

Ordovician NEWS

**IUGS COMMISSION ON STRATIGRAPHY
SUBCOMMISSION ON ORDOVICIAN STRATIGRAPHY**

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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 I am notified of any changes in address, telephone or fax number and e-mail address. Submissions for inclusion in the next issue of *Ordovician News* should arrive before 31 January 1995; when providing lists of recent publications, please include only fully refereed articles and books (not abstracts) published during 1994.

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 either on 3 1/2" diskette (either Macintosh or IBM, but please state operating system and software used) or via e-mail (preferably as encoded file).

EDITOR'S NOTE

My thanks go to Kelly Brophy for help with typing and distribution of *Ordovician News*. A directory of Ordovician Subcommission members who are now on e-mail networks is included in the current issue. In future I will send notices, requests for contributions, etc. via this method in addition to mailing material which should help speed up the process. Please keep me informed of any new or revised addresses (send to williams@sparky2.esd.mun.ca). Several longer discussion articles are included within the current issue; I encourage you to respond to myself and/or Barry Webby, and would welcome similar contributions for future volumes.

Henry Williams

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SUMMARY OF THE 1993 ANNUAL REPORT FROM THE SUBCOMMISSION ON ORDOVICIAN STRATIGRAPHY TO IUGS

2. Objectives

ISOS through its voting and corresponding membership aims to promote and coordinate all aspects of work on Ordovician stratigraphy, especially those focusing on the establishment of a unified global Ordovician time scale.

Specifically our current objectives are:

- 1) To prepare Ordovician correlation charts and explanatory notes as a basis for assembling a worldwide data-bank for global analysis of Ordovician correlation and events (a task now largely completed)
- 2) To work towards achieving standardization of internal boundaries of the Ordovician on a global basis (identifying most significant biohorizons for global correlation, finding the best boundary stratotype and framing revised Series and/or Stage divisions)
- 3) To promote regular international meetings on all aspects of Ordovician geology, especially those devoted to new stratigraphic methods and procedures.

3. Organization

Subcommission on Ordovician Stratigraphy:

Chairman - B.D. Webby (Australia)

Vice Chairman - Chen Xu (China)

Secretary - S.H. Williams (Canada)

Titular members - 22

Corresponding members - 78

The Subcommission includes one official, formally affiliated Cambrian-Ordovician Boundary Working Group, and a number of informally established groups focusing on internal boundaries, as follows:

a. Cambrian-Ordovician Boundary Working Group:

Chairman and Secretary - two candidates, R.A. Cooper (New Zealand) and G. Nowlan (Canada), proposed by nominating committee of ISOS Executive Webby and Williams, and Cambrian Subcommission Executive of Brasier and M. Taylor. A postal ballot of Titular members (with closing date of 15 November 1993) will resolve who becomes Chairman; the other has agreed to act as Secretary

Titular members - 13

Corresponding members - 57

b. Working groups focusing on 7 graptolite and conodont biohorizons with promising correlation potential for internal series and/or stage subdivisions.

4. Extent of National/Regional/Global Support of Projects

Independent support for projects comes mainly from individual Ordovician workers, through their employer organizations, and through their individual project grants from national government-funded bodies like the US National Science Foundation (NSF) and the Australian Research Council (ARC).

5. Interface with other International Projects

The Ordovician Subcommission has no official links with other global projects, though some individual Ordovician workers are members of various IGCP projects.

6. Accomplishments and products generated in 1993

a) Two Ordovician correlation charts and explanatory notes (IUGS Publication 28, East European Platform and Tuva - Asiatic Russia - 64 pp. + chart; and IUGS Publication 29, Greenland and South Africa - 52 pp. + charts) were submitted in camera ready copy to the IUGS Secretary General, Dr. Robin Brett, for publication in the new combined IUGS/Geological Society of America publication series. It is expected these will be in print before the end of 1993.

b) The Chairman (Barry Webby) spent five weeks in the Nanjing Institute of Geology and Palaeontology, China, during August-September 1993 and for much of this time revised and edited the final Ordovician correlation chart (82 columns) and explanatory notes (260 pp.) for the IUGS publication series.

c) A very successful field and indoor meeting was organized by ISOS Vice Chairman Chen Xu in China from August 27 to September 12, and was attended by a number of Subcommission members (Webby, Bergström, Mitchell, Wang Zhi-hao, Rong Jia-yu and Zhou-Zhiyi) and others. It involved indoor discussions in Nanjing focusing on the base of the *austrodentatus* Zonal level for global subdivision of the Ordovician, and a twelve day field trip to important potential boundary sections through this interval in an area near Changshan, Jiangshan and Yushan, on the borders between Zhejiang and Jiangxi Provinces (SE China).

d) A position paper on the *approximatus* level (base of "Arenig" with proposed stratotype in western Newfoundland prepared by S. Henry Williams and others) is now ready to be circulated to the voting membership for consideration, and hopefully a postal ballot in the next few months.

e) The Chairman also held discussions with Prof. J. Remane (Chairman ICS) in Neuchatel on 8 October, Dr. J. Cowie (Past Chairman ICS) in Bristol on 19 October, and various ISOS members (J.C. Gutierrez Marco in Madrid, 29 Sept. - Oct.; A. Owen in Glasgow, 14 October; and R. Fortey in London, 20-21 Oct.). He also attended the "Friends of the Ordovician" at the GSA meeting in Boston on 26 October.

f) Publication and distribution of *Ordovician News* No. 10 was arranged by ISOS Secretary Henry Williams in May 1993.

g) Establishing the new ISOS Cambrian-Ordovician Boundary Working Group has taken most of 1993 because of the need to consult fully at each stage in establishing the group with the Chairmen of ICS, the Chairman of the Cambrian Subcommission, and with other executive and titular members of Ordovician Subcommission. The proposed slate of 12 new voting members was circulated to Cambrian and Ordovician Subcommission voting members with a call for further nominations in April, and at the close of nomination on 15 June only one addition had been proposed. This resulted in a final Titular membership for the new group of 13 persons as follows: Chen Junyuan (China), R.A. Cooper (N.Z.), S. Dubinina (Russia), B. Erdtmann (Germany), R.

Ethington (USA), R. Fortey (UK), D. Kaljo (Estonia), R. Nicoll (Australia), G. Nowlan (Canada), R. Ripperdan (USA), A. Rushton (UK), J. Shergold (Australia), J. Taylor (USA).

A nominating committee comprising Chairmen and Secretaries of both Cambrian and Ordovician Subcommissions recommended two candidates (Cooper and Nowlan) for Chairman, and a postal ballot was circulated to the 13 Titular members in August for decision by mid November. Further details of organization of the new group are given in section 3a (above).

Meanwhile, work by Nowlan and Nicoll on the conodonts collected on a field trip to the Dayangcha boundary section, China, in April 1992 is continuing. Focus is now being given to the species of *Iapetognathus* as well as the cordylodids.

7. Problems encountered in 1993

No major problems were encountered.

8. Work plan for 1994

a. Main focus of Subcommission work will be directed to completion of preparation, and circulation of position papers on a number of biohorizons, and their possible stratotypes, for levels in the lower half of the Ordovician, in ascending order, from the base of the *approximatus* zone (base of "Arenig"), to the *triangularis/laevis* zone (base of "Whiterock") to the *austrodentatus* zone or *artus* zone (base of "Llanvirn") and to the *gracilis* zone (base of "Caradoc"). Focus on the upper half of the Ordovician will be left to later years. A decision will need to be taken as to whether primary focus should be given to a level at the base of *austrodentatus* or to the base of *artus* (as a potential base of the "Llanvirn"), and there will need to be full discussion among the membership about how we can redirect the main focus of our work to the establishment of global stages rather than series. A number of postal ballots are planned, and hopefully these will achieve some positive decisions before the end of next year.

b. A book entitled the "Base of the *austrodentatus* Zone as a level for global subdivision of the Ordovician" edited by Chen Xu and S.M. Bergstrom will be published in Nanjing in October 1994 (as No. 5 in the *Palaeoworld* Series), and *Ordovician News* No. 11 will also be published. It is expected that the eleventh and final Ordovician correlation chart and explanatory notes, for China, will be published by IUGS in its joint venture with GSA in 1994.

c. I am unable to comment in detail on likely work plan for the new Cambrian-Ordovician Boundary Working Group. However, both candidates for Chairman (Cooper and Nowlan) have indicated they are committed to making active progress once the ballot is declared in mid November 1993. It will be necessary for the new Chairman to examine the Dayangcha section prior to a final vote - partial support towards a return air fare from Calgary or Wellington to China is essential.

9. Potential Funding Sources outside IUGS

The Subcommission has no potential outside funding sources.

10. Anticipated Work Plan for Period 1995-1998

1995. The 7th International Symposium on the Ordovician System will be held in Las Vegas, USA from June 12-16, 1995. A second circular will be prepared and mailed in a few months. A varied technical and excursion program has been outlined in the First Circular (available from Ms. M.N. Rees, Secretary, 7th ISOS, Dept of Geosciences, Univ. of Nevada, Las Vegas, Las Vegas, NV 89154-4010, USA). A symposium volume of short papers will be published.

The Subcommission work in 1994 and through the first half of 1995 will be directed towards this important meeting - we expect to hold a series of Workshops (as we did in Sydney in 1991) focusing on the subdivision of the Ordovician System - progress and future directions. We expect that a number of proposals for global stratotype section and points (GSSPs) for Stage (and or Series) boundaries will be ready for circulation to ICS and IUGS by mid 1995.

1996. The 30th International Geological Congress will be held in Beijing in 1996, and we have already formally requested an active program of Ordovician discussions at the Congress, in the stratigraphy and palaeontology sessions. I made these requests to Professor Zhao Xun, Secretary General of the Geological Society of China and Director of the Office of the 30th IGC in Beijing on 24 September, specifically for two themes: 1) "Towards an integrated global Ordovician time scale: boundaries and subdivisions"; and 2) "Temporal and spatial patterns of Ordovician biodiversity". Co-convenors for these themes would be B.D. Webby, Chen Xu and Wang Xiao-feng (all Ordovician titular members). Chen Xu also proposes to organize a pre-Congress field trip for Ordovician workers to the Tarim Basin, NW China.

1997-8. I would hope that priority will continue to be given by a new Chairman of the Ordovician Subdivision to completing all the documentation of suitable boundary stratotypes for the Stage and Series subdivisions of the Ordovician System.

Barry Webby

CHANGES IN MEMBERSHIP

Michel Robardet (France) has transferred from Titular membership to Corresponding Member of ISOS, while Juan Carlos Gutierrez Marco (Spain) has been made a new Titular Member. Other new Corresponding Members include Naima Hamoumi (Morocco), Lars Holmer (Sweden) and Thomas Servais (Belgium). We welcome these new members to the Ordovician Subcommission and trust that they will be active contributors to our work.

ORDOVICIAN CORRELATION CHARTS

Presently, two volumes of charts (IUGS Publication 28, East European Platform and Tuva - Asiatic Russia - 64 pp. + chart; and IUGS Publication 29, Greenland and South Africa - 52 pp. + charts) are in press and should be appearing imminently, while Barry Webby is helping to assemble the final version of the Chinese Correlation Chart. All are being published in the new combined IUGS/Geological Society of America publication series.

TOWARDS ESTABLISHING GLOBALLY APPLICABLE BOUNDARIES FOR THE ORDOVICIAN SYSTEM: MAJOR INTERNATIONAL DIVISIONS AND CRITERIA FOR DEFINITIONS

1. Introduction

The International Subcommission on Ordovician Stratigraphy (ISOS) was established under the aegis of the International Union of Geological Sciences (IUGS) and International Commission on Stratigraphy (ICS) in 1974, but progress towards establishing globally recognizable intra-Ordovician subdivisions has been slow, especially given the wide ranging regional and provincial differences between Ordovician successions and biotas in the various lithospheric plates.

Prior to the Third International Symposium on the Ordovician System held in Columbus, Ohio in August 1977, efforts were directed to establishing a balanced regional distribution of membership, promoting improved radiometric dating of the Ordovician System, and actively supporting the independently established intersystem working groups, at the base and top of the Ordovician, respectively.

2. Ordovician correlation charts

However, at the Ohio meeting it was resolved to establish the major project of constructing a series of Ordovician correlation charts and explanatory notes for each lithospheric plate as a basis for all other activities such as: (i) the search for international agreement on the subdivision of the Ordovician System, (ii) the recognition of major global events, and (iii) attempts to integrate existing biostratigraphic, magnetostratigraphic and radiometric data into a unified scheme. This correlation chart project has since continued under the general editorship of Reuben J. Ross Jr, and has now provided a wide coverage - series of eleven IUGS publications - nos. 1 (China, 1980), 2 (Near & Middle East, 1980), 6 (Australia, New Zealand & Antarctica, 1981), 8 (Canada, 1981), 11 (SW Europe, 1982), 12 (United States, 1982), 21 (Kazakhstan & Middle Asia, 1986), 22 (South America, 1987), 26 (Russian Asia - including the Siberian Platform and NE Russia, 1988), 28 (East European Platform & Tuva, SE Russia, 1994) & 29 (Greenland & South Africa, 1994). A final revised and updated Chinese chart is expected to be published in 1995.

3. Regional chronostratigraphy working groups

A second important project was established during the Fourth International Ordovician Symposium at Oslo, Norway, in August 1982, with a series of regional chronostratigraphy working groups aimed mainly at appraising stratigraphic subdivisions for each region and establishing, despite the known region-to-region complexities of stratigraphic relationships, zonal ties with successions in other regions. Good progress was achieved by some of these working groups but others had limited success. From the formal reports presented at the Fifth International Symposium on the Ordovician System in St. John's Newfoundland meeting and workshop discussions in 1988 (see proceedings volume, C.R. Barnes & S.H. Williams, 1991, "Advances in Ordovician Geology" *Geol. Surv. Canada Paper* 90-9), it was recommended that future work primarily focus on

particular zonal levels that represent significant bioevents and/or have excellent global correlation potential, whether consistent with, or not in accord with, the well-used, "historical", British Series.

