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Autor: Hedberg, Hollis D.
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Stratigraphic Boundaries - A Reply

By HOLLIS D. HEDBERG

Department of Geology, Princeton University, Princeton, N.J., USA

ABSTRACT

In reply to a recent paper by Dr. JOST WIEDMANN criticizing the position of the International Subcommission on Stratigraphic Classification (ISSC) with respect to principles of stratigraphic classification, it seems necessary to re-emphasize the following points:

1. Stratigraphy is a broad subject covering all properties of rocks as strata. Important as are fossils in stratigraphic classification (biostratigraphic units), there are still many other kinds of stratigraphic units which it is also desirable to recognize (lithostratigraphic units, chronostratigraphic units, etc.) in portraying most usefully the Earth's stratigraphic sequence and the history of its origin.

2. Chronostratigraphic units, representing the rocks formed during specific time-spans of earth history, are basic to grasping earth history. Biostratigraphy has been our most valuable aid to identifying and correlating chronostratigraphic units in much of the Earth's stratigraphic sequence; but it is not the only means and there are many parts of the sequence where fossil evidence is very inadequate. We need to utilize all available kinds of evidence in attempting to extend isochronous horizons and units as widely and with as great precision as possible.

3. A biostratigraphic unit (delimited by the limits of occurrence of certain fossils) is fundamentally different from a chronostratigraphic unit which is delimited strictly by isochronous horizons. The limits of a biostratigraphic zone, due to changes in depositional facies, variations in conditions for preservation of fossils, or vagaries of fossil discovery, cannot everywhere coincide with the same time horizons, whereas the boundaries of a chronostratigraphic zone must by definition be isochronous. Hence, while we can and do utilize biostratigraphic evidence to the greatest extent, we cannot correctly say that a biostratigraphic unit is necessarily a chronostratigraphic unit. In fact, a biostratigraphic marker rarely, if ever, constitutes a synchronous horizon worldwide through all kinds of strata.

4. Since our only record of the passage of geologic time lies in the rock strata, it is appropriate that our standards for division points of geologic time should be referred to designated points in the sequence of rock strata – boundary-stratotypes. Internationally agreed stratotypes appear essential to effectively define the scope of most chronostratigraphic units; they may be helpful for some kinds of biostratigraphic units, but are not applicable to other kinds of biostratigraphic units. The choice of stratotype limits for chronostratigraphic units must inevitably be somewhat arbitrary. In the standard chronostratigraphic hierarchy, the stratotypes of units of major rank should be the composites of stratotypes of units of lesser rank.

5. The ISSC is a widely representative international body (including in its membership not only individuals but almost all national stratigraphic committees) which attempts to study principles of stratigraphic classification and terminology and to formulate recommendations for their application. It welcomes constructive criticism from all geologists. There is nothing binding in its conclusions other than as they appeal to geologists in general as being worthy of following in the interests of international geological understanding and progress.

My attention has been called to a recent paper entitled "Das Problem stratigraphischer Grenzziehung und die Jura/Kreide-Grenze" (WIEDMANN, 1968). This paper, in its initial sections, attempts to discuss principles of stratigraphy, and is quite critical of the International Subcommittee on Stratigraphic Classification (ISSC) and its work. The ISSC welcomes constructive criticism. Much of what Dr. Wiedmann has to say, has been presented before by Professor Schindewolf, a member of ISSC (see particularly, SCHINDEWOLF, 1960), and has been discussed and evaluated very thoroughly by the members of the Subcommittee during the course of years. Nevertheless, the appearance of this new paper in the *Eclogae*, in spite of its regrettably unfriendly tone and its frequently misleading statements, seems to require the time and space necessary for an answer.

I am very grateful to Dr. H. H. Renz of Corseaux sur Vevey, Switzerland, for his help in translating to English essential parts of Dr. Wiedmann's paper; and for critically reading the manuscript of my reply.

I will take up in consecutive order a number of points which are brought up in Wiedmann's paper, giving as the caption to each point the statement of ISSC philosophy to which he seems to take exception or which he seems to have misunderstood. Page, section, and paragraph references in parentheses immediately following each topic caption refer to the relevant passages in Wiedmann's paper.

