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Ordovician NEWS

IUGS COMMISSION ON STRATIGRAPHY
SUBCOMMISSION ON ORDOVICIAN STRATIGRAPHY

NO. 9 1992

INTERNATIONAL UNION OF GEOLOGICAL SCIENCES

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**INTERNATIONAL SUBCOMMISSION
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NOTES FOR CONTRIBUTORS

The continued health and survival of *Ordovician News* depends on YOU to send in items of Ordovician interest such as lists and reviews of recent publications, brief summaries of current research, notices of relevant local, national and international meetings, etc. As more geological software becomes available, details of this would also be welcomed by many of us. Also please ensure that we are notified of any changes in address or telephone number. Submissions for inclusion in the next issue of *Ordovician News* should arrive before 30 December 1992; when providing lists of recent publications, please include only fully refereed articles and books (not abstracts) published during 1992.

Contributions should be in English, typed double space and sent to: S.H. Williams, Department of Earth Sciences, Memorial University of Newfoundland, St. John's, Newfoundland A1B 3X5, Canada. For longer contributions, it would help if a copy was sent on 3 1/2" or 5 1/4" diskette if possible (either Macintosh or IBM, but please state operating system and software used).

EDITOR'S NOTE

My thanks go to Felicity O'Brien for organizing the printing and mailing of *Ordovician News*, and of the circular sent out at the end of last year. My sabbatical in Cambridge, UK lasts until July, after which I will be returning to St. John's.

Henry Williams

CHAIRMAN'S AND SECRETARY'S ADDRESSES

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MODIFIED VERSION OF 1991 ANNUAL REPORT FROM THE SUBCOMMISSION ON ORDOVICIAN STRATIGRAPHY TO IUGS

2. Overall objectives

(a) Aims to standardize internal boundaries of the Ordovician System on a global basis (including the setting of international boundary stratotypes). We have previously focused activity on preparing regional correlation charts with explanatory notes as a basis for regional chronostratigraphic appraisal of existing subdivisions and applications, and to find suitable sections for detailed study. In 1989 four (subsequently five) Ordovician chronostratigraphy working groups were established to focus on particular levels for appropriate internal boundaries; these reported in a preliminary fashion at the meeting in Tallinn in August 1990, and the work of these groups was a major theme at the Sixth International Symposium on the Ordovician System (VI ISOS) held in Sydney in July 1991; and hopefully will again be discussed at the IGC in Kyoto in 1992. We would anticipate that decisions on some of these boundaries, including recommendations on stratotypes, will be achieved within the next 4 or 5 years.

(b) To promote the development and applications of stratigraphic methods of all kinds for use in Ordovician correlation, and to clarify principles of stratigraphic procedure in order to establish a unified global Ordovician time scale. Again at the VI ISOS meeting in Sydney we focused on radiometric, and other dating methods, in addition to more conventional biostratigraphic correlation methods.

3. Fit with IUGS Science Policy

These objectives fit entirely within the framework of stated goals of the IUGS Science Policy, to encourage and promote the study of geological problems requiring international and interdisciplinary cooperation. Our work requires cooperation from many specialists worldwide, and using all possible stratigraphic methods (physical, chemical and biological) to establish a unified Ordovician time scale; and to promulgate the results of this work at International Geological Congresses, and at other IUGS sponsored international meetings.

4. Organization

The Subcommission is a body of the Commission of Stratigraphy; it was established in 1974. The present Chairman is B.D. Webby, the Vice Chairman I.F. Nikitin, and the Secretary is S.H. Williams. There are currently 19 Voting Members and 74 Corresponding Members. A number of regional chronostratigraphy working groups were established in 1983 for Britain, Baltoscandia, North America, China, Soviet Union and Australasia; the work of these groups has now been completed. Ordovician correlation charts and explanatory notes have been published regularly in a series of IUGS publications since 1980 (the project will be concluded hopefully at the end of 1992) - a number of additional charts have been received or are in the pipeline, from South Africa, Greenland, China, etc., and should be published to complete the series.

The newsletter, *Ordovician News*, has been produced regularly (eight issues since 1983).

Four (recently revised to five) global chronostratigraphy working groups were

established in 1989, as well as a global facies, palaeogeography and paleoceanography working group. This latter group is currently inactive following resignation of convenor.

5. Extent of National/Regional/Global Support

The Subcommission has wide regional and global support from Ordovician stratigraphers, palaeontologists, palaeomagnetists and geochronologists.

6. Interface with other International Projects

The Subcommission has strongly supported the activities of the IUGS Cambrian/Ordovician, and Ordovician/Silurian boundary working groups, which have had as primary aims, the standardization of the boundaries at the bottom and top of the System.

However, though the former has made substantial progress it has taken too long to achieve a decision. The working group was initially set up in 1974 to report at the IGC in Australia in 1976. It has continued under various Chairmen (Henningsmoen, Norford) to the present, that is, for 17 years, far in excess of normal time. I note in a draft article on submission procedures by A. Martinsson when he was Chairman of ICS (dated 13 February 1983) that "Working Groups set up to establish or revise the boundary between two systems of the stratigraphical column should normally conclude their work within a time not exceeding eight years". The Working Group must now make a decision on this boundary within a specific time frame (following a newly proposed visit to Dayangcha in April 1992), and then postal votes before the next IGC in Kyoto in 1992, or the working group should be replaced in favour of a joint Cambrian/Ordovician Subcommission group charged with making the decision within a specific time-frame.

The Ordovician/Silurian boundary working group has been disbanded following its decision to select the global boundary stratotype at Dob's Linn, Scotland. Links also exist with IGCP project 216 on global bioevents.

7. Chief Accomplishments Last Year

(a) An official meeting of the Subcommission on Ordovician Stratigraphy was held on 18 July in Sydney, Australia, and was attended by 37 persons, including 9 Titular and 10 Corresponding Members.

(b) Other notable achievements of the Sixth International Symposium on the Ordovician System were the progress reports on the five global Ordovician chronostratigraphy working groups aimed at focusing on the internal, major "Series" subdivisions of the Ordovician System.

(c) Most constructively useful workshop discussions were held on 15 July ("Arenig" and "Whiterock"), 16 July ("Llanvirn" and "Caradoc") and 18 July ("Ashgill"), with conclusions at the Subcommission meeting. Discussions focused on zonal levels with most promising global correlation potential for establishing Series boundaries, at spaced intervals throughout the Ordovician, and it was agreed that nine biozones should in the first instance be targeted globally. Responsibility for investigating these biozones should remain with the global chronostratigraphy working groups first established in 1989 with convenors W.B.N. Berry, R.J. Ross Jr., D.L. Bruton, S.M. Bergström and

C.R. Barnes, in ascending stratigraphic order, as follows:

- Level 1 - base of *approximatus* (Berry)
- Level 2 - base of *victoriae/laevis* (Ross)
- Level 3 - base of *austrodentatus* (Bruton)
- Level 4 - base of *artus* (Bruton)
- Level 5 - base of *gracilis* (Bergström)
- Level 6 - base of *bicornis* (Bergström)
- Level 7 - base of *undatus/americanus* (Bergström and Barnes)
- Level 8 - base of *tubuliferus* (Barnes)
- Level 9 - base of *complanatus* (Barnes)

It was also noted that the scientific work of the Cambrian/Ordovician Boundary Working Group to recommend for establishment of a Global Stratotype Section and Point (GSSP) at the base of the Ordovician, impinges on how we see the establishment of the lowest (or first) Series subdivisions of the Ordovician - how it (possibly a redefined Tremadoc) should be defined? Comments on possible ways to achieve some decisive action by this group were made in item 6 above.

The recent moves by British workers to abandon the traditional (that is, in terms of priority or usage) Series subdivisions of the Llanvirn and Llandeilo in favour of a new, combined, Towy Series raises the general issue of whether globally we should continue to be concerned to maintain British Series names in the interest of stability of nomenclature and priority, when British workers are abandoning the traditional Series names they have long claimed should be adopted for correlation worldwide.

Whether we should be moving towards an Ordovician subdivided into six Series (British subdivisions prior to the recent mergers), or to a lesser number of subdivisions (four or five seem more acceptable) remains to be resolved. Clearly a selection of the above listed biozones will provide bases for a number of global Series subdivisions. And the second stage of our work should be to assign appropriate, new, or adapt existing, Series names, with recommendations of the most appropriate Global Stratotype Section and Point (GSSP).

(d) Publication and distribution in March 1991 of the eighth issue of *Ordovician News*.

8. Chief Problems Encountered Last Year

No problems were encountered. However one should comment that it seems unfortunate that the deliberations of the IUGS Cambrian-Ordovician Boundary Working Group are seemingly no nearer solution in 1991 than they were at the time of the Calgary meeting, in 1985.

9. Chief Publications Last Year

(a) The contributed papers from the Fifth International Symposium on the Ordovician System held in St. Johns, Newfoundland, Canada in 1988 were published in 1991 as a 336 page Geological Survey of Canada Paper No. 90-9 *Advances in Ordovician Geology*, with C.R. Barnes & S.H. Williams as coeditors.

(b) An Abstracts volume, and a series of four guidebooks were published for the

Sixth International Symposium on the Ordovician System, Sydney, Australia. These have been published in the Australian Bureau of Mineral Resources (Geology and Geophysics) Records Series as follows: Record 1991/47 Abstracts of the 6th International Symposium on the Ordovician System (edited by Laurie, Webby, Nicoll and Shergold); Record 1991/48 - The Cambrian-Ordovician boundary at Black Mountain, western Queensland (Shergold, Laurie, Nicoll and Radke); Record 1991/49 - Ordovician siliciclastics and carbonates of the Amadeus Basin, Northern Territory (Laurie, Nicoll and Shergold); Record 1991/50 - Ordovician basins, volcanoes and shelves, southern and central New South Wales (Wyborn, Sherwin, Webby, Abell and Percival); and Record 1991/51 - The Ordovician graptolite sequence of Victoria (VandenBerg and Stewart).

(c) No further Ordovician correlation charts have been published, although some remain in the pipeline.

11-14. Work Plan

(a) Efforts are still being made to complete compilation of the IUGS Ordovician correlation charts and explanatory notes series for Baltoscandia (D.L. Bruton, V. Jaanusson & others), Central Europe (B.-D. Erdtmann & others), the USSR - East European Platform, the Urals and Taimyr (I. Nikitin, N.J. Ancygin, R. Männil, L. Hints, T Meidla & others), SE Asia (C. Burrett & others) and parts of Africa (J. Theron & others). This project is being scaled down, and will continue only until the end of 1992.

(b) The next issue of *Ordovician News* is expected to be published in the early part of 1992.

(c) Publication of the Proceedings volume of the Sixth International Symposium on the Ordovician System (Balkema Publishers, Rotterdam, the Netherlands - editors B.D. Webby and J.R. Laurie) is expected to be published in April-May 1992. Some forty papers have been contributed, and the 400-page volume will contain much of interest on aspects of biostratigraphy, chronostratigraphy, geochronometry, magnetostratigraphy, event stratigraphy, economic deposits, palaeogeography, biogeography, palaeoecology and regional geology.

17. Membership list (see *Ordovician News* No. 8)

18. Minutes and circulars (see *Ordovician News* No. 9)

19. Review of chief accomplishments/results over the last 5 years (1986-1990)

The 5-year report of the Subcommission (1984-89) was forwarded previously, outlining the accomplishments to 1989. In 1990 and 1991 the focus of our work has been on the potential "Series" subdivisions - reports on the work of the five (base of "Arenig", "Whiterock", "Llanvirn", "Caradoc" and "Ashgill") working groups at the meeting on 24 August in Tallinn, Estonia, and 15-19 July 1991 in Sydney outlined above. Election of B.D. Webby as Chairman and S.H. Williams as Secretary was ratified by ICS in March, 1990.

20. Anticipated objectives and work plan for next 5 years (1992-1996)

The major objective is to establish the Series subdivisions of the Ordovician within the next 5 years. The five chronostratigraphy working groups established in 1989 allow us to focus attention on the best levels for correlation, and hopefully will achieve recommendations for global boundary stratotypes within this period of time. Major focus at the Sixth International Symposium on the Ordovician System in Sydney, July 1991, was on the Ordovician chronostratigraphy theme, and discussions of progress on Series boundaries at the five workshops. Some of these discussions are incorporated in papers to be published in the Proceedings Volume in April-May 1992.

Further discussions and reports will hopefully be presented, along with the official Subcommission meeting at the 29th IGC in Kyoto in August-September 1992, although this may not be possible as very few Ordovician workers plan to attend the Kyoto IGC. The venue for the next (the Seventh) International Symposium on the Ordovician System, during 1995, has tentatively been suggested in the western United States (details will be provided later), and this will be a major focal point for the work of the Subcommission over the next few years. We would hope to have a resolution of a number of global Series boundary stratotypes by then, for ratification at the 1996 IGC.

