ACTA GEOLOGICA HISPANICA, v. 30 (1995), nº 4, p. 1-9 (Pub. 1996)

A reappraisal of 'International Stratigraphic Lexicon' and the need for the creation of named units critical catalogues

SALVADOR REGUANT*

Departament de Geologia Dinàmica, Geofísica i Paleontologia. Universitat de Barcelona. 08028, Barcelona

* Organizational member of the International Subcommission on Stratigraphic Classification, and Corresponding member of International Subcommission on Paleogene Stratigraphy

RESUMEN

El estudio de la nomenclatura de las unidades estratigráficas permite descubrir que las referidas, directa o indirectamente al tiempo geológico, por definición de alcance continental o global, tienen un tratamiento perfectamente definido y sujeto a subcomisiones y comités internacionales de la Unión Internacional de Ciencias Geológicas (IUGS) que se ocupan de su constante crítica y perfeccionamiento. No así las unidades referidas al contenido litológico o a su génesis, litoestratigráficas y genéticas respectivamente, que son, por definición, regionales. Esto indujo a la creación de catálogos por países dentro del título general de "Lexique stratigraphique international". A partir de los años 80 estos catálogos han dejado de publicarse y se intenta ahora la revitalización tanto de su publicación como de la Subcomisión que se ocupa de ella. Por otro lado, el notable crecimiento de la investigación estratigráfica en las últimas décadas ha propiciado un aumento espectacular de unidades definidas, sin excesivo sentido crítico. El auge de las perspectivas estratigráficas que hacen hincapié en el análisis sedimentológico o genético, más que en el carácter litológico, han propiciado una nomenclatura propia, también regional, que ha aumentado la confusión en la descripción de las sucesiones estratigráficas en las diversas regiones. Desde esta perspectiva se analiza la creación de nombres de unidades en el Paleógeno surpirenaico y de la cuenca del Ebro, para contabilizar la magnitud del problema. Finalmente se propone, de acuerdo con las ideas de la Comisión Internacional de Estratigrafía, la creación de catálogos regionales de unidades con el uso de métodos modernos de colección de bases de datos, y también la necesidad de eliminar la confusión creada por el uso del mismo sistema para nombrar las unidades descriptivas (litoestratigráficas) y las genéticas (secuenciales o análogas).

Palabras clave: "Lexique stratigraphique International". Unidades litoestratigráficas. Unidades genéticas. Unidades estratigráficas temporales. Paleógeno. Surpirineo. Cuenca del Ebro.

ABSTRACT

Analysis of stratigraphic terminology and classification, shows that time-related stratigraphic units, which by definition have a global extent, are the concern of international commissions and committees of the International Union of Geological Sciences (IUGS) . In contrast, lithostratigraphic, and other closely related units, are regional in extent and are catalogued in the International Stratigraphic Lexicon (ISL), the last volume of which, was published in 1987. The International Commission on Stratigraphy (ICS) is currently attempting to revitalize the publication of ISL, given that the information contained in published volumes has never been updated, and that there has been a significant increase in stratigraphic research in recent decades. The proliferation of named units in the South Pyrenean and Ebro Basin Paleogene is evaluated to illustrate the extent of the problem. Moreover, new approaches to stratigraphic analysis have led to the naming of genetic units according to similar guidelines followed in the naming of descriptive or lithostratigraphic units. This has led to considerable confusion. The proposal to revitalize the ISL is accepted as part of the solution, that should also include the publication of critical catalogues, and the creation of norms for genetic unit terminology.

Key Words: International Stratigraphic Lexicon. lithostratigraphic units, genetic units, time-related stratigraphic units. Paleogene. South Pyrenean, Ebro Basin.