1. *Biostratigraphy is not the whole of stratigraphy; there are other important branches of stratigraphy.*

(Page 324, Division-B, 1st paragraph.) WIEDMANN wishes to remove lithostratigraphy from stratigraphy, and like SCHINDEWOLF would consider it as a separate thing called "prostratigraphy". This is an unhappy and unnecessary restriction of the meaning of the word stratigraphy. Moreover, later on (page 334), he also objects to accepting the term chronostratigraphy, on the grounds that it is synonymous with biostratigraphy and thus redundant. One can only wonder why WIEDMANN continues then to use both "biostratigraphy" and "stratigraphy" since he leaves nothing in stratigraphy except biostratigraphy!

Stratigraphy, as the derivation of the word indicates, covers all properties of rocks as strata, not just their biologic aspects. Important as fossils are, we would still have stratigraphy even if we had no fossils; and regardless of how valuable biostratigraphy is for dating rocks, there is still no reason to exclude all other means. It is no aspersion on biostratigraphy to grant that there are stratigraphic properties of rocks other than their fossil content about which it is important to have information. In fact, there are clearly *many* kinds of stratigraphy – lithostratigraphy, biostratigraphy, chronostratigraphy, etc. – and we only lose much and gain nothing by attempting artificially to exclude any of them.

With reference to WIEDMANN's remarks (page 325, 3rd paragraph), not only lithostratigraphic units but also biostratigraphic units are difficult to define strictly in vertical and horizontal extent, but both are nevertheless extremely useful kinds of stratigraphic units.

2. *Biologic breaks are rarely, if ever, reflected everywhere in the stratigraphic record world-wide as identifiable synchronous horizons.*

(Pages 328–329, section-3.) Biologic breaks were probably never perfectly synchronous world-wide; for no species started everywhere at exactly the same time or became extinct everywhere at exactly the same time. Whether the time-lag, world-wide, in first appearance or in extinction was in many cases so small as to be beyond our powers of resolution is, of course, another question. However, the important point is that our only record of the passage of time lies in the rock strata. These strata, world-wide, represent so many different environmental facies (and most life forms have been so sensitive to environment, both for living and for preservation after death) that we cannot possibly expect the physical boundaries of occurrence of a fossil form in rock strata to be everywhere isochronous, even though we were to assume, for practical purposes, that origins were everywhere simultaneous and extinctions were everywhere simultaneous. For example, the earliest occurrence of a

