Towards a "Common Language" in Stratigraphy

by M.G. Bassett

The establishment of internationally agreed definitions and terminology for subdivisions of the stratigraphical column is a prerequisite for the unambiguous discussion of widespread geological phenomena. This article represents the formal announcement of ratification by IUGS of a number of standard stratigraphical units and boundaries as proposed in 1984 by various bodies of the International Commission on Stratigraphy.

Introduction

From its origins and infancy as a science in the early 19th Century, stratigraphy has formed a linking theme between all branches of geology - a framework within which other disciplines are set in order to attempt to trace both synchronous events and sequential steps in earth history. Not surprisingly, the parameters of this framework first developed, at varying rates and scales in different regions and countries, as local rock successions. Lateral variations were established through primary geological mapping, and local terminologies for stratigraphical divisions accompanied these developments.

The increasing rigour of geological investigations eventually demanded refinement of correlation between different regions, but this was often hampered and mistakes compounded by differences in definitions, standards, and terminologies. With the growth of studies of global processes and events, the need for increasingly accurate and widespread stratigraphical correlations has become paramount in the last few decades, bringing with it the need for a clear vocabulary as a means of communicating results unambiguously. Hedberg summarized this well in his introduction to the *International Stratigraphic Guide* (1976, p.v).

"Stratigraphy is a global subject, and international (global) communication and cooperation are necessary if we are to adequately comprehend the picture of the rock strata of the Earth as a whole, and to restore the history of how, when and why these strata came to be what and where they are today. Agreement on stratigraphic principles, terminology, and classificatory procedure is essential to attaining a common language of stratigraphy that will serve geologists worldwide. It will allow their efforts to be concentrated effectively on the many real scientific problems of stratigraphy, rather than being wastefully dissipated in futile argument and fruitless controversy arising because of discrepant basic principles, divergent usage of terms, and other unnecessary impediments to mutual understanding."

Role of the International Commission on Stratigraphy

Within the International Union of Geological Sciences, the statutory objectives of the International Commission on Stratigraphy (ICS) include clarification of principles of stratigraphical classification and unification of terminology, development of a standard global stratigraphical scale, distribution of information on each of the major subdivisions of the standard scale, establishment of their boundaries, and correlation of their subdivisions. International cooperation is implicit in these aims.

In its long history (see Martinsson and Bassett, 1980), ICS has evolved into a vigorous coordinator of research in many disciplines. Since 1968, under the successive chairmanship of Academician V.V. Menner (Soviet Union, Fig. 1), Dr. D.J. McLaren (Canada, Fig. 2) and the late Prof. A. Martinsson (Sweden, Fig. 3), various Subcommissions and Working Groups have devoted particular attention to the elaboration and correlation of standard Series and Stage divisions within each geological System, together with the precise definition of boundaries between them. With regard to the latter effort, the principle has become firmly accepted of defining the base of each division at a unique point in a rock sequence, representing a unique point in time to

serve as a standard against which other sequences can be correlated; correlation is achieved by the analysis of all available data, such as evidence from fossils, radiometric ages, and remanent magnetic signatures. The standard points and sections are referred to as stratotypes.

This work should not be seen as an end in itself. The amount of new research generated within ICS

Figure 1: Academician Vladimir Vasilievich Menner, Chairman of ICS 1968-1972.

Figure 2: Dr. Digby McLaren, Chairman of ICS 1972-1976.

bodies as a result of focussing on stratigraphical objectives is impressive by any standards. Discussions in the field (Fig. 4) and at related conferences provide an important forum for disseminating results and making decisions. Numerous internal working documents (Fig. 5) and more formal publications (Fig. 6) are visible results of progress, whereas even the non-scientific productions (Fig. 7) reflect a marvellous spirit of effort and collaboration.

Proposals, Procedures and Decisions

In 1983 all bodies within ICS were encouraged by the Chairman to speed up their work on establishing standards, and where possible to submit formal proposals for consideration at the 27th Session of the International Geological Con-

Figure 3: The late Professor Anders Martinsson, Chairman of ICS 1976-1983.