INTRODUCTION

The interruption in the publication of the "Lexique Stratigraphique International" (International Stratigraphic Lexicon), together with the almost complete

inactivity of the Subcommission for the Lexicon of Stratigraphy since the 80s has led to a deterioration in stratigraphic documentation around the world. Paradoxically, the spectacular increase in stratigraphic research work in recent decades has exacerbated the situation in Spain. Recent research on published lithostratigraphic named units from the South Pyrenean and Ebro Basin Paleogene is indicative of the inadequacies of information available on this subject. This paper discusses the implications of this problem and evaluates possible solutions.

THE NAMING OF STRATIGRAPHIC UNITS ACCORDING TO THE 'INTERNATIONAL STRATIGRAPHIC GUIDE'

According to the "International Stratigraphic Guide" (Salvador, 1994) the naming of different stratigraphic units should be conducted as follows:

"The name of a *lithostratigraphic* unit should be formed from the name of an appropriate local *geographic* feature, combined either with the appropiate unit-term indicating its rank (group, formation, member, bed) or with a simple lithologic term indicating the dominant rock type of which the unit is composed". (p.40; the *bold* is my own in this and in the following paragraphs).

"The name of *unconformity-bounded* units should be formed from the name of an appropriate local *geographic* feature, at or near the location where the unit is well developed, combined with the term "synthem" (or "subsynthem" or "supersynthem")". (p.50).

"The formal name of a *biostratigraphic* unit should be formed from the names of one, or preferably no more than two, appropriate *fossils* combined with the appropriate term for the kind of unit in question". (p. 66).

"The formal name of a specifically established and adequately described rock body characterized by either normal, reversed, or mixed *magnetic polarity* that permits it to be differentiated from adjacent rocks should be formed from the name of an appropriate local *geographic* feature, combined with the appropriate term for its rank - polarity superzone, zone, or subzone, etc... The currently well-established names derived from the names of distinguished contributors of the past to the science of geomagnetism (for example, Brunhes, Gauss, Matuyama) should not, however, be replaced". (p. 73).

"A formal *chronostratigraphic* unit should be given a binomial designation - a proper name plus a term-word... for example, Cretaceous System. The *geochronologic* equivalent of a chronostratigraphic unit should use the same proper name combined with the equivalent geochronologic term; for example, Cretaceous Period". (p 97-98). As is also known the names of stages (and ages) derive from "a geographic feature in the vicinity of its stratotype or type area", but "with an ending in 'ian' or 'an'; for example, Burdigalian Stage" (p.80). The names of series (and epochs), and systems (and periods) are diverse in origin, and often also have an ending in 'ian' or 'an'. Erathems (and eras), and eonothems (and eons) are named with an ending in 'zoic' except for the Archean.

This pattern of naming stratigraphic units is also followed by other codes, including the "North American Stratigraphic Code". Article 7 of this Code summarizes naming norms in the following way: "The name of a formal geologic unit is compound. For most categories, the name of a unit should consist of a geographic name combined with an appropriate rank (Wasatch Formation) or descriptive term (Viola Limestone). Biostratigraphic units are designated by appropriate biologic forms (*Exus albus* Assemblage Biozone). Worldwide chronostratigraphic units bear long established and generally accepted names of diverse origins (Triassic System)." (NACSN, 1983, p. 852).

Both the ISG ("International Stratigraphic Guide") and NASC ("North American Stratigraphic Code") use two kinds of stratigraphic units: descriptive units, based on lithologic, magnetic, or paleontological data, and interpretative time-rock units. Moreover, time units are also described. The descriptive units are named, except biostratigraphic, with geographic features added to the kind of unit. The time-rock, chronostratigraphic, units are named with special endings, or names with worlwide acceptance, though not always geographic in origin. The geochronologic units are named with the same names as chronostratigraphic units. The names, the extent, and the meaning of time-rock units, and their equivalent time-units are subject to constant control by international subcommissions of the International Commission on Stratigraphy (ICS). In fact, these subcommissions discuss, together with the chronostratigraphic units, magnetostratigraphic and biostratigraphic units since they need to survey the data to establish the geologic time of each part of the sedimentary record. A summary of these procedures is outlined below.

