V.: Tournaisian (Lower Carboniferous) conodont natural assemblages (Northern Urals).

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Invitation
All interested Palaeozoic workers are invited to attend the 1998 meeting of IGCP 406 which will be held at the Faculty of Geology, Warsaw University in Warsaw, Poland, from September 3 to 8, 1998.

Conference topics
Biodiversity of Palaeozoic vertebrates and invertebrates of Circum-Arctic regions, in connection with palaeoecology, stratigraphy and palaeogeography. Contributions on plants or palynomorphs are welcome.

Workshops: during the meeting a special symposium/workshop on Palaeozoic chondrichthyans from all over the world will be held. The workshop will be particularly focused on chondrichthyan microfossils, but any presentation dealing with sharks, both from the biostratigraphic or the morphological/phylogenetic aspect, is welcome. We invite suggestions on topics of other conference workshops.

Available equipment: Slide and overhead projectors.

Abstracts
Abstracts of conference papers should be submitted before April 1, 1998.

The text (in English, no more than 2 pages, including references) should be sent by e-mail as ASCII files. If you use special or national letters, or you want to add illustrations, please send a hard copy separately.

Estimated costs
Registration fee: 50 US$

The fee will be collected during the meeting at the registration desk.

Accommodation: 30 US$/night at the Academy hotel. The cost of living in Warsaw is ca. 10-20 US$/day.

Limited financial support from IGCP, as well as considerable reduction of accommodation/registration costs are possible. If you are interested, please inform us as soon as you can.

Excursion
A two-day (7-8.09.) post-conference excursion to the most exciting Devonian outcrops of the Holy Cross Mountains is planned. Estimated cost: 50 US$.

Deadlines:
Preliminary registration - February 15, 1998 Abstracts - April 1, 1998

Please let us know if you need an official invitation.

Address
Michal Ginter, Institute of Geology, Warsaw University, Zwirki i Wigury 93 02-089 Warszawa, POLAND, e-mail: fiszbit@geo.uw.edu.pl, fax: (48 22) 22-02-48
REGISTRATION FORM

Last name: ____________________________
First name(s): ________________________
Title: ________________________________
Sex (M/F): __________________________
Institution: __________________________
Address: ______________________________
E-mail: ______________________________
Fax: __________________________________

My attendance is: 
   probable _  definite _
I will present a paper: 
   yes _  no _
Title of presentation (coauthors' names): ____________________________
Type of presentation: 
   oral _  poster _
I intend to submit an abstract(s) entitled: __________________________
I wish to take part in: 
   conference sessions _
   workshop _
   conference dinner _
   post-conference excursion _
I need reservation at the hotel: 
   yes _  no _
   a single room _  a bed in a double room _
I wish to make my own arrangements for accommodation _
I need official invitation: 
   yes _  no _

Please complete and return by e-mail (if it is possible) before February 15, 1998
E-mail: fiszbit@geo.uw.edu.pl

Michal Ginter, Institute of Geology, Warsaw University, Zwirki i Wigury 93, 02-089 Warszawa, Poland

NOTE: A version of this form suitable for submittal via e-mail may be obtained by sending a blank message with the subject "WARSAW MEETING" to crick@uta.edu. The form will be sent to you automatically via return e-mail. You may then use your e-mail editor to complete the information and forward it to Michal.
NEW IGCP PROJECT
NORTH GONDWANA MID-PALAEozoic BIOEVENT/BIOGEOGRAPHY PATTERNS IN RELATION TO CRUSTAL DYNAMICS

Objectives:

Analysis of bioevents (especially global extinctions and recoveries), major variation in biodiversity, and change in biogeographic differentiation along the North Gondwana continental margin during the mid-Palaeozoic. Integration of these data with the biofacies & lithofacies database for the region will be undertaken in pursuit of increased precision in stratigraphic alignments and improved palaeoecologic and palaeoclimatologic syntheses. Important (even constraining) implications are predicted as regards relative positioning of crustal blocks at the beginning of the mid-Palaeozoic, and for inferring geodynamic events during the crucial period leading to the Pangaea assembly.

The principal foci of the project are:

1. Close examination of major bioevents (especially global extinctions and recoveries) and biodiversity (including isotopic indicators thereof), and the extent to which these events and their "evolution" can be discriminated from crustal block to crustal block through the region.

2. Quantitative analysis of change in biogeographic differentiation laterally as well as changing patterns through time of biogeographic similarity & dissimilarity (believed to reflect, primarily, the relative positioning of the crustal blocks through time).

3. Integration of these data with the biofacies & lithofacies database for the region to provide:

4. Increased precision in stratigraphic alignments for the time-interval on which the project is focussed, and:

5. Best possible palaeoecologic and palaeoclimatologic syntheses, time-slice by time-slice. Biofacies and lithofacies data are sparse or not readily available for the mid-Palaeozoic for more than three-quarters of the region. It is anticipated that this initiative will lead to such data being sought out and made available for regional syntheses, and that the latter will reveal patterns of change in gross sedimentary geometry and palaeogeography with important (even constraining) implications for:

6. Interpreting evolution of the palaeoceanographic setting (with attention to possible isotopic indicators of patterns in ocean chemistry), relative disposition of crustal blocks along the northern Gondwana margin at the beginning of the mid-Palaeozoic, and for inferring events during fragmentation and dispersal of the blocks - at least for the time-interval in question.

Duration of project: 5 years: 1997-2001

Relationship to other IGCP projects:

A good chronologic framework for effective prosecution of the project has crystallized as a result of activities by the IUGS subcommissions on Silurian and Devonian stratigraphy (and associated system-boundary working groups), and by the former IGCP 216 Global biological events in Earth history. The new project may be viewed as having some linkage to the former IGCP 5 Correlation of Pre-Risean and Variscan events of the Alpine-Mediterranean mountain belt (1978-1982), and IGCP 321 Gondwana dispersion and Asian accretion (1991-1996). The first of these concerned tectonics (along 8 geotraverses) of the western portion of the area on which the project is focussed, and the second had a primarily Devonian and younger focus. The project includes the heart areas of the above projects, but extends across crustal blocks between them. There are obvious links to the former IGCP 306 Stratigraphic correlation in southeast Asia (1992-1995) and, through the event aspects of the project, IGCP 293 Geochemical event markers in the Phanerozoic (1990-1993) and IGCP 335 Biotic recovery from mass extinctions (1993-1997). The project will build in a minor (biographic) way on IGCP 328 Palaeozoic microvertebrates. It has an "end-on" relationship with IGCP 351 Early Palaeozoic evolution in northwest Gondwana (1993-1997), and the new IGCP 410 Temporal and spatial patterns of Ordovician biodiversity (1997-2001).

Tentative work schedule:

1997-1999: Establishment of biofacies & lithofacies database: Defining regional entities (crustal blocks), compilation of palaeobiologic data (taxonomically consistent) for individual crustal blocks, interregional biostratigraphic correlation; discrimination of bioevent intervals and interregional comparison & contrast.

Late 1999-early 2000: Quantitative analysis of biogeographic patterns in time and space; inferred dynamic evolution (from biodata) of the North Gondwana continental margin.

2000-2001: Interaction with data from other areas of earth sciences and refining of inter-linked bio- & geodynamic model.

The initial database compilation (1997-1999), a mandatory prerequisite for the project, will be useful in itself: providing nomenclatorial consistency (biofacies, bioevent, taxonomic) across all crustal blocks of the former North Gondwana continental margin. This will have obvious relevance for communication among everyone involved, and utility for making comparison with patterns along the various segments of the former continental margin. Though it is not an articulated thrust of the project, it is anticipated that IGCP 421 will contribute in a modest way to improving the framework within which mineral exploration strategies might be developed.

Present state of activities

A vast amount of recent tectonic work has focused on the southern European region, especially the Ibero-Armorican and Alpine chains, and the Himalaya-Karakoram region and Tyan' Shan in relation to plate tectonics. Several of the mid-Palaeozoic boundary stratotypes, incidentally, have been established within the region on which this project will focus.

Geographic focus:
The swathe of countries through southern Eurasia (Portugal and Spain to southern China) having crustal blocks (or regions) hypothesized as having been part of or adjacent to the Gondwana margin during mid-Palaeozoic times. Many institutions outside this belt (e.g. in Belgium, Canada, Germany, Russia, the United Kingdom, USA) have researchers whose principal interests concern stratigraphic sequences and tectonic problems within the area in question. Interest is anticipated from scientists concerned with notionally allochthonous terranes in central America, and with relevant biostatigraphic interests (e.g. palynology) based on sequences deeper within the former Gondwana mega-continental.

Regional and other groups:

Regional and national stratigraphic scales within the North Gondwana belt are often appreciably out of alignment with each other and with the criteria for series and stage boundaries agreed to in recent years by the relevant stratigraphic subcommissions and boundary working groups. Ratification of these recommendations by the International Commission on Stratigraphy has produced stability as regards an international standard scale for the time-interval with which the project is concerned. The time is therefore ripe for a broad-scale exercise in re-correlation of the stratigraphic sequences through the North Gondwana crustal blocks. Such an exercise is necessary to provide a sufficiently rigorous basis from which to investigate anoxic and extinction events and interregional transgression-regression patterns. In order to facilitate data compilation and interpretation, there will be 9 working groups (6 of them regional groups), each with 2 or more leaders entrusted with bringing together material for syntheses of pre-Variscan palaeontologic data and stratigraphic correlations:

1. Northern Africa
2. Ibero-Armorican arc
3. Southern France-Sardinia-Carnic Alps-Thuringia-Czech regions
4. Southern Asia from Turkey-Armenia-Azerbaijan-southern Central Asia (including Afghanistan and northern Pakistan) to the Tibet-Baoshan regions of China
5. South China and southeast Asian blocks
6. Australia and New Zealand. A special focus here will be palaeogeographic & palaeobiogeographic evolution of eastern Australia during the Middle Palaeozoic - testing whether or not a strike-slip model can explain what appear to be interregional mid-Palaeozoic lithofacies & biofacies anomalies
7. Biogeographic statistical techniques
8. Isotopic signatures of global extinction events
9. Geodynamics

In anticipation that palaeomagnetic “inscrutability” may remain “a fact of life” as regards the mid-Palaeozoic for most crustal blocks in the region, it is proposed, as part of the program, to probe whether or not quantitative palaeobiogeographic data will assist in providing some constraint on the relative positioning of some of the blocks of this region during the mid-Palaeozoic. In order that the data might not be constrained by particular models, it has been proposed that the data-compilation will be undertaken, initially, without reference to (or preference for) previous geodynamic models. At a later stage (years 4 and 5, see below years 2000 and 2001) it is planned to invite a broad spectrum of colleagues with palaeomagnetic and other geodynamic skills to become involved in discussion of how their data may illuminate or impose constraints on the emerging syntheses.

Organizing the project for effectiveness

The project has been structured around a series of at least 10 international seminars and workshops. Wherever possible, for increased viability, these have been or will be associated with international or regional conventions on themes linked in some way with the project, e.g. with ECOS-7 (Seventh European Conodont Symposium, Italy, mid-1998), PAFF (Palaeogeography of Australasian Faunas and Floras, Australia, December 1997), AUSCOS-2 (Second Australasian Conodont Symposium, August 2000), the XXX IGC (Brazil, 2000), and meetings of the principal relevant subcommissions: on Silurian and Devonian stratigraphy. Regional workshops are encouraged; one of these has already taken place in France.