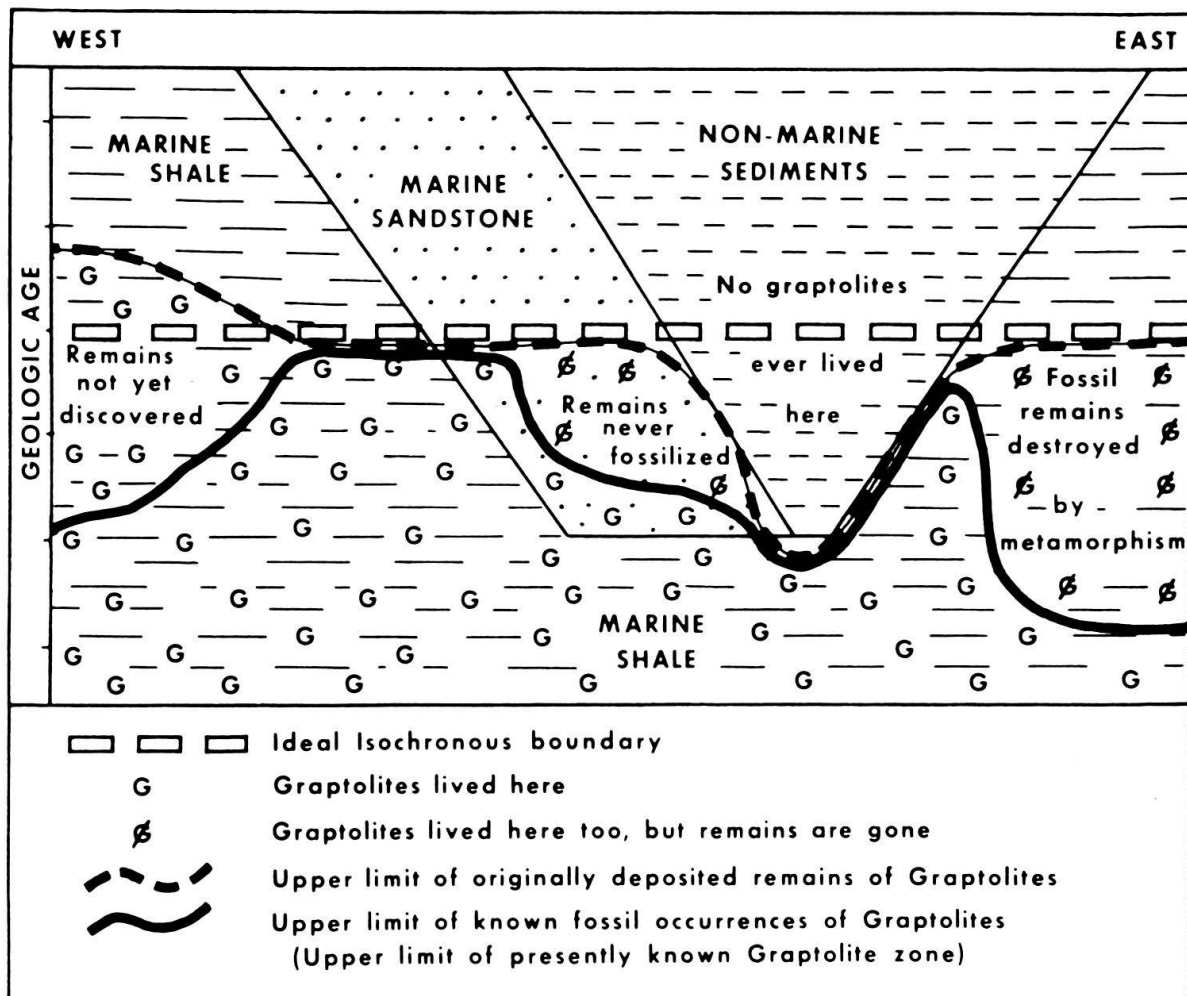


Fig. 1. Diagrammatic cross-section showing some possible relations between the upper limit of occurrence of fossil specimens of a graptolite taxon, and an isochronous horizon (chronostratigraphic boundary).

certain fossil ammonite taxon may well be older in a sequence of continuous marine deposits than in a sequence of strata of the same age in which continental deposits preceded the marine deposits. Hence we must conclude that regardless of whether or not biological breaks were historically synchronous world-wide, our *record* of them world-wide in the Earth's strata can rarely, if ever, be so (see Fig. 1, taken from HEDBERG, 1965a).

3. *The choice of the biostratigraphic criteria on which to base the type of a chronostratigraphic boundary must be to a considerable extent arbitrary, and hence to that extent, at least, the units which the boundary helps to define are artificial.*

(Pages 329–332, section-4.) WIEDMANN here confuses biostratigraphic boundaries with chronostratigraphic boundaries – not at all the same thing – so that it is difficult to consider or evaluate his discussion. Thus he makes objections to remarks quoted from ZIEGLER and AGER, without seeming to realize that they are probably talking about time and time-stratigraphic units and not about biostratigraphic units.

True biostratigraphic units are indeed artificial only to the degree that our taxonomic concepts are artificial, which is, of course, always a serious consideration. However, beyond this they are by definition always natural, at least in concept. The *choice* of biostratigraphic criteria for the type-boundaries of *chronostratigraphic* units or as guides to isochronous extension of these boundaries is, however, a quite different matter.

WIEDMANN mentions numerous faunal breaks throughout the Phanerozoic section which have been used as the bases for Stage, Series, System and Erathem boundaries. These are presumably natural, not artificial, breaks, but even so, and even supposing for a moment that they were reflected in strata world-wide everywhere as ideally isochronous horizons, still they inevitably result in rather artificial chronostratigraphic units, since only certain breaks out of many can be utilized, and who is to say that evolutionary changes in ammonite taxa, for example, constitute more natural boundaries than changes in other faunal taxa, or for that matter, in floral taxa? The horizon marked by the last ammonite does not coincide exactly with the horizon of the last dinosaur, or the last belemnite, or the last rudistid, or the last globotruncanid, and, although all of these may have become extinct at *about* the same time, the use of the limits of range of any one of them as *the* upper boundary of the Cretaceous requires a certain amount of arbitrary decision and thus gives a certain degree of artificiality to the boundary, whereas the use of all of them would fail to give any exact boundary and would leave the upper limit of Cretaceous strata open to interminable argument.