Priority through 1992 to 1996 will be given to a complete documentation of suitable boundary stratotypes for all the Series divisions of the Ordovician.

Barry Webby

SUBCOMMISSION ON ORDOVICIAN STRATIGRAPHY

Minutes of meeting on 18 July 1991 at the Edgeworth David Lecture Theatre, University of Sydney, Australia

1. The 37 people present, which included 8 Titular Members of the Subcommission, were welcomed by Barry Webby. No apologies for absence were received.

2. No objections or amendments to the agenda previously circulated were made.

3. Adoption of the minutes of the previous Subcommission meeting, held in Tallinn, August 1990 was moved by June Ross, seconded Chris Barnes and passed unanimously.

4. Chris Barnes reported that the proceedings volume from VISOS in St. John's had now been published, and was available from the Geological Survey of Canada, price \$31.20 (incl. p & p outside of Canada). All authors would receive free copies, but Henry Williams explained that unfortunately due to unexpected costs involved in outside contracting for final technical editing no other conference participants would receive free copies.

5. Barry Webby drew attention to his report on the Ordovician and Silurian field meeting, held in Estonia during August 1990, published in *Episodes*.

6. Henry Williams reported that almost 400 copies of *Ordovician News* No. 8 had been circulated during March 1991, and thanked all those who had contributed material. Rube Ross asked what the cost of each copy was. Williams replied that printing costs amounted to about \$1 per copy, and that mailing was currently achieved free. Ross suggested that members of the Subcommission be required to cover the cost of printing, but this was not supported by anyone else. Williams asked that all contributions for the next issue be mailed to him at the Sedgwick Museum, Cambridge University, where he will be on sabbatical.

7. Barry Webby introduced the item on the International Correlation Chart series. A decision had been made in Tallinn to terminate production of the charts at the Sydney meeting, but since that time a new Chinese chart had come a considerable way and should be ready for publication by 1992. Rube Ross therefore agreed to allow completion of that particular chart. Other charts received by Ross during the year included South Africa, Greenland, and Scandinavia (minus completed text). The chart on western USSR was in preparation and Dim Kaljo had promised completion in the near future. Ross mentioned that final approval for printing and financing would hopefully come from Glen Caldwell. Bob Elias asked Ross whether there were plans for an updated North American chart, including both the US and Canada. Ross showed his computer-based spreadsheet chart using Quattro Pro 4 (MS-DOS), and said that such a revised chart could be put on disk and circulated in that form. John Shergold commented that he thought the IUGS publicity for the charts was ineffective; could the Ordovician Subcommission publicity for the series be upgraded? Chris Barnes suggested that this should be left to IUGS for now until the stratigraphic nomenclature has become more stable. Bernd Erdtmann stated that the German report was ready, but that a new Paleozoic group was being constructed and that this group would need to approve their chart before it was published. Apparently Fatka had said that Czechoslovakia wanted to produce its own chart, rather than being combined with Germany.

8. Barry Webby reported that any proposed changes in titular membership of the Subcommission would have to be brought to the ICS at the 1992 IGC. In its guidelines, ICS suggests that one third of Titular Members be transferred to corresponding member status and be replaced by new Titular Members at every IGC. The Ordovician Subcommission will consequently be reviewing its Titular Members over the next six months. Webby also asked that anyone who is not currently a Corresponding Member of the Subcommission, but is an active Ordovician researcher in any field or geographic area of research and interested in contributing towards Subcommission work, should apply to him for membership. Regarding the executive, the Chairman of the Subcommission may serve for a maximum of two terms, while the Secretary and Vice Chairman may serve for an unlimited amount of time. Webby had asked Rube Ross to form a nominating committee, who had subsequently selected Stig Bergström, Chris Barnes and Valdar Jaanusson; the committee had met without Jaanusson, and proposed that Webby be retained as Chairman and Williams as Secretary. They had, however, suggested that Nikitin be replaced as Vice Chairman, and nominated two possible contenders, namely

David Bruton and Chen Xu. Titular Members of the Subcommission will be balloted to select one of these two individuals.

Brian Norford commented that under recently revised ICS guidelines, the Cambrian-Ordovician Boundary Working Group must now report to, and apply for its budget through, the Ordovician Subcommission. He thus regarded it as inappropriate for the Chairman of that Working Group to report to the Subcommission without having ex-officio status. Ross commented that one of the reasons for the change in ICS policy was probably to reduce the combined budgets. John Shergold commented that there would be Cambrian Subcommission Titular Members on the Working Group. Chris Barnes agreed with Norford's suggestion and moved that the Chairman of the Cambrian-Ordovician Boundary Working Group be an ex-officio member of the Ordovician Subcommission; the motion was seconded by Shergold. Webby considered that the motion should be voted on only by Titular Members present at the meeting. Six members were for the motion, two against.

9. Barry Webby reported that the next official meeting of the Subcommission should be at the IGC in August 1992; however, there was not much on the program to attract Ordovician workers, and he asked who might be attending. No Titular Members present planned to attend, and Chris Barnes suggested that if no Titular Members would be present that there was no point in having a Subcommission meeting at that time.

10. Barry Webby stated that about one year ago Bruno Baldis had expressed interest in holding the next ISOS in Argentina; since that time, however, no further representation had been made and there were no representatives from that country at the meeting, so he assumed that there was no longer interest in that option. The possibility of a meeting in China had also been suggested. The next IGC after Japan is, however, likely to be in China, so he did not consider it appropriate to have an Ordovician meeting in the same country the year before; Chen Xu agreed with Webby. Krizch proposed in Tallinn that Czechoslovakia had been visited by few people despite its important Ordovician geology, and that it would be a suitable place to hold the next meeting in four years' time. No recent correspondence had, however, been received confirming this offer. Berndt Erdtmann suggested that the meeting could be held in Germany if Czechoslovakia was not possible. Chris Barnes commented that the Silurian Subcommission would be meeting in Prague in 1992; he didn't feel that China should be ruled out because of the IGC. He suggested that all groups should be written to and asked to submit proposals.

Chen asked whether the Ordovician meeting couldn't coincide with the IGC, but Barnes pointed out that it should normally be held one year in advance in order to allow reports and proposals to be prepared. Wang Xiaofeng suggested that the meeting might be held in a smaller centre in China; this would reduce costs and allow a centre closer to good Ordovician sections. He also suggested Spain as a possible venue. Jim Miller supported an Ordovician meeting just before or after an IGC. Richard Fortey suggested that he would like to have excursions to type areas in the UK if the next meeting was held in Europe. Stan Finney reported that it was presently proposed to coordinate graptolite and Silurian meetings in 1996 in the US, which would clash with the IGC, and

it would be wrong to hold an Ordovician meeting at that time. Rube Ross suggested that a meeting could be run by June Ross, Pete Sheehan and himself in the western US. Finney thought that coordinated graptolite and Ordovician meetings could be held in 1995. Webby agreed that a coordinated effort would be the best solution in light of the number of upcoming meetings. He asked Williams to check on possible coordination and suggestions for the meeting in the western US in 1995, and in China prior to the IGC in 1996.

11. Barry Webby gave a quick summary of the nine levels proposed for detailed study as international series' bases. He suggested that these levels now had to be investigated in detail, and possible stratotype sections proposed. Bernd Erdtmann suggested that global stages should also be defined; Chris Barnes disagreed. Webby requested that the groups hold discussions over the next twelve months and have something for him to present for the IGC in 1992.

12. Brian Norford invited all participants to the Cambrian-Ordovician Boundary Working Group on Friday. He gave a vote of thanks to Williams for his work on Ordovician News, and to Webby for his work as Chairman of the Subcommission and of the VI ISOS.

The meeting was adjourned at 17.55.

Henry Williams

SUBCOMMISSION MEMBERSHIP Executive

Barry Webby and Henry Williams have been re-elected Chairman and Secretary of the Subcommission for an additional period. Chen Xu has been elected Vice Chairman. These positions will hopefully be ratified by the ICS.

New Corresponding Members

The following people have recently become new Corresponding Members of the Ordovician Subcommission: Bill Compston (Australia), Mary Droser (USA), Bob Elias (Canada), Norton Hillier (South Africa), Warren Huff (USA), John Laurie (Australia), Kristina Lindholm (Sweden), Bob Ripperdan (Israel), Peter Sheehan (USA), John Taylor (USA) and Alan Trench (Australia). We welcome them along, and trust that they will be active participants in the work of the Subcommission.

REPORTS OF MEETINGS

Sixth International Symposium on the Ordovician System Sydney, Australia, 15-19 July 1991

Over sixty scientists travelled to Sydney last July for the Sixth International Symposium on the Ordovician System (VI ISOS), chaired by Barry Webby of the

University of Sydney. The meeting comprised four pre-symposium excursions in eastern Australia, five days of technical sessions held at the David Edgeworth Building in the Department of Geology and Geophysics at the University of Sydney, New South Wales, and one post-symposium excursion to Victoria.

The week's technical presentations were divided into sessions on chronostratigraphy, paleoenvironmental and paleogeographic reconstructions, event stratigraphy, volcanism and tectonics, and economic deposits; poster displays were also presented, and Subcommission workshops and meetings were held every evening. The session on chronostratigraphy was wide-ranging and of particular interest in light of the Series Working Groups of the Subcommission and Cambrian-Ordovician Boundary Working Group. Presentations included aspects of geochronology and the use of biostratigraphy in defining boundaries; other papers related to this problem were also delivered in the session on event stratigraphy.

Zircon-based geochronology from bentonites and its use in correlation was discussed in both the chronostratigraphy and event stratigraphy sessions. Ages given by Australian researchers using a single-grain, ion probe method appear to disagree radically with those derived using the multi-grain, mass spectrometer isotope dilution technique. Other problems raised during the chronostratigraphy session related to the apparently contradictory ranges of graptolite taxa found in nearshore and offshore facies.

The session on paleoenvironmental and paleogeographic reconstructions concentrated mostly on Iapetus and Australasia. The session on economic deposits was relatively short, but offered an interesting comparison of Ordovician hydrocarbon occurrences and a summary of structural control of gold deposits in the gold belt of central Victoria.

Evening workshops concentrated mainly on progress made by the series working groups. A majority of Ordovician stratigraphers seem to prefer a five or six-fold division for the System, although appropriate names and boundary horizons have not been decided upon in most cases. The position of the base of the lowermost series will depend on the decision of the Cambrian-Ordovician Boundary Working Group; during the workshop to discuss progress made by this group, participants made it very clear that they considered more than enough time and effort had been spent on this problem, and that either of the two short-listed sections (Green Point, Canada and Dayangcha, China), while not perfect, would be suitable as Global Stratotype Section. Most people were in favour of a lower boundary for the second series at the base of the *Tetragraptus approximatus* Biozone, defined on graptolites; if a formal vote presently being held among Titular Members ratifies this feeling, a name and suitable stratotype section will then have to be decided. The base of the third series could be placed at an horizon near the base of the Whiterock series of the US or at a level approximately equivalent to the base of the Llanvirn in the UK. Possible graptolitic levels include horizons at or near the base of the *Isograptus victoriae* Biozone, the incoming of the biserials, or base of the *Didymograptus artus* Biozone. Definitions and names for the remaining series were apparently even more open, evidently due partly to a lack of major global physical or evolutionary events at suitable horizons.

A number of social events were scattered throughout the program; the entire Wednesday was dedicated to a combined excursion of local Triassic geology and

sightseeing (led by David Branagan and Armstrong Osborne), plus a popular visit to play with the kangaroos and koalas at a local animal reserve. The day was rounded off with a spectacular Symposium Dinner aboard a luxury cruiser in Sydney Harbour. A Chinese Banquet was held at a restaurant in the heart of Sydney's Chinatown following the final day of technical sessions.

The four pre-symposium excursions were to the Great Barrier Reef, Black Mountain, Amadeus Basin, and New South Wales. The first of these was centred on Heron Island, a place ideal for reef walking in knee-deep water at low tide across the reef flat to reef rim, a distance of about 500 m while a trip in a semi-submersible along the reef slope provided staggering views of corals and colourful fish. Guidance was given by John Jell, ably supported by Ed Frankel and Jane Hall.

The trip to Black Mountain (Mt. Unbunmaroo) in western Queensland provided an opportunity to visit and evaluate new information from the thickest-known carbonate platform sequence spanning the Cambrian-Ordovician boundary, led by John Shergold, John Laurie and Bob Nicoll.