Impetus will be maintained by a sustained pattern of thematically relevant questions for building the database; these will be directed towards regional group leaders and individual participants (reporting back through group leaders). For instance, a “best possible” zonal scheme (graptolite, conodont, ammonoid, chitinozoan) will be distributed to all participants for compiling biostratigraphic data. The project already has a dedicated home-page on the Internet (see end of this report). As work progresses, a series of progress reports will be published in an IGCP 421 Newsletter to be distributed to all workers expressing interest in the project. These progress reports will include discussion of general principles, alignment of stratigraphic scales, taxonomic procedures (and temporarily critical taxonomic problems), and inferred transgression-regression patterns. Some of these matters were discussed at the two initial meetings of IGCP 421. It is the coordinators intention to provide a key to the literature of the region: stratigraphic, taxonomic, tectonic. At all stages emphasis will be on publication of results, culminating in publication of a comprehensive, multi-authored volume devoted to North Gondwanan mid-Palaeozoic bioevent & biogeography patterns in relation to crustal dynamics. Because of widely geographic spread of countries involved we the two initial meetings were scheduled at the “poles” of the region. It is planned to have generally 2 meetings per year. The following meetings & workshops are planned to foster accumulation of relevant data, and continuous evaluation of the emerging databases:

1997

1. September 17-21 - Vienna, a highly successful inaugural meeting was hosted by the Geologische Bundesanstalt (Wien).

Principal themes: a. Setting the agenda; procedures. b. Preliminary faunal, floral and tectonic data, principally for the southern European and north African crustal blocks. c. Correlation framework. A corpus of papers from this meeting will be published by the Geologische Bundesanstalt.
Newsletter No. 14 (December 1997) — Subcommission on Devonian Stratigraphy

Excursion: mid-Palaeozoics of the Carnic Alps

1. 24-26 June - Modena & Bologna, Italy - in conjunction with the 7th European Conodont Symposium ECOS-7, organisers E. Serpagli [Modena] & M.-C. Perri [Bologna] and their colleagues, and meeting of Subcommission on the Devonian System. Contact: Dr. M. Cristina Perri, fax: (39.51) 354522; e-mail: perri@geomin.unibo.it


Excursion: Pre- and post-conference excursions to mid-Palaeozoics of Sardinia (18-23 June) and Southern Alps (27 June-2 July).

2. 6-20 December - Isfahan, Iran - hosted by Department of Geology, University of Isfahan (see separate entry)

Principal themes: a. Mid-Palaeozoic faunas and floras from the entire North Gondwana region, with some emphasis on faunas and floras from south and southeast Asian crustal blocks. b. North Gondwana global extinction event patterns (initial session)

Excursions: Mid-Palaeozoics of eastern and central Iran (see separate entry)

1999

1. September (timed for late summer) - Peshawar, Pakistan

Principal themes: a. Faunal and floral data for central and south Asian crustal blocks. b. Correlation framework for central and south Asian crustal blocks

Excursions: Possible initial excursion across the Karakoram from Kashgar (Xinjiang) through Hunza and Gilgit to Peshawar. Post-conference: Mid-Palaeozoics of Khyber Agency, Nowshera and Chitral. Possibility of brief excursion to the famed Salt Range succession.

2. Location of second meeting for 1999 not yet formalised.

2000

Note: A broad spectrum of colleagues with palaeomagnetic skills and geodynamic interests in the North Gondwana terranes will be invited to these and subsequent meetings to participate in discussion of how their data may impact on the emerging syntheses. Possibly 3 meetings will take place in 2000:

1. February. Location not yet formalised (?Morocco)

Principal theme: First multi-disciplinary confrontation of palaeobiogeographic and palaeoenvironmental (including palaeoclimatologic) data and syntheses with geotectonic & geophysical data bearing on mid-Palaeozoic crustal dynamics of the former North Gondwana region, with particular emphasis on crustal blocks in North Africa and southern Europe.

2. Meeting in conjunction with the International Geological Congress in Brazil

3. August-September at Macquarie University, Sydney (immediately following or immediately preceding the Olympic Games) - to be held concurrently with AUSCOS-2 (Second Australasian Conodont Symposium), and joined with the Third International Symposium on the Silurian System.

Principal theme: Sutures & faunas & floras with some emphasis on the mid-Palaeozoic of Australia and southeast Asia with respect to geotectonic & geophysical data

Excursions (pre- and post-conference): Focussed on biogeographic & ecologic patterns in relation to Palaeozoic sutures in eastern Australia

2001

Note: Both meetings for this year will be are timed to occur during climatically optimal periods for field work in the respective regions

1. Still to be formally arranged, but hope that it will take place in China.

Principal themes: a. Sutures & faunas & floras in the mid-Palaeozoic of southeast Asia. b.

Excursion: Key mid-Palaeozoic sequences of South China.

2. late August - Final meeting in Montpellier, France.

Principal theme: Final multi-disciplinary confrontation of palaeobiogeographic and palaeoenvironmental (including palaeoclimatologic) data and syntheses with geotectonic & geophysical data bearing on mid-Palaeozoic crustal dynamics of the former North Gondwana region

Excursion: Pyrenees & Montagne Noire mid-Palaeozoic sequences

Our aim is that this final event should be a major international congress to be sponsored, we hope, by the Société géologique de France and the IGCP, with cosponsorship by organizations such as the IUGS Silurian and Devonian sub-commissions, and the International Palaeontological Association. For this congress we visualize parallel and joint sessions on plate tectonic movements along the former North Gondwanan margin, and on palaeobiogeographic and palaeoenvironmental data and syntheses.
International Geological Correlation Program (IGCP) Project 421:  
“North Gondwana mid-Palaeozoic biogeography/bioevent patterns in relation to crustal dynamics”  

International meeting, December 1998, Isfahan, Iran  
Sponsored by the University of Isfahan and supported by various Iranian organizations

First Circular

Guide-book  
Dr M. Yazdi will coordinate preparation of the guide-book for the excursions.

Abstracts Book  
Abstracts of papers and posters to be presented at the conference should be sent to Prof. John Talent for editing and preparation of the abstracts volume. They should not be more than 2 pages in length (including references), and should be submitted by 30 August on a DOS- or MACINTOSH-formatted diskette, preferably in Word, and should be accompanied by a printed copy.

Presentations  
One or two presentations per person, poster or oral, the latter of 15 minutes duration followed by 5 minutes for discussion.

Publication  
We will be seeking a medium for publication of manuscripts presented at the conference.

Deadlines  
Registration fee. deposits (25%) for excursions, and passport details: 30 June 1998  
Abstracts: 30 August 1998

Payments  
Iranian banks and larger businesses accept major credit cards; Visa and Mastercard are most widely accepted. Methods of payment for the conference have yet to be finalised. Those interested in participating in the conference should contact one of the undersigned who will provide necessary information on the best procedure for doing so as soon as this has been clarified.

Dr. Mehdi Yazdi  
Department of Geology  
University of Isfahan  
Iran  
fax: 98 3168 7396

Prof. John A. Talent  
Centre for Ecostratigraphy and Palaeobiology  
School of Earth Sciences  
Macquarie University 2109  
Australia  
e-mail: jtalent@laurel.ocs.mq.edu.au  
fax: 61.2.9850 8428
REGISTRATION FORM FOR IGCP421 MEETING IN IRAN, DECEMBER, 1997

Note: Updated information will be available on the IGCP421 Home Page early January, 1997. Point your browser to:
http://www.es.mq.edu.au/MUCEP/igcp421.htm

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I will attend the IGCP421 Meeting in Isfahan (US$100 plus accommodation)

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I will present a paper(s)

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I will present a poster(s)

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I intend to publish the papers(s) in the symposium volume

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I am interested in participating in the pre-conference excursion

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I am interested in participating in the Shiraz-Persepolis excursion

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I am interested in participating in the post-conference excursion

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As well as updated information being posted on the Web, those people who reply to this circular will receive a hard copy of the Second Circular in March-April. Please reply promptly.

NOTE: A version of this form suitable for submittal via e-mail may be obtained by sending a blank message with the subject "IRAN MEETING" to crick@uta.edu. The form will be sent to you automatically via return e-mail. You may then use your e-mail editor to complete the information and forward it to John Talent.
Devonian Correlation Table

**Objectives**

The tried and trusty correlation chart in its basic function as a communication medium should be so modernised and normed, that through permanent updates and revisions an adaptive standard for stratigraphic colleagues should be realised. Therefore the German Subcommission on Devonian Stratigraphy seconded the edition of a mandatory and continuously updatable Devonian correlation table (DC) which should be technically easy to amend and reproduce. Updates and supplements to the DC should be published sporadically in the Senckenbergiana lethaeana journal.

**Guidelines**

**Principle:** Only the methodology of data collection and communication should be normed and standardized, but not the actual information itself.

Specifically, norms and standards can only be applied to technology, methodology, measuring institutions (cf. "Parisian standard metre", industry norms), however not to the content of scientific interpretations, which, through permanent search for actual truth, should be available for review and revision just after their publication. Therefore concepts of GSPPs or orthoichrons are critical because methods such as commissionary institutions, "Golden Spike" or zone-orthochronology on the one hand and scientific contents of taxonomy, dating or correlation on the other hand are dependent on each other and thus, at least, the former could block the review and revision of the latter.

(1) Each Devonian vertical data sequence is subdivided into three equal DC columns of Lower-, Middle- and Upper Devonian.

This subdivision is due to printing and technical considerations, because each column height of 20 cm will not exceed standard page type-face format. (The equal heights of Lower-, Middle- and Upper Devonian column is not necessarily proportional to the same periods of absolute time.)

(2) Each DC column should be an independent, freely combinable time parameter. (Differentiating of contents).

It should be attempted to create columns independent from each other as freely combinable elements, e.g. the brachiopod stratigraphies from the Hillesheim and from the PrUrn Syncline of the Eifel Mountains would be assigned to two different DC columns despite any similarities, provided that both columns are differentiated by at least one date. If data from both columns are combined within a new column afterwards, then this act will already represent a scientific evaluation as an application of the DC.

(3) Each DC column represents an independent element at the moment of publication. (Differentiating versions).

The updated version of a column represents a new column provided that old and new versions are distinguished from each other by at least one date. Such versions are separated into annual groups.

There will only be complete columns published in the DC. Single new datings must be assigned to a whole column. For example, if an author revised Moroccan brachiopod stratigraphy of Emsian stage only, he can achieve DC publication under his name by combining his new data with compiled brachiopod data from the whole Lower Devonian of a Moroccan region within one column.

(4) Each DC column, which, in accordance with (1) to (3), is an independent, freely combinable element, is assigned a registration number.

The code of a registration number (at the top and bottom of each column) distinguishes between stratigraphies (O = absolute timescale, A = chronostriatigraphy, B = biostratigraphy, H = holostratigraphy, R = regional lithostratigraphy), consecutive numbers of vertical data sequences (whereby di, dm and ds indicate Lower, Middle and Upper Devonian of the same sequence).

At the lower end of the column, the registration number is enlarged by the year of publication (96 = 1996) and the CorelDRAW Graphic program suffix (.cdr) and indicates thereby the CorelDRAW filename of the column, since each column is assigned to one specific file.

Registration numbering and files are supervised and archived by the editor under strict curatorial control.

(5) The compiler is responsible for each column.

Compilers are not necessarily identical with authors, e.g. of an index fossil zonation. As competent experts they have judiciously reviewed, refined or revised the compiled data. (If, however, data were uncritically taken over, the source must be cited by "according to ...")

Commentaries may be published, but not necessarily for the initial DC installments. Later, in an advanced stage, the DC columns, particularly the biostratigraphic columns, should be completed by concise reference lists which mention each date of a column.

The column is the intellectual property of the compiler. A published column must be cited like any other published item, e.g. "CARLS, P. (1996): Brachiopoden, Spiriferen-"Schritte", 

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The time-ruler values from 0 to 20 cm. are relative values, which the naked eye may be able to recognize characters up to 0.25 mm of the time-ruler scale. Generally all data can be reproduced via coordinates, without for example the necessity of transmitting a graphical reproduction.

Examples for reading DC co-ordinates:

(B030d196: 6.55) = base of Lower Devonian sulcatus Conodont zone.
(d1: 6.55) = point of time at Lochkovian/Pragian boundary.
(d196: 6.55) = all data concerning Lochkovian/Pragian boundary published until 1996.
(B030ds) = all recent global Conodont zones of the Upper Devonian.
(A010) = chronostratigraphy of Lower-, Middle- and Upper Devonian series in total.

The year of publication distinctly demonstrates, as when citing any scientific reference, the scientific and/or table time-ruler status to which it refers. For example, the time level (d199: 6.55) until 1999 may be positioned above the Lochkovian/Pragian boundary because of new stratigraphical correlations.

The DC data are one-dimensional, i.e. only time-controlled. The DC co-ordinates do not indicate the lateral spatial distribution of data at each point of time since that is a matter of another scientific evaluation (of palaeoecology, biofacies, bathymetry, provincialism interpretations, palaeogeography, etc.).