Moreover, who is to say that the stratigraphic limits of an order or a class in one phylum constitute a more natural boundary than the stratigraphic limits of a genus or a family in another? Who is to say that the disappearance of the archeocyathids in the *midst* of our Cambrian, for example, does not constitute a more natural System-boundary than the disappearance of certain trilobite genera or families at the *end* of our Cambrian?

4. *In a standard chronostratigraphic hierarchy, a) the scope of each unit should be defined by an upper and a lower boundary-stratotype; b) the upper and lower boundary-stratotypes of a unit of major rank (e.g., a System) should also be the upper and lower boundary-stratotypes respectively of the uppermost and lowermost of its component units of lower rank (e.g., Stages), and vice versa; and c) the unit-stratotype of a unit of major rank should be the composite of the unit-stratotypes of its component units of lower rank.*

(Page 334, 1st full paragraph.) After stressing that in any proper classificatory scheme the smallest units automatically define the larger ones (page 333, last paragraph), WIEDMANN says that he objects to Series and Systems having “eigene Stratotypen”, and says that nothing demonstrates the purely theoretical and irrational nature of modern attempts at stratigraphic classification more than the understandable, but not realizable, desire for “System-Stratotypen”. He implies that these comments of his are necessitated by statements in two papers with which I have been connected. It is hard to see what it is that WIEDMANN finds necessary to correct in the views on this matter given in the cited papers. In the first of these (ISSC, 1964, p. 17), it is clearly stated: “It may, therefore, commonly be desirable to make the stratotype of a System the composite stratotype of its Stages”. In the second of these papers (ISSC, 1968, p. 16), it is likewise clearly stated: “It appears most practicable to start the establishment of internationally approved stratotypes at the scale of Stages (or perhaps Chronozones) and to use these as building blocks for Series, Systems and Erathems – arbitrarily defining each larger unit in terms of the smaller ones. Thus the stratotype of any particular Series would be the composite of the stratotypes of its component Stages. These Stages might in turn be based on Chronozones.” With what is WIEDMANN in disagreement?

If WIEDMANN is objecting to a System *in the standard chronostratigraphic hierarchy* having a stratotype independent of the scope or the stratotypes of its component Series and Stages, then I would of course agree; but certainly I have nowhere said that it should. (Incidentally, this in no way should imply that local or regional units, *not part of the standard hierarchy*, may not be recognized straddling the boundaries of units in the standard hierarchy.)

If WIEDMANN is merely implying that a single continuously exposed section through a unit of the rank of a System is extremely rare or impossible to find – and, in any case (and as likewise for a Stage or a Series), would not be typical of the character of the unit as a whole – then I would, of course, again heartily agree.

If, however, as his wording seems more probably to indicate, WIEDMANN is implying that for some reason the scope of a System, as contrasted with that of a Stage, cannot be referred to a stratotype for definition, or that a System may not as well as a Series or a Stage have boundary-stratotypes, then I would have to disagree most emphatically.

(Page 333, last paragraph, and page 334, 3rd full paragraph.) WIEDMANN says that if we are to have stratotypes at all (which he deplors) they should be limited to zones, these being the biostratigraphical units of measure. It is hard to discuss this point since again we cannot tell whether WIEDMANN is really referring to chronozones or to biostratigraphic zones; and, if the latter, what kind of biostratigraphic zones. It makes

a great difference. I certainly agree that many chronozones may usefully have stratotypes (see quotations cited under my Topic-4) but I see no reason why *only* chronozones should have stratotypes. As for biostratigraphic zones, some kinds may usefully have stratotypes, others not (see my Topic-7).