THE PROCEDURES ON THE TIME-RELATED STRATIGRAPHIC UNITS

The International Union of Geological Sciences (IUGS) through the International Commission on Stratigraphy (ICS) has, since its foundation, supported the discussion and the establishment of the Stratigraphic Global Scale. The procedure has included the creation of specific committees, subcommissions, and/or working groups. Information describing the work of these bodies may mainly be read in the issues of successive publications of the IUGS: The IUGS Circular Letters, Geological Newsletter, and Episodes.

A few examples help to illustrate the normal procedures, both in terms of organization and definitions:

(1) In Geological Newsletter (1977/4) there is a list of 17 Subcommissions, 4 Regional Committees, and 9 Working Groups dealing with time-related stratigraphic units at that time. The Subcommissions were concerned with various specific chronostratigraphic units, stratigraphic correlation, geochronology, and magnetic polarity time scale; the Working Groups with various specific boundaries between chronostratigraphic units and the Regional Committees, as the name indicates, with the regional stratigraphy of different chronostratigraphic units.

(2) Thus, we find in Geological Newsletter (McLaren ,1972) the final "Report from the Committee on the Silurian-Devonian boundary and stratigraphy" and in Episodes (Brasier *et al.*, 1994) the final report or "Decision on the Precambrian-Cambrian boundary stratotype".

Some of these bodies edit special publications reporting on their work. The International Subcommission on Paleogene Stratigraphy, for example, periodically publishes a bulletin, chiefly for its members, called simply "Newsletter". This bulletin contains information on the activities of the Subcommission, together with review articles and news of events, meetings and publications related to Paleogene stratigraphy around the world.

In addition to the work supported by the IUGS, through the ISC, interest in time-stratigraphic units has given rise to publications about the general chronostratigraphic scale. Some are included within general books on stratigraphy (for example, Pomerol, 1973), while some books are specifically devoted to the discussion of this scale (Harland *et al.*, 1982 and 1990), and finally some articles are contained in general geological (Bates & Jackson, 1980), or specific stratigraphic dictionaries (Riba & Reguant, 1986).

Thus, we might conclude that all time-related units are of global interest, that is, a knowledge of them is fundamental to work in any region of the world. The opposite is the case for lithostratigraphic (and closely related) units, which are inevitably of regional interest only. Below, we argue the need for lithostratigraphic units compilation and for constant critical revision by examining a specific region and its strata: the South Pyrenean and Ebro Basin Paleogene stratigraphy. Before doing so, we include a review of the regional catalogues published to date, that is, the volumes of the ISL.

THE NAMING OF LITHOSTRATIGRAPHIC UNITS

The International Stratigraphic Lexicon

The History of the International Stratigraphic Lexicon

At the XIth Session of the International Geological Congress held in Stockholm in1910 (CGI, 1912), Lukas Waagen from Vienna proposed the compilation of an International Stratigraphic Lexicon (Internationalen stratigraphischen Lexicons). A subcommission was created comprising C. Diener, W. Kilian and A. Rothpeltz, to study Waagen's proposal. The subcommission accepted the proposal with some ammendments. The most important of which was that compilation should be made by analysing units established according to systems and not according to country as proposed by Waagen. The subcommission proposed the creation of a permanent commission of the International Geological Congress to carry out the work. The commission was to be formed by the following countries and their representatives: Germany (W. Branca); Austria (L. Waagen); Spain (J. Almera); USA (C. D. Walcott); France (W. Kilian); Great Britain (F. A. Bather); Italy (C. de Stefani); Portugal and Switzerland (P. Choffat); Russia (A. Karpinski), and Scandinavia (A. Hennig). The proposals of the subcommission were acccepted by the Congress in the closing session.