The time-ruler values from 0 to 20 cm. are relative values, which reflect the “portion of the whole”, i.e. the “portion of 20” (cm. of the time-ruler) in a manner analogous to the “portion of 100” by percentage calculations (per cent = per 100). Therefore 1 cm. of the time-ruler represents 5 % - the corresponding cm/% values can be compared at the left hand margins of the (A010) columns (cf pp. 274, 278, 282).

The naked eye may be able to recognize characters up to 0.25 mm on a professional print-out of a column (scale = 1 cm: 1 cm). This means that in a Devonian table of 60 cm. height 2400 time periods can be differentiated which corresponds, (according to a 46 m. y. absolute time for the total Devonian), with a resolution of approximately 20,000 years absolute time per 0.25 mm of the time ruler scale. The computer allows zooming and printing out of details without magnification limits and thus increase the resolution without any restrictions (cf the magnifying-glass symbol in the column and the corresponding detail enlargements on p. 285).

Prospect

The consequent formatting of the correlation table should lead to a standardization of stratigraphical data transfer. The definition of the DC column as an independent, freely combinable basic element allows stratigraphic colleagues a relative, simple aid, to be used either as a hard- and/or a soft copy, as card-index and/or as a computer file. This means that card-indexes could be combined to any synthetic correlation chart and that the data of the DC columns can be positioned formatted and proportioned by the attributes of a computer graphics programme (CorelDRAW). In my opinion, a suitable compromise has been found between traditional and modern methods of stratigraphic data processing. What is important is maintaining the simplicity of use of card-indexes and of the synthetic overview of chart representation. The data is nevertheless available for the future construction of complex stratigraphic data-bases and for processing. The means to do this is provided by the co-ordinates of the time ruler. Differentiating annual versions of the co-ordinates allow bibliographical processing, i.e. correlation of past, present and future stratigraphical data.

The fundamental problem with scientific EDP data transmission and data-bases is surely the anonymity of authorship. The proposed concept however guarantees intellectual property rights! It now forces the author to obey a new standardized form of publication (but does not exclude comprehensive syntheses and explanations elsewhere!). The column as a combined card-index/file contributes to the reputation of an author since it is citable, similar to a multi-paged publication. It is more or less his business card as a stratigraphic expert his sign-board of his stratigraphic work. The computer allows reproducing the data of the DC project guarantee the respect of existing intellectual properties of others which are to be treated fairly and in a professional manner. Surely in future versions of the DC, compilership and authorship will increasingly tend to be identical. (Actually, the present DC installment has already verified such a process since the majority of the present columns were mainly compiled by the intellectual property owners of the column data themselves!).

Stratigraphy uses the time-scale as an unequivocal guideline to structure the multiplicity of historical data. The time-ruler, as a definite substitute of the time-scale, is therefore also the guiding reference for norms and standards for the dissemination of stratigraphical data. Any Devonian date, once produced by an author, can be definitely reproduced by means of the DC time-ruler co-ordinates. Whether or not GSSPs and ortho­chrons will become obsolete, time and practice will tell. Conodonts as index fossils will maintain their precedence, their (“standard”) zonation however, could lose their role as a standardizing time-scale. On the contrary, the time-ruler should (which as a scale does not contain any fossil names) independently adjudicate between the arguments and data of all fossil groups and stratigraphies. Consequently, the critical feedback contains a broader (more democratic) basis, against which GSSPs and ortho­chronologic zones must prove themselves as standards.

As well as such a scientific feedback the normed DC form transmits also a neutral, graphical-calculating feedback! With-
in the graphically and mathematically fixed startand end-points of the time-ruler, the data must according to evolutionary survival principles adhere to their position with every DC amendment due to storage restrictions. Condensation and dispersion of data lead to harmonizing of the vertical data density, which can affect an individual or multiple column(s). For example in CARL 5.5 column (B121di:) the spiriferid evolution evokes a vertical extension of the column level (B121di: 9.3-9.9) to the detriment of the lower and/or upper adjacent intervals (all: 89.3 resp. 9.9-10.85). This leads to the shrinking of the Middle Siegenian in the adjoining column (R150).

Such successive harmonizing leads ultimately to an adaptive feedback, until an ideal compromise is achieved. Provided that enough big-, litho- and holo-stratigraphical data has been synthesized by such a graphical (and actually mathematical) iterative process, then a proportional copy of the real absolute time should be evolved on the 20 cm. time ruler. This kind of calibration process which is now called “Absolute time proportioning of stratigraphic correlation tables by feed-back harmonizing (AFH)” can naturally be applied to other time intervals, e.g. the 60 cm. total Devonian time-scale, or one of the Devonian (or e.g. Tertiary) stages, or substages, or zones, or to any other stratigraphic resolution.

Call for column contributions

Anyone may submit Devonian data, independent of commissions and nations, and independent of the classical Devonian regions in Germany.

Biostratigraphic column have to be created, prior to the mass of lithostratigraphic column reflecting regional geology (from the German Devonian survey geologists, a commission has already been organised under the auspices of Dr. K. H. RIBBERT, Geol. Survey Krefeld). For preliminary orientations on the datings, columns on Devonian event-stratigraphy have been outlined just for this DC edition in order to stimulate revisions. According to the above guidelines (cf. (2)), the event parameters must be clearly differentiated - and thus the time-ruler will be a great aid to function such as a numerical x-axis for plotting T-R-, anoxia-logs and other measurements (e.g. thicknesses, cyclicities, sequences, evolutionary or sedimentation rates, etc.). Generally, the event- and/or holostratigraphy as well as absolute time chronology in combination with the new DC provides a well-founded basis for further investigations.

Karsten WEDDIGE
Frankfurt am Main, November 1996
G.K.B. ALBERTI (Grosshansdorf)

Continued study of sequences rich in planktonic tentaculitid assemblages from several Lower and Middle Devonian sections in North Africa (Morocco, Algeria), in Australia (Victoria) and in several regions of Europe (Upper Franconia/Thuringia, Harz Mountains, Carnic Alps etc.) (the Lower Devonian sections with special regard to the Pragian/Emsian boundary interval), among them:

1. Pragian and “Earliest Emsian” aged portions of Bou Tbotoria) and in several regions of Europe (Upper Saxonia, Harz Mountains, Carnic Alps etc.) (the Lower Devonian sections in North Africa (Morocco, Algeria), in Australia (Victoria) and “beds” (beige-coloured silicious stylolitid concretions or silicified nodules, like the stratigraphically underlying ones with N. cancellata, and in small quartzitic “phacoids”) near the assumed top of the “Harzgerode Formation” would suggest a stratigraphical extension of the latter one near to (the theoretical) stratigraphical onset of the Wissenbach

Shales facies: In fact, in the western “Harzgerode Zone” (Benneckenstein, Trautenstein) as well as in the eastern “Harzgerode Zone” (pit of the “New brick yard Harzgerode”) in the Lower Harz Mountains (see ALBERTI & ALBERTI 1996a: fig.1 in SDS-Newsletter 13). The Asterothyinae of the “Harzgerode Formation” require special study.

2. Late Middle Devonian, mainly stylolitid and/or goniatite limestone sections (mainly varcus-Zone) in the central-Sahara (east of the mole d’Amguid in the external northwestern Tassili-n-Ajjer, called “Mouydir-NE” in ALBERTI 1997b). These sections probably were not known to PETTER 1959.

Continuation and completion of the planktonic tentaculitid studies, based on self sampled material in the eighties (see ALBERTI 1997b, 1998).

Plan on doing research (together with co-authors) on the recovered conodonts, goniatites (among them probably: Sobolewia, Archoceras/Atlantoceras, Maenioeceras s.l., Agoniatis and Pharciceras ?) and trilobites (with Buchenberg/Harz affinities). Comparative studies of Givetian planktonic tentaculitids from northwestern Sahara (Marhousa, etc.) and from Europe.

The revision of ALBERTI & SALAH’s collection of Givetian planktonic tentaculitids from the Lauthental section (Harz) could not verify the record of Nowakia biaulifera in bed 1 (nodule) from here (ALBERTI & SALAH 1980: Fig.1). In reality instead of that Viriatellina ? cf. postotomari occurs abundantly (exclusively) in bed 1. Dominant in the Stringocephalus Limestone at this locality is Viriatellina (para) minuta.

4. Brand new is the first finding of coiled planktonic tentaculitids (Corniculinitoides) in the Lowermost Pragian of North Africa (Rabat-Tiflet section, North Morocco).

Recent publications
Figure 1. Stratigraphical columns of the Lower Devonian at Jebel Amelane and at Bou Tcharafine (Tafilalt, southeastern Morocco) with the (tentative) ranges of selected planktonic tenticulid taxa (after G. Alberti, 1981: Fig. 2, modified and completed.)
R. Thomas BECKER (Berlin)

1997 was another busy year with a lot of field work, conferences, excursions and curatorial work in the huge Devonian collection of the Museum für Naturkunde. Together with M.R. House, V. Ebbighausen, J. Bockwinkel and the American team accompanying Royal Mapes from Ohio, detailed stratigraphical work was continued in southern Morocco. Special attention was given to the famous pharciceratid successions of Hassi Nebech in the Southern Taflilt, to the Mrakeb and Rich Bou Kourazia sections in the Southern Maider, and to the eastern-most Taflilt just at the Moroccan-Algerian border. Highlights include the discovery of rich haematized goniatite faunas from a level between the two Kellwasser limestones at Ouidane Chebbi, haematized Chotoc Event faunas with Pinacites, first North African karacyrinelyids, synwoeklumeriids and possibly Kielcensia (the latter two groups were purchased) and the discovery in the northern Maider of a Cymacylaimenia-imteriorid interval sandwiched between latest Famennian quartzites which are supposed to correlate with the Hangenberg Event interval. Exciting is also a Middle Famennian colonial rugose coral from ammonoid biofacies which may represent an important link in rugosan evolution and recovery after the Kellwasser Crisis. Collaborative work on this colonial coral is under way with D. Weyer from Magdeburg.

In the Rhenish Slate Mountains, field work and ammonoid studies proceeded in various ways. In relation to the attempts of the German SDS to redefine the German standard Upper Devonian "Stufen" (Adorf, Nehden, Hemberg, Dasberg, Wocklum), old museum collections and new faunas from the Hemberg type locality (N of Iserlohn) were revisited. The Nie Brick work section of the northern Sauerland was resampled and yielded some precisely horizonted Flexicylindra and the "Rectocharina retransa" Group which were formerly described from the Holy Cross Mountains. M. Piecha from the Krefeld Survey (GLA-NRW) started intensive conodont collecting of this important Hemberg/Dasberg section. An oldest glaziellid (Upper Devonian IV) and associated ammonoids have been described in a small paper which is in press. Conodont sampling for isotope studies continued together with T. Steuber (Erlangen) at the D/C boundary. Sampling, as a joint project with G. Klapper, was also completed to allow the application of Frasnian Montagne Noire conodont zones (Klapper, 1989) to German standard reference sections. Results hopefully will be presented at the Bologna ECOS meeting.

In the final phase of the INTAS project on the Timan Upper Devonian and comparisons with Middle Europe (jointly with M.R. House, V. Menner, P. Bultynck, N. Ov纳税naya, A. Kuźmin & S. Yatskov) excursions led to South Devon and the Belgian Upper Devonian reef complexes. Ammonoid localities in North Cornwall proved to be still productive. Following the Rochester SDS meeting, work on the Frasnian-Famennian boundary of New York was conducted with the good company of E. Schindler and Michael House are we were guided by J. Over and Bill Kirchgasser. Subsequently, Gil Klapper kindly showed me the Frasnian of Iowa including the Kellwasser Event beds (black shales) at famous Sweetland Creek. Ammonoid collecting, however, is not an easy job in Iowa. The US tour finished with visits to the ammonoid-stuffed lunatic asylum of Royal Mapes and to Susan Klofak and Neal Landman at the New York Museum.

In the museum, the search for old types of Devonian ammonoids has continued and was exceedingly successful. Apart from Berlin originals of Paekelmann (1913), Schmidt (1924), Schindewolf (1937, 1938) and Müller (1956), types of Lange (1929) were discovered and, as a consequence of a pre-war loan, also figured specimens (holo- and lectotypes, e.g., the last monotype of Alpinites kayseri) of Schindewolf (1923) could be located.

References of 1997


Alain BLIECK (Paris)
Recent Devonian activities

1 February 25 - March 3, 1997, Universidade do Algarve,
UCTRA (Unidade de Ciencias e Tecnologias dos Recursos
Aquatcios), Faro, Portugal.