5. *Biostratigraphic units differ fundamentally in concept from chronostratigraphic units and their boundaries will only locally coincide.*

(Page 334, 2nd full paragraph.) WIEDMANN persistently seeks to eliminate the term chronostratigraphy and the category of chronostratigraphic units. Also he wishes to build his Stages out of biostratigraphic zones rather than chronozones. He seems unable or unwilling to grasp the important and fundamental difference between a biostratigraphic zone and a chronostratigraphic zone – the fact that a biostratigraphic zone is delimited by the actual limits of occurrence of specimens of a taxon or specimens representing some other paleontological feature; whereas a chronostratigraphic zone (chronozone) is defined as a unit representing all rocks formed during a certain time-span of earth history and only that time-span. The two are not the same. The limits of a biostratigraphic zone, due to changes in depositional facies, variations in conditions for preservation of fossils, or vagaries of fossil discovery, cannot everywhere coincide with the same time-horizon in rock strata (see Fig. 1); whereas the boundaries of a chronozone must by definition be isochronous. Of the two, only the chronostratigraphic zones can be the building blocks for Stages, or Series, or Systems, if these latter are to be accepted as units having everywhere isochronous boundaries. A biostratigraphic zone (or, better yet, the evidence from many biostratigraphic zones) may usually be the best *aid* we may have to chronostratigraphy, but it is not in itself a chronostratigraphic unit.

6. *The use of type sections or stratotypes to define the boundaries of chronostratigraphic units should not be interpreted as a mixing of lithostratigraphy and chronostratigraphy.*

(Pages 334–335, 3rd full paragraph on page 334 and paragraph beginning at bottom of page 334 and continuing on page 335.) WIEDMANN here confuses stratotypes with lithostratigraphy, and biostratigraphy with chronostratigraphy, and says that a choice is necessary between basing standards for “biostratigraphic” (chronostratigraphic?) units on “biologic holotypes” or on “lithologic stratotypes” (whatever he means by this last?). He then indicates that the definition of biostratigraphic units must be based on faunal changes (Why not floral changes also?). However, he is probably using “biostratigraphy” here in the sense of chronostratigraphy and we can scarcely agree that chronostratigraphic units should be defined by “biologic holotypes”. Neither, of course, do we think that chronostratigraphic units can be defined by lithology, as he seems to infer that we do. Apparently, he confuses the using of the sequence of strata as a *record of the passage of time* with using lithology as an indicator of time-correlation. Finally, WIEDMANN rejects the use of stratotypes because, he says, quoting SCHINDEWOLF, “We cannot measure time with the tape measure”: Who is trying to do so?

7. Stratotypes are necessary to satisfactorily define the boundaries of most chronostratigraphic units; they are helpful for some kinds of biostratigraphic units; but they are not applicable to all kinds of biostratigraphic units.

(Page 335, 1st full paragraph.) WIEDMANN quotes the ISSC draft report on stratotypes (1968) to the effect that “biostratigraphic units ... where the biologic concept is the controlling factor, cannot be referred satisfactorily for definition to a stratotype”, and says that this is the only statement in this report with which he can agree without reservation. Unfortunately, this agreement on his part has little significance, since, as explained under my Topic-5, his biostratigraphic units include both the biostratigraphic and the chronostratigraphic units of the ISSC. As explained in the ISSC circular to which WIEDMANN makes reference, biostratigraphic units, such as assemblage-zones, may have useful stratotypes since this allows the assemblage to be defined in terms of the fossil content characterizing a certain specific interval of rock strata, rather than merely in words alone. On the other hand, there is little value in a stratotype for such biostratigraphic units as range-zones, where the concept of the unit is controlled entirely by a biologic concept and the scope of the zone is defined by whatever may be the range of a certain taxon, regardless of any specific section of rock strata.

8. It is useful to recognize certain kinds or categories of stratotypes just as it is useful to recognize certain kinds or categories of biologic types.

(Page 335, 2nd full paragraph.) WIEDMANN again objects to the use of type sections in chronostratigraphy because “the dimension of time, insofar as this has to do with chronology, is included with that of space” (?). He says that stratotypes are useful only for lithostratigraphy! He then objects to the number of “by HEDBERG (1968) constructed” terms for various kinds of stratotypes. It is of interest that of the 10 terms he lists, only three (unit-, boundary- and composite-stratotypes) were developed by me. Two (proto- and auxiliary-stratotypes) are apparently inventions of WIEDMANN, or at least I have never heard of them before, and the remainder were, I believe, first used in the USSR rules for study and description of stratotypes (USSR Interdepartmental Stratigraphic Committee, 1965 (1963)). These terms have the same usefulness for stratotypes as do similar terms for biologic types, and it seems unnecessary to say more in defense of their use.