4. Global chronostratigraphy working groups

This led to the present focus of work (since 1988) aimed at standardizing internal boundaries of the Ordovician System on a global basis, including the establishment of international boundary stratotypes. At the official Subcommission meeting held at the IGC in Washington D.C. in 1989, four global chronostratigraphy working groups were established (with convenors) to focus on zonal levels near the bases of the "Arenig" (W.B.N. Berry) "Llanvirn" (D. Bruton & R.J. Ross Jr), "Caradoc" (S. Bergström) and "Ashgill" (C.R. Barnes), respectively. Aims are: (i) to identify significant biohorizons for such global correlation using graptolites and/or conodonts, (ii) to use them in proposals for the revision of each Series boundary, and (iii) to find the best available boundary stratotype for the revised Series. Efforts have been focussed on zonal levels representing significant bioevents or where excellent correlation potential existed, in relatively close proximity to existing historical conceptions of Series divisions.

In Tallinn, Estonia, in 1990, a number of position papers were presented by the global chronostratigraphy working group convenors (or their proxies). Three general recommendations resulted from these discussions, namely that: (i) we should retain the British concept of Series divisions rather than downgrade them to stage intervals as suggested by some Soviet and German specialists; (ii) that there was general though by no means universal agreement that we should retain the British Series names in the interests of stability of nomenclature and priority; and (iii) that given the present state of knowledge we should focus on graptolites and conodonts as biostratigraphically the most important groups. The base of the *approximatus* graptolite Zone was demonstrated to be the best level to focus attention at or near the base of the "Arenig", and though not strictly equating with the base of the Caradoc, the level at the base of the *gracilis* graptolite Zone was seen to be the most easily recognized globally.

At the Sixth International Symposium on the Ordovician System at Sydney in July 1991, there was again a series of working group discussions aimed at the various key biozone levels through the Ordovician. Nine biozone levels (convenors in brackets) were targeted for investigation, as follows:

- Level 9 - base of *complanatus* (Barnes)
- Level 8 - base of *tubuliferus* (Barnes) [?base of Ashgill]
- Level 7 - base of *undatus/americanus* (Bergström & Barnes)
- Level 6 - base of *bicornis* (Bergström)
- Level 5 - base of *gracilis* (Bergström) [?base of Caradoc]
- Level 4 - base of *artus* (Bruton) [base of Llanvirn]
- Level 3 - base of *austrodentatus* (Bruton)
- Level 2 - base of *victoriae/laevis* (Ross) [base of Whiterock]
- Level 1 - base of *approximatus* (Berry) [base of Arenig]

A full report of the various Sydney workshop discussions was presented in *Ordovician News* no. 9 (1992, p.14-19) and will not be reiterated here. Focus has continued on a number of these biozone levels, and aspects of these will be discussed below.

5. New Cambrian-Ordovician Boundary Working Group

The former IUGS & ICS Cambrian-Ordovician Boundary Working Group (COBWG I) was disbanded by the ICS at the end of August 1992. After lengthy deliberations and consultation through the latter part of 1992 and much of 1993 a new ISOS Cambrian-Ordovician boundary (COBWG II) was established. Procedures and results have been reported elsewhere in *Ordovician News* nos 10 (1993) and 11 (1994). In mid December 1993, Dr Roger Cooper (New Zealand) and Dr Godfrey Nowlan (Canada) were ratified by the ICS Bureau as new Chairman and Secretary, respectively. The Subcommission is now administratively responsible for COBWG II.

Roger and Godfrey have already circulated a letter dated 8 February 1994 to all working group members outlining work progress, work plans, the present position, and requests for support (see separate report in this issue of *Ordovician News*). They have noted the important decisions of the previous Working Group, achieved in formal ballots as: (i) that the boundary horizon should be placed "at or near the base of the Tremadoc Series" (voted in 1982); (ii) that "conodonts be the primary guide for a horizon close to, but below the first influx of nematophorous graptolites" (voted 1985-86); and (iii) that Dayangcha is the favoured section (voted 1991).

In another important development, R.J. Ross Jr, L.F. Hintze, R.L. Ethington, J.F. Miller, M.E. Taylor and J.E. Repetski have circulated a preliminary 75 pp. report (with 3 pls, 1 Table and 10 figures) as *U.S. Geological Survey Open-File Report 93-598*, entitled 'The Ibexian Series (Lower Ordovician)', a replacement for "Canadian Series" in North American Chronostratigraphy'. The lower boundary of the Ibexian Series is recognized by the first appearance of the conodont *Cordylodus andresi* which locally defines the base of the *Hirsutodontus hirsutus* Subzone of the *C. proavus* Zone. This seemingly represents a boundary horizon well below the base of the Tremadoc Series, and well below the first influx of nematophorous graptolites. Graptolites are only recorded from the upper part of the Ibexian Series successions (from the Tulean and Blackhillsian stages). Significantly, however, a very complete conodont record (with associated shelly faunas) is represented upward from the base through the *C. intermedius*, *C. lindstromi*, *Iapetognathus* and *C. angulatus* zones.

6. Directives of new Executive of the International Commission on Stratigraphy 1993

No official meetings of the Ordovician Subcommission were held during 1992, but new officers of the ICS were installed during the IGC in Kyoto, Professor J. Remane, Univ. of Neuchatel, Switzerland as the new Chairman and Dr Klaus Gohrbandt, Chevron Oil, San Ramon, California, USA as Secretary General.

At the meeting of the Bureau of ICS in London, March 1993, the progress and work plans of constituent bodies were reviewed. The current goals of the commission included:

"to establish stratotypes (GSSPs) for all chronostratigraphic boundaries to stage level, from terminal Proterozoic to the end of the Cenozoic erathem". Furthermore it was noted that the "SC on Ordovician which was established in 1974, has not yet produced any definition of stages. Instead, it is publishing global correlation charts and is studying "series" of nine global graptolite/conodont zones. Chairman will encourage the SC to direct its activities toward the definition of stages".

Professor Remane in a consolidated report on ICS Subcommission activities in December 1993, further noted that "The classical European subdivisions of the Ordovician as Tremadoc, Arenig etc., are often difficult to correlate around the world due to strong paleogeographic provincialism. The SC has therefore chosen a different approach, searching for correlative biohorizons which may provide a base for solid boundary definitions. This research has obviously made good progress and should now lead to the establishment of formal units on series/stage level".

7. Subcommission Workshop and Field Meeting, Nanjing, China, August-September 1993

In late August to early September 1993, there was an Ordovician Subcommission workshop with other discussions and lectures at the Institute of Geology & Palaeontology, Academia Sinica, in Nanjing, hosted by Vice Chairman of the Subcommission, Professor Chen Xu, and there was also an opportunity to examine important "Arenig-Llanvirn" sections (specifically a base of the *austrodentatus* graptolite zonal level) in the field in the Jiangshan-Yushan-Changshang area of Zhejiang and Jiangxi provinces in SE China. Important discussions were held by a number of Titular and Corresponding members and others in Nanjing at the Workshop on 27 and 29 August, and again on 12 September after the field excursion. The workshop agenda was as follows: (i) previous Ordovician Subcommission visit to China, October 1978; (ii) Cambrian-Ordovician boundary review; (iii) internal Ordovician subdivisions, Sydney 1991 & ICS directive to define stages, March 1993; (iv) review of biozones with global correlation potential; (v) Ordovician ?series (Lower, Middle and Upper); (vi) Seventh International Symposium, Las Vegas, June 1995; (vii) Arrangements for next IGC, Beijing August 1996. The minutes of this meeting prepared by Dr Chuck E. Mitchell (State University of New York, Buffalo, USA), are published elsewhere in this issue of *Ordovician News*.

The field meeting from 1 - 11 September was one of the highlights of the visit, involving collection and study of the main "Arenig to Llanvirn" candidate sections (Huangnitang, Hentang, Chenjiawu, Quantouping, Fengzu and Huangnigang), within the Ningkuo Formation (shales with interbedded thin limestones), of the Jiangshan, Changshan and Yushan (JCY) area, SE China (Zhejiang & Jiangxi provinces), that is, is an area some 400 km south of Nanjing. Visits were also made to the Cambrian-Ordovician boundary section at Xiyangshan, to examine the plinth-like slates in Caradoc horizons at Yenwashan (near Changshan), and to the good exposures of mid-Ashgill carbonate mud mounds in the Jitoushan sections (and quarry) and mid-Ashgill coral biostromes and algal laminated carbonates of the Zhuzhai section (near Yushan). We also enjoyed many sightseeing stops *en route*, especially to the Lake of 1000 Islands near

Jiande, and on West Lake in Hangzhou.

The Huangnitang section near Changshan has a most continuous graptolite record (graptolites preserved in-the-round) across the base of the *Undulograptus austrodentatus* Zone and will be proposed as the primary candidate boundary stratotype section for Ordovician subdivision. Very good supplementary sections are also available in the JCY area (especially Hentang and Chenjiawu). An auxiliary stratotype (ASP) will also be established through the same interval in the shallower Yangtze Platform, where a good conodont record exists, as well as flattened graptolites. Chen Xu, S.M. Bergström, C.E. Mitchell, Wang Zhi-hao, D. Winston and Zhang Yuan-dong are currently preparing a full report on the *austrodentatus* Zone to be published towards the end of 1994, in issue Number 5 of *Palaeoworld*, a monograph series of the Laboratory of Palaeobiology & Stratigraphy, Nanjing Institute of Geology & Palaeontology, Academia Sinica. Included will be sections on the regional stratigraphy, lithological succession, depositional environments, graptolite and conodont faunal descriptions, zonations and global correlations.

8. General discussion of implications of ICS guidelines suggesting we give priority to establishing stages in our future work

In the light of the above-stated ICS directives, we should seriously consider adopting formal units at the stage, rather than series, level. There seems to be two alternative ways we could perhaps achieve this.

a. First alternative: As I have outlined in the discussions held in Nanjing last August (see Minutes of the Nanjing meeting published elsewhere in this issue of *Ordovician News*), we could establish eight stages based on the graptolite and conodont biozone scheme first outlined at the workshops in Sydney and relevant British subdivisions (see Scheme 1 in Fig 1). This would involve subdividing what seems to be the longer British intervals such as the Tremadoc, Arenig and Caradoc each into two, and the Llanvirn and Ashgill left as single stages (for a total of eight stage subdivisions). We would therefore be looking at focussing attention on the seven intervals: 1, at the base of Lancefieldian 2 (between lower and upper Tremadoc); 2, at establishing a GSSP on the *approximatus* level (base of Arenig); 3, at the base of *laevis/triangularis/victoriae* (base of Whiterock; i.e., between lower and upper Arenig); 4, at the base of *austrodentatus* (or *artus*) (base of Llanvirn); 5, at the base of *gracilis* (base of Caradoc); 6, at the base of *undatus/americanus* and Deiche bentonite of 454 Ma (between lower and upper Caradoc); and 7, at the base of *complanatus/ordovicicus* (base of Ashgill). We might contemplate using some British names but larger, subdivided intervals might be better with new global stage names. Alternatively we may be better to use subdivisions such as Tremadoc 1 and 2, Arenig 1 and 2 and Caradoc 1 and 2 as the stage level, and this may be less disruptive in terms of historical usage and priority (Fig. 1).

We should aim to establish a three-fold Series subdivision, with Lower, Middle and Upper Series, which would be far more useful and applicable for the geological community than named divisions. I have already outlined (see Nanjing SOS workshop report prepared by Chuck Mitchell), and I reiterate below, reasons why this approach

would be far more acceptable and useful. Of the eight stages, three might be best grouped in the Lower (up to base of Whiterock), two or three (to base of *gracilis* or to base of *undatus/americanus*) for the Middle, and the remaining two or three, to the Upper Series.

SERIES	SCHEME 1		SCHEME 2		SUGGESTED KEY GLOBAL GRAPTOLITE/CONODONT BIOZONE INTERVALS FOR SUBCOMMISSION STUDY	
	SERIES	STAGES	SERIES	STAGES	acuminatus	Dob's Linn, Scotland
ORDOVICIAN	U	Ashgill	U	Ashgill	<i>persculptus</i>	(?440 Ma)
		Caradoc 2		Caradoc	<i>complanatus/ordovicicus</i>	
	M	Caradoc 1	M	Llanvirn	<i>undatus(c)/americanus</i> (454 Ma) [?base of Eastonian]	
		Llanvirn		Llanvirn	<i>gracilis</i>	
	L	Arenig 2	L	Arenig	{ <i>artus</i> { <i>austrodentatus</i> [base of Darriwilian]	
		Arenig 1			<i>laevis(c)/triangularis(c)/victoriae</i> [base of Whiterock]	
	Tremadoc 2	Tremadoc 1	Tremadoc		<i>approximatus</i>	
					<i>lindstromi(c)</i>	Dayangcha, China
						(?490 Ma)

Figure 1.

b. Second alternative: A simpler approach would be to make the present British series the global stages, with a total of 5 stage divisions for the Ordovician, irrespective of their variable length (see Scheme 2 in accompanying Fig.1). This would mean 5 divisions for a period of about 50 Ma. Recent Cambrian ion probe dates range from 544Ma at the base of Lower Cambrian to 503 Ma at the level of late Middle Cambrian (J.H. Shergold 1994, "Problems of the Cambrian time scale" Abstracts volume of Australas. Palaeont. Convention, Macquarie Univ., Sydney, p.50) suggesting that the Cambrian-Ordovician boundary is likely to be only about 490Ma. For comparison the Devonian now has 7 formally adopted stages for an interval of about 55 Ma! And the Devonian seems a better model for comparison than the Silurian with its 8 stages for only 28 Ma! To be relatively consistent with the Devonian, the Silurian series should also be stages, probably just three - the Llandovery, Wenlock and the Ludlow-Pridoli (combined). The finer Silurian subdivisions would best be viewed as substages.

Introducing the five British Series as global Stages would in terms of priority and usage be less disruptive than that of the first proposal (to introduce eight Stage divisions), though there would be some differences in the length of these stages.

However, again looking at the Devonian as a model, there is considerable variation in the relative length of some Devonian stages, for example, the Emsian which is markedly longer than some of the others. Yet Devonian workers have not felt the need to subdivide it. Indeed there are already two formal Czech subdivisions of the Emsian Stage, namely the Zlickhovian and Dajelian, but they have not been adopted in the standardizing of the Devonian stage subdivisions. These Czech subdivisions may, as M.R. House (1988, "International definition of Devonian System boundaries": *Proc. Ussher Society* 7, 41-46) has noted, survive as substages. In the Ordovician we would certainly need to seriously consider formal adoption of the Hirnantian as a substage at the top of the Ashgill.