Constança BEXIGA has defended her "licenciatura" thesis
on "Pteraspidsiformes (Agnatha, Heterostraci) of the Lower
Devonian, Franckelryggen Formation of Spitsbergen: mor-
phology and biometrics" on February 26 in Faro. The jury
was composed of Prs J.P. Andrade and T.C. Borges, and A.
Bieck. The defence was successful. The main conclusion
of the work deals with the systematics of a sample of small
pteraspids from a yet unpublished sandstone layer in the mid-
dle of the Franckelryggen Formation, east of the Raudfjord,
NW Spitsbergen island. This sample is composed of individ-
uals (dorsal and ventral shields of the head carapace) which
morphologically may be divided in two lots: one of shorter,
wider shields; one of longer, narrower shields. However, the
biometrical analysis has shown that they correspond to a sin-
el population. This population is considered to represent a
new sample of Pteropterus aquilonia (Bexiga, 1997).

After this defence A. Bieck, C. Derycke and C. Bexiga
have been during four days in the field in SE Alenteje (Poma-
rao region) and W Algarve (Bordeira region), looking after
Upper Devonian-Lower Carboniferous vertebrate micromar-
kings of the South Portuguese Zone, where chondrichthyan
ichthyoliths had been mentioned in conodont-bearing beds
(Oliveira, 1983; Van den Boogaard, 1990). Several limy sand-
stone layers have been sampled for acid leaching.

2 July 4-6, 1997, Buckow (Berlin), Germany: IGCP 406
meeting "Circum-Arctic Palaeozoic vertebrates — biologi-
cal and geological significance".

Oral communication of C. BEXIGA & A. BLIECK (speak-
er) on "New data on pteraspids (Pteraspisdomorphi, Hetero-
straci) of the Lower Devonian, Franckelryggen Formation of
Spitsbergen" [see above]; and report of the activities of the
French Working Group of IGCP 406 on the Russian (Seven-
nayra Zemlya), European (Spitsbergen) and Canadian Arctic.

3 July 10-21, 1997, Vilnius, Lithuania: IGCP 406 workshop
on Lower and Middle Devonian heterostracans of the Rus-

dian Arctic (Severnaya Zemlya) — A. BLIECK & V.N.
KARATAJUTE-TALIMAA.

This joint project is part of a collaborative work on the
Silurian-Devonian series of Severnaya Zemlya. A first mem-
oir on the stratigraphy will be published in Russian (R.G.
Matukhin & V.V. Menner coord.); a second memoir on the
palaeontology will be published in English in Geodiversitas
coord.). The main aim of the workshop held in Vilnius was to
study the Early and Middle Devonian heterostracan assem-
bles of the October Revolution Island (except psammeostids
which E. Mark-Kurik is in charge of) (heterostracans are un-
known in the Silurian of this island). A preliminary result of
this workshop is the following list of taxa:

Tesseraspis mosaica, T. sp., Corvaspis sp. cf. C. kingi, C.
Traquairaspisformes indet., Poraspis sp. cf. P. polaris, P. sp.,
Homalaspisella sp., Irregulareaspis sp.? ?, Anglaspis nov.
sp., Cienaspis nov. sp., Ct. sp., Putoranaspis sp., Amphispis-
formes indet., Amphiaspidsformes indet., Unkaraspis sp.,
Protopteraspis sp., Miltaspis sp., Protopteraspidae nov.
gen. et sp. 1, Protopteraspidae nov. gen. et sp. 2, Gigantas-
pis sp., Pteropterusformes indet.

The taxon provisionally named Protopteraspidae nov.
gen. et sp. 2, from the red detrital Vstrechnaya Formation, is
dated Middle Devonian (Eifelian in Karatajute-Talimaa &
Matukhin, 1997) after its associated vertebrate fauna (placo-
derms, sarcopterygians, psammeostids). It is one of the rare
Middle Devonian Pteraspidsiformes (sesu Blieck, 1984).

Other subjects of interest were about Siluro-Devonian het-
terostracans of eastern Europe (Podolia, East Baltic, Timan-
Pechora) and Spitsbergen, as well as about Ordovician-Siluri-

an microremains of Siberia and Mongolia, and Silurian-De-

vonian achantodians (with J.I. VALIUKVEICIUS).

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4 List of recent publications

Papers
BLIECK A., CONTI M.A., DALLA VECCHIA P.M., FLÜGEL H.W., GAND
G., HUBBMAN B., LELEIVRE H., MARITONI N., NICOUSA I.,
POPLIN C., SCHNEIDER J.W. & WERNERBURG R (1997) - Palaeozoic
microvertebrate biochronology and global marine/non-marine
correlation. - In RACHEBEUF F. & GAYET M. (eds), Actualités paléontologiques
à l'honneur de Claude Babin (Lyon, 21-22 Mai 1995). Geobios, Mémoire
Spécial n° 20: 437-446.

TURNER S. & BLIECK A. (1997) - The final flings of IGCP 328: Palaeozoic
microvertebrate biochronology and global marine/non-marine

Book review
1 vol. rel. 19x26,5cm, VIII+ 695 p., (3): 343-350.

POPLIN C., BLIECK A., CLOUTIER R., DERYCKE C., GOUJET D.,
JANVIER P., LELIEVRE H., MARIOTTI N., NICOSIA U.,
POPLIN C., SCHNEIDER J.W. & WERNERBURG R (1997) - Palaeozoic


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Papers
BLIECK A., CONTI M.A., DALLA VECCHIA P.M., FLÜGEL H.W., GAND
G., HUBBMAN B., LELEIVRE H., MARITONI N., NICOUSA I.,
POPLIN C., SCHNEIDER J.W. & WERNERBURG R (1997) - Palaeozoic
microvertebrate biochronology and global marine/non-marine
correlation. - In RACHEBEUF F. & GAYET M. (eds), Actualités paléontologiques
à l'honneur de Claude Babin (Lyon, 21-22 Mai 1995). Geobios, Mémoire
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Book review
1 vol. rel. 19x26,5cm, VIII+ 695 p., (3): 343-350.
CM Carlton Brett (Rochester)

During the first half of 1997 a good deal of my attention was, of course, devoted to preparations for the SDS International Meeting on Cyclicitiy and Bioevents in the Devonian System. This meeting, which I dedicated to Amadeus Grabau, the great local western New York palaeontologist, was held July 20-27 in Rochester and in Devonian outcrops across New York State. Over 50 scientists participated in the formal talk sessions and some 25 made the full six day field trip from Lake Erie to the Catskill Front. I learned a good deal from the meeting and enjoyed interacting with many Devonian workers. (But, having organized the Silurian and Devonian symposium, for the respective subcommissions in the past two years, I’m not inclined to run another international symposium for a year or two.). I am in the process of making slight corrections to the field trip guidebook (“Devonian Cyclicitiy and Sequence Stratigraphy in New York State”, C. E. Brett and C.A. Ver Straeten, editors, 369 p.) and, within the next month, I will reprint more copies of this book and the abstracts volume (“The Amadeus Grabau Symposium: International Meeting on Cyclicitiy and Bioevents in the Devonian System”, 49 p.) I would be like to compile a list of mebers of SDS who might be interested in obtaining copies of either booklet.

On other fronts, Gordon Baird (SUNY College at Fredonia) and I have continued our work on the detailed cycle and event stratigraphy of the upper Givetian Tully Formation in central New York and central Pennsylvania and have been able to extend a number of tie-lines and event beds east and south of the region of Phil Heckel’s classic work on the Tully. Chuck Ver Straeten (post-doctotal student at Northwestern University) and I have also begun work on the microstratigraphy and correaltion of the Eifelian Columbus and Delaware limestones of Ohio into the New York equivalents. Notably, we believe that we can recognize equivalents of the upper Union Springs Formation (Chestnut Street beds) and Cherry Valley Lime-

stone within the upper Delaware Formation. We hope to inte-
egrate these studies with work already underway by Jed Day, Bill Koch, and Art Boucot on stratigraphy, paleontology, and bioevents in the upper Eifelian of the mid-continent. I have also just received National Science Foundation funding for collaborative research with Brad Sageman, Dave Hollander, and Charles Ver Straeten of Northwestern University on a project entitled “Organic Carbon Burial Anoxia, and Ecological-Evolutionary Events in the Appalachian Basin During the Middle and Late Devonian (Givetian-Famennian)”; this research involves comparative microstratigraphy, paleontol­ogy, and geochemistry of drill cores through the Middle and Upper Devonian in western and central New York State.

Relevant Publications:

- Brett, C.E. and Ver Straeten, C.A. 1997, Devonian Cyclicitiy and Sequence Stratigraphy in New York State, Field Trip Guidebook for SDS Meeting;University of Rochester; Rochester,NY 369 p.
Rex E. CRICK & Brooks ELLWOOD (Texas)

This past year has seen a good deal of refinement and application of magnetic susceptibility to event-stratigraphy and cyclostratigraphy. We now refer to what we do as MSEC (Magnetic Susceptibility Event and Cyclostratigraphy). We have been exceptionally fortunate in being able to collaborate with a number of SDS and otherwise Devonian oriented colleagues. Without their assistance our work could not have progressed to its present level. Our thanks go to R. Thomas Becker (Berlin), Pierre Bulyinck (Bruxelles), Roland Dressen (Mol, Belgium), Ahmed El Hassani (Rabat), Raimund Feist (Montpellier), Michael House (Southampton, UK), Jindra Hladil (Praha), Jeff Over (Geneva, New York), Gerhard Plodowski (Frankfurt), Bradley B. Sageman (Evanston, Illinois), Eberhard Schindler (Frankfurt), Hans P. Schönlaub (Wien), Karsten Weddige (Frankfurt), Willi Ziegler (Frankfurt).

Figure 1 shows the stratigraphic range of the MSEC work for the various areas we have worked. The only GSSP sequence yet to be sampled is that for the Pragian/Emsian boundary in Uzbekistan. The Silurian/Devonian boundary sequence shown for Australia was analyzed using samples supplied by TM John Talent. The original work on the Frasnian/Famennian GSSP was done using samples supplied by TM Raimund Feist. We have expanded sampling with visits to the Montagne Noire in collaboration with TM Feist. With the exceptions of Morocco where work began a few years ago and the Frasnian/Famennian sections in France, the vast majority of the sequences of Figure 1 have been completed in the past 12 months. The Moroccan sequences are the most complete due in part to the time spent there but also because of the exception exposures. We are in the process of preparing a composite MSEC curve for Anti-Atlas Morocco. It remains to complete the remainder of the Famennian and to document the overlap of the Emsian between the Ma'der and Tafilalt basins. We hope to complete this work in 1998.

**Update on MSEC**

MS is basically a proxy for the lithogenic or detrital fraction of marine sediment. Roughly, it is a quantitative measure of the amount of iron-bearing minerals in a sample (Ellwood, 1988; Ellwood et al., 1996). It is important to note that MS data are very different from the magnetic polarities that record the magnetic properties of Earth's magnetic field in rocks. Like magnetic polarities that depend on the conservation of iron in rocks, MS also depends on the preservation of iron. However, unlike magnetic polarities that can be easily remagnetized by heating, MS is largely unaffected by low to moderate thermal processes. Because the magnitude of MS varies inversely to the carbonate content of marine sediment as it tracks the lithogenic:biogenic ratio (Ellwood and Ledbetter, 1977), MS has also proven useful as a paleoclimatic indicator (Curry et al., 1995; Robinson, 1993).

**Mineral contributors to the MSEC signature**

Optical studies on residues extracted from samples of limestone used in this study show detrital magnetite. Remanent magnetic studies on samples collected for paleomagnetic work also show thermal demagnetization curves with magnetite Curie temperatures at about 580°C (Fig. 2). While these samples are remagnetized and exhibit a Carboniferous direction,
the magnetite still persists and is the dominant contributor to the MS.

**The role of iron stains and pyritization**

The effect on MS of hematite staining and pyritization is low. Both hematite and pyrite exhibit a low MS value unless in high concentration, and such zones are avoided during sampling. Furthermore, MS measurement of red/gray banded limestones show no MS difference between beds.