9. Chronostratigraphy, which deals with the age and time relations of the Earth's strata, is one of the most important parts of stratigraphy since it provides the basis for geologic history. Chronostratigraphic classification is the organization of rock strata into units with respect to age or time of origin, and it utilizes any and all possible means of time-correlation to attain this end.

(Pages 335–338, section-6). Section-6 is an amazing part of WIEDMANN's paper which questions the existence and individuality of chronostratigraphy as a branch of stratigraphy – its “Eigenständigkeit”. On reading this section, one is filled principally with a great weariness (and a sense of futility) before the task of correcting this series of apparently willful misunderstandings. The following topics (10), (11) and (12) deal with parts of WIEDMANN's section-6.

10. *The scope of a chronostratigraphic unit is defined by the length of time which it represents, not by its physical thickness.*

(Page 336, first 8 lines of 1st full paragraph.) WIEDMANN says that if one wishes to know by what means other than biostratigraphy time can be measured, one is told by HEDBERG (ISSC, 1961) that “the magnitude of a chronostratigraphic unit is measured by the length of the time interval to which its rocks correspond – not their thickness in meters or feet.” WIEDMANN then terms this “a surprising recommendation to measure time with the help of time”. Of course, the quotation which he cites is simply a statement that the *magnitude* of a chronostratigraphic unit depends on its time-value, not on its thickness. There is no question involved of trying to “measure time with the help of time” but, instead, only one of utilizing the only record we have of the passage of geologic time for marking off time intervals or intervals of geologic history. Would WIEDMANN object? Would he prefer to “measure time with a tape-measure”?

11. *Granting the outstanding value of fossils, there are still many other guides, entirely independent of fossils, to approximating the position of isochronous boundary surfaces.*

(Page 336, second part of 1st full paragraph.) WIEDMANN then goes on to say that he has finally discovered “in a concealed place” (in ISSC, 1961) that the means which may lead to the recognition of isochronous surfaces are “fossils, lithology, radioactive data, sequence of beds, tracing of bedding planes, unconformities, transgressions and regressions, evidences of volcanic activity, tectonic episodes, evidences of paleoclimatic changes, and other stratigraphic criteria”. The passage he quotes actually goes on to say that these constitute available *guides* to approximating the position of isochronous bounding surfaces. Would WIEDMANN disagree? He says that these are unimportant and that the majority of them can only be dated by fossils. This is not the point. The point is that they are all *aids* under appropriate circumstances to approximating the position of isochronous surfaces and that, with the exception of fossils themselves, they are all valuable regardless of whether fossils are present or not. Would WIEDMANN disagree? Would he completely reject the evidence of bedding plane trace or sequence of beds or radiometric dates? Would he reject the evidence of magnetic reversals which has come into so much prominence since the date of the remarks which he quotes? Apparently so, as in the next paragraph he re-asserts that fossil content remains at present the only criterion for the recognition of isochronous surfaces!

One is tempted to ask whether if WIEDMANN were following a thin continuous outcrop of a marine limestone along a sea-cliff and if he found only gastropod fossils in the first mile, only pelecypod fossils in the second mile, and no fossils at all in the third mile, would he fail to believe his senses that the bed was probably still of approximately the same age all along the cliff even though he had found no fossils to support this belief?

12. *Biostratigraphic criteria constitute some of our most useful guides to chronostratigraphic boundaries, but biostratigraphy and chronostratigraphy are not synonymous.*