The excursion to examine the 2000 m thick Ordovician siliciclastic sequence of the Amadeus Basin included nights under the stars in swags, with Bob Nicoll, John Laurie, John Shergold, Monica Young and colleagues from the BMR and Northern Territory team doing a tremendous job as both scientific and domestic leaders.

The wettest weather was found on the New South Wales excursion, led by Barry Webby, Laurie Sherwin, Ian Percival and Doon Wyborn. The party was guided through an assortment of sediments, volcanics and diverse fossil assemblages in the Cowra Trough, Orange and Parkes of western NSW.

During the post-symposium excursion to Victoria, ably led by Fons VandenBerg and Ian Stewart, the participants were treated to an excess of beautifully preserved material from one of the world's classic areas for Ordovician graptolites. Popular non-graptolite stops included Permian tillites and a trip down a restored gold mine at Bendigo.

Barry Webby and his enthusiastic and able committee must be congratulated for their splendid organisation of the meeting.

Henry Williams, with help in excursion reports from
David Bruton, Barrie Rickards and John Taylor
(this is a summary of a report written for *Episodes*)

IGCP Project 310 - Global paleogeography of the late Precambrian and early Paleozoic

Tallinn, Estonia, 23-29 September 1991

This project was proposed by K.B. Seslavinsky (Moscow) and his colleagues at the beginning of 1991. It was not, however approved by 19th Session of the IGC Assessments Board, who recommended revision and resubmission. The main purpose of the Tallinn meeting was, therefore, to detail this project. Twenty two reports were presented, of which four (by H. Heinsalu, L. Hints, J. Nõlvak and T. Meidla (Tallinn, Estonia), G.V. Zinovenko (Minsk, Byelorussia) and Y.E. Dimitrovskaya (Yaroslav, Russia) dealt with aspects of sedimentation, distribution of facies and stratigraphic

background for the compilation of Ordovician maps of the East European Platform.

An agreement was reached to include ten global paleogeographic maps in the project: two Vendian, six Cambrian and two early Ordovician. K.B. Seslavinsky, I Murdmaa (Moscow) and P. Crimes (Liverpool, UK) were proposed as leaders for the project. Excursions to Cambrian and Ordovician sections in northern Estonia were held both before and after the indoor discussions.

Linda Hints

Friends of the Ordovician

San Diego, USA, 22 October 1991

The Friends of the Ordovician convened for an hour or so in San Diego during the annual meeting of the Geological Society of America. The attendance of 19 was reasonable given the location of coastal southwest California; a larger number can be expected next year in Cincinnati. The proceedings consisted of a report of each attendee about his or her particular activities or interests in connection with the Ordovician. The balance of the meeting was devoted to perceptions of the Sydney meeting from those who were able to attend. All were very complimentary of their experiences at the technical sessions and on the field excursions. None of the protagonists in the heated debates were present in San Diego, so the meeting remained placid and Ray Ethington and Walt Sweet were able to have dinner without indigestion following the meeting!

Ray Ethington

The First Session of the Baltic Stratigraphical Association

Tallinn, Estonia, 6-7 November 1991

In October 1990, the Baltic Regional Stratigraphical Committee of the USSR Stratigraphical Committee was reorganized into the Baltic Stratigraphical Association, including Estonian, Latvian and Lithuanian Stratigraphical Commissions. The main purpose of the Association is to coordinate general stratigraphic studies in the Baltic states.

The program consisted of 18 reports, four of which were focused on the Ordovician; these included chitinozoan zonation in the East Baltic (J Nõlvak), stratigraphy of the Prokuni Stage (L. Hints, J Nõlvak and T. Meidla), lithostratigraphy of the Middle Ordovician Jõhvi and Keila stages (L. Ainsaar, Tartu University, Estonia), and results of the revision of the structural-facies belts and stratigraphy in the southeast East Baltic (J. Lashkohv and J. Paskevicius, Vilnius, Lithuania).

During this First Session, the status and purpose of the Association were discussed and adopted. A. Grigelis (Vilnius) was elected Chairman of the Association, and H. Nestor (Tallinn) elected Chairman of the Ordovician-Silurian commission. Of the planned studies, the most essential is the revision of stratigraphic correlation charts of the East Baltic. Preliminary corrections and supplements should be presented at the Second Session of the Association in autumn 1992.

REPORT FROM THE CAMBRIAN-ORDOVICIAN BOUNDARY WORKING GROUP

In May 1991, formal postal balloting was conducted of the Voting Members on questions that resulted from informal votes passed at the 1990 business meeting in Novosibirsk. Between the two best-known potential global stratotypes (but without precise identification of a specific horizon at either), preference was given to Dayangcha, China (64%) over Green Point, Canada (36%). However, 46% of the Voting Members indicated that they were not prepared to approve a stratotype at Dayangcha, while 67% stated that they were not prepared to approve a stratotype at Green Point. The Voting Members approved by 62% that biotic groups other than conodonts should be used as the primary guide for definition of the boundary, but voted against both graptolites (58%) and trilobites (80%) as the primary guide although these two biotic groups are the only obvious alternatives to conodonts.

The Working Group met in Sydney, Australia on 19 July 1991, following an excellent field trip to the Black Mountain section, Queensland, led by John Shergold, John Laurie and Bob Nicoll. High costs of travel led to only 7 of the 17 Voting Members and 8 of the 50 Corresponding Members being able to attend. Discussion at the business meeting was intense and members of the Executive disagreed with some of the Chairman's actions, including allowing the full participation of guests in discussion and in the presenting of motions, and his permitting voting on a newly refined horizon at Green Point despite the May postal voting having resulted in a majority not in favour of a global stratotype at Green Point. Several recommendations from the meeting will be presented in the next Circular of the Working Group.

A very significant advance this year has been the detailed taxonomic study of early species of *Cordylodus* presented by Bob Nicoll at Sydney and later published in December. This refines the species concept of *C. lindstromi* and defines an older and related new species, *C. prolindstromi*, thus sharpening the biostratigraphic correlations provided by both taxa. If this taxonomic revision proves to be applicable to previous identifications of *C. lindstromi*, *C. proavus* and some other *Cordylodus* taxa that occur within many of the important Cambrian-Ordovician boundary sections, some of the anomalies may be solved that caused concern for the precision of correlation provided by first occurrences of *C. lindstromi*. First occurrences of the revised *C. lindstromi* (*sensu stricto*) are thought to be slightly younger than those of *C. lindstromi* (*sensu lato*) and thus closer to, but still older than, the first occurrence of nematophorous graptolites.

Following the Sydney meeting, Chen Junyuan has prepared the critical resolution for the Working Group to consider approving a Global Stratotype Section and Point (GSSP) at a specific horizon within the Dayangcha section, northeastern China, to mark the base of the Ordovician System. He has also forwarded an invitation for a small delegation of the Working Group to visit the section early in 1992 and to participate in improving knowledge of critical parts of the sequence.

Brian Norford, Chairman C.O.B.W.G.

ORDOVICIAN SUBCOMMISSION SERIES WORKING GROUPS

Workshops held at VI ISOS, Sydney, August 1991

"Arenig"

(convenor - Bill Berry, meeting chaired by Henry Williams)

Henry Williams introduced the workshop with a summary of proposals and comments received by Bill Berry from working group members, together with points made in Berry's submission to the Sydney Symposium Volume. The problems regarding the development of the Tremadoc and Arenig series in Wales are now well known; these have been eased since the work by Richard Fortey *et al.*, but no solution in terms of a revised definition apparently satisfactory to workers outside the UK has been found. The definition of the lowermost series of the Ordovician will be dependant on the final recommendations made by the Cambrian-Ordovician Boundary Working Group. Several responses have been received regarding definition of the second series, which all support one of two options:

1 (vast majority). Use the base of the *approximatus* Biozone and retain the term "Arenig" for the second series of the Ordovician; this has the advantage of common usage over the past twenty years.

2 (only supported by one or two). Use the "Hunnebergian" as an additional series, lying between the highest Tremadoc and lowest Arenig demonstrably present in North Wales.

In terms of relevant paleontological groups in defining a series, most favour graptolites, with fewer people wanting conodonts. The advantage in using the base of the *approximatus* Biozone is that it is widespread, easily recognized with early non-bithecate dichograptids following bithecate forms, can be correlated precisely with conodont and other faunal biozones (approximating to the base of the *Prioniodus elegans* conodont Biozone), and has been studied thoroughly in many parts of the world in recent years. Disadvantages include the apparent restriction of the fauna to low paleolatitudes (although this concept has recently been challenged by Roger Cooper), and that it is rare in sediments deposited around Baltica and apparently absent in those of Avalonia and Gondwanaland.

The late Tremadoc was a time of global regression, explaining the almost ubiquitous hiatus or highly oxygenated sediments present at this level; this was followed by a major transgression at or near the base of the *approximatus* Biozone, suggesting that if a series boundary was placed at this horizon it would be representing both a biological and physical event.

Rube Ross stated that with the new age obtained for the base of the Llyfnant Flags, the chronometric ages for the Lower Ordovician were up in the air. Bernd Erdtmann commented that the global regression was at or about the extinction of the cordylodans, and that the incoming of *approximatus* and the transgression was much higher. He also considered that *approximatus* did not occur in deep water, but this was refuted by Roger Cooper. Erdtmann agreed that the base of the *approximatus* Biozone would be a suitable horizon for the series boundary, but considered that the Hunneberg should be retained as a separate (sub)unit below; he did not consider that a Hunneberg Series was warranted.

Kristina Lindholm stated that the reason for the base of the *approximatus* Biozone being so easy to recognize was that it was a hiatus. Stig Bergström replied to Erdtmann, saying that the type *Cordylodus* is post-*approximatus* Biozone, while other representatives of the genus occur higher in the Arenig; they were certainly not extinct by the *approximatus* Biozone. Williams, in response to Lindholm, commented that the faunal breaks in the Cow Head Group were not important and that nothing was missing that occurred elsewhere; Lindholm disagreed. Cooper asked whether there was evidence for diachronous conodont appearances in relation to *approximatus* Biozone assemblages; Erdtmann replied that the appearance of *approximatus* in Scandinavia appeared to be diachronous, but nothing much could be offered in terms of irrefutable evidence. Cooper agreed that Erdtmann might be right.

Ross recalled that in Ibex *approximatus* had been recorded from the Filmore Limestone in association with conodonts, but couldn't remember who published this. Barnes reminded the meeting about the Cambrian-Ordovician boundary process, and suggested that if base of *approximatus* had sufficient support then the working group should move to selection of a type section suitable for definition as global stratotype. Bob Nicoll said that he had examined sections in both Scandinavia and Australia, and could identify four eustatic events, namely middle La2, and bases of La3, Be1 and Be2; there should be an attempt to recognize the links between faunal changes and physical events and define the series boundary accordingly. Webby responded that definition should be primarily biostratigraphic, with bioevents and physical events as secondary tools.

Fortey said that the *approximatus* Biozone was difficult to recognize in Gondwanaland and periGondwanaland; acritarch floras were recognizable in these which could be correlated with *approximatus* and were now better understood than previously. Therefore there could be one or more parastratotype sections in the UK for the base of the series. Barnes commented that the *approximatus* Biozone was within the *proteus* conodont Biozone. Barrie Rickards supported Barnes, saying that there must be a schedule for the decision. Webby suggested that a motion could be made to place the base of the second series at the base of the *approximatus* Biozone and have a straw vote if most people at the meeting agreed. It was the biozone that was important, not the name of the series for the time being. If defined on graptolites it should, however, be reliably tied into conodont and other zonal schemes. Williams consequently proposed that the base of the *approximatus* graptolite Biozone be adopted as the base of the second series of the Ordovician System; the motion was seconded by Erdtmann. Webby commented to Norford that only a straw vote could be held at that meeting, but that it would be a useful reflection of the views of people present. If the vote was in favour of the motion, the result would be forwarded to Titular Members for a formal postal vote. Twenty people voted for the motion, with three against. Barnes remarked that if no good sections at this horizon were found it might have to be reconsidered, but that he presently supported the motion. Lindholm remained unhappy with the level. Williams asked whether there were any good continuous sections through the interval in addition to western Newfoundland and Hunneberg. Erdtmann suggested Tøyen in Oslo, Wang Xiaofeng remarked that there were several good Chinese sections. Ian Stewart said that he knew of one possible section in Victoria, but that it had not yet been properly studied. Bergström suggested the

Marathon Limestone of Texas. Chuck Mitchell considered Oslo to be inadequate, as David Bruton stated that there were no *approximatus* or conodonts; Erdtmann disagreed. Webby promised to take the motion forward to Titular Members of the Subcommission for a formal postal ballot.