**The effect on MSEC of single large volcanic eruptions or bolide impacts**

On a global basis, both bolide impacts and single large eruptions are essentially geologically instantaneous events. The iron-rich component of these events is diluted and localized when incorporated into marine sediments, mixed by organisms in the marine environment, and lithified. The resulting layer is usually less than 10 cm thick and in sampling, even at 5 cm intervals, may only yield a single MS high value. Due to dilution, that value will not generally be substantially higher than other values. Furthermore, where the material is from a granitic or andesitic magma, magnetite is generally low or absent. The result in such cases can be MS values significantly lower than might be expected. As an example, the Tioga B k-bentonite in the Onondaga limestone has MS values only slightly higher than those of the Onondaga limestone (3.38 x 10^-9 m^3/kg versus 1.45 x 10^-9 m^3/kg for the Onondaga), values that are significantly lower than most rocks we have examined from Morocco.

The less common flood-type basaltic erosions may make a significant, long-term contribution to the detrital input of marine sediments. However, this effect may be more local or regional than global, and it needs to be tested. Such events may turn out to be excellent MSEC markers.

**Controls on MSEC signatures**

The primary controls on the MSEC signatures in marine rocks are sea level (base level) changes and climate. MSEC events can result from global sea-level fluctuations causing (1) base level changes and therefore corresponding changes in detrital influx into the world's oceans, (2) changes in global climate, or (3) result from local small-scale tectonic effects. Regional events can be differentiated from global events by comparing MSEC composite reference sections (CRSs) between regions and identifying those events that are not observed in both data sets (regional) versus those that are observed in both (global). Local MSEC events are high-frequency in nature and may not extend beyond one section. During times of regression, base level is lowered and increased erosion increases the detrital contribution into the marine system, primarily from rivers. This material is then dispersed by bottom currents throughout ocean basins (Sachs and Ellwood, 1988) and MS magnitudes increase accordingly. Locally, sections sampled in marine strata deposited proximal to points of discharge or paleo-deltas of ancient river systems will have elevated MS magnitudes relative to sections distal from these points. While the MS magnitudes will be different among such sections, variations resulting from erosional events will be identifiable in all sections within basins, providing that the sections are reasonably complete, hence the value of hemipelagic/pelagic sequences for the development of MSEC CRSs. If the event is global, then the MS effects will be global. In the case of transgression, base level rises and MS magnitudes are reduced as a result.

Several factors have been proposed as causal mechanisms for global sea-level fluctuations. These factors cause base-level changes that in turn result in changes in detrital influx into the worlds oceans. They include (1) ocean spreading rate changes and corresponding ocean basin volume changes (Hays and Pitman, 1973), (2) mass redistribution due to mantle convection (Gurnis, 1990), (3) isostatic crustal balance, (4) orogenesis and short-wavelength uncompensated topography, (5) epeirogeny driven by dynamic topography effects and including post-glacial rebound and tectonic uplift (Lithgow-Bertoloni and Gurnis, 1997), and (6) subduction (Piromallo et al., 1997). In addition, δ⁠1⁠8⁠O variations, related to long-term variations in continental ice volume, have also been shown to arise from variations in Earth's orbit through the influence of orbital forcing cycles (Imbrie et al., 1984). These climate fluctuations, then, produce long-term changes in detrital input into ocean basins. Observed oscillations in oxygen isotopic data have been tied directly to the MS signal in marine sediments, indicating that MSEC data sets for marine sedimentary samples are, at least in part, controlled by climatic variations.

Climate has two effects. First, changes in rainfall associated with variations in climate increase MS magnitudes during periods of high rainfall and increased rates of continental erosion, while lower rainfall results in lower erosion rates and decreased MS magnitudes. Second, glacial advances and associated lowering of base-level result in increased erosion and increased MS magnitudes. A second effect, erosion by glaciers, also produces an increase in detrital input into the marine system. This effect, causing elevated MS magnitudes due to detrital input into the South Atlantic Ocean, can be seen today coming from glacial erosion of Antarctica and the dispersion of this material northward into ocean basins by bottom currents (Sachs and Ellwood, 1988).

Another climatic effect is pedogenesis. Long-term, climate-driven pedogenesis results in the cyclic production of magnetite and maghemite in soils, which in turn are eroded and transported into ocean basins. These cycles persist through diagenesis. This is clear from the fact that even though MS magnitudes are significantly reduced in limestones and shales, by as much as two orders of magnitude from those of un lithified marine sediments (Sachs and Ellwood, 1988), MS trends still remain.

Secondary effects on the MSEC data set are weathering, alteration and iron migration and concentration. In sampling we choose sections that exhibit low weathering magnitudes and clean samples as much as possible of weathering ripples. Obvious areas of alteration and areas of structural complexity are avoided during sampling, as are areas of iron concentration, such as pyrite nodules. However, the effect of hematite staining, often present in sections, is minimal because of the low MS carried in hematite stains.

**Evidence that MSEC works**

Several factors indicate that the MSEC method works. First, polarity studies on the same rocks indicate that an ac-
MS values for samples from 11 sites in the same limestone bed from both Bou Tchrafine (BT6 to BT15) and Jebel Amelane (JA7 Bed). Each BT data point represents the mean and standard deviation of MS values for six samples. The JA data points represent MS data for individual samples taken from the base to the top of the bed and show the variation within a single limestone bed. Dashed lines represent the highest and lowest MS values for bed JA7. Distance represents the site separation distance in meters. Magnetic susceptibility is given as m/kg and the range reported is the entire range of MS values from the Tafilalt Basin, Morocco.

Figure 3—MS values for samples from 11 sites in the same limestone bed from both Bou Tchrafine (BT6 to BT15) and Jebel Amelane (JA7 Bed). Each BT data point represents the mean and standard deviation of MS values for six samples. The JA data points represent MS data for individual samples taken from the base to the top of the bed and show the variation within a single limestone bed. Dashed lines represent the highest and lowest MS values for bed JA7. Distance represents the site separation distance in meters. Magnetic susceptibility is given as m/kg and the range reported is the entire range of MS values from the Tafilalt Basin, Morocco.

Quired remanence has persisted since the Paleozoic. In some instances this may be a remagnetized remanence, but in others the remanence is clearly primary. The carrier of remanence in such rocks is fine-grained (<1 mm), usually magnetite. Such grains are more easily mobilized than are the larger detrital grains (>7 mm) responsible for the MS signature. Therefore, because polarity studies work in limestones, so must MS studies, and in fact when polarity studies do not work, the simplicity of MS measurement virtually insures that MSEC studies on the same sample sets will work.

Second, multiple samples (6 each) from the same bed at single sites, from the same bed at 10 sites separated by 100 m intervals over a distance of 1 km, and from the same bed at sites separated by 25 km, give essentially the same values. This is illustrated by the data in Figure 3. Bed JA7 at Jebel Amelane is the same bed as that containing samples BT 6 to 15 at Bou Tchrafine. The data for JA7 are for eight samples collected consecutively from the bottom to the top of the bed and illustrate the variations that may be expected from a single bed. The variations within sites BT-6 to BT-15 and for JA7, while statistically identical can be attributed to within-site variability and to weathering.

Third, empirical results from sections separated by over 500 km document essentially identical MSEC trends (Crick et al., 1997). This includes Eifelian/Givetian boundary sequences from Morocco (including the GSSP), the Czech Republic and France. Other work shows the same trends in Frasnian/Famennian boundary sequences in France (including the GSSP), Belgium, Germany, France, Morocco, and southern Oklahoma.

Fourth, replicate measurements of the same samples using different methods yield essentially the same results. Figure 4 gives the Jebel Amelane data set for samples measured in situ, using a portable Bartington susceptibility instrument (open symbols in Fig. 4), and in the laboratory on samples collected from as near as possible to the place measured using the field instrument. In the main, the results are very similar. Possible reasons for the differences include: (1) weathering products in field samples that were removed or reduced in collected samples; (2) slightly different locations of samples that have a slight amount of within bed variability (see Fig. 3); (3) the Bartington field instrument is not as sensitive as the laboratory instrument and typically loses resolution for samples with very low MS magnitudes; and (4) the sand in the western S-
hara contains magnetite and can affect the results if sample sites are not cleaned carefully before the field measurement.

Interpretation of MS data

In general, variations in MS magnitude within a sequence represent changes in the original rate of supply of the iron-bearing lithogenic or detrital fraction to the marine system. Two, somewhat independent controls, constrain the influx of iron-bearing minerals into the marine realm: the degree of climate-induced erosion, and adjustments in base level either through global sea level rise and fall or through tectonically induced changes in attitude of a region relative to sea level. Climate, controlled by orbital forcing cycles, causes variable erosion rates that, in turn, impart a rhythmicity to sedimentary sequences detectable in MSEC data and useful for cyclostratigraphy.

As discussed above, variations in sea level may be controlled by orbital forcing cycles but may also have a random element related to large-scale tectonic controls such as those related to dynamic topography (Gurnis, 1988; Gurnis, 1990; Lithgow-Bertelloni and Gurnis, 1997). In our experience, random adjustments to base level through relative or net changes in sea level are responsible for the MSEC events. Tectonically induced changes on a large scale will produce first-order isochronous MSEC events that can be identified and correlated on a global, regional, and local scales, particularly when sequences are constructed from sediment of the same general facies, i.e., pelagic, hemipelagic, neritic. Changes in regional processes will produce second-order MSEC events of moderate frequency and limited in importance to the region of origin. MSEC data will also contain abundant third-order, high-frequency events created by local fluctuations in the type and rate of sediment accumulation. Third-order events are generally not replicated among sections. MSEC data will thus exhibit a complex signature that is representative of the processes and controls on the relative iron content of marine sediments. There is, however, an order to this signature. Global events and processes control the basic character of a signature and fix the general position of major peaks and sustained trends observable in MSEC data sets from different paleogeographies. Regional events and processes generally impart a character to the MSEC data that is distinctive within a region but one that does not obscure the global signature. Modifications to the MSEC signature for individual sequences are useful in comparing variations between geographically related sequences and, if unwanted, may be removed by filtering.

Completed work demonstrates that MSEC events make exceptionally good chronostratigraphic markers. MSEC events are of two types. Those composed of high magnitudes and those composed of low magnitudes. The high magnitude events are typically shorter in duration and more numerous than low magnitude events which are generally fewer in number and of longer duration. Because high magnitude MSEC events represent less time, they are more useful for chronocorrelation and generally increase the resolution of correlation by factors of between 3 and 10. Due to the inherent lack of uniqueness of most MSEC signatures (true also in polarity studies), it is necessary to establish basic biostratigraphic frameworks for temporal constraint. MSEC can then be used to define chronostratigraphic boundaries as is done with polarity magnetostratigraphic markers under Section 2.4 of the revised guidelines for establishing global chronostratigraphic standards (Remane et al., 1997).

Interpretation of MS signatures

We interpret MSEC events in the following ways. Increases in MS magnitude correspond to relative or net drops in sea level. Highest magnitudes represent maximum low stands in sea level. Decreasing magnitudes correspond to relative or net rises in sea level. Lowest magnitudes represent maximum high stands in sea level. Increasing magnitudes correspond to relative or net falls in sea level. Commonly a number of consecutive MS lows or highs will coalesce into broad episodes indicative of sea level stasis. The character of the increase or decrease in MS magnitudes within a sequence represents the rate of the process or processes responsible for the change.

Status of MSEC and Event Stratigraphy

MS data faithfully detect random events of the type related to tectonically induced fluctuations in sea level. In the beginning we concentrated on developing MSEC signatures in sequences known to contain Devonian bioevents (Walliser, 1995). In each case we have been able to identify an abiotic MSEC event whose duration either equals that of the bioevent or is longer. We suspect that the correspondence between MSEC events and biotic events is ultimately linked to tectonic or climatic factors that MS is tracking. MSEC signatures have been studied for only a few of the 17 Devonian biotic events, but in each case we find the same correlation between the stratigraphic position of the biotic event and the MSEC event. There are, however, a large number of MSEC events which do not correspond directly to known biotic or other events and these events are equally valuable to chronocorrelation by MSEC events.