(Page 336, 2nd full paragraph to end of section-6 on page 338.) WIEDMANN then goes on to claim that even HEDBERG agrees that fossil content is the only criterion for recognition of isochronous surfaces and that consequently chronostratigraphy and

biostratigraphy are identical, and attempts to support this claim with the following quotations attributed to me: “A chronostratigraphic unit may frequently coincide *in its type section* with the scope of a biostratigraphic unit” (*italics by me*) (ISSC, 1961). “From this type section (stratotype) the boundary may be extended around the world, by means of paleontology *or any other useful supplemental methods of time-correlation*, to achieve as nearly as possible the ideal of an isochronous boundary” (*italics by me*) (ISSC, 1964). “Within the essential requirement that the (chronostratigraphic) boundary be placed in a sequence of continuous deposition, it is desirable that it coincide with or lie near to points of sharply time-significant change in paleontology such as boundaries of range-zones or identifiable points in biogenetic sequences” (ISSC, 1968). WIEDMANN then comments: “Here the cause would have been better served by an honest admission that also the chronostratigraphic boundaries can only be fixed by biostratigraphic criteria”. WIEDMANN fails to see the difference between 1. emphasizing the great value of paleontology in time-correlation, and 2. granting that there may be other means of time-correlation and that they also under appropriate circumstances may be useful. This also applies to the comment of HANCOCK (1966, p. 179) to which WIEDMANN refers.

WIEDMANN continues: “Chronostratigraphy in HEDBERG’s sense has to be considered as a younger synonym of biostratigraphy and has therefore to be eliminated”. WIEDMANN says this has already been requested by SCHINDEWOLF, JELETZKY, SEITZ, CALLOMON and DONOVAN, DONOVAN, and HANCOCK. He then again (top of page 337) quotes HANCOCK (1966, p. 179) and here I need only repeat my own published reply to HANCOCK (which WIEDMANN has ignored):

“J. M. HANCOCK (1966) feels that my paper on “Chronostratigraphy and Biostratigraphy” “has an air of theory divorced from practical application”. He says that I object to a time-scale based on “biozones” but have nothing better to offer in its place. I am afraid that this is again simply a misunderstanding of my views. I object to saying that a biostratigraphic unit is the same as a chronostratigraphic unit – because it just isn’t. “A biostratigraphic unit (a unit representing the actual extent of known occurrence in the rocks of specimens of certain taxons or of certain paleontological features) rarely, if ever, constitutes a chronostratigraphic unit (a unit representing all rocks formed during a certain time-span of earth history, and only that time-span)” (HEDBERG, 1965, p. 453). I do not know of any biostratigraphic zone which in itself everywhere fulfills the requirement of a chronostratigraphic zone and hence I cannot go along with the idea of building a time scale out of biostratigraphic zones. On the other hand, this in no way impedes the fullest use of “biozones” and biostratigraphic evidence as *aids* to the building of a chronostratigraphic scale based on chronozones and Stages. I would certainly, of course, support the using of evidence from all kinds of biostratigraphic zones for the recognition and tracing of chronostratigraphic zones. I would gladly use not only these biostratigraphic zones, and all other biostratigraphic evidence, but also all other kinds of evidence for all it was worth. If we are trying to divide the earth’s sequence of rocks into units representing equal age everywhere we need all the means of age determination we can find and, in the Phanerozoic particularly, all the evidence from all kinds of fossils, not just the range of occurrences of some one fossil or some one group of fossils, which cannot possibly itself constitute a body of rocks of equal age everywhere since no fossil or group of fossils were preserved everywhere in all facies of rocks over the whole earth. Let us not continue to live in a dream world of this sort, no matter how attractive its supposed simplicity, but let us get back to reality.” (HEDBERG, 1968, pp. 194–195.)

The remainder of WIEDMANN’s section-6 is devoted to an attempt to discredit the idea of chronostratigraphy because he says there have been variations in its interpre-

tation and application. I think this is only a part of healthy progress and I do not think this point needs any comment, besides which, I have not had the opportunity to see the paper by B. ZIEGLER to which he refers.

13. *Precision and scientific accuracy in stratigraphy demand an adequate vocabulary of precisely defined terms.*

(Pages 338–339, section-7.) In this section, WIEDMANN complains about the recognition of distinct categories of stratigraphic classification, such as lithostratigraphic, biostratigraphic and chronostratigraphic, and the use of separate unit terms for each. Here we can only say that few people wish to have more terms than they find use for, and I, also, see in the literature today many terms which to me seem unnecessary. However, communication requires words to express thoughts and if there are useful concepts behind a term there should be no objection to the existence of the term. Those terms which are not useful will soon disappear.