At successive Sessions of the International Geological Congress reports were presented on the activities of the Commission until the XXIInd Session held in India in 1964 (IGC, 1972). Work on the Lexicon was subject to many vicissitudes. For example, in the report of the Commission at the XVIIIth Sesssion in Great Britain, 1948 (IGC, 1950) " Dr. S. H. Haughton (South Africa)

said that during the period which had elapsed since the last Congress, little had been done...with regard to the production of the Lexicon of Stratigraphy. He had discussed the matter with Sir Lewis Fermor, who had given the information that the material for the production of an Asiatic volume was practically complete in India... The African volume had appeared some time before the war. The Geological Survey of the United States had issued its own Lexicon of Stratigraphic Terms in so far as North America was concerned" (p. 182) Other members of the Commission also present additional information in this report, but without offering specific data as to the state of publications in other countries.

At the XIXth Session of the International Geological Congress held in Algiers, in 1952 (CGI, 1956) the Commission for the Lexicon of Stratigraphy was reorganized to form two subcommissions: Subcommission for the Lexicon of Stratigraphy, and Subcommission for Stratigraphic Nomenclature. As reported above, until the XXIInd Session in India in 1964 (IGC, 1972) the reports of the Subcommission for the Lexicon of Stratigraphy were included in the General Proceedings of successive Sessions of the International Geological Congresses. At the XXIIInd Session held in Czechoslovakia in 1968 (IGC, 1970), and at the Sessions thereafter, there is no further information from this Subcommission. At the XVIIIth Session in 1948 (IGC, 1950) and at successive Sessions a proposal was made to set up an International Geological Union. After much discussion and with the support of Unesco, the International Union of Geological Sciences (IUGS) was created and admitted as a member Union of the International Council of Scientific Unions (ICSU) the highest ranking international, non-governmental organizations in science in September 1961 (Harrison, 1986). This meant the formal separation of the Subcommission for the Lexicon of Stratigraphy from the International Geological Congress. However, during the Sessions of the International Geological Congresses, the IUGS Committee met and renewed executive committee members. The successive periodical issues and magazines of the IUGS supply data about the evolution of the Subcommission for the Lexicon of Stratigraphy, which belongs to the International Commission on Stratigraphy (ICS).

A review of successive issues of "Episodes" illustrates the evolution (regretably its, on the whole, lack of activity) of the Subcommission for the Lexicon of Stratigraphy, from 1978 until now. In the of september 1994 issue, J. Remane and K. H. Gohrbandt, as Chairman and Secretary of ICS, express the desire to revitalize the publication of the International Stratigraphic Lexicon, making it the main goal for the Subcommission for the Lexicon of Stratigraphy, with these words: "With the support of the French *Centre National de la Recherche Scientifique*, around 125 volumes and parts of the lexicon had been published, on behalf of IGC/IUGS, by 1977. These document the lithostratigraphy of the continents of Europe (including the USSR), Asia, Africa, Latin America, and Oceania/Australia. The subcommission became moribund in the mid-1980s due to lack of funding for printing. The last publication (on the Swiss Molasse Basin) appeared in 1987 and was published by the Swiss Geological Commission and the National Hydrological and Geological Service. The International Stratigraphic Lexicon (Lexique Stratigraphique International) is an immeasurably valuable source of global lithostratigraphic information. It is the standard reference for regional stratigraphy, but it is of diminished value today because it has never been updated." (Remane & Gohrbandt, 1994: p. 75).

The content of the International Stratigraphic Lexicon (Lexique Stratigraphique International)

Many of the volumes published bear the general title in French, given the largely French support received. There are two kinds of volumes: most are devoted to the description of local stratigraphic (almost exclusively lithostratigraphic) units; while some are devoted to the so-called "Termes stratigraphiques majeurs", that is to the chronostratigraphic units generally accepted in the standard stratigraphic scale. See, for example, Sornay (1968).