"Whiterock"

(convenor - Rube Ross)

Ross introduced the meeting, stating that the base of the *Orthidiella* Biozone, currently used as the base of the Whiterock, more or less correlated with the base of the *I. v. victoriae* graptolite Biozone in western Newfoundland. He now had a Whiterock fauna from the Vinini Formation in the type area of the US which included trilobites, brachiopods, graptolites and conodonts. Stan Finney was studying the graptolite fauna, some of which came from Whiterock Canyon, and included isograptids. This level would be suitable as the base of the third series of the Ordovician, because in addition to the faunal changes Noel James et al. considered Bed 12 of the Cow Head Group to mark the beginning of the Taconic Orogeny, representing a major unconformity and widespread physical event.

Brian Norford asked whether there was a significant brachiopod bioevent at the base of the *Orthidiella* Biozone; Ross replied that there almost certainly was. Arne Nielsen commented that there was a major gap in Utah and that *Orthidiella* was missing; he considered that the first occurrence of *Orthidiella* in Newfoundland was controlled by eustatic events. Henry Williams considered that if the base of a global series was to be drawn near this level based on graptolites, then the appearance of the *victoriae* lineage, rather than that of *I. v. victoriae* itself, would be a more suitable horizon. Richard Fortey acknowledged that the interval might be useful stratigraphic interval in the US, but expressed doubt whether the Whiterock would be suitable for a global series. Roger Cooper remarked that the earliest members of the *victoriae* lineage (i.e., *I. v. lunatus*) was not known from shelf sequences.; *I. v. victoriae*, which occurred about half way through the lineage, was apparently not restricted by either latitude or depth. Bernd Erdtmann considered that if a quiet boundary was to be used for the base of the third series, then it should be defined in a deep water sequence. The type Whiterock is a shelf sequence (denied by Ross), so there would be problems with biostratigraphic resolution.

Barry Webby asked how applicable the Whiterock boundary would be outside North America? Ross replied that Wang and others had recognized *O. evae* and other conodonts characteristic of the interval in China, although Chen Xu stated that it was difficult to recognize the interval both in shelf and slope sequences. Bob Nicoll said that he didn't like the conodont ranges presented for the Whiterock, and that if the base of the *approximatus* Biozone was used for the second series, then the Whiterock would not be too early for the base of the third. June Ross responded that the series need not represent equal intervals of geological time. Webby reiterated his comment from the previous meeting that the important task at present was to establish possible levels for correlation; we would worry about names, etc. later. Chris Barnes considered that the series should represent second order events within the system, i.e., must be significant events. The Whiterock represents a regressive event, therefore no rock record is present.

Webby asked whether any proposals should be made for forwarding to Titular Members? June Ross replied that there should be a motion and a straw vote. Cooper considered that the best horizon would be at the appearance of *I. v. victoriae*; Rube Ross said yes, or at the appearance of *Tripodus laevis*. June Ross formally proposed that these two horizons should be explored as possible levels at which to define the base of the third series of the Ordovician System; the motion was seconded by Rube Ross. Seven voted for the motion, with seven against. Webby said that because of the lack of a majority, an open mind should be kept, but that he would inform the Titular Members of the result and ask them to vote.

"Llanvirn"

(convenor - David Bruton)

Bruton gave a summary of comments that he had received from Working Group members, together with his own opinions. Richard Fortey responded that a Geological Society of London committee had been formed to produce a new correlation chart for the UK. They preferred to place the base of the third series of the Ordovician at the base of *D. artus* Biozone, rather than at the earlier appearance of *austrodentatus*. Chuck Mitchell responded that either of these levels could be correlated in Scandinavia. Bergström stated that he was concerned with the name "Towy Series"; the name was the last priority, not the first. Henry Williams commented that he preferred the base of the *austrodentatus* Biozone, as it marked a more fundamental change in graptolite fauna than the later horizon, but that he knew of no continuously fossiliferous section in which such a level could be defined. Chen Xu replied that there were sections in China with mixed limestone/shale facies extending from *approximatus* to *gracilis* biozones. Bruton adjourned the meeting, asking for more details of the *austrodentatus* Biozone from graptolite workers within three months, i.e. November, and the relation to conodonts.

"Caradoc"

(convenor - Stig Bergström)

Bergström introduced the meeting by drawing attention to the views expressed in his abstract published in the abstract level, highlighting four possible levels at which a series boundary could be placed; he considered it preferable to have a boundary defined on distinctive fossil taxa that could be easily identified by non-specialists. Wide-ranging discussion on these horizons yielded no consensus regarding either the best level or fossil group. Several cautions regarding the base of the *N. gracilis* Biozone were made, particularly the sudden appearance of the assemblage apparently controlled by the onset of black shale deposition which may well represent an eustatic transgression.

As no consensus was arrived at, a straw vote was held to see the relative popularity of Bergström's four possible levels, together with a fifth. Participants were asked to vote whether they considered each possibility suitable for further investigation as a series boundary.

Results were:

Votes	Horizon
1	Base of <i>anserinus</i> conodont Biozone
9	Base of <i>gracilis</i> graptolite Biozone
6	Base of <i>aculeatus</i> conodont Biozone
10	Base of <i>undatus/lanceolatus</i> graptolite Biozone
10	First appearance of <i>Climacograptus bicornis</i>

Richard Fortey then proposed a motion to investigate possible sections suitable for definition of the boundary at the three possible graptolite levels; the motion was seconded by Barry Webby and passed unanimously.

"Ashgill"

(convenor - Chris Barnes)

Barnes opened the meeting with his comment made in Tallinn regarding the apparently short-lived nature of the Ashgill Series as currently understood; most other members of the working group had responded that they considered the short duration unimportant, when so many major physical and biological events had occurred during the interval. Although considerable work had been done in the UK regarding precise definition of the Caradoc-Ashgill boundary in northern England, few non-UK members of the working group were in favour of using this traditional, shelly-based boundary. He continued that if graptolites were preferred for definition, then there was no clear-cut horizon for the base of the top series of the Ordovician; the only zonal boundary near the presently accepted base of the Ashgill was between the *D. clingani* and *P. linearis* biozones which Henry Williams had defined at an arbitrary point at Dob's Linn defined on the last occurrence of *Corynoides*, *Neurograptus* and *Dicranograptus* and gradual incoming of new forms including "*N.*" *tubuliferus* and *P. linearis*. Other possible horizons might be at the base of Ea 3 in Victoria, or at an equivalent level in the western US.

Rube Ross stated that the trilobites in the type Ashgill section do not occur in his own North American collections, and that there were no associated conodonts or graptolites; therefore he considered the UK sections unsuitable for type status. He recalled that there were two possible suitable sections in northern Canada; Barnes and Brian Norford responded that there weren't. Williams commented that he had found the incoming of "*N.*" *tubuliferus* to be an easily recognized and useful marker for the *linearis* Biozone. Earlier records of the species from the previous *clingani* Biozone had not been substantiated in recent years since the revision of taxa from these levels, although naturally further investigation would be needed to check these apparently contradictory ranges. The species appeared to be present in the new section at Whitland in South Wales. Williams also preferred retention of the Ashgill or broadly equivalent interval as the top series of the Ordovician. Chen Xu preferred the base of the *D. complanatus* Biozone; he reported that there was no *P. linearis* in China, and that he found "*N.*" *tubuliferus* within the "C." *spiniferus* Biozone in his sections.

Peter Sheehan agreed with the retention of the Ashgill or equivalent as the top series; he felt that it could be made longer, perhaps using the base of the Cincinnati. Sheehan

considered the type Ashgill sections unsuitable, and commented that the stages were unrecognizable outside that area. Barrie Rickards stated that there were graptolites in the type Ashgill, but that they were not diagnostic or present near the base of the series. He asked whether there were assemblages elsewhere that included "*N.*" *tubuliferus*; Williams responded that it was one of the most widespread species at this level. Stig Bergström suggested that perhaps the base of the series could be defined by a bentonite, and that the type locality should be in a mixed sequence.

Chuck Mitchell considered the base of the Cincinnati to be a problem; there was no outcrop in the type section, and it was currently defined lithostratigraphically, not biostratigraphically. The base of the *spiniferus* Biozone might prove to be a suitable level, but the first occurrence of the index fossil appeared to be diachronous. Stan Finney commented that *tubuliferus* first occurred in the Big Fork Chert and the Hanson Creek Formation, together with conodonts. Fons VandenBerg thought that the type Caradoc-Ashgill boundary looked like a possible hiatus with the synchronous appearances and disappearances; Richard Fortey replied that there was no apparent lithological evidence for any breaks. Barnes drew attention to the ongoing study of a new section at Whitland in South Wales, where a thick sequence with mixed faunas had been exposed that might prove suitable for a stratotype section if a level near to the traditional base of the Ashgill was selected.

Wang Xiaofeng reported that he knew of complete sections in South China from middle to late Ordovician with mixed faunas. Williams commented that the Oslo region had a good mixed succession, but that he and David Bruton had recorded a possible hiatus at the Caradoc-Ashgill boundary. Bruton proposed that there should be a straw vote for the retention of the Ashgill Series. Barry Webby replied that this would be premature, but that there could be an informal vote regarding the possible horizons listed by Barnes. Williams proposed that the first occurrence of "*N.*" *tubuliferus* be added to the list; this motion was seconded by Rickards. Barnes asked for confirmation that a majority of people present favoured retention of a top series spanning an interval from a level approximating to the base of the Ashgill to the base of the Silurian. Twenty two voted yes, three no, and six abstained.

Following that vote, Webby's suggestion, incorporating Williams' amendment, was taken up. Participants were asked to vote for the horizons which they considered worthy of further investigation as possible levels for the base of the top series of the Ordovician. Results were:

	YES	NO	ABSTAIN
Base of <i>complanatus</i> Biozone	12	4	12
Appearance of <i>tubuliferus</i>	15	8	7
Base of <i>linearis</i> Biozone	0	Most	5
Base of <i>spiniferus</i> Biozone	4	4	Most
(bentonite)	10	8	12

It was therefore decided to encourage further investigation of these levels, with the exception of the base of the *linearis* Biozone as defined at Dob's Linn which appeared to lack any support.

NEW CHINESE STRATIGRAPHIC PROJECTS

A proposal for the *austrodentatus* Zone level as the base of the "Llanvirn" Series

An informal working group, initiated by Chen Xu and Zhang Yuandong, is planning to study this level in the Jiangshan-Changshan-Yushan area in the borders of Zhejiang and Jiangxi provinces during the next year or so, where continuous sections yield well preserved graptolite and conodont faunas. Two members of the working group are from the US and anyone else who is interested in participating in the project should contact Chen Xu.

Chen Xu

A proposal to study Ashgill brachiopod community ecology, palaeogeography and facies analysis in the Jiangshan-Changshan-Yushan area

The Ashgill rocks of this area are poorly known, and are very different from those of the better known Yangtze region. They contain a diverse, mixed faunal assemblage including brachiopods, trilobites, conodonts and reef-building organisms. Continuous sections are present across the Caradoc-Ashgill boundary.

The project was initiated by Rong Jiayu and Zhan Renbin, who encourage anyone interested in the study to contact them.

Rong Jiayu

PROCEEDINGS OF VISOS, ST. JOHN'S, AUGUST 1988

Advances in Ordovician Geology was published last summer as *Geological Survey of Canada, Paper 90-9*; authors should have received their free copy of the volume, and everyone was sent an order form last autumn (attached to the back of the *Ordovician News* reminder). We apologise for not being able to offer a reduced price to participants as originally hoped, but had to spend our remaining resources on contracting out the final technical editing in order to avoid any further delay in publication. We trust that you will find the volume an asset to your bookshelf, and hope that you will encourage your libraries and colleagues to purchase copies. They may be obtained for \$Can31.20 (incl. p&p) from: Publication Division, Geological Survey of Canada, 601 Booth Street, Ottawa, Ontario K1A 0E8, Canada.

Chris Barnes, Henry Williams
Editors, VISOS proceedings volume

PROCEEDINGS OF VI ISOS, SYDNEY, JULY 1991

Manuscripts were collected by Barry Webby during the meeting in Sydney. Publication (by Balkema Publishers, Rotterdam, the Netherlands - editors B.D. Webby and J.R. Laurie) is expected in April-May 1992. Some forty papers have been contributed, and the 400-page volume will contain much of interest on aspects of biostratigraphy, chronostratigraphy, geochronometry, magnetostratigraphy, event

stratigraphy, economic deposits, palaeogeography, biogeography, palaeoecology and regional geology. Details will be circulated when it becomes available.