It is true that there are many who are not worried about precision in their writing (or thinking) and, if they are satisfied not to be accurately understood, I suppose that they must take that course. However, they should not object to precision on the part of others. It is said that there are many rather simple and ignorant people who get along with a vocabulary of only 600 words, but most of us feel that we need many more, and our dictionaries contain hundreds of thousands of words. Personally, I would say that the ISSC-recommended terminology, as shown on the accompanying chart (Fig. 2) (reproduced from HEDBERG, 1967) is extremely simple, and nowhere near as complicated as WIEDMANN would try to make it seem. One of the very difficulties of discussing WIEDMANN's paper is exactly his failure to define precisely the terms he uses. It may be more comfortable and less exacting to live in a shady dreamworld of vague and inaccurate terminology but it does not lead to scientific progress.

14. *The ISSC is a widely representative and democratic organization dedicated to exploring matters of stratigraphic classification and terminology and making recommendations thereon.*

(Page 334, footnote; page 339, last paragraph of section-7.) In a footnote on page 334, WIEDMANN appears to attempt to cast aspersions on the International Subcommittee on Stratigraphic Classification (ISSC) because he disagrees with its conclusions. He infers that "its presidency and the composition of its members are determined by itself in violation of the basic rules of democratic and international formation of opinion". Here I can only request that he not make any more implications of this sort unless he can substantiate them.

The president of the ISSC is appointed for a 4-year term by the International Commission on Stratigraphy with the approval of the International Union of Geological Sciences (IUGS) (formerly by the International Geological Congress). The Subcommittee had its birth at the 19th International Geological Congress in Algiers in 1952. All members of the International Commission on Stratigraphy, which at that time numbered some 300 leading stratigraphers from all over the world, were invited to become members of the Subcommittee, as well as a few other individuals

STRATIGRAPHIC CLASSIFICATION		
KINDS	PRINCIPAL UNITS	
LITHOSTRATIGRAPHIC	Group Formation Member Bed(s)	
BIOSTRATIGRAPHIC	Biostratigraphic Zones Assemblage-zone, -subzone, -zonule Range-zone Concurrent-range-zone (Oppel-zone) Epibole or peak-zone Etc.	
CHRONOSTRATIGRAPHIC	Eratthem System Series Stage Substage Chronozone	EQUIVALENT TIME TERMS Era Period Epoch Age (time) (time, chron)
OTHER STRATIGRAPHIC (Mineralogic, environmental, seismic, etc.)	-zone	
<p>Prefixes sub- and super- may be used with unit terms, when appropriate, if additional ranks are needed. "Zone" is a general term which may be used with any kind of stratigraphic classification. It should be prefixed to indicate the kind of zone (biostratigraphic zone, mineral-zone, range-zone, chronozone, etc.) if this is not otherwise clear.</p>		

Fig. 2. Chart showing major categories of stratigraphic classification and the principal units in each.

known to be particularly interested and active in this field. Subsequently, invitations to membership have been repeatedly extended to all members of the Commission on Stratigraphy and its subsidiaries. Other individuals have been accepted for membership only with the approval of the Commission on Stratigraphy. There are at present some 50 Individual Members and some 35–40 countries are represented. An effort has been made to seek members from various national and technical backgrounds, and representing divergent viewpoints.

In addition to its Individual Members, the Subcommittee includes in its membership, *ex officio*, the presidents of each of the 17 subcommissions, committees, and working groups of the Commission on Stratigraphy. Further, the Subcommittee includes in its membership some 25 Organizational Members representing almost

every national or regional commission or committee on stratigraphy or stratigraphic classification in existence.

Dr. Wiedmann is correct that there is nothing internationally binding in the conclusions of this Subcommittee, but he is in error with respect to the inferences he makes regarding its composition. It is too bad that he did not consult for information on this point his colleague at Tübingen, Professor Schindewolf, who is a charter member of the Subcommittee. In addition to the work of its members, the Subcommittee welcomes, and has frequently invited, outside comments on its projects. Professor Wiedmann was himself cordially invited by letter to attend the most recent meeting of the Subcommittee in 1968.

In view of the rather widely representative character of the ISSC, it is possible that the fact that Dr. Wiedmann does not agree with its conclusions on categories of stratigraphic classification and unit terms may not be an entirely valid basis for the serious doubts which he expresses (page 339) as to the usefulness of this organization.

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