Figure 4: Discussing Silurian classification and correlation where it matters most - in the field. Members of the Silurian Subcommittee in Podolia, Ukraine, U.S.S.R., May 1983. The spirit of international cooperation is reflected in the countries of origin of these participants - China, Russia, Estonia, Ukraine, Latvia, Romania, East Germany, Poland, England, Ireland and Wales.

gress in Moscow. The proposals that were received are summarized below. The statutes of IUGS and of ICS demand only a simple majority for any decision to be passed, but in order to ensure that reasonable agreement could be achieved internationally, the ICS Officers adopted a general procedure of passing any proposal to the next stage of discussion only where a reasonable working majority (normally 60% or more) was first obtained among voting members within the respective Subcommittee or Working Group. All proposals were then presented for discussion at the ICS Business Meeting in Moscow on 13 August 1984. In each case approval was obtained to submit the proposals to a full postal ballot of all 25 Commission Voting Members (the ICS Bureau and Chairmen of Subcommittees). The results of that ballot are given below for each of the proposals.

The proposals were next reported, on behalf of ICS, by M.G. Bassett and J.W. Cowie to a meeting of the full IUGS Executive Committee in Rabat, Morocco on 10 February 1985. All approved decisions by ICS were subsequently submitted to the IUGS Executive in writing for a postal ballot, and on 31 May 1985 the Secretary-General of the Union (R. Sinding-Larsen) informed M.G. Bassett that all had received majority support from the Executive. This support represents formal ratification of the decisions by IUGS, and the statements below are the formal expression of this ratification. The accompanying papers in this issue of Episodes give the background to these decisions. In each case, full accounts in support of these background summaries either have been published elsewhere and are referred to in the following papers, or are now being prepared for publication by the respective Subcommittee and Working Groups.

Decision on the Base of the Cambrian System Postponed

Following 12 years research on relevant sections throughout the world, the Working Group on the Precambrian-Cambrian Boundary (through its Chairman J.W. Cowie) submitted to ICS on June 1, 1984, a formal proposal for boundary definition. In

addition to the necessary approval within the Working Group, the submission was supported by a unanimous vote of the Subcommittee on Precambrian Stratigraphy and a majority vote of the Subcommittee on Cambrian Stratigraphy.

In summary, the Working Group proposed that the base of the Cambrian System (i.e. the Precambrian-Cambrian Boundary) should be defined at a point at the base of Unit (Bed) 7 within the Yuhucun Formation in a stratotype section at Kunyang Quarry, Meishucun, Jinning County, Yunnan Province, Peoples Republic of China. This boundary coincides with the boundary between faunal zones I and II in the section, the *Anabarites-Circotheca* Zone and the *Paragloborilus-Siphonogonuchites* Zone, based on small shelly body fossils. Details are given in the accompanying paper by J.W. Cowie.

However, at meetings of the Working Group at the Moscow Congress on 5 and 6 August 1984, further detailed discussions revealed the serious concern among some members about limitations in potential for correlation of the proposed boundary level in the stratotype section. In the light of these discussions, the Working Group agreed that a statement reflecting the concern on problems of correlation should be added to the original boundary submission as a rider, including a suggestion

Figure 5: An example of a submission (on the Přídolí Series) to a Subcommittee.

that "postponement (of a decision) would probably be wiser than acceptance at this stage." At the ICS Business Meeting in Moscow a few days later, the Working Group Chairman formally asked the Commission to add this rider to the submission, and it was agreed that it should be included in the papers to be circulated for voting in the postal ballot. Subsequent voting on the submission by ICS resulted in 4 votes in favour of the proposed boundary definition, with 16 in favour of postponement of the decision (in the light of the rider and pending further studies of correlation), 1 against, and 4 abstentions.

The matter of the definition of the base of the Cambrian System has thus been referred back to the Precambrian-Cambrian Boundary Working Group for further study and future resubmission. The decision does not necessarily imply that the candidature of the Meishucun section has been rejected; it is still on the table for consideration unless removed by a ballot of the Voting Members of the Working Group.

The Base of the Silurian System

Through its Secretary, L.R.M. Cocks, the Working Group on the Ordovician-Silurian Boundary made a formal submission to ICS on 3 June 1984, almost exactly 10 years after the Group began its work.

In this, the base of the Silurian System is defined at a point 1.6 metres above the base of the Birkhill Shale Formation in a stratotype section in a trench on the north side of the Linn Branch stream at Dob's Linn, near Moffat, United Kingdom, British National Grid Reference NT 1962 1584. The

Figure 6: The cover of a publication produced by the Subcommittee on Cretaceous Stratigraphy.