NEWS AND CURRENT RESEARCH OF ORDOVICIAN WORKERS

Ingo Appelt (Germany) is carrying out investigations on existing bio- and lithostratigraphic boundaries based at TU, Berlin, with particular emphasis on the fauna of the Ek Shale (upper Llandovery-Wenlock) and other Ordovician-Early Silurian sediments, based on sections on Helgøya Island, south-central Norway.

Misha Appolonov (Kazakhstan) is studying sedimentary paleoenvironments and depositional sequences in type sections of the Selety River and Chu-Ili Mountains regions, central Kazakhstan. He invites colleagues interested in participating in this study to discuss such possibilities, particularly if internationally-based financial support should be available.

Ricardo Astini (Argentina) is currently finishing his Ph.D. on Ordovician siliciclastic sequence facies and sequence stratigraphy. He is also dealing with Silurian and Devonian clastic facies in an attempt to give an integral approach to Precordillera basin evolution.

Claude Babin (France) continues his work on Ordovician bivalves and cephalopods, and paleogeography of the PeriGondwanan area.

Chris Barnes (Canada) is working on Ordovician stratigraphy and conodont micropaleontology from a variety of localities around the world. Of immediate concern are the Lower and Middle Ordovician sequences in the Rocky Mountains and the comparison with conodont faunas from eastern Canada. Other work involves conodont faunas from the Edgewood Group (Illinois, Missouri), Cliefden Caves region, central New South Wales, and the platform to slope faunas from western Newfoundland. Collaboration with other specialists involves studies of isotope geochemistry and thermal maturation using Lower Paleozoic conodonts.

Juan Benedetto (Argentina) is leader of a research group at the University of Córdoba that has been working for the last five years on aspects of the Lower Paleozoic of western Argentina (Northwestern and Precordillera basins), and has an extensive list of relevant publications produced by the group that he is willing to send to anyone interested in their work. His own work centres on Ordovician articulate brachiopods from western Argentina. Current research includes taxonomy and biostratigraphy of Middle and Late (Hirnantian) brachiopod faunas from the Precordilleran basin, and Early Ordovician brachiopods from the northwestern region. He is also studying the biogeographic relationships of brachiopod faunas of western Argentina and their implications on paleogeographic reconstructions of Gondwanaland.

Merete Bjerreskov (Denmark) has made recent studies of pyrite in Ordovician graptolites from Bornholm, Denmark, and is currently completing the correlation chart for the Ordovician System in Greenland with Paul Smith (UK).

Alain Blieck (France) participated in a one month expedition, organized by P.Y. Gagnier (Canada) and funded by a grant from the National Geographic Society, to collect and date vertebrate-bearing localities in the Ordovician of the Subandean domain of

Bolivia. New specimens of *Sacabambaspis janvieri* were collected, as well as new localities discovered. Invertebrates, including lingulids, bivalves and trilobites among others, were collected from the vertebrate-bearing Anzaldo (Cuchupunata) Formation and from the underlying Capinota Formation in order to ascertain whether they were Llanvirn or Caradoc in age. Samples from the overlying Cancaniri Formation were also taken for palynological examination. A paper is in press in *Geobios* on the origin of the chordates in the Cambrian and appearance of vertebrates in the Ordovician.

Frank Brunton (Canada) is beginning a two year postdoctoral fellowship with Noel James at Queen's University, Ontario to look at Carboniferous reef mounds of the Sverdrup Basin. Most of his other work has been on Silurian reef paleoecology, stromatoporoid taxonomy and paleoecology, and carbonate platform evolution, but he is also very much interested in Ordovician biostratigraphy and reef development.

Edsel Brussa (Argentina) is working on the taxonomy and biostratigraphy of Ordovician graptolites from the central-western Precordillera of San Juan, Argentina.

Fernando Cañas (Argentina) is studying the stratigraphy, facies and microfacies analysis of the Early Ordovician platform carbonates of the Precordilleran basin.

Marcelo Carrera (Argentina) is looking at the Ordovician sponge and bryozoan faunas of the Argentinian Precordillera, including their taxonomy, and paleoecological and paleogeographic significance.

Roger Cooper (New Zealand) has completed, with Fons VandenBerg (Australia), a full review of the combined Australian and New Zealand graptolite sequence, including a revised checklist of valid species and bibliography, a revised zonal range chart, illustrations of useful species, and definitions of all zones and stages (*in press, Alcheringa*). A joint manuscript (with Tony Wright) on the stratigraphy and trilobite faunas of the Late Cambrian-Early Ordovician sequence at Mount Patriarch is in preparation. A new method of calibrating the Ordovician time scale using graphic correlation of deep water graptolitic shale sequences was presented at the Sydney meeting and suggests that some of these zones and stages have durations considerably different from those currently accepted (*Balkema*). A joint paper with Andy Tulloch outlines the New Zealand tectonostratigraphic terranes and relates them to those of the Lachlan Fold Belt of Australia (*Tectonophysics*).

Tony Cooper (UK) and other members of the British Geological Survey (UK) Lake District Mapping Project, are progressing with their resurvey on two main fronts. Tony Cooper, Richard Hughes, Rob Barnes and Phil Stone are all involved with the resurvey of the early Ordovician Skiddaw Group. Maps for the Cockermouth district are almost complete and the Keswick area is well advanced. A paper on the Skiddaw Group stratigraphy in conjunction with Stewart Molyneux, Adrian Rushton and Rick Moore is nearing completion; work on a structural paper is advancing. Rick Moore (Leeds University) has almost completed his thesis on the provenance and sedimentology of the Skiddaw Group. The Eycott Volcanic Group has been surveyed by Dave Millward, and a paper, in conjunction with Stewart Molyneux, on it and its unconformable relationship with the underlying Skiddaw Group is in press. Neil Fortey is looking at the geochemistry and mineralogy of Ordovician and Silurian bentonites in the area, and assessing the low grade metamorphism. Eric Johnson, Mike Petterson and Brett Beddoe-

Stevens, along with the Liverpool University mapping contract team run by Peter Kokelaar, have finished mapping the Borrowdale Volcanic Group of the Ambleside map, covering most of the central Lake District. It is planned to have the map and accompanying memoir completed this year. Papers describing the stratigraphy, volcanology and geochemistry of the Borrowdale Volcanic Group are also well advanced.

Mary Droser (US) and Nigel Hughes (Australia) are continuing studies of the spatial and temporal distribution of *Rusophycus*, with particular emphasis on Lower Paleozoic occurrences. Primary field work has concentrated on exceptionally well preserved Lower Ordovician *Rusophycus* from Mootwingee, New South Wales. Mary and Richard Fortey (UK) are continuing their examination of the biofacies, paleoecology and ichnology of the low to mid-Ordovician transition in the Great Basin. Mary's student Xing Li is studying the nature of Ordovician fossil concentrations in the Great Basin.

Bob Elias (Canada) has completed manuscripts on latest Ordovician to earliest Silurian solitary rugose corals of the east-central US, microborings and growth in late Ordovician halysitids and other corals (with Lee Dongjin) and a study of latest Ordovician to earliest Silurian corals in the east-central US (with Graham Young).

Bernd Erdtmann (Germany) organized a two day conference last February on Pre-Variscan Basement Geology of Germany in the Context of Peri-Gondwana, which was attended by more than 70 scientists and from which a potential proposal for an IGCP project entitled Peri-Gondwana Early Palaeozoic basins, sequence and biostratigraphy - and palaeoclimates. Anybody interested in joining the planning and coordination of this project should contact Bernd at the earliest opportunity. Other projects include a cooperative venture between the Technische Universität Berlin and the Ministry of Geology and Mineral Resources of China on coalification and organic reflectance studies of Cambro-Ordovician rocks in China (see section by Wang Xiaofeng), and a NATO-supported project also involving Michael Vanguestaine and Thomas Servais (Univ. Liège, Belgium) and Jörg Maletz (TUB) on acritarch/graptolite biostratigraphy of the Ordovician formations of the Brabant Massif and of the Ebbe Anticline of Westfalia.

Stan Finney (USA) has concentrated his field research on the Ordovician Vinini Formation of central Nevada over the last five years. Given the huge expanse of available outcrops, the problems yet to be solved, and the amount of field work still to be done, he feels that he will be working in Nevada until the year 2000. Graptolites are the most common fossils available for dating and correlation, while conodonts can also be recovered from some lithologies (being studied by Ray Ethington, USA). Turbiditic sandstones in the Vinini Formation have yielded large collections of beautifully preserved graptolites representing the isograptid fauna. Conodont faunas from the same sandstones include many species also known from the basal Whiterock at its stratotype section, in addition to several Australian species. Stan and Ray Ethington are currently working on a paper documenting these faunas. Stan is Chairman of the Organizing Committee for the Graptolite Working Group of the IPA, and is planning for the 5th International Symposium in the USA, probably in 1995 and possibly coordinated with the next Ordovician Symposium.

Robert Frey (US) has research interests which centre on the paleontology and paleoecology of Ordovician nautiloids and pelecypods, Ordovician epeiric sea

environments and depositional facies, and Ordovician paleogeography and extinction events. He is presently working on a study of Ordovician nautiloid faunas from Kentucky and adjacent states as part of the U.S.G.S. Professional Paper 1066 series. Additional work in progress includes a systematic study of some Middle Ordovician nautiloids from the Platteville Formation of Wisconsin, a study of facies control of nautiloid distribution in the Late Ordovician of Laurentia, and an investigation into the effects of the widespread Middle Ordovician (Rocklandian) Deicke and Millbrig volcanic events on nautiloid faunas in eastern Laurentia.

Dave Harper (Ireland) continues with statistical analysis of global brachiopod distributions during the early Ordovician with Bob Neuman (US) and the late Ordovician with Rong Jiayu (China). Analysis of the Ordovician faunal history of the North Atlantic area, with Richard Fortey and Alan Owen (UK), is advanced. Monographic description of a number of Ordovician faunas from Ireland, Scotland, Wales and Norway continues. Some progress has been made with Tony Wright and Anne McClean on the description, biostratigraphy and paleoecology of the brachiopods of the type Ashgill. A chapter on the Ordovician of Ireland for the revised correlation of the Ordovician of the British Isles nears completion.

Zarela Herrera (Argentina) is studying Early Ordovician articulate brachiopods of the Precordillera in central-western Argentina, and is revising the Ordovician inarticulate brachiopods of the same region.

Thomas Heuse (Germany) has commenced micropalaeontological investigations at TU, Berlin, on the Schwarzburg Anticline (Thuringia) and the Zentralsächische Lineament (Saxony) of the Saxothuringian Zone in southern east Germany. Acritarchs have been recovered which allow a reassessment of the ages and stratigraphic correlation of low grade metamorphic sequences devoid of macrofossils.

Linda Hints (Estonia) and her colleagues Jaak Nõlvak and Tõnu Meidla from the Institute of Geology continue to work on a project concerning the composition and dynamics of Late Ordovician faunal associations. During the first period of the four year project, their research has concentrated on the topmost part of the Ordovician section, on brachiopods, chitinozoans and ostracodes. Linda plans an examination of the *Hirnantian* fauna (*s.l.*) in several core sections from the north and central East Baltic. Biostratigraphically significant results of this work will be used in preparation of the stratigraphic correlation chart of the Baltic states.

Peter Huttel (Germany) is continuing his studies on the sedimentology of Lower Ordovician limestones and glauconites in Scandinavia, and together with Jörg Maletz is reviewing proposed eustatic events at the Cambrian-Ordovician boundary and in the Lower and Middle Ordovician.

John Laurie (Australia) is continuing work on the Early Ordovician Horn Valley trilobites of central Australia. Arne Nielsen (University of Copenhagen, Denmark) visited the BMR on a Carlsberg Fellowship from March 1990 to August 1991 to study the paleoecology of the Horn Valley Siltstone with a view to detecting sea-level changes. Preliminary results on the lower part of the unit are very encouraging. Also under way is a taxonomic and biostratigraphic study of the Emanuel Formation trilobites (with John Shergold) from the Canning Basin in Western Australia.

Jörg Maletz (Germany) has just finished his doctoral thesis on biostratigraphy and paleogeography of Lower Ordovician graptolite faunas in Scandinavia and eastern Canada. Taxonomic work on pseudisograptids is in progress, indicating a well documented evolution of this group in the lower Dariwillian (Da1-Da3). Several species have been isolated and proximal structures can be demonstrated. A manuscript discussing the Arenig-Llanvirn boundary in the Quebec Appalachians is in press (*Newsletters on Stratigraphy*). Together with Thomas Servais (Université de Liège, Belgium), Jörg is currently working on Llanvirn graptolite and acritarch faunas from Germany, Belgium and Scandinavia, both on surface and core materials. The biostratigraphic zonation has to be refined and better international correlation of endemic graptolite faunas, including pendent didymograptids, will be achieved through comparison of biserial graptolite species.