There is the question of how to define the beginning and ending of MSEC events. Although the general character of MSEC events is easy to detect graphically and defined by significant departures from general trends in MS magnitude, there are no objective criteria for marking their beginning and ending. Subjectivity comes into play because an MSEC data set consists of data from two input sources. The first is the continuous or near continuous record of fluctuations in the amount of iron delivered to the pelagic realm as a consequence of the effects of orbital forcing cycles on climate. The second is the record of random but major increases or decreases in the amount of iron delivered to the pelagic realm as a consequence of disturbances in the global tectonic system. Data from the first source create an MS signal that is cyclic. The second source produces a signal of random but major increases or decreases in MS magnitudes. The mixing of the two signals gives the impression that the random events are part of the cyclic MS record. While there are several ways of placing boundaries on such events, we have chosen to place boundaries midway along trends of change in MS magnitudes toward an interval of low or high MS values (the beginning and lower boundary of an MSEC event) and away from an interval of low or high MS values (the ending and upper boundary of an MSEC event). The definition of MSEC event bound-
The Status of MSEC and Cyclostratigraphy

Cyclostratigraphy relies on the extraction of cycles present in strata. The growing interest in cyclostratigraphy and its application has produced a wide variety of techniques for extracting signals. These range from the spacing and thickness of beds to elemental profiles by neutron activation analysis. Fischer (Fischer, 1995) offers a summary of the common methods. Common concerns about the inadequacies of the sedimentary record to support cyclostratigraphy have been eloquently rebuffed by Fischer. Concerns that orbital forcing cycles (Milankovitch Cycles) are being misused to interpret periodicities in sedimentary phenomena are well documented (Algeo and Wilkinson, 1988; Anders et al., 1987; Fischer, 1995). These concerns may be well founded when studies are based on physical measurements and observations in outcrop and core, and particularly so when studies are based on typical shelf facies. One of the reasons that the SDS and other subcommissions on stratigraphy have avoided shelf facies was to reduce the likelihood of encountering incomplete sequences when selecting GSSPs. While it is likely that pelagic sequences on submarine rises will exhibit some degree of incompleteness, results from the Ocean Drilling Program suggest that stratigraphic gaps in such facies may be less than previously estimated. Although we have and will continue to use exclusively pelagic sequences in constructing CRSs, we are very aware that most if not all sequences may contain cryptic stratigraphic gaps.

Cyclostratigraphy does have a few safeguards against introducing large errors during analysis. The first lies in the inherent hierarchy of orbital forcing cycles. Small gaps of time in the precessional (19-23 ka, modern not Devonian) and obliquity (41 ka, modern not Devonian) cycles can be compensated for with the much longer 106 ka and 413 ka eccentricity cycles whose periodicities appear to have remained constant over geologic time (Berger et al., 1989). The second safeguard is reproducibility of results. As demonstrated in the following examples, elements of MSEC signatures occur in sequences far removed from the reference section. These signatures have a decided cyclicity that we consider to be the result of orbital forcing cycles. Unlike the concern of Algeo and Wilkinson and others, MSEC data are based on samples taken without regard for the physical characteristics of sequences (other than to avoid structural and other ambiguities) and the data do not show correlation with facies. To effectively correlate between nannofossil, hemipelagic, and pelagic facies will require the creation of an MSEC CRS in the facies with the dominant biostratigraphic control. However, it is now clear that detrital iron input rather than facies type dominates the MS. This is illustrated in Figure 5 where we present the range of MS values for marine limestone and shale sequences that we have measured for sections in Morocco, France, Belgium, the Czech Republic, the United States (Georgia and Oklahoma) and Vietnam. These results show clearly that there is a broad range of MS values in both limestones and shales and that the MS values observed are controlled mainly by the iron content within these rocks and is generally independent of l
MS values continue through Bed 121. The sequence of low magnitudes of Beds 108-121 defines the Late Eifelian MSEC Event. The important reversal in this trend is Peak 2a that begins to develop in the upper portion of Bed 110 and continues through Bed 111. The appearance of Po. ensensis coincides with the small peak in Bed 115. The return to low MS values, similar to those of Beds 101-107, begins with Beds 120/121, but before the disappearance of Po. ensensis.

The trend of increasing MS magnitudes that defines the upper boundary of the Late Eifelian MSEC Event culminates in Peak 3 in the upper portion of Bed 122, immediately below the GSSP. Peak 3 is followed by another decrease in magnitude, at the point where Po. hemiansatus appears, and one that is sustained through Bed 127. A sustained and well-documented increase in MS magnitude follows this low point and begins an interval of enhanced magnitudes through Beds 128-149. The appearance of Polygnathus varcus occurs in this interval, which is divisible into Peaks 4, 5, 6, and 7. Magnitudes in Beds 150-161 document a return to values similar to those of the pre-Late Eifelian MSEC Event. Peaks 8 and 9 occur within this interval.

The overall interpretation of the MSEC signature for the sequence is that of a steady lowering of sea level in the middle T. k. kockelianus Zone (Peak 1) abruptly reversed to a sustained high stand through the remainder of the T. k. kockelianus Zone and all but the latest Po. ensensis Zone (Peak 2). Sea level begins to fall in the latest Po. ensensis Zone and, although variable, an interval of low sea level stand continues through the Po. hemiansatus Zone and into the Lower Po. varcus Zone (Peaks 3-7). A shift toward a rise in sea level occurs in the early portion of the Lower Po. varcus Zone and continues to the end of the sequence (Peaks 8-9). This interpretation is supported by comparison with the T-R Cycles of Johnson et al. (1985). Although the T-R Cycles of Johnson et al. (1985) have not been formerly recognized in north Africa, interpretation of the MSEC data in the context of sea level curves shows a rough correspondence with transgressive peaks occurring consistently earlier in southern Morocco than in North America. The latest portion (shallowing) of T-R Cycle 1e is essentially equivalent to the sequence prior to the Late Eifelian MSEC Event (Beds 101-107). The deepening episode marking the Late Eifelian MSEC Event corresponds to the earlier portion of T-R Cycle 1f. It is likely that the shallowing event following the Eifelian - Givetian boundary corresponds to the completion of the first subcycle of Cycle 1f.

The data presented here document an abiotic, low-magnitude MSEC event (Late Eifelian MSEC Event) that encompasses the Kakáč - otomari Event. The boundaries of this MSEC event do not correspond to any known faunal turnover. The lower boundary occurs in the upper Tortodus kockelianus kockelianus Zone and the upper boundary lies in the upper Polygnathus ensensis Zone. The general character of the event is one of an episode of rapid and prolonged rise in sea level. Because of the many differences between the MSEC event and the Kakáč - otomari Event, we use the term Late Eifelian MSEC Event when referring to the longer interval defined by MS data (Figure 6, Peak 2). It is tempting to speculate that the physical controls responsible for the Late Eifelian MSEC Event introduced sufficient environment stress to cause the faunal changes we use to recognize the beginning of the Givetian.

The Late Eifelian MSEC Event is only one of 9 MSEC events identified in the GSSP boundary sequence but it is the only one related to an increase in sea level, although other broad trends exist, e.g., the trend defined by MSEC Events 8 & 9. The MSEC events are described in detail elsewhere (Crick et al., 1997) and are shown in Figure 7 to have correlatable value among sections of the same basin (Fig. 7, A, B, C) as well as between regions (eastern Morocco and southern France). At least one study (Galle et al., 1995) places the Montagne Noire region between 600 and 1000 km from eastern Morocco during the Devonian. The upper and lower limits of these additional sequences for JA, BT, and PBMN were chosen from much longer MSEC signatures on the basis of their agreement with the combined biostratigraphy and MSEC signature of the GSSP. Thus the thickness of the boundary sequence of JA, BT, and PBMN corresponds to GSSP MSEC Events 1 through 9. Differences in rate of sediment accumulation among sections is shown as differences in section thickness. Differences between the MSEC signature for the Montagne Noire and those of the Tafilalt of southeastern Morocco are no greater than among the Tafilalt sections. Boundaries of the Late Eifelian MSEC Event boundaries in JA, BT and PBMN were positioned relative to trends in transition between MSEC.
Table 1 - Stratigraphic thickness of Late Eifelian MSEC Event and zones of *Polygnathus ensensis* and *Po. hemiansatus* in percentages of either the Eifelian or Givetian portion of each boundary sequence in Fig. 7 depending on the stratigraphic position of the event and zones: Eifelian for the Late Eifelian MSEC Event and *Po. ensensis* and the Givetian for *Po. hemiansatus*. The thickness of the Late Eifelian MSEC Event is essentially a constant percentage of the Eifelian portion of the boundary sequence while those of the two biozones are more variable. The lack of variability in the percent duration of the Late Eifelian MSEC Event is attributable to a number of factors such as the density of sampling, the continuous nature of MSEC data, no difficulties with preservation, but most important is that the geometry of the MSEC signature is preserved regardless of differences in rates of sediment supply and accumulation. It is this last factor that allows reproducible results when applying criteria to select MSEC event boundaries. Variability in the percent duration of the two biozones among the four sequences is almost certainly due to the lower sample density common to biostratigraphic studies as well as vagaries in the presence and preservation of biozone taxa. These four sections are the exception in that they are extremely well known for their biostratigraphy.

**Frasnian/Famennian Boundary and Upper Kellwasser Event**

Figure 8 illustrates a similar but much more complex MSEC analysis of the Frasnian/Famennian GSSP and associated boundary sequences in the Montagne Noire region of southern France. The sequences are short with thickness ranging from 0.7 m to 2.35 m. For this reason, each sequence was analyzed centimeter by centimeter for portions available for sampling. TM Raimund Feist (Univ. Montpellier/CNRS) provided the initial samples and details of conodont zonation.
Figure 8 – Comparison of MSEC signatures for Frasnian/Famennian boundary sections in Montagne Noire of southern France. Each dot on an MSEC curve is a sample. Dashed portions within curves represent missed section. Heavy dashed lines among sections represent lines of correlation based on conodont biozones. Light dashed lines among sections represent correlations on the basis of MSEC peaks or events. Details in the text.
This and the frequency of events provide a very detailed event stratigraphy for the GSSP in the Upper Quarry section at Goumiac beginning in the uppermost *Pa. rhenana* Zone and extending almost to the Middle *Pa. triangularis* Zone where resolution was lost due to missing section. The GSSP, Lower Quarry (LQ) and Caussess-et-Veyran: South (CVS) sections are separated by less than 1 km. The LSC section lies approximately 40 km northeast of the GSSP. GSSP, LQ, and CVS sections are described as having been deposited on submarine rises while LSC was deposited in a deeper basinal setting (Feist, 1985; 1990). Although the magnitudes of the MSEC events vary, the control is quite good and greatly enhances the already excellent biostratigraphy. Particularly interesting is the agreement between the MSEC data and the boundaries of the Upper Kellwasser (UKW) Event. The rapid decrease in MS magnitudes in beds of GSSP, LQ, and CVS, picked as the starting point for the UKW by others using different criteria (see summary in Girard and Feist, 1996) is suggestive of a deepening point for the UKW by others using different criteria (see summary in Girard and Feist, 1996).

The sequence represents a greater portion of time beginning in the uppermost *Pa. rhenana* Zone and ending in the Upper *Pa. triangularis* Zone and includes the Lower Kellwasser in the uppermost Lower *Pa. rhenana* Zone. Both Kellwasser horizons contain MSEC signatures indicative of sea-level rise. The MSEC signature for the Acke Valley UKW is very similar to those of Montagne Noire sections and nearly identical to that of CVS with MSEC event 11 being well defined and an event peak occurring where events 12/13 should be located. Either the data are too coarse to resolve the peaks or one of the peaks is unique to the Montagne Noire region. The sample spacing above the Frasnian/Famennian boundary is too coarse to extend the event stratigraphy into the Lower *Pa. triangularis* Zone. We plan to resample the sequence at the same interval as used for the GSSP.

**Kellwasser type section, Acke Valley, Harz Mts., Germany**

Access to the section and details of biostratigraphy were made possible by CM Shindler. Figure 9 illustrates the MSEC signature of the Kellwasser type section. Like the GSSP, it too is only a few meters thick (as sampled) but samples were taken at intervals of 4 to 5 cm as opposed to 1 cm at the GSSP. The sequence represents a greater portion of time beginning in the Lower *Pa. rhenana* Zone and ending in the Upper *Pa. triangularis* Zone. The sample spacing above the Frasnian/Famennian boundary is too coarse to extend the event stratigraphy into the Lower *Pa. triangularis* Zone. We plan to resample the sequence at the same interval as used for the GSSP.