CRETACEOUS STAGE BOUNDARIES COPENHAGEN 1983

Figure 7: Logotype designed for an international conference and field excursion of the Subcommittee on Silurian Stratigraphy in Podolia, Ukraine, U.S.S.R., May 1983. The brachiopod is *Delthyris magna*, one of the common and distinctive species in the Upper Silurian rocks of the region.

background to this proposal is described in the accompanying paper by L.R.M. Cocks (see Fig. 8). In the stratotype section the boundary point coincides with the base of the graptolite Biozone of *Parakidograptus acuminatus*, marked by the first appearance of *P. acuminatus* itself together with *Akidograptus ascensus*.

The definition was approved by ICS by a majority vote, with 15 in favour, 4 against, and 6 abstentions.

Series and Stage Divisions of the Silurian System

The Subcommittee on Silurian Stratigraphy was constituted in 1974, and in 1976 it embarked on an eight year program designed to establish primary chronostratigraphical divisions throughout the Silurian System. Definition and ratification of two central divisions, the Wenlock and Ludlow Series, each with two component stage divisions, respectively the Sheinwoodian and Homerian Stages and the Gorstian and Ludfordian Stages, was accomplished in 1981 (Martinsson et al., 1981). These results have been summarized elsewhere (Holland, 1982, 1984).

Completion of the program was achieved with the submission on 29 May 1984 (by C.H. Holland as Chairman of the Subcommittee) of five proposals for boundaries and units within the remainder of the Silurian System. The background to these proposals is described in the accompanying paper by Holland. Formal ratification is as follows:

1. The first (lowest) Series of the Silurian System is named the Llandovery Series. The name is taken from the type area around the town of Llandovery in Dyfed, southern Wales, U.K. The base of the Llandovery Series is coincident with the base of the Silurian System as defined by the Ordovician-Silurian Boundary Working Group (see above). ICS approved this proposal with 18 in favour, 3 against, and 4 abstentions.
2. The first (lower) Stage of the Llandovery Series is named the Rhuddanian Stage. The name is taken from Cefn-Rhuddan Farm in the type Llandovery area. The base of the Rhuddanian Stage is coincident with the base of the Llandovery Series and the base of the Silurian System (see above). ICS approved this proposal with 18 in favour, 3 against, and 4 abstentions.
3. The second (middle) Stage of the Llandovery Series is named the Aeronian Stage. The name is taken from Cwm-coed-Aeron Farm in the type Llandovery area. The boundary stratotype for the base of the Aeronian Stage is in the Trefawr forestry road section 500 metres north of Cwm-coed-Aeron Farm at British National Grid Reference SN 8380 3935, the marker point for the base is within a continuous

Figure 8: Careful identification of critical trilobite and graptolite horizons and lithostratigraphical level just below the stratotype section for the Ordovician-Silurian Boundary at Dob's Linn, Scotland. Sign in lower left indicates the *extraordinarius* Band.

lithological section through part of the Trefawr Formation at the base of locality 72 in transect h as described by Cocks and others (1984, p. 165, figs. 60, 61, 62, 63). This point correlates with the base of the *Monograptus triangulatus* graptolite Biozone in the section. The base of the Aeronian Stage automatically defines the top of the underlying Rhudanian Stage. ICS approved this definition with 18 in favour, 3 against, and 4 abstentions.

4. The third (upper) Stage of the Llandovery Series is named the Telychian Stage. The name taken from Penlan-Telych Farm in the type Llandovery area. The boundary stratotype for the base of the Telychian Stage is in an old quarry on the west side of the Cefn Cerig road at British National Grid Reference SN 7743 3232; the marker point for the base is within a continuous lithological section through part of the Wormwood Formation at locality 162 in transect d as described by Cocks and others (1984, p. 167, figs. 64, 65, 66, 67). This point correlates with the base of the *Monograptus turriculatus* graptolite Biozone and is marked by distinctive changes in brachiopod evolutionary lineages involving the replacement of *Eocoelia intermedia* by *Eocoelia curtisi* and of *Stricklandia lens progressa* by *Stricklandia laevis*. The base of the Telychian Stage automatically

Figure 9: Section in Upper Silurian rocks on the bank of the Dnestr River, Podolia; apart from data on the rock face itself, a detailed log through the section is available on the large notice at right, and a rope provided for critical study of the whole outcrop! Such attention to detail is a feature of many excursions throughout the world.

defines the top of the underlying Aeronian Stage. ICS approved this definition by 17 votes in favour, 4 against, and 4 abstentions.