Again it would seem best to establish a three-fold subdivision into Series (named Lower, Middle & Upper) rather than two, or four, five or more subdivisions. In other parts of the geological column two Series subdivisions (Lower & Upper) are employed, for example, the Cretaceous and the Permian systems, but a threefold subdivision into Series is more commonly used, with Lower, Middle & Upper Series subdivisions for the Cambrian, Devonian, Triassic and Jurassic systems and three-fold named Paleocene, Eocene & Oligocene for the Paleogene System [see official IUGS 1989 Global Stratigraphic chart, in *Episodes* 12 (2)].

Not that we should slavishly follow patterns adopted in other parts of the geological column given our unique record, and complexity of stratigraphic relationships, but we must achieve a relatively simple, broad, two or three-fold grouping if for no other reason than to avoid the current chaos, with nearly every regional three-fold scheme subdivided differently, and with so many different conceptions of Middle Ordovician. It is clear from a brief survey of papers that, in discussing the general patterns of global faunal distributions, concepts of Lower (or early), Middle (middle) and Upper (late), have been used as often as the British (Tremadoc-Ashgill) subdivisions. For example, A. Williams used both approaches in discussing the broad patterns of global brachiopod distribution, first with mainly early, middle and late Ordovician subdivisions in the *Treatise on Invertebrate Paleontology*, Part H, pp. 237-250, 1965), and second using British subdivisions (in *Organisms and Continents through Time* no 12, pp. 241-269). V. Jaanusson in the *Treatise on Invertebrate Paleontology*, Part A, 136-166, 1979) also used both the more informal lower, middle and upper Ordovician subdivisions and the formal British (also a few North American and Baltic) names in his global review of Ordovician biogeography and biostratigraphy. More recently, however, the British terminology seems to have become increasingly accepted; for example, by Bergström in reviewing the global conodont patterns, and by Finney, Chen Xu, Berry & Wilde in their reviews of graptolite distributions (see papers in W.S. McKerrow & C.R. Scotese (eds) *Palaeogeography and Biogeography, Geological Society of London Memoir* 12). So clearly both the broader Lower, Middle & Upper Series terminology is needed, as well as the British nomenclature. If we adopt a British five Stage subdivision, then a broader threefold Series usage should be Tremadoc and Arenig as Lower, Llanvirn (incorporating the former Llandeilo) as Middle, and Caradoc-Ashgill as Upper Ordovician Series.

c. Further discussion: Many other alternative directions exist. Some workers, for example, would prefer to introduce new names, rather than to redefine the long used, and existing British (and/or North American) series or stage names. However I doubt whether the geological community will appreciate the introduction of a whole bevy of new names for the main Ordovician subdivisions, given that the British names, despite their inadequacies, have for so long been used, almost by default, as the global subdivisions, and by so many non-British Ordovician workers.

In making the above comments I have taken what some may regard as a somewhat provocative and activist stance, but I think we have reached a point in our Subcommission work where we need an overall plan and direction for our decision making, namely to establish stratotypes (GSSPs) for all Ordovician chronostratigraphic boundaries to stage level in reasonable time. Some of the matters discussed above have more to do with semantics than science. However, we must attempt to find, using democratic processes, the clearest overall expression of opinion of how the membership feels on these issues, and how you think we can achieve an early consensus on the best, most practical approach to the overall subdivision of the Ordovician System, given historical priority, and the known record and the complexities of the stratigraphic record. I therefore would much appreciate it if you have views on how we should next proceed, whether you support the first or the second approach indicated above, or an alternative approach, to please write to Henry Williams as Secretary, by 31 July 1994 at the latest.

9. Suggested Work Plan to mid-1996

(i) "Arenig" (with Bill Berry as convenor and assisted by Henry Williams)

The majority of members attending the "Arenig" workshop in Sydney agreed to use the base of the *approximatus* graptolite Zone and retain the term Arenig as the second Series ("Arenig") of the Ordovician. Bill Berry's presented a position paper, subsequently published in the proceedings volume (B.D. Webby & J.R. Laurie, 1992, *Global Perspectives on Ordovician Geology*, Balkema, Rotterdam, The Netherlands), in favour of establishing the base at this level. The Titular members of the Subcommission, in January-March 1992, voted in favour (18 votes for, 1 against) of "the base of the *approximatus* graptolite biozone as the base of the second Series of the Ordovician System".

A proposal for the global stratotype section and Point (GSSP) for the boundary at the base of the Arenig is now proposed by Henry Williams, Chris Barnes, Felicity O'Brien and Douglas Boyce (see Henry Williams' summary elsewhere in this issue of *Ordovician News*) in the Ledge section on the Cow Head Peninsula, western Newfoundland. I would like to establish in a preliminary ballot of Titular members whether there is support for establishment of this GSSP in this western Newfoundland section, based on the first occurrence of *Tetragraptus approximatus approximatus*, 2.9 m above the base of the Factory Cove Member, Shallow Bay Formation of the Cow Head Group. The base of the *Prionodus elegans* conodont Zone is given as "slightly above" the base of the *T.*

approximatus Zone. This is an excellent section, and with good index fossils which can be correlated globally.

It is hoped we can achieve a favourable formal vote by a good majority, so we can request acceptance and ratification of this boundary by ICS/IUGS later this year.

(ii). Whiterock (R.J. Ross Jr convenor)

An important paper was published by R.J. Ross Jr and R. L Ethington in the Sydney symposium proceedings volume, entitled North American Whiterock Series suited for global correlation (in B.D. Webby & J.R. Laurie, eds. 1992, *Global Perspectives on Ordovician Geology*, Balkema, Rotterdam, pp.135-152). Further discussion by the membership is needed to establish whether there is general support for further work at this level. Rube Ross, Stig Bergström and Chuck Mitchell have been requested to advise.

(iii) Llanvirn (D. Bruton convenor)

Opinion is currently divided between those who support a more traditional placement of the base of the Llanvirn within the Atlantic province using the base of the *D. artus* Zone, and those who would prefer the boundary defined in the Pacific province, slightly earlier, at the base of the *U. austrodentatus* Zone. This latter could be a redefined base for the Llanvirn (retaining the British name), or an alternative, relevant "Pacific" stage name could be used, such as Darriwilian. Two position papers are required as a basis for a decision as to which zonal index should be used. It is hoped that papers in favour of the *artus* level by David Bruton (and colleagues), and in favour of the *austrodentatus* level by Chuck Mitchell (and colleagues) can be assembled and circulated as a basis for a postal ballot in the second half of 1994.

(iv) Caradoc (S. Bergström/C. Barnes, convenors)

It has been recognized that the base of the *N. gracilis* graptolite Zone is a particularly good datum for global correlation, though the level lies within the middle of the *Pygodus anserinus* conodont Zone making precise ties with the conodont zonal succession difficult. It was suggested at the Nanjing workshop last August, that Stig Bergström and Stan Finney be approached to provide an updated version of their 1986 paper on the biostratigraphy of the *N. gracilis* Zone (in Hughes C.P. & Rickards, R.B. (eds) *Palaeoecology and Biostratigraphy of graptolites. Geological Society of London, Special Publication 20*, pp. 47-59) as a basis for circulation also later this year of a postal ballot for or against the base of *gracilis* as the base of the Caradoc.

Again following the recent discussions in Nanjing, it seems important that further evaluation of the *Phragmodus undatus/Corynoides americanus/Deike* bentonite level should be made. It seems to represent a very promising level for precise global correlation, given that it seems to coincide with the major Trenton transgression, the widespread Deike ash layer, in North America and Baltica, and the base approximates the base of the Eastonian in Australia. More regional work needs to be done, and better sections found, as a basis for a later decision.

(v) Ashgill (C. Barnes/S. Bergström, convenors)

The *Amorphognathus ordovicicus/Dicellograptus complanatus* zones seem to be recognized widely, and they represent well understood taxa. Consequently it is hoped that Chris Barnes and Stig Bergström (with the support of Henry Williams) will be able to assemble essential data in a position paper as a basis for a ballot later this year.

Barry Webby

PROPOSED ORDOVICIAN SCIENTIFIC PROGRAM FOR 30TH INTERNATIONAL GEOLOGICAL CONGRESS, BEIJING, 1996

During my visit to China in August-September 1993, I discussed with Professor Chen Xu (Nanjing) and Professor Wang Xiaofeng (Yichang) the possibility of an active program of discussions at the next IGC, on the following two themes:

- (i) "Towards an integrated global Ordovician time scale: boundaries and subdivisions"
- (ii) "Temporal and spatial patterns of Ordovician biodiversity"

The first topic is vitally important, a primary goal of the work of the Subcommission. The second focuses on the major Ordovician radiation event, a period of the greatest diversification of life on earth, when many of the existing modern phyla made their first appearances. An attempt will be made to review the factors which may have promoted this major diversification.

I arranged a meeting with Professor Zhao Xun, Deputy Director of the Chinese Academy of Geological Sciences, and Chairman of the Organizing Committee, in Beijing prior to my departure from China, and he indicated that our request for inclusion in the program would be considered at the next meeting of their Committee.

The Ordovician Subcommission will sponsor these seminars, and I have also contacted Professor Jurgen Remane, Chairman of the International Commission on Stratigraphy (ICS) for similar support. He has responded by saying that "both subjects are of great importance for stratigraphy and should have full support of ICS". I am also hopeful that the International Palaeontological Association, through Professor David Bruton, Secretary General of IPA will also support with IPA sponsorship the second theme.

Barry Webby

**MINUTES OF THE ISOS WORKSHOP & MEETING OF THE
ORDOVICIAN SUBCOMMISSION, NANJING, P.R. CHINA,
AUG. 29, 1993**

Present: S.M. Bergström, Chen Xu, C.E. Mitchell (acting Secretary), Rong Jia-yu, Wang Zhi-hao, B.D. Webby (Chairman), Yang Tie-fen, Zhang Yuan-dong, Zhan Ren-bin, Zhao Jiang-tian, Zhou Zhi-ji

Agenda

1. Previous visit of Subcommission, October, 1978

2. Changing status of Cambrian-Ordovician Boundary Working Group
3. Internal subdivisions, Sydney, 1991 & ICS directives to emphasize stages
4. Review of biozones with global correlation potential
5. Ordovician Series (Lower, Middle, and Upper)?
6. 7th International Symposium on the Ordovician System, Las Vegas, June, 1995
7. Arrangements for next IGC, Beijing, Aug., 1996 (Official meeting, program and field trips)

1. Previous visit of Subcommission to P.R. China, Oct., 1978

Webby introduced the meeting with a slide show from the previous visit of the Ordovician Subcommission (SOS) to China, and expressed gratitude of that group for the opportunity to examine sections in China, and for the collegiality and hospitality given the foreign scientists.

2. Changing status of Cambrian-Ordovician Boundary Working Group

Webby outlined the history of the Cambrian-Ordovician Boundary Working Group and its present status. [The first part of this section of the minutes is omitted as full details of these developments were presented previously in *Ordovician News* 10 (1993, pp.9-18). Drs Roger Cooper and Godfrey Nowlan have since been elected Chairman and Secretary of the new Working Group - BDW]

Still to be decided is what to do with the candidate section at Dayangcha and what level to choose as stratotype. Work is ongoing on both of these issues. Brian Norford, Bob Nicoll, and Maurits Lindström visited the Dayangcha section in April, 1992. They collected duplicate samples that are now under study by Bob, and Godfrey Nowlan, who are presently working together on the faunas in Canberra. Most samples have been processed and yielded conodonts with good to poor preservation. Both agree that there are great problems with *Cordyloceraspis* systematics, in which species distinctions are too subtle for the group to be very useful. Nowlan suggests they may need to consider other taxa. The first appearance datum (FAD) of *Iapetognathus angustus* Lindström, 1955, is very near the FAD of the earliest nematophorous graptolites and the species appears to be very widespread. Godfrey and Bob are now working to establish its range in Dayangcha and elsewhere, and hope to proceed with all due speed to produce a recommendation for a stratotype locality and level prior to the Las Vegas ISOS in June 1995, and final resolution of the boundary at the Beijing IGC, 1996.

Discussion:

Bergström: Are any other sections being considered as potential stratotypes?

Webby: No. All other proposed sections were excluded during the deliberations of the previous Working Group, leaving only Dayangcha. Nevertheless, other sections need to be studied and other candidates could emerge. As for the stratotype level, as I understand it, the focus is presently on the *I. angustus* first appearance.

Bergström: Will the new Working Group be able to revisit earlier decisions?

Webby: The new Working Group should not reconsider these but should continue to honor the earlier postal votes in which it was decided to focus on a boundary near the base

of the traditional Tremadoc and to base the boundary on the conodonts. However, this ultimately will be up to the new Working Group Chairman, and if it proves impossible to find a suitable level in the Dayangcha section, then indeed may be necessary to revisit some decisions.

Chen: Are Nicoll and Nowlan looking at material from other sections than Dayangcha?

Webby: Yes, based on the discussion at the last Pander Society meeting especially in relation to the problems that have beset *Cordyloceraspis*.

Bergström: Could you clarify whether the Subcommission has to ratify a decision by the C-O Boundary Working Group?

Webby: The Working Group chairman will transmit decisions to Webby (or current SOS chairperson), and he will forward them to ICS, but no vote by the SOS will be needed. The connection between the C-O Boundary Working Group and the SOS is entirely administrative — SOS handles the budget and annual reports, but exerts no control over the scientific work of the Working Group.

Rong: Have any new boundary sections been proposed?

Webby: No. There are only two: Green Point and Dayangcha. The former has been voted down. The latter has not, but has failed to receive sufficient votes to be approved. If the results of the next vote on Dayangcha (which will be an up or down vote on this section alone) is to decline this section, then the new group will have to re-open the discussions and find some new sections. Any candidate section, however, must have both conodonts and graptolites in the boundary interval, and no other sections of this nature are available at present. Thus, the new group need to seek resolution on this section first.

Bergström: Wish to comment on possible new boundary level. *Iapetognathus angustus* is described from Baltica. It is also now known from North America in warm-water localities. It often occurs in moderate abundance and is quite distinctive. Also point out that the lower Marathon Limestone, west Texas, contains graptolites, conodonts, and even trilobites in this interval. However, access is a serious problem. Most land owners in the region are uncooperative (some openly hostile in fact). Thus, this part of the section has not been examined in detail.