In the first case, unit descriptions are made according to the country and not the system as was initially proposed. When more than one volume for a country exists, each volume deals with one or more closely related system. In some cases there are two or more country lexicons described in the same volume, following the same pattern as indicated above. The general division of the publications is made geographically: Europe; Africa; Asia; USSR, Latin America , Oceania, North America.

Thus, "fascicule 10a" from the "volume I:Espagne" (Llopis Lladó 1958) contains: (a) a general description of Spanish stratigraphy; (b) an alphabetically ordered description of the lithostratigraphic units defined in Spain; (c) a list of references from which the data are taken, and a stratigraphic index.

An analysis of published lithostratigraphic units in the South Pyrenean and Ebro Basin Paleogene: A case study.

An advanced study of published lithostratigraphic units from South Pyrenean and Ebro Basin Paleogene illustrates the critical situation in the field of stratigraphic nomenclature. Here, we report the present state of this research as a brief case study.

The spectacular growth of published named units

A study on lithostratigraphic and closely related units defined in South Pyrenean Paleogene and neighbouring areas and cited in geological papers published between 1958 and 1995, revealed 338 geographic names designating lithostratigraphic, or closely related, units. This represents a particularly spectacular growth in the number of names compared whit the number of Paleogene units defined up to 1958 in several Western Europe countries (Table 1)

The total number of geographically named units, corresponding to lithostratigraphic, or closely related, units, described up to 1958 in an area comprising Great Britain, France, Belgium, The Netherlands, Italy, Spain, and a large part of Germany is only 14 more than the number found in an incomplete study now in progress, of a region of Spain, corresponding to perhaps a third or a half of the Spanish Paleogene. Were we to compare this with the 1957 compilation of Spanish Paleogene units, the number of named units would be 30 times greater.

The proliferation of names and the resulting confusion

The great increase in the number of defined units is due partly to the intensive stratigraphic work on the Paleogene sedimentary record over the last forty years, mainly in the South Pyrenees, and the Central and Eastern parts of the Ebro Basin. However, this research work has had an unfortunate effect: the excessive proliferation of names.

Analysis of this proliferation of supposedly different local stratigraphic units, demonstrates that it is due to:

1 - The significantly increased amount of stratigraphic research work on South Pyrenean Paleogene, both for economic and purely scientific purposes.

Table 1.- Number of named Paleogene regional stratigraphic units described up to 1995 compared with the number contained in some volumes of "Lexique Stratigraphique International" for Western Europe countries, published before 1958. Data from our study and from Curry (1958); Denizot (1957); Hinsch (1958); Piaz et Trevisan (1956), and Llopis Lladó (1958)

countries	geographically named litho-stratigraphic units	fossil named units	chrono-stratigraphic units	others (mainly lithologic names)
South Pyrenean & Ebro Basin (1995)	> 338			
Great Britain	56	57	1	36
France, Belgium, The Netherlands, Luxembourg	242	26	81	47
North Germany	16	2	12	8
Italy	28		9	9
Spain	10		4	1

2 - The relatively small extension of the South Pyrenean Paleogene units that can be defined in a regional study by mapping or establishing stratigraphic successions.

3 - Problems of uncomplete definition when the authors introduce new units, mainly through non paying attention to the lateral extension and/or to the presence of the created unit in areas not strictly belonging to the research area.

4 - Researchers general disregard for previous work.

5 - The changing paradigm in sedimentary record interpretation, and the frequent confusion that authors show with regards to the exact meaning and function of different kinds of unit given the different approach each tends to follow.

This last point leads to a more general discussion on different kinds of units based upon the observation of lithological characters. In fact, mainly two different approaches are at present used in lithologic analysis. The descriptive approach leads to the well known lithostratigraphic units. An interpretative approach (Vera, 1994) is the basis of allostratigraphic (NACSN, 1983) or unconformity-bounded units (Salvador, 1994), and of the depositional sequences and related units (Mitchum *et al.*, 1977) . Some discussion follows to clarify this double approach.