Silvi Mägi (Estonia) is studying the stratigraphy and lithology of the Arenig and Llanvirn Latorp, Volkov and Kunda stages in the Baltic region.

Sandy McCracken (Canada) is continuing work on conodonts from Canada, including Ordovician-Silurian faunas in the Yukon, and Arctic Islands and Middle-Late Ordovician on Baffin Island. Geochemical studies are in progress with W. Goodfellow, C. Geroire, M.J. Melchin and G.S. Nowlan, and CAI and Mississippi Valley Type deposit studies with D. Sangster and G.S. Nowlan.

Mike Melchin (Canada) has moved to St. Francis Xavier University in Nova Scotia. Work is continuing on Late Ordovician and Early Silurian compressed and uncompressed graptolites from Arctic Canada. Several projects are currently underway, including the Ordovician-Silurian boundary with Sandy McCracken (conodonts) and Wayne Goodfellow (geochemistry). A preliminary report of the biostratigraphic results of this study are in press. Chitinozoa are also being studied from these sections. Two master's theses currently under Mike's supervision are Late Ordovician uncompressed graptolites of the Cape Phillips Formation (Sherrill Senior) and Late Ordovician-Early Silurian palynology of the Allen Bay Formation, Griffith Island, N.W.T. (Huang Xiaowen).

Robert Neuman (US) is working on a paper documenting the occurrence of ten brachiopod genera in a Late Ordovician *Foliomena* assemblage from northeastern Maine. The assemblage consists largely of very small strophomenides, the most numerous being *Paromalomena*, followed by *Foliomena* and a new genus of Christianiidae, plus small numbers of the remaining seven genera. The associated trilobites are being studied by David Bruton (Norway).

Jaak Nõlvak (Estonia) continues a detailed taxonomic and biostratigraphic study on Ordovician chitinozoans from the East Baltic. In co-operation with colleagues from Sweden and Finland, a biozonation for the Ordovician of Baltoscandia has been worked out.

Matthew Parkes (Ireland) has a *Bulletin of the British Museum* in press, on Caradoc brachiopods from SE Ireland, and another paper in press (*Terra Nova*) on a biogeographical synthesis of these faunas. A second paper on the trilobites (with Alan Own, UK) is near completion, and a paper (with Doug Palmer, UK) has been submitted on the faunas and stratigraphy of the Lower Palaeozoic Kildare inlier of Ireland. A contribution to the brachiopod chapter of the *Fossil Record* (2nd Edition) has also been made. Other Ordovician research in progress includes various ongoing projects with Dave

Harper (Ireland) on Irish Ordovician brachiopods, and on Hirnantian palaeokarst at Portrane.

Ian Percival (Australia) has left Esso in an attempt to re-establish an academic career. His current and future research projects include Ordovician trimerellid brachiopods and inarticulate brachiopods from New South Wales, and Island arc articulate brachiopod faunas.

Susanne Pohler (ex-Canada) has moved to Australia for a couple of years or so to work on Devonian limestones with John Talent and Ruth Mawson. She is still, however, concerning herself with Ordovician matters, including early Ordovician conodonts from southern France and Turkey (with Chris Barnes and Andreas Küppers) and conodont biostratigraphy of the Cow Head Group, western Newfoundland (with Chris Barnes and Ji Zhai liang).

Ivar Puura (Estonia) is presently working on brachiopods and biostratigraphy of Cambrian-Ordovician boundary beds in Baltoscandia.

William Read (US) has been working on sediments deposited in Late Ordovician-Early Silurian tidal lagoons, finding that they contain, among other things, an abundance of beautifully preserved miniature eurypterids. If anyone knows of someone who is especially interested in these creatures, a name and address would be appreciated; he will be glad to send photographs, and possibly specimens.

Keith Rigby (US) worked last fall with Matilde Beresi (Argentina), who has the most extensive collections of Early Paleozoic sponges from South America, on the description and illustration of Ordovician sponges from Argentina. The material is well preserved and diverse, consisting mainly of orthoclad lithistid demosponges, much like Ordovician faunas from North America and Australia. Hexactinellids are represented only by scattered spicules and root tufts. Heteractinid calcareous forms are known in the collection only as isolated octactine spicules. A total of ten demosponge genera, including fifteen species, are represented in the material that she and William Sill collected from the Arenig of the San Juan Formation in the Precordilleran region of San Juan province. Keith also continues work on Ordovician faunas from North America, and hopes to finish up describing faunas from Newfoundland and the Mingan Islands of eastern Canada this summer.

Rob Ripperan (ex-US) has moved to the Weizmann Institute of Science in Rehovot, Israel, where he is continuing his research on the Cambrian-Ordovician boundary, looking at stable isotopes in the same sections on which he did his magnetostratigraphy work, including localities in Newfoundland, the western United States, Australia, China and Kazakhstan. He plans to extend his work up through the Early Ordovician of the UK, and is keen on collecting from other localities where paleomagnetic work might be more practical.

Mike Romano (UK) is continuing work with Alan Owen (UK) on a revision of Ordovician trilobites from eastern Ireland, and a paper with Alan Owen and Dave Harper (Ireland) on the Ordovician biogeography of the Grangegeeth Terrane and the Iapetus suture zone has just been published. Work is also continuing on Portuguese Ordovician trilobites and trace fossils.

Teresa Sánchez (Argentina) is studying the systematics on Ordovician pelecypods, the variation in taxonomic composition of *Hirnantia* faunas related to paleoenvironmental fluctuation, and the paleoecology of carbonate sequences (Arenig-Llanvirn) and autecology of associated brachiopod faunas.

Olaf Schmidt (Germany) plans to finish his Ph.D. thesis on the Bogo Shale graptolites this summer. New data on the genus *Allograptus* will be published in the IV International Graptolite Conference Volume.

Enrico Serpagli (Italy) and the friends of the informal Sardinian working group (W.Hammann, E. Villas, A. Ferretti, F. Leone) continue to work on Ordovician faunas, and bio- and lithostratigraphy in Sardinia and related areas. Ashgill conodonts have now been illustrated for the first time, but the more important achievement was the establishment of lithostratigraphic units and biostratigraphy of the post-sardic Ordovician sequence in SW Sardinia, based mostly on trilobites, brachiopods and conodonts. A large monograph on trilobites by W. Hammann is in advanced progress.

Hendrik Siegmund (Germany), who is based at TU Berlin, records that his last year's studies on sedimentary facies and depositional environments of the Middle Ordovician Furberg Formation in the northeastern Mjösa district of southern Norway show that the sediments of that formation were deposited in an outer to inner clastic shelf area. Both sedimentary structures and fossil distribution suggest a strong influence of storm events. Publication of results is planned for late 1992.

Blanca Toro (Argentina) is working on the taxonomy and biostratigraphy of Early Ordovician graptolites from the Cordillera Oriental (northwestern Argentina).

Simon Tull (UK) has joined the Cambridge Arctic Shelf Programme, where he will be working on the geological evolution of the Arctic region and the regions of the previous Soviet Union; he is also continuing with his own interests in conodonts.

Norberto Vaccari (Argentina) is studying the trilobites of the Early-Middle Ordovician of the Argentinian Precordillera (San Juan and La Rioja Provinces), including the taxonomy, biostratigraphy and paleobiogeographic affinities of the fauna.

Beatriz Waisfeld (Argentina) is working on taphonomy, paleoecology and trilobite taxonomy in Early Ordovician sequences of the Cordillera Oriental, northwestern Argentina.

Wang Xiaofeng (China) reports that a cooperative project between TU Berlin and YIGMR, Yichang, which started in 1988, is continuing its investigations into work on the reflectance of Early Paleozoic zooclasts and distribution patterns of regional maturity in the west Yangtze platform. Collaborators include B.-D. Erdtmann, A. Hoffknecht, R. Brocke, Xiao Jianxin, Li Zhihong, Chen Shanqing and Chen Xiaohong. Three manuscripts are being prepared on the reflectance properties of graptolites, chitinozoans and scolecodonts and their use as indicators of thermal maturity.

Henry Williams (Canada) has been spending the last few months basking in the relative warmth of southern Scotland and Cambridge while on a one year sabbatical. In addition to ploughing through a backlog of data on Newfoundland, he has recollected from, and is in the process of revising or refining, the lower zones of the Moffat Shale Group and Ordovician-Silurian boundary interval at Dob's Linn. He has also just completed a contract (with Elliott Burden, Canada) for Mobil Oil Canada, investigating

thermal maturities of potential Ordovician source rocks in western Newfoundland, based on graptolite reflectances, palynomorphs and organic particle alteration.

Graham Young (Canada) is currently studying the systematics and distribution of latest Ordovician and earliest Silurian colonial corals of the east-central United States, working with Bob Elias. In parallel with this, he is examining patterns of growth in selected Ordovician and Silurian tabulate coral taxa.

Zhang Jianhua (China) is continuing work on conodonts in the Ordovician Kuniutan Formation (Llanvirn) of the central Yangtze Platform of China. He is also working on Llanvirn phosphatic inarticulate brachiopods from Nunan province.

ORDOVICIAN PUBLICATIONS, 1991

The following bibliography was compiled from lists returned following distribution of the *Ordovician News* circular; it does not include references in press or any abstracts.

ACHAB, A. 1991. Biogeography of Ordovician chitinozoa. In BARNES, C. R. and WILLIAMS, S. H. (ed.). *Advances in Ordovician geology. Geological Survey of Canada, Paper 90-9*, pp. 135-142.

APPOLLONOV, M. 1991. Cambrian-Ordovician boundary beds in the U.S.S.R. In BARNES, C. R. and WILLIAMS, S. H. (ed.). *Advances in Ordovician geology. Geological Survey of Canada, Paper 90-9*, pp. 33-45.

BABIN, C. and GUTIERREZ-MARCO, J.L. 1991. Midle Ordovician bivalves from Spain and their phyletic and palaeogeographic significance. *Palaeontology* 34, pp. 109-147.

BARNES, C. R., JI, Z. and POHLER, S. M. L. 1991. A review of Ordovician conodont paleontology of the Canadian Cordillera. *Geological Survey of Canada, Bulletin* 417, pp. 27-40.

BARNES, C. R. and NORFORD, B. S. 1991. Ordovician stratigraphy and paleontology of the Main and Western Ranges, Rocky Mountains. In SMITH, P. (ed.). *A field guide to the paleontology of southwestern Canada. Canadian Paleontology Conference, 1*, pp. 118-134.

BARNES, C. R. and WILLIAMS, S. H. (ed.). 1991. Advances in Ordovician geology. *Geological Survey of Canada, Paper 90-9*, pp. 1-336.

BARNES, C. R. and WILLIAMS, S. H. 1991. Introduction. In BARNES, C. R. and WILLIAMS, S. H. (ed.). *Advances in Ordovician geology. Geological Survey of Canada, Paper 90-9*, pp. 1-3.

BECKLY, A. and MALETZ, J. 1991. The Ordovician graptolites *Azygograptus* and *Jishougraptus* in Scandinavia and Britain. *Palaeontology* 34, pp. 887-925.

BLIECK, A., ELLIOTT, D.K. and GAGNIER, P.Y. Some questions concerning the phylogenetic relationships of heterostracans, Ordovician to Devonian jawless vertebrates. In CHANG, Meemann, LIU, Yuhai and ZHANG Guorui (ed.). *Early vertebrates and related problems of evolutionary biology (Intern. Symp., Beijing, 1987)*, pp. 1-17. Science Press, Beijing

BRENCHLEY, P. J., ROMANO, M., YOUNG, T. P. and STORCH, P. 1991. Hirnantian glaciomarine diamictites - evidence for the spread of glaciation and its effect

on Upper Ordovician faunas. In BARNES, C. R. and WILLIAMS, S. H. (ed.). *Advances in Ordovician geology. Geological Survey of Canada, Paper 90-9*, pp. 325-336.

BRIGGS, D. E. G., BOTRELL, S. H. and RAISWELL, R. Pyritization of soft-bodied fossils: Beecher's Trilobite Bed, Late Ordovician, New York State. *Geology*

CHEN, J. 1991. Bathymetric biosignals and Ordovician chronology of eustatic variations. In BARNES, C. R. and WILLIAMS, S. H. (ed.). *Advances in Ordovician geology. Geological Survey of Canada, Paper 90-9*, pp. 299-311.

COOK, H. E. et al. 1991. Comparison of two early Paleozoic carbonate submarine fans - western United States and southern Kazakhstan, Soviet Union. In COOPER, J. D. and STEVENS, C. H. (ed.). *Paleozoic paleogeography of the western United States. Pacific Section SEPM* 67, pp. 847-872.