Chen: There has been some dispute between Erdtmann and Lin Yao-qun about interpretation of the graptolites from Dayangcha. Do you have any idea whether this has been resolved?

Webby: No, but Roger Cooper should be involved also.

3. Internal subdivisions, Sydney, 1991, & ICS directives to emphasize stages

At the Sydney ISOS meeting there were afternoon and evening workshops to examine several biozone boundaries to determine whether they might be suitable for series level divisions within the Ordovician System. Consensus was reached: 1) that focus should be on graptolites and conodonts; 2) that these boundaries should be globally useful, as far as possible; and 3) that the base of the series should be selected by picking the base of the relevant useful biozone. That is, the focus must be on identifying particular levels with

outstanding global correlation potential, not on the units *per se*. Since the Sydney meeting the ICS, in a directive sent in March 1993, states that their goal now is to establish global stages (comparable to the Mesozoic stages) for the whole Phanerozoic column, and that, consequently, the focus of subcommission work should be to establish global stratotype sections and positions (GSSPs) for stage subdivisions of the systems.

Thus, the SOS needs to define a set of global stages for the Ordovician based on conodonts and graptolites. Subsequent to this work, the stages should be bundled into series. This, of course, may mean moving away from the model of traditional British Ordovician series. Furthermore, ICS is anxious that this work proceed quickly. They point out that the SOS has been in existence for many years. It has spent considerable time producing a set of correlation charts that are quite useful but, perhaps as a consequence, SOS has come to very few decisions that are leading toward establishment of GSSPs.

At Sydney, the SOS members did select the base of the *Tetragraptus approximatus* Zone as a suitable level for the base of a global unit. Balloting of the voting members ratified this decision (18 yes; 1 no; 0 abstain). Our job now is to locate a stratotype section for this level. Bill Berry is working with Henry Williams to locate a suitable section. Greatest potential appears to be in the Cow Head Group of western Newfoundland. We hope to have a formal proposal for the resolution of this GSSP soon.

Propose that in general work should proceed in three steps for each GSSP. 1. Select biozones with outstanding potential. 2. Select section with both graptolites and conodonts in the appropriate interval. 3. Select a name for the overlying unit. Presently we have identified nine potential levels for global correlation within the Ordovician.

[A discussion of the status of the nine potential levels accepted in Sydney was then presented in ascending stratigraphic order, with frank suggestions of how we should next proceed, what new levels should be added, and how existing levels should be revised or abandoned - BDW]

A. [Suggested new level for investigation] Base of Lancefieldian 2. or other possible level below the *T. approximatus* Zone.

There is still much work needed to identify a possible level in this interval. However, if we are to have a stage-level division of the Ordovician, we may need to find a level below the *T. approximatus* FAD because this interval is perhaps too long for a single stage.

Zhou: Yes, we do need to subdivide the "Tremadoc".

Chen: Agree. Good level may be the base of the *Adelograptus-Clonograptus* Zone with *Staurograptus dichotomous/Rhabdinopora flabelliformis* and *Psigraptus* zones together in the Tremadoc 1.

Bergström: There is a problem at this level, however. There is no good connection between conodont and graptolite zonations. The interval is not well controlled and it is hard to find sections with both groups. Although I do agree with the need for subdivision, more work is needed before we can settle on either a particular group or a

specific level to employ here. There is a great thickness of carbonates during this oldest Ordovician interval which is not subdivisible by graptolites. Will need to include conodonts in any definition of stages in this part of the Ordovician. Perhaps look to the Marathon Limestone or Cow Head Group for a tie between the two groups that could provide a useful level for a stratotype.

Rong: Is there any possibility of using "Tremadoc" as a series and leaving stage level subdivision for later after more work has been completed? Much of the faunal history for Tremadoc times remains unclear.

Webby: We do not have good radiometric dates in this interval, but the Tremadoc is probably quite long compared to other parts of the Ordovician. But certainly it is poorly known with no good basis at present for global subdivision.

Mitchell: With the selection of the *T. approximatus* FAD as the base of the overlying stage, and with the selection of the base of the Ordovician System, we will have bracketed a "Tremadocian" unit that could be used as such in the interim. I see no immediate need to make a discussion about a series in this interval. Instead we should continue to focus on stages in the interval and later bundle them into some useful higher level unit.

Zhou: Suggest we select a level based on graptolites and pick a conodont boundary closest to the base of this stage.

Webby: Yes, we need to focus on biozones and stratotypes, and leave names for later. It is important if we are to make progress in establishing global units that we not get hung up on the names and traditional scope of the British units. Should seek to preserve names where we can of course, but be willing to introduce new units if required.

Bergström: We need to produce, as basis for discussion, a correlation chart with graptolite, conodont, and trilobite biozones in the "Tremadoc" interval for consideration of possible stadal divisions.

B. *Tetragraptus approximatus* Zone (W.B.N. Berry, convenor)

A report from Berry and Williams is needed as soon as possible for discussion in Las Vegas [or before - BDW] on the stratotype sections for the *T. approximatus* FAD. [Since this discussion the Williams, Barnes, O'Brien and Boyce manuscript proposing a global stratotype at Cow Head has been completed (October-November 1993), and is in process of circulation to members - BDW]

C. *Isograptus victoriae victoriae/Tripodus laevis* level (R.J. Ross Jr convenor)

Bergström: There are good possibilities to link together conodont, graptolite and shelly fossil zonations at this level, which also coincides with a major sea-level drop.

Chen: Yes, and we have a good *I. victoriae* succession in the Jiangshan-Changshan-Yushan (JCY) area but no conodonts have yet been reported from these strata. We hope to be able to link in limestone with conodonts. We probably could recognize this boundary in many places in China.

Mitchell: Although the base of these two zones probably are similar in age, their exact relationships are not known from within a single continuously fossiliferous section and probably are not precisely coincident. Which particular level is best to choose?

Bergström: The FADs of North American *Tripodus laevis* and Baltic *Baltoniodus triangularis* are essentially identical. Could pick base of the *Histiodella altifrons* - *B. triangularis* zone as the stratotype level. This would lie close to the base of trilobite Zone L and the *I. victoriae victoriae* Zone (Castlemanian-2). The disappearance of the very widespread conodont *Oepicodus evae* also appears to be synchronous globally, coincident with this boundary, and may provide an additional useful ancillary correlation tool. The interval this would create between the *T. approximatus* FAD and the *B. triangularis* FAD would be a suitable length for a stage.

Webby: Agree that conodonts probably provide the better criterion in this case, since the evolution of the *I. victoriae* lineage is a gradual one. The conodont species give a more identifiable datum.

Chen: Yes, also important to recall that we are not certain that base of *I. victoriae victoriae* Zone is synchronous globally, since these graptolites seldom occur with conodonts against which their ranges can be checked.

Webby: Consensus it to focus on the *laevis/triangularis* Biozone as the primary level with *I. victoriae victoriae* and *Orthidiella* zones as secondary criteria. Mitchell will communicate our interest in this level to Rube Ross and urge him to join with Bergström in search for a suitable stratotype section for this level. Bergström will write a brief position paper on this level for publication and Webby will seek a postal ballot on whether the base of the *laevis/triangularis* Biozone is a suitable level for a stadal stratotype following publication and comment on the position paper.

D. *Undulograptus austrodentatus/Didymograptus artus* zones (D.L. Bruton convenor).

Mitchell: The *U. austrodentatus* FAD is quite a good level. In addition to the first appearance of this species, there are several others, especially *Pseudisograptus zhejiangensis*, *P. angel*, *Undulograptus sinicus*, and *U. cumbrensis*, that occur just above this level and that are highly distinctive and occur widely in both Pacific and Atlantic settings. Based on work in China, Newfoundland and elsewhere we now have placed the origin of *U. austrodentatus* and of diplograptaceans in general in an evolutionary context. This and the rapid succession of changes that take place in the graptolite faunas through the lower part of the *U. austrodentatus* Zone provide a secure context in which to evaluate the synchrony of this species' FAD across the globe. The JCY region (SE China) is likely to produce an excellent stratotype section.

Bergström: Based on the new conodont data that Wang has obtained in the JCY area, it appears that the base of the *U. austrodentatus* Zone is close to the *Paroistodus originalis* - *Microzarkodina flabellum parva* zonal boundary. Also, the interval from the base of the *B. triangularis* Zone to base of the *U. austrodentatus* Zone is a good length for a stage.

Webby: The *U. austrodentatus* level is clearly the better of the two. *D. artus* is far too limited in its occurrence to be a suitable candidate level. Appears that the time has come to put forward a position paper. Ask Mitchell to do this with response/comments from David Bruton. This paper should be circulated prior to publication and as soon as possible. Again will seek ballot on this level following circulation of a position paper.

E. *Nemagraptus gracilis* Zone. [It was recommended that Stig Bergström and Chris Barnes should combine efforts as convenors of one working group to handle the whole interval from *N. gracilis* to *Dicellograptus complanatus* zones].

Bergström: *N. gracilis* provides an excellent datum but this level is not near any conodont zonal boundary, i.e. it falls within the middle of the *Pygodus anserinus* Zone. This situation is tolerable, but it is important to emphasize the need to focus on the FAD of this species not the incoming of any *Nemagraptus* species. Some are significantly older than *N. gracilis*.

Mitchell: This is quite comparable to the situation with *U. austrodentatus*, where use of the first diplograptacean, regardless of which species it happened to be, has produced considerable confusion about the timing of the appearance of diplograptaceans as a group. In any of these attempts to establish a global boundary it is essential to rely exclusively on the FAD of a single well-defined species.

Webby: Should circulate Finney & Bergström's (1986) contribution on the *N. gracilis* Zone with updating as position paper, and seek a postal vote to endorse this level.

F. *Climacograptus bicornis* Zone (Bergström/Barnes)

Bergström: No clear ancestor for this species, although it is common and distinctive. However, its range is not well determined relative to the conodont zonation. Consequently a stage based on this species would be difficult to use in carbonate platforms.

Webby: Probably best to delete this level from further consideration for now.

G. *Phragmodus undatus/Corynoides americanus/Deicke K-bentonite* (Bergström/Barnes)

Bergström: This level corresponds to the world-wide "Trenton" transgression; it is more or less equivalent to the base of the Eastonian 1 in Australia, and is associated with a good radiometric date (454 ± 1 Ma) from Deicke zircons. It appears that this K-bentonite can be traced over much of central and eastern North America as well as across Baltica. We believe we have also identified it in the upper part of the "*Diplograptus multidens*" Zone in Wales.

Mitchell: *C. americanus* Zone is present over a wide area in North America and is present also in Victoria, Australia and in China, but at present its base (at least in its type area in New York State) is not well defined — it usually lies above an unconformity or in an upward deepening sequence that grades from carbonates into black shales. We might be able to find better sections elsewhere, however.

Chen: We have identified the *P. undatus* Zone in Tarim sections where it is easily recognizable. Basinal sections in the region also produce *C. americanus* but it is not easy to find sections with both. Transitional facies often produce neither, but perhaps Dawango section in Tarim region would do. We do not yet have sufficient data to be certain, however.

Webby: Again, it would produce a stage between the *N. gracilis* and *P. undatus* FADs of reasonable length. This level seems generally acceptable, but we should focus on the *P. undatus* Zone and not the K-bentonite, or *C. americanus* Zone, as the principal criterion.

H. *Climacograptus tubuliferus* Zone (Bergström/Barnes)

Mitchell: This species is widely distributed, but again its range is not well known relative to conodonts or any shelly fossils. It does, however, appear at a convenient distance above the *P. undatus* FAD.

Chen: the species is not very well defined.

Mitchell: True, its separation from *C. caudatus* is not very clear at present, but perhaps Henry Williams or Stan Finney, who have worked with these taxa, could help refine its definition.

Webby: Perhaps we should give priority to work on other upper Ordovician levels, immediately above and below this level.

I. *Amorphognathus ordovicicus/Dicellograptus complanatus* zones.(Barnes/Bergström)

This seems to be a good level. They are distinctive, well understood taxa that occur widely. We should move forward to establishing a GSSP at this level.

5. Ordovician Series divisions (Lower, Middle, and Upper)?

We may arrive at a division of the Ordovician System that employs about eight stages (if we subdivide the "Tremadoc"). These could be usefully combined into three series, similar to the situation in the Devonian, which has seven stages. A four-fold division is not very useful — it does not lend itself to handy communication ("upper Lower," "lower Upper," etc.) or to a natural correspondence with the faunal/eustatic history of the System. A two-fold division gives intervals that are too long for many uses (e.g., each encompass too much evolutionary change to be a very meaningful faunal package) and has similar problems to a four-fold division. There was general agreement that a three-fold series division was best, and generally fits well with current practice in many regions. Bergström noted that the units ought to have names beside Lower, Middle, and Upper, but that these would probably need to be new so as to avoid the confusion that would inevitably result from the redefinition of existing names. Zhou emphasized the need to make a discussion on a three-fold division, which he supports, so that we can provide a common language to communicate our work. The various existing uses of Lower Ordovician, Upper Ordovician, etc., are frustrating and needlessly confusing.

Possible levels for the base of the Middle Ordovician and Upper Ordovician were discussed. There was general agreement that the most likely level for the base of the Middle Ordovician was the *B. triangularis/l. victoriae victoriae* FAD. The base of the Upper Ordovician could coincide with the *P. undatus/C. americanus* FAD. Chen and Webby agreed that the latter could be correlated widely by one means or another within China and Australia as it is in North America. Bergström noted that *P. undatus* FAD might be somewhat more difficult to recognize in Baltic or other Atlantic Province localities, where it lies within the upper part of the *Prioniodus lobatus* Subzone of the *Amorphognathus tvaerensis* Zone, or within the upper part of the "*D.*" *multidens* Zone. Webby enquired whether there would be any support for use of the *N. gracilis* FAD for the base of the Upper Ordovician, and Bergström pointed out that this level is not near any conodont boundary and, thus, would be nearly impossible to recognize with any precision

in carbonate facies, particularly in tropical settings where *P. anserinus* is generally absent.

6. 7th International Symposium on the Ordovician System, Las Vegas, June, 1995

Webby mentioned arrival of first circular and need to begin planning attendance at the upcoming 7th ISOS. Mitchell outlined plans for field trips and the planned association of the Las Vegas ISOS with the 5th International Meeting of the Graptolite Working Group, International Palaeontological Association. Information about either can be obtained from Stan Finney, Department of Geology, California State University, Long Beach, 1250 Bellflower Blvd., Long Beach CA., 90840, USA.