5. The fourth (uppermost) Series of the Silurian System is named the Přídolí Series. The name is taken from Přídolí in the type Barrandian area (Prague Basin) of Bohemia, Czechoslovakia (see also Figs. 9 and 10). The boundary stratotype for the base of the Přídolí Series is in the Požary section near Reporyje, Prague; the marker point for the base is at the base of bed 96 in the section, conforming with the base of the Přídolí Formation at its junction with the underlying Kopanina Formation. It should be noted that Czech stratigraphers have agreed to change the name of the Přídolí Formation in a future publication in order to avoid its coincidence with the Series name. The marker point correlates with the base of the *Monograptus parultimus* graptolite Biozone in the section. The base of the Přídolí Series automatically defines the top of the underlying Ludlow Series. ICS approved this proposal and definition by 20 votes in favour, 1 against, and 4 abstentions.

Stage Divisions of the Devonian System

A set of proposals from the Subcommittee on Devonian Stratigraphy was submitted on 30 May 1984 by the Chairman W. Ziegler, who with the Vice-Chairman G. Klapper has also

described the background to the submission in the accompanying paper. The Subcommittee has now been active for 12 years, and an initial announcement of some of the decisions ratified here was made in 1982 (Ziegler and Klapper, 1982).

The proposals were submitted in four separate documents, which were summarized under six points for formal voting within ICS and IUGS. The same order is followed here for ratification.

1. The first (lowest) Series of the Devonian System includes three Stage divisions named (in ascending order) the Lochkovian Stage, the Pragian Stage, and the Emsian Stage. The names of the first two relate to localities in the Barrandian area (Prague Basin) of Bohemia, Czechoslovakia, and the third to the classical Rhenish area of West Germany. The base of the Lochkovian Stage is coincident with the base of the Devonian System (see Martinsson, 1977) and automatically defines the top of the underlying Přídolí Series of the Silurian System. Decisions on definition of the lower boundary levels for the Pragian and Emsian and on basal boundary stratotype sections will be made within the next few years. ICS approved adoption of the Stage names with 21 in favour, 0 against, and 4 abstentions.

2. The second (middle) Series of the Devonian System includes two Stage divisions named (in ascending order) the Eifelian Stage and the Givetian Stage. The names relate to localities in the Rhenish-Belgian region. ICS approved adoption of the Stage names with 21 in favour, 0 against, and 4 abstentions.

3. The third (middle) Series of the Devonian System includes two Stage divisions named (in ascending order) the Frasnian Stage and the Famennian Stage. The names relate to localities in the Ardennes region of Belgium. The top of the Famennian Stage and of the Devonian System is defined automatically by the base of the Carboniferous System. ICS approved adoption of the Stage names with 21 in favour, 0 against, and 4 abstentions.

4. The boundary stratotype for the base of the Middle Devonian Series and of the Eifelian Stage is in a trench section at Wetteldorf Richtschnitt near Schönecken-Wetteldorf, Eifel Hills, Federal Republic of Germany (Schönecken 1:250,000 map sheet r33 765 h57 130); the marker point for the base is at 21.25 metres above the base of the exposed section within a continuous lithological succession through part of the Upper Heisdorf Formation, 1.9 metres below the base of the Lower Lauch Formation (Wolfenbach Member). This point is coincident with the base of the *Polygnathus costatus partitus* conodont Biozone in the section. The base of the Eifelian Stage automatically defines the top of the underlying Emsian Stage and the Lower Devonian Series. ICS approved this definition with 21 in favour, 0 against, and 4 abstentions.

The two further proposals by the Subcommittee on Devonian Stratigraphy were also approved in a ballot by ICS, but in a meeting of the Commission Bureau in London, U.K., on 22 February 1985 it was agreed that they should not yet be submitted for final ratification. This is because both proposals relate to recognition of Stage boundaries not as yet defined in full in basal stratotype sections. The faunal criteria used to recognize and correlate these boundaries are accepted and recommended by ICS for global usage and will be presented to IUGS for formal ratification when tied to stratotype points on agreement of the Subcommittee. The agreed boundary criteria are as follows:

5. The base of the Upper Devonian Series and of the Frasnian Stage is taken at a level coincident with the base of the Lower *asymmetricus* conodont Biozone, defined by the first occurrence of the conodont *Ancyrodella rotundiloba rotundiloba*.

6. The base of the Famennian Stage is taken at a level coincident with the base of the Middle *Palmitolepis triangularis* conodont Biozone, defined by the first occurrence of the conodont *Palmitolepis delicatula*.