COOPER, R. A. 1990. Interpretation of tectonically deformed fossils. *New Zealand Journal of Geology and Geophysics* 33, pp. 321-322.

COOPER, R. A., FORTEY, R. A. and LINDHOLM, K. 1991. Latitudinal and depth zonation of Early Ordovician graptolites. *Lethaia* 24, pp. 199-218.

COOPER, R. A. and LINDHOLM, K. 1990. A precise world wide correlation of Early Ordovician graptolite sequences. *Geological Magazine* 127, pp. 497-525.

CORNÉE, J. -J and DESTOMBES, J. 1991. L'Ordovien de la partie w du Massif Ancien du Haut-Atlas occidental (Maroc Hercynien). *Geobios* 24, pp. 403-415.

DIECCHIO, R. J. 1991. Taconian sedimentary basins of the Appalachians. In BARNES, C. R. and WILLIAMS, S. H. (ed.). *Advances in Ordovician geology. Geological Survey of Canada 90-9*, pp. 225-234.

DUBININA, S. V. 1991. Upper Cambrian and Lower Ordovician conodont associations from open ocean paleoenvironments, illustrated by Batyrbay and Sarykum sections in Kazakhstan. In BARNES, C. R. and WILLIAMS, S. H. (ed.). *Advances in Ordovician geology. Geological Survey of Canada, Paper 90-9*, pp. 107-124.

DUNNING, G. R. and KROGH, T. E. 1991. Stratigraphic correlation of the Appalachian Ordovician using advanced U-Pb zircon geochronology techniques. In BARNES, C. R. and WILLIAMS, S. H. (ed.). *Advances in Ordovician geology. Geological Survey of Canada, Paper 90-9*, pp. 85-92.

ELIAS, R. J. 1991. Environmental cycles and bioevents in the Upper Ordovician Red River-Stony Mountain Solitary Rugose Coral Province of North America. In BARNES, C. R. and WILLIAMS, S. H. (ed.). *Advances in Ordovician geology. Geological Survey of Canada paper 90-9*, pp. 205-211.

ELLIOTT, D. K., BLIECK, A. R. M. and GEGNIER, P. -Y. 1991. Ordovician vertebrates. In BARNES, C. R. and WILLIAMS, S. H. (ed.). *Advances in Ordovician geology. Geological Survey of Canada, Paper 90-9*, pp. 93-106.

ERDTMANN, B. -D. 1992. The post-Cadomian Early Palaeozoic tectonostratigraphy of Germany - Attempt at an analytical review. In ANDRÉ, L., HERBOSCH, A., VANGUESTAINE, M. and VERNIER, J. (ed.). *Proceedings of the International Meeting on the Caledonides of the Midlands and the Brabant Massif, Brussels, 20-23 September 1989. Ann. Soc. Géol. Belg.* 114 (1), pp. 1-25.

- ETTENSOHN, F. R. 1991. Flexural interpretation of relationships between Ordovician tectonism and stratigraphic sequences, central and southern Appalachians, U.S.A. In BARNES, C. R. and WILLIAMS, S. H. (ed.). *Advances in Ordovician geology. Geological Survey of Canada, Paper 90-9*, pp. 213-224.
- EVANS, J. A., STONE, P. and FLOYD, J. 1991. Isotopic characteristics of Ordovician greywacke provenance in the Southern Uplands of Scotland. *Geological Society Special Publication 57*, pp. 161-172.
- FALK, F. 1991. Schwermineralanalytische Untersuchungen im Thüringischen Schiefergebirge. *Neues Jahrb. Geol. Paläont. Mh.* 8, pp. 477-488.
- FALK, F. and LÜTZNER, H. 1991. Schichtungsgefüge der Goldisthal- und Frauenbach-Folge (Kambro-Ordovizium) im Thüringischen Schiefergebirge. *Wiss. Beiträge Ernst-Moritz-Arndt-Universität Greifswald.*, pp. 27-31.
- FERRETTI, A. and SERPAGLI, E. 1991. First record of Ordovician conodonts from southwestern Sardinia. *Riv. Ital. Paleont. Strat.* 97, pp. 27-34.
- FINNEY, S. C. and PERRY, B. D. 1991. Depositional setting and paleogeography of Ordovician Vinini Formation, central Nevada. In COOPER, J. D. and STEVENS, C. H. (ed.). *Paleozoic paleogeography of the western U.S. - II.*, pp. 747-766. Pacific Section, Society of Sedimentary Geologists.
- FORTEY, R. A., BASSETT, M. G., HARPER, D. A. T., HUGHES, R. A., INGHAM, J. K., MOLYNEUX, S. G., OWEN, A. W., OWENS, R. M., RUSHTON, A. W. A. and SHELDON, P. R. 1991. Progress and problems in the selection of stratotypes for the bases of series in the Ordovician System of the historical type area in the U.K. In BARNES, C. R. and WILLIAMS, S. H. (ed.). *Advances in Ordovician geology. Geological Survey of Canada, Paper 90-9*, pp. 5-25.
- FROEHLICH, B., URBANEK, Z. and SCHNEIDER, W. 1991. Shallow-water carbonates in the Ordovician turbidite slates of the Góry Kaczawskie, Sudetes (SW Poland). *Neues Jahrb. Geol. Paläont. Mh.*, pp. 31-47.
- GUO, B., SANDERS, J. E. and FRIEDMAN, G. M. 1991. Columbia Gas Company No. 1 Finnegan Boring, Washington County, New York: microlithofacies and petroleum prospects in Lower Paleozoic platform strata beneath Taconic Allochthon. *Northeastern Geology* 12, pp. 238-265.
- GUO, B., SANDERS, J. E. and FRIEDMAN, G. M. 1991. Petrophysical characteristics of selected formations penetrated by the Finnegan Boring, southern Washington County, New York. *Northeastern Geology* 13, pp. 32-38.
- HARPER, D. A. T., PARKES, M. A., HÖEY, A. N. and MURPHY, F. C. 1991. Intra-Iapetus brachiopods from the Ordovician of eastern Ireland: implications for Caledonide correlation. *Canadian Journal of Earth Sciences* 27, pp. 1757-1761.
- HEATH, R. A. and OWEN, A. W. 1991. Stratigraphy and biotas across the Ordovician-Silurian boundary in Hadeland, Norway. *Norsk Geologisk Tidsskrift* 71, pp. 91-106.
- HENRY, J. -L and DESTOMBES, J. 1991. Un biofacies à Trilobites Homalonotidae dans l'Ordovicien de la marge nord-gondwanienne: implications paléobiologiques et paléographiques. *Lethaia* 24, pp. 249-253.
- HERRERA, Z. and BENEDETTO, J.L. 1991. Early Ordovician faunas of the Precordilleran basin, western Argentina. In MACKINNON, D. I., LEE, D. E. and

- CAMPBELL, J. D. (ed.). *Brachiopods through time, Proceedings of the 2nd International Brachiopod Congress, University of Otago, Dunedin, New Zealand, 5-9 February, 1990.*, pp. 283-302. A.A. Balkema, Rotterdam.
- HIGGINS, A. K., INESON, J. R., PEEL, J. S., SURLYK, F. and SØNDERHOLM, M. 1991. Lower Palaeozoic Franklinian Basin of North Greenland. In PEEL, J. S. and SØNDERHOLM, M. (ed.). *Sedimentary basins of North Greenland. Bulletin Grønlands Geologiske Undersøgelse* 160, pp. 71-139.
- KALVACHEVA, R. 1990. Review of microfossil datings (Early Paleozoic acritarchs and Devonian crinoid ossicles) of low-grade metamorphic rocks in Stara Planina Mountains and Vakarel Hill. In NIKOLOV, T. G. (ed.). *Microfossils in Bulgarian stratigraphy.*, pp. 13-22. Bulgarian Geological Society [in Russian].
- KANARIS-SOUTIRIOU, R., MILLWARD, D. and RUNDLE, C. C. 1991. The Great Whinscale Dacite - an enigmatic lava flow from the Borrowdale Volcanic Group, English Lake District. *Proceedings of the Yorkshire Geological Society* 48, pp. 393-408.
- KESSLER, G. 1991. Subsidence controlled stratigraphic sequences and the origin of shelf sand ridges, Winnipeg Group (Middle Ordovician), Manitoba, Saskatchewan and North Dakota. In CHRISTOPHER, J. E. and HAIDL, F. (ed.). *Sixth International Williston Basin Symposium. Saskatchewan Geological Society, Special Publication 11*, pp. 1-13.
- KOREN, T. N. 1991. Evolutionary crisis of the Ashgill graptolites. In BARNES, C.R. and WILLIAMS, S. H. (ed.). *Advances in Ordovician geology. Geological Survey of Canada, Paper 90-9*, pp. 157-164.
- KORTS, A. 1991. Distribution of calcareous algae, oncolites and stromatolites in Wenlock-Ludlow boundary beds in Estonia. *Proceedings of the Estonian Academy of Sciences, Geology* 40, pp. 43-49.
- LAURIE, J. R. 1991. Articulate brachiopods from the Ordovician and Lower Silurian of Tasmania. *Memoir of the Association of Australasian Palaeontologists* 11, pp. 1-106.
- LAURIE, J. R. 1991. Ordovician brachiopod biostratigraphy of Tasmania. In MACKINNON, D. I., LEE, D. E. and CAMPBELL, J. D. (ed.). *Brachiopods through time, Proceedings of the 2nd International Brachiopod Congress, University of Otago, Dunedin, New Zealand, 5-9 February, 1990.*, pp. 303-310. A.A. Balkema, Rotterdam.
- LAURIE, J. R., NICOLL, R. S. and SHERGOLD, J. H. (compilers). 1991. Lower-Middle Ordovician siliciclastics and carbonates of the Amadeus Basin, Northern Territory. Sixth International Symposium on the Ordovician System. Guidebook for Field Excursion 2. *Bureau of Mineral Resources, Geology and Geophysics, Record 1991/49*, pp. 1-74.
- LAURIE, J. R., WEBBY, B. D., NICOLL, R. S. and SHERGOLD, J. H. (ed.). 1991. Sixth International Symposium on the Ordovician System, Abstracts. *Bureau of Mineral Resources, Geology and Geophysics, Record 1991/47*, pp. 1-41.
- LEE, D. -J and ELIAS, R. J. 1991. Mode of growth and life-history strategies of a Late Ordovician halysitid coral. *Journal of Paleontology* 65, pp. 191-199.

- LENZ, A. C. and MELCHIN, M. J. 1991. Wenlock (Silurian) graptolites, Cape Phillips Formation, Canadian Arctic Islands. *Transactions of the Royal Society of Edinburgh: Earth Sciences* 82, pp. 211-237.
- LEONE, F., HAMMANN, W., LASKE, R., SERPAGLI, E. and VILLAS, E. 1991. Lithostratigraphic units and biostratigraphy of the post-sardic Ordovician sequence in south-west Sardinia. *Boll. Soc. Paleontol. Italiana* 30, pp. 201-235.
- MALETZ, J., RUSHTON, A. W. A. and LINDHOLM, K. 1991. A new Ordovician didymograptid, and its bearing on the correlation of the Skiddaw Group of England with the Tøyen shale of Scandinavia. *Geological Magazine* 128, pp. 335-343.
- MCCRACKEN, A. D. 1991. Middle Ordovician conodonts from the Cordilleran Road River Group, northern Yukon. In ORCHARD, M. J. and MCCRACKEN, A. D. (ed.). *Ordovician to Triassic conodont paleontology of the Canadian Cordillera. Geological Survey of Canada, Bulletin* 417, pp. 41-63.
- MELCHIN, M. J. and MITCHELL, C. E. 1991. Late Ordovician extinction in the Graptoloidea. In BARNES, C. R. and WILLIAMS, S. H. (ed.). *Advances in Ordovician geology. Geological Survey of Canada, Paper* 90-9, pp. 143-156.
- MERGL, M. 1992. Arenig (Lower Ordovician) orthid brachiopods from the Prague Basin, Bohemia. *Casopis Min. Geol.* 36, pp. 1-13.
- MIDDLETON, P. D., MARSHALL, J. D. and BRENCLEY, P. J. 1991. Evidence for isotopic change associated with Late Ordovician glaciation, from brachiopods and marine cements of central Sweden. In BARNES, C. R. and WILLIAMS, S. H. (ed.). *Advances in Ordovician geology. Geological Survey of Canada, Paper* 90-9, pp. 313-323.
- MITCHELL, C. E. and BERGSTRÖM, S. M. 1991. New graptolite and lithostratigraphic evidence from the Cincinnati region, U.S.A., for the definition and correlation of the base of the Cincinnati Series (Upper Ordovician). In BARNES, C.R. and WILLIAMS, S.H. (ed.). *Advances in Ordovician geology. Geological Survey of Canada, Paper* 90-9, pp. 59-77.
- MURPHY, F. C. et al. 1991. An appraisal of Caledonian suspect terranes in Ireland. *Irish Journal of Earth Sciences* 11, pp. 11-41.
- NIKITIN, I. F., FRID, N. M. and ZVONTSOV, V. S. 1991. Paleogeography and main features of volcanicity in the Ordovician of Kazakhstan and North Tien Shan. In BARNES, C. R. and WILLIAMS, S. H. (ed.). *Advances in Ordovician geology. Geological Survey of Canada, Paper* 90-9, pp. 259-270.
- NORFORD, B. S. 1991. The international working group on the Cambrian-Ordovician boundary: report of progress. In BARNES, C. R. and WILLIAMS, S. H. (ed.). *Advances in Ordovician geology. Geological Survey of Canada, Paper* 90-9, pp. 27-32.
- OLD, R. A. et al. 1991. Geology of the country around Redditch. *Memoir of the British Geological Survey Sheet 183 (England and Wales)*
- ORCHARD, M. J. and MCCRACKEN, A. D. (ed.). 1991. *Ordovician to Triassic conodont paleontology of the Canadian Cordillera. Geological Survey of Canada, Bulletin* 417, pp. 1-335.
- ORTEGA, G., and BRUSSA, E. 1990. La Subzona de *Climacograptus bicornis*