7. Arrangements for Ordovician program, official meeting and field trips, next IGC, Beijing, August, 1996

Webby reported his intention to request a formal meeting of the SOS to take place as part of the IGC schedule of events. He also expects to make some membership changes in the Subcommission at or before that time and that, according to ICS rules, the SOS will need to select a new chairperson for the 4-year period following the Beijing IGC.

Webby also indicated he would be discussing further with Chinese Titular members and the organizers of the Beijing IGC the possibility of establishing a strong Ordovician scientific program, and to this end is proposing two topics, (i) "Towards an integrated global Ordovician time scale; boundaries and subdivisions" and (ii) "Temporal and spatial patterns of Ordovician biodiversity"

In addition to this, Webby with Chinese colleagues, especially Chen Xu and Wang Xiaofeng, seek endorsement of an official Ordovician field trip to Tarim. Chen described the logistics and possible goals of a trip to this region, where there is the potential for several stadal GSSPs. There is still much to be done in this region, but he expects that will have most lithostratigraphic and biostratigraphic studies completed by 1996. Sections include the base of the *N. gracilis* Zone together with conodonts and shelly fossils. Higher in the section, faunas of the *C. americanus* to *Climacograptus (Diplacanthograptus) spiniferus* zones are present in similarly mixed facies. The region is also interesting tectonically. The trip will probably last about 10 days and be arranged to precede the IGC meetings. It will begin in Ürümqi ("Ooroomich") with a short pre-trip excursion to Tienshan. From Ürümqi will either fly or take a coach to Aksu and travel by four-wheel drive vehicles from Aksu to the field area. Costs to reach this remote region, unfortunately, are high, but Chen will try to keep them as low as possible. Round-trip air fare from Beijing to Ürümqi will probably be about \$400 US and expenses from there and in the field (including transportation) will probably average about \$95 per day. Thus, the total cost may be about \$1500 US. Webby stressed the importance of firming up these plans as soon as possible and sending out notices with the next *Ordovician News* so that potential participants can begin to plan for this expense by seeking grants and the like. SOS, as usual, has no money with which to underwrite such a trip, despite its importance to our mission.

Chuck Mitchell

CAMBRIAN ORDOVICIAN BOUNDARY INVESTIGATIONS

- UNDER WAY AGAIN

The new Working Group

The last issue of Ordovician News (No 10) carried Brian Norford's report (his last as Chairman) on activities of the Cambrian Ordovician Boundary Working Group (COBWG). A full report in the same issue by Barry Webby outlined the history of, and progress made by, COBWG since its inception in 1974, together with changes in structure of the International Commission on Stratigraphy. Boundary Working Groups now report directly to the relevant Subcommission, in our case the Ordovician Subcommission. Election of a new Working Group now became the responsibility of the Chairman of the Ordovician Subcommission and Barry outlined the steps leading up to the election of the new group. Membership of the new group was listed in his report. Since then a new executive has been elected by the membership. The new Working Group is as follows: *Chen Junyuan (China, cephalopods), *Cooper, R.A. (New Zealand, graptolites; Chairman), *Erdtmann, B-D (Germany, graptolites), Ethington (USA, conodonts), Fortey, R.A. (UK, trilobites, graptolites), *Kaljo, D. (Estonia, graptolites), Nicoll, R.S. (Australia, conodonts), Nowlan, G.S. (Canada, conodonts; Secretary), Ripperdan, R. (USA, paleomagnetism), Rushton, A.W.A. (UK, trilobites), *Shergold, J.H. (Australia, trilobites), Taylor, J.F. (USA, trilobites) [* - denotes titular member of the old working group].

Where do we go from here? In view of the stalemate reached by the last Working Group after 18 years of deliberation, one might wonder what the new Group hopes to achieve and within what time frame. We feel that the new Group is inheriting a substantial legacy of research, compilation ideas and suggestions on the question of the boundary and its definition - a major achievement by the outgoing Working Group. A number of important decisions were reached in formal ballots and these form the logical basis from which to proceed. Principally, these are:

1. That the Boundary horizon should be placed "at or near the base of the Tremadoc Series" (voted in 1982).
2. That "conodonts be the primary guide for a horizon close to but below the first influx of nematophorous graptolites" (1985-6).
3. That Dayangcha is the favoured section (1991).

A first task for the new Group will be to define the immediate questions to be tackled and outline a work programme to resolve them. The focus will clearly be on the Dayangcha section in northeast China, and the concerns about its suitability for GSSP that have been expressed by Working Group members and others. Work under way or recently completed includes a detailed study by Bob Nicoll and Godfrey Nowlan of conodonts from samples collected by Nicoll and Norford across the boundary interval in the Dayangcha section. A recent report on the sedimentology of this boundary interval by Maurits Lindström has been previously circulated to Working Group members. At the time of writing, a circular to go out to all members is in preparation.

Membership List

We are updating the list of Cambrian-Ordovician Boundary Working Group corresponding members. If you are actively involved in research relevant to the boundary question and wish to become a corresponding member, please contact Godfrey Nowlan. If you have been a corresponding member in the immediate past, please confirm your continuing interest to Godfrey (see Ordovician News No. 10 and present issue for addresses and e-mail addresses of Secretary and Chairman).

Roger Cooper, Chairman
Godfrey Nowlan, Secretary

A PROPOSED GLOBAL STRATOTYPE FOR THE SECOND SERIES OF THE ORDOVICIAN SYSTEM: COW HEAD PENINSULA, WESTERN NEWFOUNDLAND

S. Henry Williams, Christopher R. Barnes, Felicity H.C. O'Brien and W. Douglas Boyce

n.b. This submission is an extract of a manuscript accepted by the Bulletin of Canadian Petroleum Geology. It is circulated prior to the appearance of that publication in order to assist the discussion and decision making process related to selection of a GSSP for the base of the second series of the Ordovician System.

Abstract

The first occurrence of *Tetragraptus approximatus approximatus* is now taken as marking the base of the second ('Arenig') series of the Ordovician System. We propose that the Cow Head Peninsula, western Newfoundland, be adopted for Global Stratotype Section and Point (GSSP), with the boundary placed at the base of the *T. approximatus* Zone, 2.9 m above the base of the Factory Cove Member, Shallow Bay Formation of the Cow Head Group. The well-preserved graptolite fauna occurs in association with abundant conodonts, demonstrating this level to correspond closely with the base of the *Prionodus elegans* conodont Zone. Immediately underlying strata yield bithecate graptoloid assemblages, generally taken as indicating the latest part of the previous ('Tremadoc') series. Neighbouring sections also yield typically 'Tremadoc' deep-water trilobites from this level, permitting correlation between the three fossil groups. Other fossils, including acritarchs, are also present in the Cow Head Group sections, which are structurally simple, of low thermal maturity (CAI 1.5 or less) and suitable for chemo- and magnetostratigraphic studies.

The "Tremadoc"- "Arenig" boundary in the Cow Head Group

The Subcommission on Ordovician Stratigraphy (ICS, IUGS) has ratified a proposal to place the lower boundary of the second series of the Ordovician (here referred to as 'Arenig' for the sake of brevity) at the first occurrence of *Tetragraptus approximatus*

approximatus. Although this taxon is a distinctive and relatively common element of many early Arenig 'Pacific province', low latitude graptolite assemblages (Cooper *et al.*, 1991), there are comparatively few continuous, well-documented graptolitic sequences across the 'Tremadoc'-'Arenig' boundary available for selection as stratotype. These include some in North America, particularly the Canadian Cordillera (Lenz and Jackson, 1986) and western Newfoundland (Williams and Stevens, 1988, 1991), southern Scandinavia (Lindholm, 1991a, b; Maletz *et al.*, 1991; Löfgren 1993a, b), Taimyr, Siberia (Obut and Sobolevskaya, 1962), and China (e.g., Chen *et al.*, 1983). Despite the well known sequence of graptolite 'stages' in Australasia (e.g., Vandenberg and Cooper, 1992), there appear to be no continuous sections in this region, with the one possible exception of Aorangi Mine in New Zealand (Cooper, 1979a, b; S.H.W. and R.A. Cooper, *personal observation*, 1992). Of the areas listed above, the most fully documented, accessible and apparently suitable for designation as stratotype appear to be those sections in the Cow Head Group, western Newfoundland, and in southern Scandinavia; we here propose a stratotype section in the Cow Head Group, which offers an excellent combination of rich, mixed faunas and continuous strata, simple structure and easy access.

The Cow Head Group, belonging to the Humber Arm Supergroup, is composed of a sequence of marine sediments 300-500 metres thick of Middle Cambrian to early Middle Ordovician age; these were deposited in a slope to toe-of-slope setting on the eastern margin of Laurentia, and include a variety of shales, thin bedded carbonates and limestone breccias (e.g., see James and Stevens, 1986; Williams and Stevens, 1988). The level that has been adopted as the base of the new second series of the Ordovician System (i.e., first appearance of *T. approximatus approximatus*) is present in a number of sections in the Cow Head Group, six of which offer continuous exposure and diagnostic graptolites. The level is close to the boundary between Bed 8 and Bed 9, marking the boundary between the Stearing Island and Factory Cove members of the Shallow Bay Formation (James and Stevens, 1986). Unfortunately, in all sections except that at Cow Head, the boundary interval is represented by a sequence of red shale which is generally unfossiliferous (with the exception of rare conodont elements). At Cow Head the interval is marked by a 3 metre package of mostly pale, grey-green dolostone and shale, although poorly fossiliferous, characteristic late Tremadoc graptolites have been recovered from black laminae in the lower portion, while rare *T. approximatus approximatus* occurs in the higher part (Fig. 1). The boundary is thus taken above a 2 metre unfossiliferous interval of parallel-bedded, alternating dolostone and dolomitic shale. As this is by far the most continuously graptolitic sequence across the boundary interval, we here propose the section exposed on the Ledge at the westernmost end of the Cow Head Peninsula as Global Stratotype Section and Point (GSSP) for the second series of the Ordovician System (Fig. 1); specifically, the boundary should be placed at the first occurrence of *T.*

approximatus approximatus 2.9 metres above the base of the Factory Cove Member (Bed 9), near to the top of the dolomitic interval (unit 1) just below the conglomerate referred to unit 2 of Bed 9 by James and Stevens (1986). Little erosion appears to have occurred during the deposition of either this or many other minor conglomerates in the Cow Head Group; even if any minor erosion was present the conglomerate lies unequivocally above the Tremadoc-Arenig transition.

The sediments comprising the Tremadoc-Arenig boundary interval clearly indicate a physical change, which may have been a global regressive phase or a time of increased oceanic circulation unrelated to eustatic change (Barnes, 1984; Fortey, 1984). At many sections elsewhere in the world, this interval is marked by a hiatus, and a global eustatic regression would appear to be the most logical explanation. The cause of such a regression is presently unknown, but it might well have been this physical change that triggered the major bioevent affecting graptolite evolution across the boundary (Barnes *et al.* *in press*).

The three Cow Head Group sections which have been studied in detail for conodonts during the present study are at the Cow Head Peninsula, St. Paul's Inlet and Martin Point South. The lowest parts of these sections examined during the present study all fall above the level of the *Cordylodus angulatus* Zone. At St. Paul's Inlet, the assemblage below this level includes *C. angulatus*, *Rossodus manitouensis* Repetski and Ethington and other taxa that have been described from an equivalent level in the St. George Group (Ji and Barnes, 1994).

The major change in the conodont fauna seems to have occurred a little earlier than the graptolite faunal turnover. The appearance of the genus *Prioniodus* at Cow Head is just below the first appearance of *Tetragraptus approximatus approximatus*, with conodonts of the lower part of the *P. proteus* Zone occurring in the top part of Bed 8 in association with a late Tremadoc graptolite fauna. The first species of *Prioniodus* found within the *T. approximatus* Zone is *P. adami* Stouge and Bagnoli (Stouge and Bagnoli, 1988) which is also found together with *P. elegans* Pander in another sample collected near the base of Bed 9. Thus, the Cow Head sections indicate that the base of the *P. elegans* Zone is slightly above the base of the *T. approximatus* Zone which defines the base of the Arenig.

Most trilobites collected from the Cow Head Group to date have come from transported limestone boulders within the carbonate breccia beds (e.g., Fortey *et al.*, 1982; Kindle and Whittington, 1958; Ludvigsen *et al.*, 1989). Trilobites from conglomerates within Beds 9 and 10 (James and Stevens, 1986) suggest a late Tremadoc or early Arenig age (late Jeffersonian to Cassinian), and are similar to those from the Barbace Cove Member of the Boat Harbour Formation and Catoche Formation (Knight and Boyce, 1991).