The Base of the Pleistocene Series

On behalf of the Pliocene-Pleistocene Boundary Working Group, R.P. Suggate submitted a formal proposal for definition of the base of the Pleistocene Series dated 27 May 1984. The submission was accompanied by a separate description of the proposed stratotype and its correlation, prepared by the Working Group Chairman and Secretary, E. Aguirre and G. Pasini, who have also summarized the details in the accompanying paper.

Figure 10: Dr. Tatyana Koren (U.S.S.R.) demonstrates the base of the Skala "horizon" at its type locality on the bank of the Dnestr River, Podolia. The Skala was one of the possible candidates for the Upper Silurian Series.

The boundary stratotype for the base of the Pleistocene Series is within subsection B of the Vrica Section, approximately 4 km south of Crotona in the Marchesato Peninsula, Calabria, southern Italy, latitude 39°02' 18.61" north, longitude 17°08' 05.79" east. The marker point for the base is at the base of the claystone conformably overlying the sapropelic marker bed e in the section. The boundary lies between the Last Appearance Datum of *Discoaster brouweri* (below) and the Last Appearance Datums of *Globigerinoides obliquus extremus* and *Cyclococcolithus macintyreii* and First Appearance Datums of *Gephyrocapsa oceanica* and *Globigerinoides tenellus* (above); these taxa are distinctive nannoplankton and foraminifera of widespread distribution. It also lies between the top of the Olduvai normal polarity zone and a zone with dominantly left-coiled specimens of the foraminifer *Neogloboquadrina pachyderma*. The boundary is some 3-6 metres (representing a period of 10,000-20,000 years) above the top of the Olduvai normal polarity subchron. The base of the Pleistocene Series automatically defines the top of the underlying Pliocene Series. ICS approved the definition by 20 votes in favour, 1 against, and 4 abstentions.

Other Proposals and Agreements

In addition to the formal decisions outlined above, almost every group within ICS has made rapid progress over the past few years towards the establishment of standard chronostratigraphical divisions throughout the geological column. For the most part, proposals within any one Subcommittee or

Boundary Working Group are still being tested and modified prior to announcement to wider audiences, but in some cases sufficiently firm agreement has been reached to warrant advertisement. Two such cases are incorporated in the accompanying papers by E. Paproth and M. Streel, and by H.R. Lane and W.L. Manger. In recommending the biostratigraphical criteria to be used globally in recognizing the base of the Carboniferous System and a mid-Carboniferous boundary level, respectively, both these proposals represent significant steps towards eventual boundary definition in stratotype sections.

Under its new Chairman for 1984-1989 (J.W. Cowie), ICS has high hopes that the completion of a full set of internationally agreed units and names at the System, Series and Stage levels will be achieved in the near future. Only then will the geological community be able to express and correlate the effects of world-wide events in unambiguous terminology.

Acknowledgements

It is a pleasure to thank the many geologists throughout the world who have contributed to the work of ICS in establishing international standards, not only in the results presented here but also in the vast amount of research that is continuing throughout the geological column. Since my formal involvement began in 1976, successive Executive Committees of IUGS have given strong backing and financial support to all aspects of stratigraphy. Whilst it is invidious to single out anyone individual in a cooperative program such as this, I am sure that on this occasion others will understand if I pay a particular tribute to Academician Menner, who on 24 November this year will celebrate his 80th birthday. Apart from being responsible for setting up the present organizational structure of ICS, he was a Vice-President of IUGS from 1976 to 1984 and was thus involved directly in discussions on the subjects reported in this volume; the strong support enjoyed by ICS within IUGS owes much to his wise counsel and vigorous promotion.

Professor Menner has been associated for 50 years with the Geological Institute of the Soviet Academy of Sciences where he is still Deputy Director, and he is also known for his stimulating teaching at the Moscow Geological Prospecting Institute (1930-1965) and Moscow State University (since 1966). He has published fundamental palaeontological and stratigraphical research from almost every System through the Precambrian and Phanerozoic, and his work has brought him many honours both at home and abroad, including the Order of Lenin - the highest recognition within the Soviet Union. The realization of some of Professor Menner's contributions to stratigraphy as embodied in results in this issue of Episodes provides a suitable form of greeting for his 80th birthday.

Dr. Michael G. Bassett was Secretary-General of the ICS from 1976 to 1984 and is currently a member of the Commission Bureau. He is Head of the Department of Geology at the National Museum of Wales, Cardiff, U.K., and is a Vice-President of The Palaeontological Association. His research interests are centred on Palaeozoic brachiopods, biostratigraphy and facies developments, particularly in the U.K. and Scandinavia.

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