**Lower Devonian, Jbel Issemour, Taalalt, Morocco**

The MSEC signature for Jbel Issemour located on the northern margin of the Ma’der Basin is shown in Figures 10, 11, and 12. The work was possible through continued collaboration with our long time field partner CM Ahmed El Hassani (Rabat) and new collaboration with members of the Department for Paleontology and Historical Geology at the Senckenberg Research Institute (Ulrich Jansen, Gerhard Plodowski, CM Eberhard Schindler, Gunnar Schraudt, TM Karsten Weddige, TM Willi Ziegler). The Senckenberg group is developing the biostratigraphy necessary to show the temporal position of MSEC events. We have a general idea of the position of stage boundaries from published and unpublished works of Henri Hollard and it is on this basis that we have placed stage boundaries in Figures 10, 11, and 12. It should be appreciated that samples are still being analyzed and that the total thickness sampled at approximately 10 cm intervals is close to 260 m. Figure 10 shows the complete sample density of 1919 samples and the position of beds identified as tempestite layers with elevated MS magnitudes.
have given it the name Zlichov MSEC Event I. There is a second MSEC of low magnitude and decent duration above Bed 42 to which we have assigned the name Zlichov MSEC Event II. Based on our experience in the Tafilelt and MSEC work across the Zlichovian/Dalejean boundary near Rabat we have positioned the Daleje Event (Walliser, 1995) just prior to the rapid rise in MS magnitudes (= sea level fall).

The MSEC signature is less subjective when using it to characterize the history of sea level changes or transgressive-regressive cycles for the region of at least the Ma’der. The transgressive (T)-regressive (R) cycles suggested in Figure 12 may represent the effects of sea level changes on the Ma’der, the northern margin of Gondwana, or Earth. We will not know the extent until further comparison are made. It is clear from Figure 12 that there are many episodes of sea level rise and fall within each of the larger T-R cycles. The thick bar labeled with (“Pre Ia”), etc. reproduces the T-R cycles of Johnson et al. (Johnson et al., 1985) for Euramerica. The adjacent bar presents the T-R cycles defined on the same general criteria of Johnson et al. (1985), that is, a T-R cycle begins with a deepening event and ends with a shallowing event. The greatest similarity between our T-R cycles and those of Johnson et al. is in the Pragian portion of the MSEC signature. We feel the remaining differences are due either to the greater resolution of MSEC data or regional differences. We feel that the MSEC

Figure 10 - MSEC signature through the Lower Devonian portion of the sequence at Jbel Issemour (Ma’der Basin, Tafilelt, Maroc). The signature is unaltered and represents 1919 samples with an approximate spacing of 10 cm. Much of the noise in the signature is due to very high frequency fluctuations in MS magnitude. Bed numbers are shown for a few of the more important beds (see text). High frequency and very high MS magnitude peaks are tempestite layers. Only those of the highest magnitude are shown. There is some disagreement over the position of all but the S/D boundary. Resolution awaits biostratigraphic work currently underway at the Senckenberg Research Institute (Frankfurt).

Figure 11 shows the MSEC signature with high frequencies removed by the splining. The temporal position of “events” is not well controlled biostratigraphically and we really are not looking to match the known events with the position or duration of MSEC events. They may coincide and they may not. We know where the S/D boundary located and we see a decrease in MSEC values at the boundary as we have in other sections on other continents. The Lochkovian/Pragian boundary lies somewhere between Bed 21 and Bed 29. We will have to wait on conodont and trilobite biostratigraphic results from the Senckenberg to make a final decision. Based on Hollard’s descriptions, we are more certain of the Pragian/Zlichov boundary at or very near our Bed 36. There is also the possibility of this boundary falling within Bed 42. The preliminary definition of the boundary here corresponds to the classic boundary in Bohemia. The boundary falls within a major MSEC event of low magnitude and rather long duration, and describes a rapid and prolonged drop in sea level. Because this is the first MSEC event in the Zlichovian we
Figure 12—Same curve as Fig. 11 showing various subdivisions of the MSEC curve in support of transgressive cycles and regressive cycles and T-R cycles (after Johnson et al., 1985). Dm1 (Devonian Ma’der 1) through Dm6 represent T-R cycles defined on the same general criteria of Johnson et al. (1985). L, Lochkovian; P, Pragian; Ez, Emsian (Zlichovian); Ed, Emsian (Dalejan). R, regression; T, transgression. The T-R cycles of Johnson et al. (1985) are shown for comparison.

The Lochkovian, Pragian, and Zlichovian sea level history for the Ma’der reads as follows. The Lochkovian began with a slight regression, experienced a transgression followed by a regression perhaps more severe than the initial regression and ended with a transgression. The Pragian began with a regression that continued through most of the stage which ended with transgression. MSEC data suggest that there were at least four different regressive episodes (P-R1a to P-R1d) separated with short-lived deepening or stasis events. The Zlichovian began with a brief regression followed by an equally brief transgression and then experienced a long-lived regression and an equally long-lived transgression. It appears that the Dalejan began with a regression of unknown duration (we’ll know more as samples are analyzed).


CM Ahmed EL HASSANI (Rabat, Morocco)

During this year I concentrated my work essentially on the eastern Anti Atlas and also by the achievement of the geological map of Khemisset to 1/100 000 which will be printed in the Notes & Memoirs of geological service of Morocco soon. This map includes a Paleozoic substratum (Cambrian to Permian) and a Mesozoic-Cenozoic cover. The Devonian is well exposed on this map, notably in the zone of Tiflet and also in the zone of Tiliouine-Tsili to the South part of the map.

The investigations into the eastern Anti Atlas were elaborated in two periods:

May 18-28: in collaboration with Prof. Rex E. CRICK & Prof. Brooks ELLWOOD (University of Texas at Arlington); our works were concentrated on the MagnetoSusceptibility and Cyclostratigraphy of the Devonian in Bou Tchrafine, Hamar Lakhdad, Jebel Amelane and Mech Irdane.

October 27 to November 7: in company of Prof. Brooks ELLWOOD. We were interested by Lower Devonian sections in the Maider basin. A collaboration on the biostratigraphy of this outcrop was efficient with colleagues from the Senckenberg Museum of Frankfurt (notably E. Schindler). The chosen outcrop in the Jebel Isemour (NW of Maider) includes the Silurian-Devonian boundary and allows to follow the set of Lower Devonian on more than 300m of continuous section. This outcrop is very well exposed and is very rich in fossils (especially Trilobites, Goniatites, Tentaculites, Brachiopodes, ...).

In the Moroccan Meseta, beside my work on the Khemisset map, I follow with big interest the work of Dr. EL KAMEL (from Casablanca University, PhD in progress) on the Rehamna massive. In the carbonate platform of Northern Rehamna, Late Emsian-Late Givetian reefs are preceded and variations and concentrations in the Argentine Basin, South Atlantic Ocean: Deep Sea Research. v. 35, p. 929-942.


CM P.E. ISAACSON

Since Upper Devonian rocks throughout South America have source rock potential, recent work has addressed better biostratigraphic controls and depositional settings of rocks of the Devonian System as a whole. Southern South America has the classical Malvinokaffric benthic faunas, whose correlation to other areas has always been speculative.

Devonian paleobiogeography of the central Andes is influenced by three major factors: paleogeographic setting, high latitudinal position (and cold temperatures) of the region during Early Devonian time, and an apparent influx of slightly warmer water during Middle and Late Devonian time. The highly endemic Malvinokaffric and Carlina-Australis faunas of southern South America, Antarctica, and South Africa have long been assumed to have lived in cold water, with evolutionary ties to Eastern Americas Realm organisms of the northern Appalachian Basin, U.S.A., and possibly the Bohemian region of central Europe. Unfortunately, the Malvinokaffric faunas provide a basis for correlations within part of South America, though biostratigraphic precision for sequence stratigraphic analysis and correlation to extra-Gondwanan Devonian units continues to be a problem. It has been suggested that Early Devonian Eastern Americas Realm brachiopods entered the region by means of an influx of warmer water, and the migration routes may have been restricted by intra-arc basins. Higher in the Andean sequence, however, the much lower diversity "post-Malvinokaffric" fauna has been identified. It consists of the "circum-Atlantic" brachiopod genus, Tropidoleptus and other taxa. It appears that Rhihiphtyris, above Tropidoleptus in the Devonian sequence, moved from Libya, where both taxa are present in the Idr Formation, of Givetian age. This Middle Devonian fauna, however, does not achieve the diversity of "Hamilton" and other Givetian fauna in New York and North Africa. Megafaunas are absent from Upper Devonian rocks in the Andes. Therefore, these rocks have been correlated by palynomorphs, utilizing the standard European zones.

Late Devonian rocks have few benthic faunas and no conodonts, although recent work, by Streel and Loboziak (Brazilian basins), Wood (Peru), Yavrdova (Bolivia), has recovered palynomorphs with excellent potential for correlation to sections on other continents. Biogeographic comparisons of Late Devonian palynomorphs and marine microplankton point to the close relation between western Gondwana, some parts of North America (Ohio, Michigan, Ontario, Tennessee), as well as North Africa (Libyan and Algerian subsurface). This is unexpected considering the presumed difference in paleo-artic and paleosubtropical position of the Gondwanan and Laurussian terranes. There was free dispersal of both land-derived and planktonic species such as Umbellasphaeridium saharicum between western Gondwana and Appalachians, areas of supposed palaeotropical to paleo-polar regions. There is a possibility of newly opened migrational routes between western Gondwana and Appalachian region during Late Devonian.

Significant in Upper Devonian rocks are glacial diamictons of Pamennian age, which originate from Lake Titicaca through most of Brazil. It appears that this Late Devonian glaciation may have influenced non-South American sequences. It may be a suspect in the Frasnian/Famennian extinction event.

In July, 1996, a meeting on South American Silurian and Devonian stratigraphy and paleontology was held in Ponta Grossa (Paran), Brazil. Because of this meeting, held in hon-
Uruguay:

Rodolfo Barnech, Claudio Gaucher, Pedro Sprechmann
(t heir paper was withdrawn, so specialties are not given)

Other Regions:

I apologize for incomplete reporting for other countries,
but they were unrepresented at the Ponta Grossa meeting.

In Argentina, a basin analysis of Devonian units in the Taraja-Salta basin has been published (Daniel Stark). Other specialists involved in Devonian research include Bruno Baldis, Juan Benedetto, Gustavo Gonzalez-Bonorino, Teresa Sanchez, among many others. Eduardo Ottone has published on Devonian palynology.

Similarly, I have little information from Colombia, Venezuela, and Ecuador, where new information from the Orient suggests presence of a fossiliferous Devonian sequence there.

Little Devonian work has been completed recently in Peru. Chilean Devonian outcrops are limited; they and their faunas have been described by Heinrich Bahlburg, Christoph Breitkreuz, Hans Niemeyer, and Felipe Urzua.

Ruth MAWSON and John TALENT (Sydney)

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

A long paper on the Late Devonian-Early Carboniferous conodonts from the Burdekin Basin, their chronological implications, and the Devonian-Early Carboniferous T-R pattern in north-eastern Queensland has appeared in the Journal of the Geological Society, London, with facies analysis, Elvio Bosetti (inarticulate brachiopods), Norma Maria da Costa (palynology), Roberto Daemon (palynology), Vera Fonseca (brachiopods), Almirio Franca (stratigraphy), Joss, Henrique Godoy (ichnology), Yngve Grahn (chitinozoans), Roberto Iannuzzi (paleobotany), Joss, Henrique Melo (regional synthesis), Setembrino Petr (regional synthesis), and Raquel Quodros (brachiopods)

Brazil:

Mario Assine (palynology), Ines Azvedo (ostracodes), Leonardo Borgoh (facies analysis), Elvio Bosetti (inarticulate brachiopods), Norma Maria da Costa (palynology), Roberto Daemon (palynology), Vera Fonseca (brachiopods), Almirio Franca (stratigraphy), Joss, Henrique Godoy (ichnology), Yngve Grahn (chitinozoans), Roberto Ianuzzi (paleobotany), Joss, Henrique Melo (regional synthesis), Setembrino Petr (regional synthesis), and Raquel Quodros (brachiopods)

Bolivia:

Oscar Aristegui (sedimentology), Alejandra Dalenz (bivalves), Enrique Diaz (sedimentology), Magaly Gonzalez (stratigraphy), Bruce Liebermann (trilobites), LeGrand Smith (trilobites), and Ramiro Suarez-Soruco (regional synthesis)

South America:

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Turner et al. submitted) and consideration of the biostatigraphical potential of these sharks by Ginter and Ivanov (e.g., 1992, 1995a,b) has prompted re-appraisal of type material from the USA.