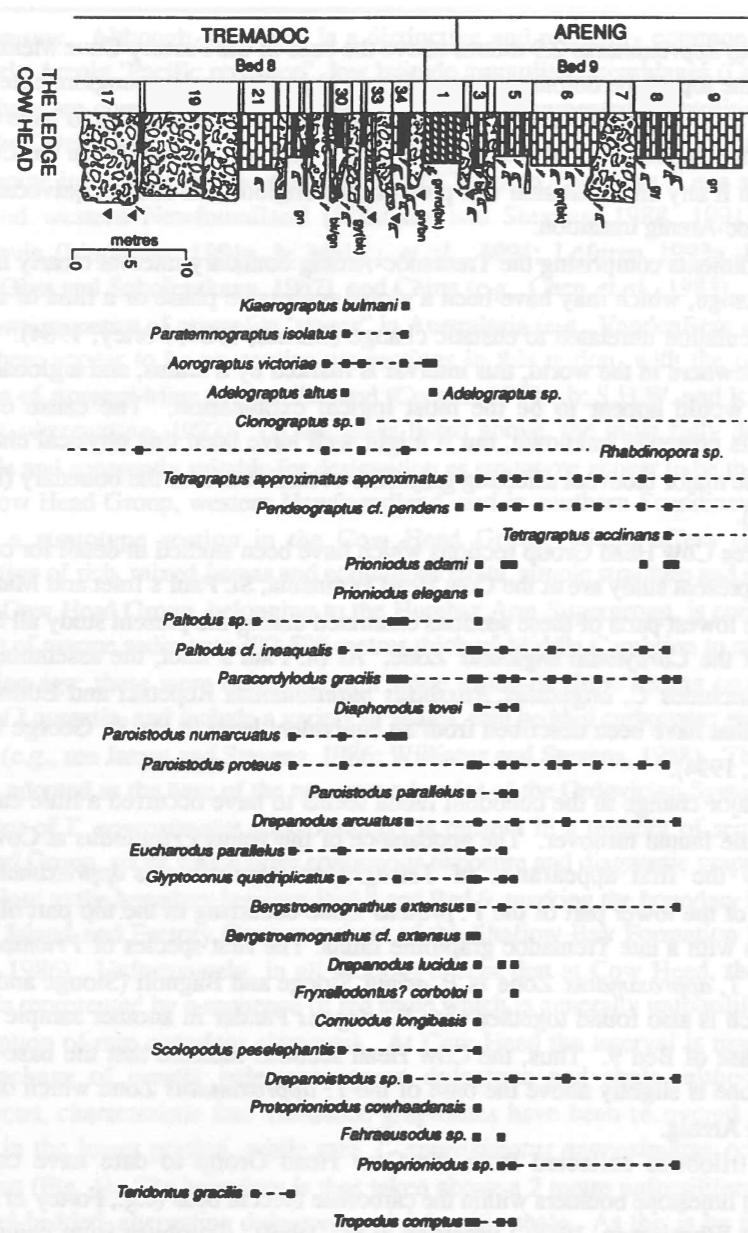


Fig. 1. Faunal range chart for the Tremadoc-Arenig boundary interval, Cow Head Peninsula (incorporates data from James and Stevens, 1986, Williams and Stevens, 1991 Fähræus and Nowlan, 1978 and Stouge and Bagnoli, 1988).

During the course of collecting graptolites from late Tremadoc strata at Martin Point and Green Point, a number of minute trilobites were discovered in calcareous black shales associated with an abundant graptolite fauna (Williams and Stevens, 1991). Despite the small size of the trilobites (the largest is only a few millimetres long) and difficulties with identification to the specific level, the fauna is diverse and includes: ?*Angelina* sp. indet., *Apatocephalus* sp., *Asaphellus* sp., *Asaphoon* sp. cf. *A. pithogastron* Hutchison and Ingham, *Hospes* sp. indet., *Macropyge* sp. indet., *Orometopus* sp. indet., *Parabolinella* sp. indet., *Pseudokainella* sp. indet. and *Shumardia* sp. indet. This faunule is suggestive of the Tremadoc Series and appears to represent a deep, cold water, open-ocean assemblage in contrast with trilobite faunas from the limestone conglomerates of the Cow Head Group, which are typical of the warm, shallow water, low latitude carbonate platform(s) that formed along the Laurentian margin.

Suitability of the Cow Head Peninsula as stratotype section

The section proposed as GSSP on the Cow Head Peninsula (Fig. 1) fulfills all of the requirements for such a section as listed by Cowie *et al.* (1986). Sedimentation within the boundary interval is continuous (although with some, apparently minor sedimentary breaks related to breccia deposition both above and below the boundary); a mixed, diverse faunal assemblage including graptolites, conodonts and trilobites is present at Cow Head or at neighbouring equivalent sections; exposure of the interval extends along strike for several metres at the type section, and is repeated in at least five other sections within the area; correlation may be readily achieved with sections throughout the world, using either graptolites or conodonts, while acritarchs and chitinozoans are also known to occur; there are no significant structural complexities; conodont CAI's of 1.5 and low graptolite reflectance values indicate that burial temperatures have not exceeded 90°C; a number of successful magnetostratigraphic and chemostratigraphic studies have been completed across the Cambrian-Ordovician boundary at Green Point, demonstrating the excellent potential for such studies at the Tremadoc-Arenig boundary; although some comparative sections (including Western Brook Pond, Martin Point and Green Point) lie within the Gros Morne National Park and are protected, the proposed Cow Head section lies outside and both access and study are unrestricted; the community of Cow Head is situated off a paved highway 90 km from Deer Lake Airport, and has both motel and campground facilities; access to the section involves an easy 20 minute walk from the nearest point at which a vehicle may be left.

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Henry Williams

FRIENDS OF THE ORDOVICIAN

The friends of the Ordovician met on October 26, 1993 from 5:00 to 7:30 PM in the Boston Park Plaza Hotel during the annual meeting of the Geological Society of America. The meeting was well attended and included a number of visitors from other countries as well as friends from across the United States. Following introductions and brief comments about their interest and activities concerning the Ordovician, Barry Webby reviewed the current status of the reconstituted Cambrian-Ordovician Boundary Working

Group. Rube Ross reported that preparation is nearly complete of a manuscript discussing the biostratigraphy of the type Ibexian Series in western Utah. It will be issued initially as an Open-File Report of the United States Geological Survey and ultimately as a Professional Paper.

Ray Ethington and Rube Ross reviewed the status of preparations for the International Symposium on the Ordovician System that is being organized for Las Vegas in mid-June of 1995. Following adjournment of the formal meeting, participants engaged in vigorous discussion in small groups until the hotel staff urged them to make room available for another organization.

Ray Ethington

7th INTERNATIONAL SYMPOSIUM ON THE ORDOVICIAN SYSTEM

The SEPM (Society of Sedimentary Geologists) has agreed to sponsor the 7th ISOS. The Pacific Section-SEPM has agreed to publish the conference proceedings. These will include a Guidebook for all the field trips and a volume of Short Papers. Instead of abstracts or a symposium volume of lengthy papers, the organizing committee has decided that all contributors will submit short papers that will be published in time for distribution at the meeting. The papers in this Short Papers volume will be refereed, edited and returned to the authors for necessary revisions and resubmission as camera-ready copy. Maximum length will be 4 published pages. Contributions may, however, be as short as an abstract for those not wanting to produce a full paper yet still wanting to present a paper at the meeting.

A meeting of the Friends of the Ordovician has been scheduled for March 22, 1994 at the Cordilleran section meeting of the Geological Society of America in San Bernardino, CA. The organizing committee of the 7th ISOS will meet to review plans for the Las Vegas meeting, determine registration fees and field trip costs, and to further develop the technical program.

The Second Circular with registration materials and instructions for submission of short papers will be mailed in May, 1994. Those who have not responded to the First Circular are encouraged to do so immediately, in order to be assured of receiving the Second Circular.

Volunteers are still being recruited to serve as theme session conveners. Those wishing to develop specific theme sessions are encouraged to contact S. Finney.

Stan Finney

VENUE FOR 8th ORDOVICIAN SYMPOSIUM

Several suggestions and offers have been made so far with regards to the Eighth Ordovician Symposium following that to be held in Las Vegas and probably in 1999. Bernd Erdmann made the first suggestion, proposing (in mid-1993) a joint Berlin and Prague meeting. Barry Webby responded that he considered Prague to be the better venue for an Ordovician meeting, possibly organized in conjunction with a graptolite meeting in Berlin either before or after the Symposium. Bruno Baldis wrote in the same year that he was interested in having the meeting in Argentina, possibly in 1998. This year, Juan-Carlos Gutierrez Marco has submitted a detailed proposal for a meeting in Spain, with sessions in Madrid or Toledo. We need to approve the final decision on where to hold the next meeting at Las Vegas next year, so would welcome comments on the three suggestions before then.

Barry Webby/Henry Williams

WOGOGOB 94

The next WOGOGOB meeting (Working Group on Ordovician Geology of Baltoscandia) will be held on the island of Bornholm, Denmark from 30 August to 1 September 1994, together with pre- and post-symposium excursions. Svend Stouge is the symposium host.

For information, contact: WOGOGOB 94, Geological Survey of Denmark, Thoravej 8, 2400 Copenhagen NV, Denmark.

GRANTS FOR STUDENT RESEARCH

The Institute for Cambrian Studies has announced a fledgling Graduate Student Research Grant program to support field and laboratory research of doctoral students. Successful proposals will deal with any aspect of Cambrian history, including, but not restricted to, paleontology, sedimentology, paleobiogeography, or geochronology. The grants are open to graduate students of any nationality for work anywhere in the world.

Interested persons should write for detailed information and application procedures to:
Dr. Michael E. Taylor, Secretary-Treasurer

Institute for Cambrian Studies
3480 Everett Street
Wheat Ridge, Co 80033-5861
U.S.A.

or by e-mail to 73611.2771@compuserve.com.

Mike Taylor

ABOUT SUBDIVISIONS IN THE ORDOVICIAN OF THE MEDITERRANEAN REGIONS

Regional stratigraphic scales are fairly common for the Ordovician. Several attempts have also been made to introduce such stratigraphic subdivisions in the Ordovician succession of the "Mediterranean" regions. The first formal proposal (Spjeldnaes, 1967) was a three fold subdivision into the Zagorian, Morgatian and Tafilaltiane series. Because of problems in making accurate correlations between the Mediterranean successions and the British standard Ordovician subdivisions, Spjeldnaes' regional "Series" were not adopted by south-western Europe stratigraphers. Later, Havlicek & Marek (1973) proposed a more detailed chronostratigraphic scheme based on the Ordovician succession of Bohemia. This scale was used only by a few authors outside Bohemia. More recently, San Jose et al. (1992) introduced a new Ordovician Series: the Oretan (see report by J.C. Gutierrez-Marco and I. Rabano in *Ordovician News* 10). This subdivision seems also, at the moment, of limited use for northern Gondwanan Ordovician sequences. What is really needed are well documented ranges of the major fossil groups for accurate correlation purposes.

The selection of a new index fossil and stratotype for each Series boundary will certainly improve the possibilities of correlation with any new Ordovician international standard scale. Therefore, the creation of a north Gondwana regional chronostratigraphic terminology seems premature until the possibilities of direct or indirect correlation with this new standard have been tested. If it appears later that regional "Stages" or "Series" are really needed for the Ordovician of northern Gondwana, then it would be judicious to select boundaries giving at least some ties with the international scale.

As a chitinozoan worker, however, I assume that there are not serious difficulties for closely spaced correlation (i.e. short time interval ties) within the Ordovician sequences of northern Gondwana, from Arabia to Morocco or from Niger to western Europe and, in addition, there are already some accurate ties with the Ordovician succession of other paleocontinents (see Paris 1990, 1992, 1994).

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Florentin Paris

REPORT ON THE "ORDOVICIAN K-BENTONITES IN THE IAPETUS REGION" PROJECT

Ordovician K-bentonites have been recognized in North America since the 1920's and in northwestern Europe since the 1940's. After a period of pioneer investigations in North America during the 1920's and 1930's, and in Baltoscandia during the 1940's and 1950's, relatively little K-bentonite research was carried out until the 1980's. However, during the last 10 years, there has been a great revival of Paleozoic K-bentonite research in both North America and Europe and several new and highly significant techniques have been developed, especially in the area of high-precision geochemical analysis and trace element studies, which have revolutionized the identification and regional tracing of individual beds and the use of K-bentonites as tectonomagmatic indicators. Other important aspects of K-bentonite research during the last few years include the recognition of individual beds as time-planes across the Atlantic, the biotic effects locally and regionally of gigantic ash falls, the effects of large amounts of volcanic dust in the atmosphere, the regional dispersal and grain size patterns of individual beds, eruption dynamics of the source volcano(s), and the use of thickness and grain size patterns for reconstruction of the Ordovician paleogeography in the Iapetus region.

We carried out research on K-bentonites individually for many years, but a few years ago we joined forces on a large, NSF-supported project that has been focused on the stratigraphy, distribution and geological and biological significance of Ordovician K-bentonites in North America and Europe. Currently this project includes more than 200 localities and we, and our students, have carried out a very considerable amount of geological fieldwork in eastern USA, southern Canada, Norway, Sweden, Denmark (Bornholm) and the British Isles. During the last couple of years, we have also worked on

Silurian K-bentonites, both in Europe and North America, and most of our fieldwork last summer was devoted to successions of that age in northwestern Europe. Although we have directed most of our efforts in the Ordovician to the major beds in the upper Middle Ordovician, we have collected samples from and investigated beds throughout the system from the lower Arenigian to the upper Ashgillian. There are relatively few beds in the Lower Ordovician and lower Middle Ordovician, a very great number (more than 150 in southern Sweden and more than 50 in eastern USA) in the upper Middle Ordovician, and relatively few in the Upper Ordovician. Of special interest and significance are the thick beds in the upper Middle Ordovician that we have traced across Baltoscandia to, probably, Great Britain, and across eastern North America from the Appalachians to the Upper Mississippi Valley. Trace element composition, isotopic age, and stratigraphic position suggest that the most widespread bed, the Millbrig in North America and the Kinnekulle ("Big Bentonite") in northwestern Europe, represent the same eruption. Several other beds, or complexes of beds, can be traced over considerable distances and offer great potential as time-planes. Chemical analyses of many North American and European K-bentonites show that they were derived from felsic calc-alkalic magmas in a destructive plate-margin setting. Regional trends in thickness and grain size suggest that the source of the Millbrig-Kinnekulle bed was located in the westernmost Iapetus near the margin of the Laurentian plate in a region east of the Southern Appalachians in terms of today's geography. Interestingly, we have found no evidence that the Millbrig-Kinnekulle ash fall, clearly one of the largest, if not the largest, in the Earth's Phanerozoic history, caused a notable extinction event. Obviously, the deposition of a locally several m thick ash layer during a time period of a few days must have had a devastating effect on especially the marine bottom faunas but apparently, there was a rapid repopulation, presumably from immigration from regions outside those that received significant amounts of ash.

Our results this far were briefly summarized in an article in *Geology* a little more than a year ago, and we have presented reviews of various aspects of this research in numerous (more than 20) lectures at recent national and international meetings. We are currently preparing a summary volume on Ordovician K-bentonites in the Iapetus region that we hope will be published as a *Geological Society of America Special Paper*, and several other papers on specific aspects of our research are near completion.