DESCRIPTIVE AND GENETIC UNITS

The preceding paragrahs discussed the history of the description and catalogues of the nearly exclusively lithostratigraphic units. The publication of "Seismic Stratigraphy" (Payton, 1977) was the beginning of the very extensive use of the sedimentologic or genetic units. However, the papers contained in this book, mainly that by Mitchum, Vail & Thompson cited before, present a slightly different perspective from the genetic units defined in "North American Stratigraphic Code" (NACSN, 1983) and in the "International Stratigraphic Code" (Salvador, 1994)., as discussed in Reguant (1989).

In fact the success of the sequential analysis following the patterns of the cited "Seismic stratigraphy" have renewed the discussion concerning different unit types, mainly those derived from lithologic or from sedimentologic approaches in recent years. The debate needs, however, greater clarification. In fact the ICS recently (Remane & Gohrbandt, 1994) addressed the issue proposing to "establish a Committee on Genetic Stratigraphy". The need for such a Committee is clear, given the emergence of so-called Sequence, Event and Cyclic Stratigraphy. According to this report "The boundaries between these three fields, Sequence, Event and Cyclic Stratigraphy, are often gradational but they all embrace different aspects of the analysis of three-dimensional geometries, and the distribution of lithologies".

An example of the need of this clarification may be seen by analyzing the confusion present in recent publications on South Pyrenean and Ebro Basin Paleogene stratigraphy, by the fact that genetic units have been named with the same pattern as lithostratigraphic units. A sample of this fact taken from all articles published in the journals of the Spanish Geological Society: "Revista de la Sociedad Geológica de España" and "Geogaceta", is examined below. Table 2 shows the number of articles including lithostratigraphic and genetic named units.

Table 2.- Information on lithostratigraphic (and closely related) units taken from the journals published by the " Sociedad Geológica de España" (Geogaceta , 1986 to 1995; and Revista de la Sociedad Geológica de España , 1988 to 1995)

Number of published articles:	39
Number of articles mentioning geographic names associated with stratigraphic units:	37
Total number of names mentioned:	308
Total number of different names:	188
Number of names applied to lithostratigraphic units:	132
Number of names applied to Sequence genetic units:	42
Number of names applied to genetic units, not explicitely accepted in Sequence Stratigraphy:	29

According to "International Stratigraphic Guide" guidelines, in these articles the names of lithostratigraphic units are formed from the name of a geographic feature combined either with the appropriate unit-term indicating its rank (group, formation, member, bed) or with a simple lithologic term indicating the dominant rock type of which it is composed (limestone, marls, sandstone, etc.). Moreover some unusual terms are used as, for example, "megacapa" (megabed).

The genetic units are named within the specific terms of Sequence Stratigraphy (Sequential Complex, Depositional Sequence, Depositional System, 4th order Cycle), or with other less formalized terms (Turbiditic System, Megaturbidite, Platform, Delta Complex, Delta Fan, Alluvial System, Coast Fan). The term "Complex" is used sometimes without qualification. It seems that in some cases it is equivalent to a Group, while in others it has a genetic meaning.

In certain cases the same author uses a geographic name applied both to lithostratigraphic and genetic units, while some names are used indiscriminately by different authors to describe both lithostratigraphic and genetic units. For example, Ager, Navarri, and Serraduy are used by some authors to describe a lithostratigraphic unit and by others to describe a genetic sequential unit.

It seems clear that these procedures are somewhat confusing, and that the system of naming should be clarified. The proposal by the ICS to create a Committee on Genetic Stratigraphy should help to clarify the nomenclature rules for genetic units.

The genetic units named in these articles are all established as regional, although the authors and users of the depositional sequence units often seem to accept that they are of global extent as chronostratigraphic units. This is another aspect to be clarified. In fact, however, the confusion in naming the regional lithologic units is the main target of the discussion here, because the two kinds of units refer to the same rocks, and often to the same set of stratified rocks. Some lithologic maps have also been drawn up naming the units with genetic names, without reference to the kind of rocks represented.