Other activities can be incorporated in the new IGCP project 421 ‘North Gondwanan mid-Palaeozoic biodynamics’ (leaders: John Talent and Raimund Feist):

The studies on the NE Albanian Palaeozoic have been continued (Selam Meredo from the Polytechnic University of Tirana has been in Frankfurt for two months) and demonstrated at the initial meeting of the IGCP project in Wien.

New activities are part of the cooperation project between the Forschungsinstitut Senckenberg, Frankfurt and the University of Marrakech, Morocco which are also contributing to the IGCP project. Research here is concentrated on Lower Devonian sections in the western Anti-Atlas.

Contributions to the two working groups of the German SDS (subdivisions of the Emsian and Famennian stages) will continue.

Recent publications:


Susan TURNER (Brisbane)

Phoebodontoform and xenacanthiform shark teeth in USA and their significance for the Devonian Correlation Table (DK)

Discovery of Devonian-Carboniferous phoebodont and xenacanthiform teeth in Australia (e.g., Turner 1982, e.g., Turner et al. submitted) and consideration of the biostatigraphical potential of these sharks by Ginter and Ivanov (e.g., 1992, 1995a,b) has prompted re-appraisal of type material from the USA.

The type phoebodont, Phoebodus sophiae, which was described from the Cedar Valley Group of Iowa in the last century (St John and Worthen 1875) is now thought to be indicative of the mid varcus CZ. Phoebodus sophiae also occurs in the material from the North Evans Conodont Bed at the base of the Genesee Formation (considered to be a remanite deposit condensing Givetian-lower Frasnian varcusherrmanni-cristatus to lower asymmetricus Conodont zones) from New York State (Turner 1997 in press). While most phoebodont teeth are microscopic, larger teeth of this shark are found including a new record in the Milwaukee Formation of Milwaukee (Paul Mayer coll., Milwaukee Public Museum). P. sophiae seems to appear worldwide in relation to the Taghanic onlap (Ia-R cycle). It also occurs in Russia, the Holy Cross Mountains and several other places in Europe, and in Australia, all appearing in the same time interval. Ginter (1995) has produced a zonation based on the type and other phoebodont taxa which occurs principally in shelf marine rocks. There is little sign of strong provincialism in this mid Devonian to Carboniferous group of sharks.

Another group of xenacanthiform sharks appear in significant numbers in Givetian times. Examination of USA Devonian “Dittodus” species described by Eastman in 1899 from a fissure filling in a quarry near Chicago, Illinois, indicates that “Dittodus” prisus and “D.” striatus teeth probably belong in the same dentition; these xenacanthiform teeth have been referred to a new genus, Wellerodus by Turner (Modern Geology 1997 in press). Weller (1899) thought that this infill was Famennian in age as the shark teeth were associated with numerous ptyctodont toothplates (e.g. Klussendorf et al. 1988) but they could probably more likely be of Givetian age.

Klussendorf et al. (1898) give other examples of these “sink hole” faunas in the mid west. Further teeth called “Dittodus prisus” and “D. striatus” and spines referred to Cienacanthus wrighti by Hussakof and Bryant (1918) came from the North Evans Limestone, from the older Upper Tully Formation (varcus zone), and the younger Rhinestreet Shale (renana zone). Turner (1997 in press) has transferred these to a new species, Wellerodus wellsi.

These teeth and spines are most similar to those of Antarctilamna prisca Young 1982, from the Aztec Silstone of Antarctica and Bunga Beds of eastern Australia, presumed Givetian to early Frasnian in age, which Young presumed were preserved in non-marine deposits. However, as these xenacanthiform sharks were probably not restricted to fresh or even shallow water and it is possible that these taxa are synonymous; further material from New York State will need to be examined to enable further assessment.

Most of the other xenacanthiform teeth from the North Evans Conodont Bed were called “Dittodus” grabaui by Hussakof and Bryant (1918). Turner (1997 in press) has placed these within the genus Omalodus Ginter and Ivanov (1992) while some are comparable with Phoebodus fassigatus Ginter & Ivanov 1992. Omalodus bryanti (Wells 1944) was described from the (Givetian) Kidville and East Liberty Bonebeds of Kentucky and Ohio. Teeth referred to P. bryanti and i by Gross (1973, tab. 34, fig. 23 and tab 35, fig. 8 respectively) from the Cedar Valley Limestone of Iowa are also now placed in Omalodus grabaui. Wells (1944b, p. 140) perceptively thought that the teeth of his new taxon, P. bryanti, were sim-
ilar to very small teeth of "D. grabaui". Ginter and Ivanov (1992) transferred Wells' and Gross' P. bryanti to their genus Omalodus. These other omalodontid teeth in the U.S.A. seem to differ from Hussakof and Bryant's material in only small details. New omalodont records include the Thiensville Formation of Milwaukee (J. Kuglitsch coll., Turner pers. obs. 1997), supporting a Givetian age for that unit, and the Prout Limestone of EC Ohio (Sparling & Turner in prep.).

Although omalodonts may occur earlier in the Devonian, the phoebodontiform and xenacanthiform sharks first appear in the USA across the midwestern basin in early Givetian times with maximum spread occurring with the transgression noted in the late Frasnian in New York State and Utah (Turner & Youngquist 1995). Ginter (1995) has documented the Frasnian-Famennian boundary collapse of these sharks with no known Famennian omalodonts and Lazarus phoebodont taxa in the early mid Famennian (also Ginter & Turner MS, 1997 submitted).

Turner (1997 in press) recommended that the name 'Dittodus' should be finally suppressed. Ginter (pers. comm.) is preparing a column reflecting the new data for the Devonian Correlation Table (DK).

References

For most pre 1990s refs see Ginter & Ivanov 1995 a,b, and Turner 1997


Ginter, M. & Turner, S. MS. A new Upper Devonian phoebodontid from Melville Island, Canada, and the significance of the early Famennian "Grey Zone".


CM Nian-Zhong Wang (Beijing)

Vertebrate publications for 1997


E.A. Yolkin (Novosibirsk)

During last year my team and myself continued to work on projects that are mentioned in the Newsletter #13, particularly:

1. The Silurian and Devonian event-stratigraphy and paleo-geography of the West Siberia;

2. The subsurface Paleozoic stratigraphy of the Western Siberian Plane; 3. The Information-Research Complex "BIOCHRON".

I would also like to ask all colleagues to pay attention to the Kitab Research sections in discussions on substage subdivisions, possibly to the West Siberian ones. Here you could find new interesting data. During ten years work there are accumulated numerous collections. It is possible that they will soon be lost. Let's work together on belteral or multilateral basis. A financial support could be from different sources, particularly INTAS, INTAS-RFBR (Russian Foundation of Basic Researches) and so on.

Finally, sad news. Dr. Zheltonoglova Vera Artem'evna (rugose corals, Novokuznetsk) passed away at 30th December 1997.

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RECALIBRATING DEVONIAN TIME WITH NEW U-Pb ZIRCON AGES FROM EASTERN NORTH AMERICA

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Oneonta, New York 13820-4015
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Six new U-Pb zircon ages from the Appalachian Basin and adjacent areas of eastern North America have enabled a recalibration of the Devonian time scale. The age for the lowest of these samples (a K-bentonite in the Kalkberg Formation, Helderberg Group) was presented at the SDS meeting in Rochester by Ebert and Tucker (1997). This and the other new ages were presented at the annual meeting of the Geological Society of America in Salt Lake City (Tucker, et. al. 1997) and are summarized below (Table 1). Some dates differ slightly from those that appear in the Tucker, et. al. abstract as a result of later analyses.

TABLE 1: U-Pb Zircon Data From Eastern North America

<table>
<thead>
<tr>
<th>Sample</th>
<th>Location</th>
<th>U-Pb Age</th>
<th>Lithostratigraphy</th>
<th>Stage and Biostratigraphy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kalkberg K-bentonite</td>
<td>Cherry Valley, NY</td>
<td>417.6 +/- 1 Ma</td>
<td>Kalkberg Formation, Helderberg Group</td>
<td>Lochkovian Icriodus woschmidtii</td>
</tr>
<tr>
<td>Sprout Brook K-bentonites</td>
<td>Cherry Valley, NY</td>
<td>408.3 +/- 1.9 Ma</td>
<td>Esopus Formation, Tristates Group</td>
<td>Probable Emsian Erymythris (Polygnathus dehiscens or gronbergi to inversus)</td>
</tr>
<tr>
<td>Tioga Bentonite</td>
<td>Wardville, PA and Wyethville, VA</td>
<td>391.4 +/- 1.8 Ma</td>
<td>Onondaga Formation</td>
<td>Eifelian Polygnathus costatus costatus</td>
</tr>
<tr>
<td>Center Hill K-bentonite</td>
<td>Little War Gap, TN</td>
<td>380.8 +/- 1 Ma</td>
<td>Chattanooga Shale</td>
<td>Prasian Palmatelepis punctata to hassi</td>
</tr>
<tr>
<td>Carrow Formation Tuff</td>
<td>New Brunswick</td>
<td>363.8 +/- 2.2 Ma</td>
<td>Pumiceous Tuff Member of Carrow Formation, Piskahegan Group</td>
<td>Famennian pusillites-lepidophyta spore zone or possibly flexuosa-cornuta spore zone (Fa2d to Fa2c) equivalent to expansa zone</td>
</tr>
<tr>
<td>Bailey Rock Rhyolite</td>
<td>New Brunswick</td>
<td>363.4 +/- 1.8 Ma</td>
<td>Bailey Rock Rhyolite, Piskahegan Group</td>
<td>Famennian pusillites-lepidophyta spore zone or possibly flexuosa-cornuta spore zone (Fa2d to Fa2c) equivalent to expansa zone</td>
</tr>
</tbody>
</table>

These new ages, in conjunction with published isotopic ages from the early and late Ludlovian, Eifelian and early Tournaisian, have been used by Tucker, et. al. (in review) to recalibrate the Devonian time scale. The revised Devonian Time Scale is summarized in Table 2.

TABLE 2: REVISED DEVONIAN TIME SCALE (after Tucker, et. al., in review)

<table>
<thead>
<tr>
<th>STAGE</th>
<th>AGE OF LOWER BOUNDARY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tournaisian (Devonian - Carboniferous boundary)</td>
<td>362 Ma</td>
</tr>
<tr>
<td>Famennian</td>
<td>376.5 Ma</td>
</tr>
<tr>
<td>Frasnian</td>
<td>382.5 Ma</td>
</tr>
<tr>
<td>Givetian</td>
<td>387.5 Ma</td>
</tr>
<tr>
<td>Eifelian</td>
<td>394 Ma</td>
</tr>
<tr>
<td>Emsian</td>
<td>409.5 Ma</td>
</tr>
<tr>
<td>Pragian</td>
<td>413.5 Ma</td>
</tr>
<tr>
<td>Lochkovian (Silurian - Devonian boundary)</td>
<td>418 Ma</td>
</tr>
</tbody>
</table>
INFORMATION FOR CONTRIBUTORS

There are several ways to provide contributions to the Newsletter.

1. Original typewritten copy — No more than two pages are acceptable since this material will have to be either retyped into a computer file or scanned.

2. Computer file on disk — Text files in any DOS, WINDOWS or MACINTOSH word processing format are acceptable. Graphic files are acceptable in any standard format but if the desire is to retain the original appearance, it is better to convert the file to PIC/PICT or TIF/TIFF in order of preference.

3. E-mail — Text material is acceptable when contained within the body of the e-mail message. Formatted text material and graphics can be attached to e-mail messages after being encoded with encoders such as BinHex. Check with your systems administrator or computer guru if you are unsure how to accomplish the attachment of text or graphics.

4. Anonymous ftp — The File Transfer Protocol (ftp) allows for the transferring of text and graphic files between your computer (regardless of type) and the server in my laboratory (geology.uta.edu). The required TelNet and FTP software programs are available at any computing facility. Please send an e-mail message following the transfer with details of what was sent, etc.
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