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Stig Bergström, Warren Huff, and Dennis Kolata

SPECIAL RESEARCH PROGRAM NO. 267 "ANDEAN DEFORMATION PROCESSES"

As an integral contribution to this project, I have been appointed to head an Ordovician stratigraphy working group. During July and August 1993 a reconnaissance expedition was organized into the unmetamorphosed and less tightly folded Cordillera Oriental of southern Bolivia including the classic sections in adjacent Salta and Jujuy in Argentina as well as the more complexly folded (and probably thrusted) regions of the Altiplano further to the west. The sparsely fossiliferous Eastern Cordilleran Ordovician consists of shallow marine sandstones, siltstones and claystones ranging from a Late Cambrian (*Trempealeau?*) to late Arenig (*Azygograptus lapworthi*: Beckly & Maletz, 1991) covering at least 8 km (!) of more or less continuous section. Tremadoc strata (ca. 4,500 m) are well documented from *Rhabdinopora parabola (belgica)*, *Jujuyaspis keideli* and other trilobites through *Adelograptus tenellus*, *Bryograptus copiosus*, *Clonograptus* spp. and *Tetragraptus (?) longus*. No distinct disconformities could be observed within the C/O boundary interval, but an erosional gap occurs ca. 50m below the first occurrence of *Araneograptus (Ceratopyge Regressive Event?)*. While measuring sections and collecting acritarch samples several new graptolite horizons were discovered - one even in a massive mid-August snowstorm at 4400 m altitude near Tupiza. More fieldwork is planned for July-August 1994 together with Thomas Heuse (TUB, acritarchs) in cooperation with Cristina Moya (Salta, Argentina) and Heriberto Slamanca (Potosí, Bolivia). The fabulously fossiliferous Cerro de San Bernardo within the charming Precordilleran city of Salta yields one of the best Lower Ordovician clastic sections that I have ever seen! What a site for a future Ordovician conference!

Bernd Erdmann

CRE (CERATOPYGE REGRESSIVE EVENT)

During a "Baltic states Stratigraphy Conference" in Vilnius/Lithuania in May 1993 a committee was established for the study of a single Early Ordovician Event: the CRE (*Ceratopyge Regressive Event*: Lapworth's original C/O boundary at Tremadoc/Arenig hiatus) all across the East European Platform from the Caledonian active to the Uralian passive margins and from the Trollfjord-Timan Lineament (TTL-N) to the Törnquist Teisseire (TTL-S). Included are those founding fathers for this "*Ceratopyge-Varang* Event Project" at the Oslo "WOGOGOB" 92 Conference; altogether 39 scientists from 10 countries submitted research proposals by early September 1993. A grant proposal was submitted to the "Volkswagen Foundation" to generate funds for collective "field conferences", however, most regrettably, this proposal was turned down in late November 1993 (without reasons given). Alternatives are now being pursued and suggestions for

potential sponsored are most welcome! Potentially interested project participants may contact me for two previously published circulars (no.1 including project outline and goals).

Bernd Erdtmann

THE ORDOVICIAN OF THE PRAGUE BASIN

A new regional chronostratigraphic working group was established by Czech Geological Society for the Ordovician of the Prague Basin (Barrandian area) in October 1993. After four decades of mostly inward-looking research in the Barrandian Ordovician, coordination with internationally organized research becomes necessary. The working group is led by J. Kraft (chairman), includes B.D. Erdtmann and V. Havlicek as consultants and the following specialists for the various fossil groups:

Sponges - M. Kucera"; Worms" - P. Kraft; Brachiopods - M. Mergl; Bivalves - J. Kriz; Gastropods - J. Fryda, R. Horny; Cephalopods - J. Marek; Trilobites - P. Budil, O. Fatka; Crustaceans - I. Chlupac; Ostracodes - M. Kruta; Echinoderms - V. Petr. R. Prokop; Graptolites - J. Kraft, P. Kraft, P. Storch; Acritarchs - O. Fatka, M. Vavrdova; Hyoliths - L. Marek; Conodonts - J. Zuskova; Chitinozoans - O. Fatka; Icnofossils - R. Mikulas; Paleobotany - Z. Kvacek.

Oldrich Fatka

XII CONGRESO GEOLOGICO ARGENTINO Y II CONGRESO DE EXPLORACION DE HIDROCARBUROS

Matilde Beresi (Argentina) submitted a long list of papers published last year in the proceedings of the XII Congreso Geologico Argentino y II Congreso de Exploracion de Hidrocarburos (*Geologia y Recursos Naturales de Mendoza*, edited by V. Ramos) which took place in Mendoza 11 to 15 October 1993. Unfortunately there is insufficient space to list all of them here, but the volume includes over twenty papers on all aspects of hydrocarbon and related research in Argentina including structure, stratigraphy, paleontology and plate tectonics. I am unaware of how copies may be obtained, but suggest that anyone interested might contact Matilde (see e-mail and other address in this volume).

[ed]

PALAEZOIC BIOCHRONOLOGY OF THE GREAT BASIN, WESTERN UNITED STATES - U.S.G.S. OPEN FILE REPORT 93-598

Rube Ross, Lehi Hintz, Ray Ethington, Jim Miller, Mike Taylor, and John Repetski have combined data to formally define the Lower Ordovician Ibexian Series and several new stages in the House-Confusion Range area of west-central Utah. The report will be published as a U.S. Geological Survey Professional Paper. A preliminary version was released in November 1993 as U.S. Geological Survey Open-File Report 93-598. The Open-File contains a section on Echinoderm Biostratigraphy by J. Sprinkle and T. Guensburg. A copy of the report can be ordered from the "Branch of Publication Distribution, Open-File Report Section, U.S. Geological Survey, Denver Federal Center, Denver, CO 80225 U.S.A. (Price not yet available).

Mike Taylor

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Please note that previous issues of *Palaeoworld* (numbers 1 and 2) consist of collected research papers mostly written in Chinese.

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NEWS AND CURRENT RESEARCH OF ORDOVICIAN WORKERS

LEHO AINSAAR (Estonia) is studying the sedimentology of Ordovician (Llandeilo, Caradoc, Ashgill) carbonate rocks of Estonia with emphasis on cyclic sedimentation and cyclic stratigraphy.

BRUNO BALDIS (Argentina) is the group leader for a new IGCP project dealing with "Early Paleozoic evolution in NW Gondwana". The research group is composed of Lic. Ricardo Martinez, Lic. Maria Pereyra, Lic. Angel Perez and Lic. Carlos Villegas. The first international meeting was held at Medellin, Colombia in June 1993 with a second meeting scheduled to take place at Rabat, Morocco in the last part of 1994. The group has continued to develop their research efforts in the reconstructions of the Ordovician peri-Gondwanan basins located in South America and their links toward the similar basins in northern Africa. The group has also generated recent studies on Llanvirn-Caradoc trilobite faunas of the Argentine Precordillera (San Juan Province), in which a new "realm" has been detected mainly composed of new genera of trinucleids and raphiophorids.

CHRIS BARNES (Canada) continues work on Ordovician conodonts and stratigraphy. The Ashgill section at Whitland, Wales, was recollected. Annalisa Ferretti (Modena University) visited as a PDF and joint papers on the Whitland fauna

and an equivalent fauna from Kalkbank, Germany, are in final states of preparation. These are pertinent to the works of the Ashgill Working Group. With Henry Williams (Memorial University) and colleagues a paper was completed (and summarized in this issue) on a proposed stratotype for the second series of the Ordovician. Field work in the Canadian Rocky Mountains is permitting correlation of shelf to outboard parautochthonous terranes (with Zailiang Ji and Lee McAnally) and allowing direct comparison to new Ordovician conodont faunas from north and central China (under study by Jianquin Chen). Initial studies are nearing completion on strontium (with Jan Veizer, Ottawa University) and neodymium isotope studies on conodonts (with Cindy Wright and with Stein Jacobsen, Harvard University) to establish a better understanding of Ordovician sea water history and paleogeography.

STIG BERGSTRÖM (USA) has several publications in press on conodonts, graptolites, biostratigraphy, etc., in North America. This past summer Stig conducted fieldwork in Britain and Northern Ireland in late June and in Sweden in early July. He also spent three very enjoyable and productive weeks in China in August-September working with the Nanjing group on mostly lower Ordovician faunas in an attempt to find global reference levels in the Ordovician. Most of his current research deals with K-bentonites, the Ordovician-Silurian boundary, conodont and graptolite biostratigraphy in North America and Europe and Ordovician global reference levels.

PAT BRENCHLEY (UK) has started a new project with Susan Kidwell on the evolution of shell concentrations. Initially they are comparing Ordovician-Silurian concentrations with those in the Neogene. Work is also continuing on a ^{13}C and ^{18}O stratigraphy for the Ordovician and early Silurian to determine climatic and oceanographic changes associated with the end Ordovician glaciation and extinction.

RAINER BROCKE (Germany) is continuing study on Ordovician acritarchs from China. Together with Oldrich Fatka he is working on the revision of the acritarch genera *Arbusculidium*, *Aureotesta* and *Marrocanium*.

CARLOS CINGOLANI (Argentina) is currently working on the geotectonics on Famatinian-Taconic Orogen (with Dalla Salda), the Ordovician sequences of Sierra Pintada de San Rafael (with Alfredo Cuerda), the Lower Paleozoic cratonic sequences in Buenos Aires Province and ichnological biostratigraphy in the Balcarce Formation (with Adolph Seilacher), and on a collaborative project to investigate stratigraphic similarities between Caradoc sequences in the Precordillera and North America. Also on the distribution and origin of Middle Ordovician K-Bentonites with Warren Huff and

colleagues from the USA).

ROBIN COCKS (UK) has been working with Stuart McKerrow this past year on a paper indicating that the Celtic province and fauna were distributed on both sides of the Iapetus during the early Ordovician and thus the "Province" is not a viable palaeogeographic concept.

ROGER COOPER (New Zealand) is mostly tied up with terrane problems and regional stratigraphy and structure of the Early Paleozoic of New Zealand, when he gets time for research.

TONY COOPER (UK) is continuing a survey of the Skiddaw Group (early Ordovician) of the English Lake District with Richard Hughes. For this study Adrian Rushton is looking at the graptolites and Stewart Molyneux the acritarchs.

MARY DROSER (USA) is continuing her work with Richard Fortey on the paleontology and paleoecology of the low to mid-Ordovician transition in the Great Basin. She is also working with Xing Li on Ordovician shell beds. Pete Sadler and Mary are working on new methods of correlation and range extensions using the Ordovician of the Great Basin as a test. She is also continuing work with Nigel Hughes on the spatial and temporal distribution of *Rusophycus* with particular emphasis on the variations among Ordovician forms.

BOB ELIAS (Canada) is studying solitary rugose corals from a new upper Middle Ordovician formation in the northern Rocky Mountains of British Columbia. Research continues on environmental cycles and correlation in the Upper Ordovician of cratonic North America. Other studies with Graham Young, include coral faunas during the Ordovician-Silurian mass extinction and recovery. Doctoral student Adam Melzak is working on rugose corals from the Upper Ordovician to lowermost Silurian of Anticosti Island, Quebec.

BERND ERDTMANN (Germany) is working on a new Ordovician project in southern Bolivia and northern Argentina. As an integral contribution to a German NSF-sponsored Special Research Program No. 267 "Andean Deformation Processes" Bernie was appointed to head an Ordovician stratigraphy working group. In late June 1993 Bernie was appointed as "Foreign Consultant Member" to the "Preparatory Committee for the 30th International Geological Congress in 1996" by the Chinese Academy of Geological Sciences. A conference on "Problems in the taxonomy of the Cambrian-

Ordovician acritarchs" was hosted by Bernie Erdtmann & coworkers on Dec. 10-11, 1993 in Berlin which was attended by 14 "acritarchologists" from Belgium, the Czech Republic, Sweden, Finland, Estonia, and Germany (heated discussions!).

OLDRICH FATKA (Czechoslovakia) continues his studies of acritarchs and partly also of chitinozoans from Arenig (Klabava and lowermost Sarka formations of the Prague Basin). Some selected Lower Ordovician acritarch genera with potential for long-distance stratigraphic correlation (*Arbusculidium*, *Aureotesta*, *Marrocanium* ao.) have been revised recently in cooperation with Rainer Brock (Germany). During a von Humboldt Foundation scholarship at the TU Berlin (since May 1993) a database was prepared for literature on Ordovician fossils from the Prague Basin.

GERALD FRIEDMAN (USA) is continuing his study of high-frequency peritidal carbonate facies of the Cambro-Ordovician (Sauk) passive margin of the northern Apppalachian Basin. Papers and abstracts have been published in the regional journal, *Northeastern Geology*.

BOB FREY (USA) has commenced studies (in association with Brian Norford) on a rich Late Ordovician (perhaps Maysvillian or early Richmondian) cephalopod fauna from the basal Beaverfoot Formation of southeastern British Columbia.

YNGVE GRAHN (Sweden) is working with Jaak Nölvak (Estonia) on chitinozoan dating of Ordovician impact events in Baltoscandia. Together with Sahire Idil and Anne Marit Østvedt (Norway) a monograph dealing with Caradoc and Ashgill chitinozoa will be published soon. He is also working with Mário V. Caputo (Brazil) on different aspects on the Ordovician of Brazil.

THOMAS HEUSE (GERMANY) will be completing micropalaeontological investigations on the Ordovician of the Variscan Belt of SE Germany (Schwarzburg and Berga Anticlinoria in Thuringia, and Central Saxonian Lineament of Saxony) by June 1994. A paper describing an Upper Ordovician (Ashgill) acritarch association from the Frankenberg Allochthon in Saxony has been accepted for publication in "Neues Jahrbuch, Pal. Monatsh." and in print since December 1992. Another paper on mid-upper Arenig graptolites and acritarch associations from the "Griffelschiefer" (which was debated as straddling the Arenig/Llanvirn) of the Thuringian Schwarzburg Anticlinorium is in preparation. Beginning in July 1994 Thomas plans to join the Special Research Programme No. 267, together with Berndt Erdtmann (Germany), dealing with acritarch-chitinozoan and macrofossil biostratigraphy of the Cordillera Oriental and the

Altiplano of southernmost Bolivia and northern Argentina.

NIGEL HUGHES (USA) is now assistant curator at the Cincinnati Museum of Natural History. The museum has a fair collection of local Cincinnati fossils and people are more than welcome to come and work on the collections. Nigel has a guest room!! Plans for work on the Ordovician include collaboration with **Jon Adrain** on some silicified trilobite material from Kentucky.

KIRILL IVANOV (Russia) wishes to exchange literature and ideas on Ordovician volcanism, MORB isotopes, deep sea or ocean floor sedimentation and stratigraphy, etc. Kirill is with the Russian Academy of Sciences, Uralian Branch, Ekaterinburg (former Sverdlovsk).