PROPOSALS

According to the ideas discussed above it seems to be interesting to make some proposals both for lithostratigraphic and for genetic units.

(A) for lithostratigraphic units

Given the present situation a solution needs to be urgently implemented: to revitalize the International Stratigraphic Lexicon, through the creation of critical regional catalogues, which should constantly be updated. Only in this way can we hope to improve our knowledge and communication of the research results of the stratigraphy of specific areas.

Concerning the creation of critical regional catalogues we can see a good example by Marechal (1993) in which he discusses and proposes a lithostratigraphic scale for the Paleogene of Belgium. Marechal's study synthesizes the number of lithostratigraphic units for all Belgium to include 23 formations and 53 members, while he maps the extension of the main units. Some years ago an attempt was started in Spain to update the Spanish Stratigraphic Lexicon, in which I myself was involved. An inquiry concerning the possible collaborators and a pattern of lithostratigraphic units description was send to all Spanish stratigraphers. This initiative was not successful, but some years later a very interesting work (García, 1982) was published revising and updating the Cretaceous lithostratigraphic units from different Spanish basins. Unfortunately only the first part of this work was published, concerning the establishment and discussion of Cretaceous lithostratigraphic units, but the second part that would contain all indexes and references has never been published. This results in a less efficient usefulness of this book, but his influence has been important in later Cretaceous studies.

An international proposal has been made by the ICS, in document mentioned above whereby: "ICS ...plans to investigate whether the Lexicon can be revitalized as a Global Lithostratigraphic Computer Data Base, whether funding for this project can be secured and whether the geological surveys of IUGS Member Countries will be willing to prepare the data. If the outcome of the initial assessment is positive, the long-term aims will be:

— to establish and maintain a uniform format for the documentation and display of data;

— to manage a centralised global computer data base;

— to coordinate and assist in the input into the data base by IUGS Member Countries and to coordinate periodic reviews and updates of existing data, and

— to organise and assist in the retrieval of data"

Initial reports suggest that the ICS has not been very successful in its attempts to find stratigraphers who would be willing to cooperate in this work (personal communication from Prof. Jürgen Remane). The problem, however, remains urgent, at least, with regards to obtaining an accurate catalogue of the lithostratigraphic units belonging to both different areas and different geologic periods.

For the Paleogene stratigraphic record of the South Pyrenean and Ebro Basin area we have started a compilation of all named units used in these areas. Evidently, such a simple compilation would not be sufficient to solve the whole problem. For this reason, the unit catalogue must be a critical catalogue, which recommends uses, eliminates unnecessary and poorly established names, and maps the extension of each unit named.

(B) for genetic units

As cited above it seems very necessary to establish a Committee on Genetic Stratigraphy. Some concepts must be clarified and some naming rules must be established. One of the main goals of such a commission should be to define clearly the relationships between different established genetic units, namely, unconformity bounded units, allostratigraphic units, and all units established by the authors of Sequence Stratigraphy. The unconformity bounded units and allostratigraphic units are of unavoidable regional extent. Is it the same for the sequence stratigraphic units? Or perhaps such units are of global extent, or perhaps are only some of them global and analogous in use to the chronostratigraphic units, and others are only of regional extent? In the case of global or interregional value it seems necessary to establish adequate stratotypes -unit stratotype or boundary stratotypes- for each unit as requested by Miall (1992). It the case of regional units adequate maps and type sections must be also published when a new unit is established or a revision of a unit is done,

The naming rules must allow to reader of geological papers and maps to distinguish immediately if the unit involved is a genetic or a descriptive lithostratigraphic one. The use of the same pattern for both units is a source of confusion as have been discussed above. Before we have the general accepted rules for genetic units, all stratigraphers must be very careful in the description of such a genetic units, indicating clearly the scope and nature of each unit used, mainly if this unit is an established new unit. It seems clear that, logically and chronologically, first is the recognition of the descriptive lithologic units and secondly the interpretation as a product of some sedimentological process. For this reason it seems better to indicate first the lithologic content of the units defined and after the attribution to a specific genetic unit.