- (Caradociano temprano) en la Formación Las Plantas en su localidad tipo, Precordillera de San Juan, Argentina. *Ameghiniana* 27.
- OWEN, A. W., HARPER, D. A. T. and RONG, J. 1991. Hirnantian trilobites and brachiopods in space and time. In BARNES, C. R. and WILLIAMS, S. H. (ed.). *Advances in Ordovician geology. Geological Survey of Canada, Paper* 90-9, pp. 179-190.
- OWEN, A. W., HARPER, D. A. T. and ROMANO, M. 1992. The Ordovician biogeography of the Grangegeeth terrane and the position of the Iapetus suture in western Ireland. *Journal of the Geological Society of London* 149 (1), 1991.
- PALMER, D. and RICKARDS, R. B. (ed.). *Graptolites-writing in the rocks. Fossils illustrated, vol. 1.* Boydell, Woodbridge.
- PARKES, M. A. and VAUGHAN, A. P. M. 1991. Discussion on sequence stratigraphy of the Welsh Basin. *Journal of the Geological Society of London* 148, pp. 1144.
- PEEL, J. S. 1991. The classes Tergomya and Helcionelloida, and early molluscan evolution. *Bulletin Grønlands Geologiske Undersøgelse* 161, pp. 11-65.
- PEEL, J. S. 1991. Functional morphology of the Class Helcionelloida nov., and the early evolution of the Mollusca. In SIMONETTA, A. and CONWAY MORRIS, S. (ed.). *The early evolution of Metazoa and the significance of problematic taxa*, pp. 157-177. Cambridge University Press, Cambridge.
- PEEL, J. S. 1991. Salpingostomatiform and related bellerophontacean gastropods from Greenland and the Baltic region. *Bulletin Grønlands Geologiske Undersøgelse* 161, pp. 67-116.
- PEEL, J. S. and SØNDERHOLM, M. (ed.). 1991. *Sedimentary basins of North Greenland. Bulletin Grønlands Geologiske Undersøgelse* 160, pp. 1-164.
- PERCIVAL, I. G. 1991. Late Ordovician articulate brachiopods from central New South Wales. *Association of Australasian Palaeontologists, Memoir* 11, pp. 107-177.
- POHLER, S.L. and ORCHARD, M.Y. 1991. Ordovician conodont biostratigraphy, western Canadian Cordillera. *Geological Survey of Canada, Paper* 90-15, 1-37 pp.
- POTTER, A. W. 1991. Discussion of the systematic placement of the Ordovician brachiopod genera *Cooperea* and *Craspidelia* by Cocks and Rong (1989). *Journal of Paleontology* 65, pp. 742-755.
- POTTER, A. W. et al. 1991. Early Paleozoic stratigraphic, paleogeographic, and biogeographic relations of the eastern Klamath belt, northern California. *Geological Society of America, Special Paper* 225, pp. 57-74.
- POTTER, A. W., WATKINS, R., BOUCOT, A. J., ELIAS, R. J., FLORY, R. A. and RIGBY, J. K. 1991. Biogeography of the Upper Ordovician Montgomery Limestone, Shoo Fly Complex, northern Sierra Nevada, California, and comparisons of the Shoo Fly Complex with the Yreka terrane. *Geological Society of America, Special Paper* 255, pp. 33-41.
1991. PUURA, I., KALM, V., KIVISILLA, J., KLEIN, V., PUURA, V., RAUDSEP, R. and RIET, K. (ed.). *Geology and mineral resources of Estonia: Symposium materials*, pp. 1-100. Tallinn [in Estonian].
- PUURA, V., KALM, V. and PUURA, I. (ed.). 1991. *Geology and mineral resources of Estonia: Excursion guide*, pp. 1-81. Tallinn [in Estonian].

- PUURA, I., ROOSE, A. and BAUERT, H. 1991. Oil shale geology and mining. In European Workshop on: Human impact on environment. Tartu, 1991, pp. 43-53.
- ROHR, D. M. 1991. Incomplete and complete shell borings from the Ordovician (Whiterockian) of Nevada. *Journal of Paleontology* 65, pp. 687-688.
- ROMANO, M. 1991. Lower to Middle Ordovician trace fossils from the Central Iberian Zone of Portugal and Spain. In BARNES, C. R. and WILLIAMS, S. H. (ed.). *Advances in Ordovician geology. Geological Survey of Canada, Paper 90-9*, pp. 191-204.
- ROMANO, M. 1991. Trilobites from the Ordovician of Portugal. *Palaeontology* 34, pp. 329-355.
- SÁNCHEZ, T.M. 1990. Bivalvos del Ordovicico medio-tardio de la Precordillera de San Juan, Argentina. *Ameghiniana* 27.
- SÁNCHEZ, T. M., BENEDETTO, J.L. and BRUSSA, E. 1991. Late Ordovician stratigraphy, paleoecology, and sea level changes in the Argentine Precordillera. In BARNES, C. R. and WILLIAMS, S. H. (ed.). *Advances in Ordovician geology. Geological Survey of Canada, Paper 90-9*, pp. 245-258.
- SCOTESE, S. R. and MCKERROW, W. S. 1991. Ordovician plate tectonic reconstructions. In BARNES, C. R. and WILLIAMS, S. H. (ed.). *Advances in Ordovician geology. Geological Survey of Canada 90-9*, pp. 271-282.
- SHERGOLD, J. H., NICOLL, R. S., LAURIE, J. R. and RADKE, B. M. 1991. The Cambrian-Ordovician boundary at Black Mountain, western Queensland. Sixth International Symposium on the Ordovician System, Guidebook for Field Excursion 1. *Bureau of Mineral Resources, Geology and Geophysics, Record 1991/48*, pp. 1-50.
- SLOAN, R. E. 1991. A chronology of North American trilobite genera. In BARNES, C. R. and WILLIAMS, S. H. (ed.). *Advances in Ordovician geology. Geological Survey of Canada, Paper 90-9*, pp. 165-177.
- SMITH, M. P. 1991. Ordovician conodonts of East and North Greenland. *Meddelelser om Grønland* 26, pp. 1-80.
- STAIT, B. A. and BARNES, C. R. 1991. Stratigraphy of the Middle Ordovician Long Point Group, western Newfoundland. In BARNES, C. R. and WILLIAMS, S. H. (ed.). *Advances in Ordovician geology. Geological Survey of Canada, Paper 90-9*, pp. 235-244.
- STAIT, K. A. and BARNES, C. R. 1991. Conodont biostratigraphy of the upper St. George Group (Canadian to Whiterockian), western Newfoundland. In BARNES, C.R. and WILLIAMS, S. H. (ed.). *Advances in Ordovician geology. Geological Survey of Canada, Paper 90-9*, pp. 125-134.
- STONE, P., GREEN, P. M., LINTERN, B. C., PLANT, J. A., SIMPSON, P. R. and BREWARD, N. 1991. Geochemistry characterizes provenance in southern Scotland. *Geology Today Sept-Oct 1991*, pp. 177-181.
- STONE, P. and SMELLIE, J. L. 1991. The Ballantrae ophiolite, Scotland: an Ordovician island arc-marginal basin assemblage. In MALPAS, J., MOORES, E.M., PANAYIOTOU, A. and XENOPHOTOS, C. (ed.). *Ophiolites: oceanic crustal analogues. Proceedings of the Symposium "TROODOS 1987". Geological Survey*

- Department, Nicosia, Cyprus.
- SURLYK, F. 1991. Tectonostratigraphy of North Greenland. In PEEL, J. S. and SØNDERHOLM, M. (ed.). *Sedimentary basins of North Greenland. Bulletin Grønlands Geologiske Undersøgelse* 160, pp. 25-47.
- TORSVIK, T., RYAN, P. D., TRENCH, A. and HARPER, D. A. T. 1991. Cambrian-Ordovician palaeogeography of Baltica. *Geology* 19, pp. 7-10.
- TRENCH, A., MCKERROW, W. S. and TORSVIK, T. H. 1991. Ordovician magnetostratigraphy: a correlation of global data. *Journal of the Geological Society, London* 148, pp. 949-957.
- TRENCH, A. and TORSVIK, T. H. 1991. The Lower Palaeozoic apparent polar wander path for Baltica: palaeomagnetic data from Silurian limestones of Gotland, Sweden. *Geophysics J. Int.* 107, pp. 373-379.
- VAHER, R., WINTERHALTER, B., MÄGI, S. and PÖLIMA, L. 1991. Osadocnij chehol. In RAUKAS, A. (ed.). *Geologiya Finskogo zaliva*, pp. 1-149. Valgus, Tallinn.
- VANDEBERG, A.H.M. and STEWART, I.R. 1991. The Ordovician graptolite sequence of Victoria. Guidebook for Field Excursion 4. *Bureau of Mineral Resources, Geology and Geophysics, Record 1991/51*.
- WEBBY, B. D., VANDENBERG, A. H. M., COOPER, R. A., STEWART, I., SHERGOLD, J. H., NICOLL, R. S., BURRETT, C. F., STAIT, B., COOPER, B. J., LAURIE, J. and SHERWIN, L. 1991. Subdivisions of the Ordovician System in Australia. In BARNES, C. R. and WILLIAMS, S. H. (ed.). *Advances in Ordovician geology. Geological Survey of Canada, Paper 90-9*, pp. 47-57.
- WILDE, P. 1991. Oceanography in the Ordovician. In BARNES, C. R. and WILLIAMS, S. H. (ed.). *Advances in Ordovician geology. Geological Survey of Canada, Paper 90-9*, pp. 283-298.
- WILLIAMS, D. M. and HARPER, D. A. T. 1991. End Silurian modifications of Caledonian terranes in western Ireland. *Journal of the Geological Society, London* 148, pp. 165-171.
- WILLIAMS, S. H. 1991. Stratigraphy and graptolites of the Upper Ordovician Point Leamington Formation, central Newfoundland. *Canadian Journal of Earth Sciences* 28, pp. 581-600.
- WILLIAMS, S. H. and O'BRIEN, B. H. 1991. Silurian (Llandovery) graptolites from the Bay of Exploits, north-central Newfoundland, and their geological significance. *Canadian Journal of Earth Sciences* 28, pp. 1534-1540.
- WILLIAMS, S. H. and STEVENS, R. K. 1991. Late Tremadoc graptolites from western Newfoundland. *Palaeontology* 34, pp. 1-48.
- WYBORN, D., SHERWIN, L., WEBBY, B. D., ABELL, R. S. and PERCIVAL, I. G. 1991. Ordovician basins, volcanoes and shelves, southern and central New South Wales. Sixth International Symposium on the Ordovician System. Guidebook for Field Excursion 3. *Bureau of Mineral Resources, Geology and Geophysics, Record 1991/50*.
- YOCHELSON, E. L. 1991. Contributions of 19th century Canadian geologists to the adoption of the Ordovician System. In BARNES, C. R. and WILLIAMS, S. H. (ed.).

- Advances in Ordovician geology. Geological Survey of Canada, Paper 90-9, pp. 79-84.*
- ZHANG, J. and HAN, N. 1991. Discovery of Stelleroidea from the Upper Ordovician in China. *Geological Review* 37, pp. 368-372.

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