JISUO JIN (Canada) with **Glen Caldwell** and **Brian Norford** is completing a study of the Upper Ordovician brachiopod biostratigraphy and taxonomy of the Hudson Bay Basin and the adjacent part of the Williston Basin (southern Manitoba). Also a detailed taxonomic study of latest Middle Ordovician brachiopods from a new formation in east-central British Columbia.

DIMITRI KALJO (Estonia) is about to resume his long-interrupted study of Ordovician rugose corals. The project is planned in cooperation with **Bjørn Neuman** (Norway).

MARTIN KELLER (Germany), who is working on the sedimentology and facies of the Cambro-Ordovician carbonate platform, slope and basin deposits in the Argentine Precordillera, starts comparative studies on the Ordovician successions in the Western U.S. in order to contribute sedimentological aspects to the question of whether the Precordilleran terrane was part of Laurentia until the Lower Ordovician.

ED LANDING (USA) has finished a project with **S.R. Westrop** and **L. Hunt** on Lower Ordovician trilobites of the Tribes Hill Formation, eastern New York, and is completing work on a separate report on the formation's conodonts (*Rossodus manitouensis* Zone). A report on the biota (trilobites, brachiopods, graptolites, conodonts, acritarchs, and foraminifera) of the McLeod Brook Formation (upper Tremadoc), Cape Breton Island is in preparation with **R. Fortey** and **G. Wood**.

OLIVER LEHNERT (Germany) is continuing his work on Ordovician conodonts from the Argentine Precordillera. He is interested mainly in paleogeographic questions of

these faunas, especially in light of the recent discussion on the allochthonous nature of the Precordillera. Recently recovered Tremadoc and lowermost Arenig shallow water conodonts, typical "Midcontinent" forms, which with certainty may be regarded as warm water realm, are of special importance.

ANITA LÖFGREN (Sweden) is continuing work on early Ordovician conodonts, particularly trying to refine Baltoscandian biozonation and find ties with Laurentian zonations.

PEEP MANNIK (Estonia) is continuing work on Ordovician and Silurian conodonts from East Baltic.

SANDY McCACKEN (Canada) is continuing work on conodonts from northern Canada (Arctic Islands Ordovician-Silurian, Baffin Island, Hudson Bay Lowlands Middle-Late Ordovician). He is also continuing geochemical studies on the Ordovician-Silurian boundary in the Arctic Islands with **W. Goodfellow**, **C. Gregoire**, **M.J. Melchin**, and **G.S. Nowlan**.

MICHAL MERGL (Czech Republic) is working on a systematic study of Ordovician inarticulate brachiopods. His initial paper is about the systematic position, stratigraphic distribution, and significance of elkaniid genus *Elkanisca*.

BRIAN NORFORD (Canada) has compiled a set of taxonomic papers (brachiopods (Jin and Norford), corals (Elias), bryozoans (Bolton), pelecypods (Johnston)) on the faunas and biostratigraphy of a new latest Middle Ordovician formation in east-central British Columbia that represents a slope environment. Syntheses of Ordovician and Silurian rocks in outcrop and in the subsurface of western and northwestern Canada have been completed with **Mike Cecile** and several other scientists. Occurrences of Middle Ordovician graptolites are being documented in the Alexander Terrane of the extreme northwest of British Columbia and a detailed study of the Glenogle Formation and its graptolites (with **Dennis Jackson**) and other faunas is finally nearing conclusion. Compilation of Ordovician correlation charts and maps for the Arctic continues with **Godfrey Nowlan**, **Valentyn Bondarev**, **Jaroslav Spassky**, **Anita Harris**, **Julie Dumoulin**, **John Peel** and **Bernie Erdtmann** as part of a Canada-Russia scientific agreement.

GODFREY NOWLAN (Canada) is working on pre-Devonian biostratigraphy of the subsurface of the Western Canada Basin, Ordovician-Silurian boundary biostratigraphy and

geochemistry, CAI: regional evaluations and economic deposits, Arctic Circumpolar correlation charts for Ordovician and Silurian, and the Cambro-Ordovician boundary.

ALAN OWEN (Glasgow) continues work on the faunas of the Leinster terrane in Ireland (with **Matthew Parkes** amongst others), the faunas and stratigraphy of the Scottish Southern Uplands (with **Howard Armstrong**, **Euan Clarkson & others**) and on aspects of the Ordovician of the Oslo Region. The compilation and editing (with **Dave Harper**) of a Palaeontological Association Guide to Upper Ordovician fossils is nearly complete and work on the revision of the British Ordovician Correlation Chart (coordinated by **Richard Fortey**) is well advanced. Alan currently has three research students: **Tim McCormick** is writing his Ph.D. thesis on stasis in trilobites. **Alison Bowdler** is finishing an M.Sc. on British Caradoc cryptolithines (jointly supervised with **Keith Ingham**) and **Simon Peers** has just started a Ph.D. linking the phylogeny of various trilobite lineages with their palaeogeographical distribution.

IVO PAALITS (GERMANY) is continuing his Ph.D. study of Early Palaeozoic acritarchs from the Gorlitz Synclinorium (Saxony, Germany). His future main interest will be concerned with the acritarch biozonation of the Tremadoc on the East European Platform.

FLORENTIN PARIS (France) is working on Ordovician chitinozoan biostratigraphy and palaeoenvironments in North Africa, Saudi Arabia and western Europe. Particular attention is being paid to palaeobiogeographic affinities within northern Gondwanan regions. New investigations are also being carried out on ^{18}O from biogenic phosphates (e.g. inarticulate brachiopods and conodonts) with **Christophe Lecuyer** and **Michel Robardet** (Rennes).

MATTHEW PARKES (UK) is leaving the National Museum of Wales for a project in Dublin to curate the C19th fossil collections of the Geological Survey of Ireland. Before this he is trying to tie up several projects including biostratigraphical work at Portrane and Lambay Island in eastern Ireland, and describing Lower Ordovician brachiopods from Wilcox Pass, Canada with **Mike Bassett**. His British Museum Bulletin on Caradoc brachiopods from SE Ireland has been further delayed by them, but work with **Alan Owen** on the trilobites continues.

IVAR PUURA (Sweden) is studying the lingulate brachiopods and biostratigraphy of Cambrian-Ordovician boundary beds in Baltoscandia.

TERESA PODHALANSKA (Poland) is working on the sedimentology and stratigraphy of the Lower/Middle Ordovician sediments (especially limestones) in eastern and northern Poland/Polish Baltic Basin and the accompanying microboring assemblages, coated grains and discontinuity surfaces.

JOHN REPETSKI (USA) is continuing documentation and correlation of the Ibexian stratotype with **Rube Ross et al.** John is also helping **Godfrey Nowlan** with an Alaska Ordovician segment for his series of Arctic circumpolar correlation charts. He also continues studies of Lower and Middle Ordovician in the Midcontinent U.S., mainly including from the Upper Mississippi Valley south to the Reelfoot rift basin and from the Ozark shelf southward to the Ouachita Mountains. Studies include southern faunas and stratigraphy in terms of testing some of the recent SWEAT reconstructions which place the South American Occidentalia terrane near or in the Ouachita reentrant or embayment. John is helping lead discussions at several stops on a Ouachitas field trip this spring. Studies continue with **John Taylor** on the Stonehenge Limestone and adjacent and equivalent units, along and across the central Appalachians. John and **Anita Harris** are helping to produce a series of Cambro-Ordovician transects across the central Appalachians and two more should appear in 1994. In the western U.S. John and Anita are compiling hundreds of new Ordovician data points for updating the Great Basin CAI maps. Chasing eustatic and other breaks near the base of the Ibexian continues in collaboration with **Mike Taylor**. John is also studying conodont surface texture alteration and hydrothermal/mineralizing fluids which involves Ordovician strata in many areas. Work continues on several Lower Ordovician sections in Mexico and is ongoing on systematics, especially on taxa that are, or potentially are, particularly important to decisions on bases of the System and its Series and Stages.

MICHEL ROBARDET (France) is continuing studies on the Ordovician of the Ossa-Morena Zone, South Spain, the Upper Ordovician and the Ordovician-Silurian transition of the West Asturian-Leonese Zone, North-West Spain and the Arenig-Llanvirn transition in the Central Iberian Zone, Spain and Portugal, in cooperation with **Isabel Rabano**, **Juan-Carlos Gutierrez Marco**, **Graciela Sarmiento (Spain)**, **José-Manuel Piçarra (Portugal)**, **Claude Babin**, **Michel Melou (France)**. He is also working on the Ordovician to Devonian palaeogeography of southwestern Europe (France and Iberian Peninsula) and the palaeobiogeographical data which can constrain the reconstruction of the Variscan Belt (with Florentin Paris).

OLAF SCHMIDT-GUNDEL (Germany) is due to finish his Ph.D. thesis about the graptolite faunas of the Bogo and the Lo Shales (Lower Ordovician, west Norway) this

spring. Olaf has started compiling a graptolite reference list and is requesting publication lists from graptolite workers. Anyone who has not received a letter from Olaf is welcome to send their publication list. The "complete" list is planned to be published, or at least to be made available for any who may be interested.

JOHN SHERGOLD (Australia) is finalising a monograph on the trilobites of the Emanuel Formation, Canning Basin, Western Australia in collaboration with **John Laurie**. Other current collaborative studies are with **Bob Nicoll** and **Stephan Ebneth** (Germany) on the Cambrian-Ordovician strontium curve at Black Mountain, western Queensland; with **Eladio Linan** (Spain) and **Oswaldo Bordonaro** (Argentina) on agnostid trilobites found in Cambrian olistoliths from Middle Ordovician shales in the Argentinian Precordillera; and with **Bruno Baldis** and **S. Peralta** (Argentina) on a small Arenig-Llanvirn trilobite faunule from the San Juan Formation near San Juan, Argentina.

PAUL SMITH (UK) has a new Ph.D student, **Maxine Huselbee**, who is working on conodonts across the Cambrian-Ordovician boundary in North and East Greenland.

SVEND STOUGE (Denmark) is currently involved in studies on conodonts from North America (together with **Jorg Maletz** who is doing the graptolites) and Baltoscandia. A study on acritarchs and conodonts from the Baltoscandian region is in progress together with the University of Pisa, Italy. **Jan Audun Rasmussen** is finishing his Ph.D. thesis on conodonts from the Caledonides in Norway and Sweden.

SIMON TULL (UK) has been in the western Pri-Polar Urals in 1993 carrying out fieldwork along the River Kozhim. This is the key section for Middle Ordovician-Lower Devonian successions of the western Urals. The Middle and Upper Ordovician successions are superb. They are dominated by shallowing-upward, low energy, subtidal-intertidal, carbonate cycles. He hopes to return in 1994.

MICHAEL TAYLOR (USA) continues work on a monograph that deals with geology, sedimentology, paleontology, and paleoecology of the Middle Cambrian to Arenig of the Malii Karatau region, Republic of Kazakhstan. The report will include a number of chapters by **M.K. Apollonov**, **G.Kh. Ergaliev**, **M.I. Taylor**, **H.E. Cook**, and others from the Kazakhstan and Russian Academy of Sciences. The report is based on field work conducted from 1987-92.

H.E.Cook and **M.E. Taylor** are completing a report on lower Paleozoic sequence stratigraphy in the Great Basin, western U.S. The local history will be compared with

the Malii Karatau region, Southern Kazakhstan, and other areas using a new high resolution biostratigraphy that combines trilobites and conodonts.

MURIEL VIDAL (France) has started a Ph.D. thesis on Ordovician (Arenig) trilobites from Morocco and southern France, mostly asaphids (with **J.L. Henry** and **J. Destombes**).

BARRY WEBBY (Australia) is currently involved in a study of Upper Ordovician offshore island biotas in central New South Wales, associated in work on the ion probe dating of acid volcanic and tuffs from Lower Ordovician acid volcanics and tuffs from North Queensland, and editing the new and revised Ordovician correlation and explanatory notes for China, prepared by **Chen Xu** and many other Chinese workers. It describes 245 units, and these are assembled in an 82 column chart. During a recent period of study leave from August to October 1993 he visited China, Spain, Switzerland, UK and attended the Boston GSA meeting. In early February 1994 he attended the Australasian Association of Palaeontologists Convention at Macquarie University, Sydney, presenting a paper with **Ian Percival** entitled "Sponge-dominated island-slope associations in the Ordovician Malongulli Formation, New South Wales".

HENRY WILLIAMS (Canada) has spent the last year trying to get some research written up and submitted for publication rather than attempting yet more collecting. A number of these are now in press, including a Tremadoc-Arenig boundary stratotype proposal (with **Chris Barnes**, **Doug Boyce** and **Felicity O'Brien**; see abbreviated version in this issue of *Ordovician News*). **Rod Taylor** is now almost a year into an M.Sc. project on the taxonomy and biostratigraphy of Llanvirn graptolites from western Newfoundland.

MARK WILSON (USA) continues to work on Ordovician hardgrounds and the paleoecological systems associated with them. **Mark** and **Tim Palmer (UK)** and **Paul Taylor (UK)** are pursuing a study of bioimmured fossils, especially hydroids and foraminiferans, preserved underneath Ordovician bryozoans. **Mark** and **Paul** are also completing projects on Ordovician bryozoans, particularly *Corynotrypa* and the Early Ordovician *Dianulites* group.

TONY WRIGHT (UK) is currently working on a morphological reassessment of the clitambonitid brachiopods with **Madis Rubel**, and looking for a research student for the recently discovered late Caradoc brachiopod faunas of Pomeroy, Co. Tyrone.

GRAHAM YOUNG (Canada) is studying Late Ordovician tabulate coral from southern Manitoba. Other projects are based on latest Ordovician to earliest Silurian colonial corals of the east-central U.S.A. (with Bob Elias). These include paleoenvironmental reconstruction using paleoecology and taphonomy of colonial and solitary corals, and the relationship between growth form and internal morphology in favositids.

DONALD ZENGER (USA) is continuing work comparing the incredibly similar fauna and patterns of burrow-mottling, and associated dolomitization, in widely separated locations of Upper Ordovician (Edenian) units at El Paso, Texas (Upham Dolomite), northwest Wyoming (Bighorn Dolomite), and east-central Montana (Red River Formation). According to Flower (1961), this facies extends as far as Greenland.

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