ACKNOWLEDGEMENTS

The author is most grateful to Prof. J. A. Vera for suggestions and additional information that have been improved the text and to Mr. I. Robinson and R. Rycroft for revising the English text. This research was supported by DGICYT Projects PB94-0914, and PB94-0826.

REFERENCES

(In addition to the following specific references, all articles from the journals published by the " Sociedad Geológica de España" (Geogaceta, 1986 to 1995; and Revista de la Sociedad Geológica de España, 1988 to 1995) were reviewed, for mentions and descriptions of Paleogene lithostratigraphic units from South Pyrenean and Ebro Basin)

BATES, R. L., AND JACKSON, J. A. (eds.), 1980. *Glossary of Geology.* 2nd edition. Virginia, American Geological Institute, 749 pp

BRASIER, M., COWIE, J., AND TAYLOR, M., 1994, Decision on the Precambrian-Cambrian boundary stratotype. *Episodes*, 17 (1-2): 3-8.

CGI (CONGRÈS GÉOLOGIQUE INTERNATIONAL), 1912. *Compte rendu de la XIème Session du Congrès Géologique International (Stockholm 1910).* Premier fascicule. Stockholm, Kungl. Boktryckeriet. P. A. Norstedt & Söner, 740 pp.

CGI (CONGRÈS GÉOLOGIQUE INTERNATIONAL), 1956. *Comptes rendus de la XIXème Session. Alger 1952. Généralités. Historique, Liste des membres, Assemblée Générale, Conseil, Commissions, Tables.* Fascicule XXII. Alger, 389 pp.

CURRY, D. (ed) 1958 Fascicule 3a XII. Paléogène. In W. F. WHITTARD ET S. SIMPSON (eds) Fascicule 3a Angleterre, Pays de Gales, Écosse. In PRUVOST, P. (ed) *Lexique Stratigraphique International.Volume I. Europe.* Paris, Centre National de la Recherche Scientifique, 1-82.

DENIZOT. G. (ed), 1957 Fascicule 4a VII. Tertiaire. In: France, Belgique, Pays-Bas, Luxembourg. In PRUVOST, P. (ed) *Lexique Stratigraphique International.Volume I. Europe.* Paris, Centre National de la Recherche Scientifique, 1-217.

GARCIA, A. (ed). *El Cretácico de España*, Universidad Complutense de Madrid, Madrid, 680 pp.

HARLAND, W. B., COX, A. V., LLEWELLING, P. G., SMITH, A. G., and WALTERS, R., 1982. *A Geological Time Scale.* Cambridge, Cambridge University Press, 131 pp.

HARLAND, W. B., ARMSTRONG, R. L., COX, A. V., CRAIG, L. E., SMITH, A. G., AND SMITH, D. G., 1990. *A Geological Time Scale* 1989. Cambridge, Cambridge University Press, 263 pp.

HARRISON, J. M., 1986. The Early Days of IUGS. *Episodes*, 9 (1), 3-6.

HINSCH, W. (ed), 1958. Fascicule 5h1. Tertiaire Allemagne du Nord. In A. BENTZ (ed.) Fascicule 5. Allemagne. In PRUVOST, P. (ed) *Lexique Stratigraphique International.Volume I. Europe.* Paris, Centre National de la Recherche Scientifique, 1-77.

IGC (INTERNATIONAL GEOLOGICAL CONGRESS. A. J. BUTLER, ed.), 1950. *Report of the Eighteenth Session. Great Britain* 1948. Part I. General Proceedings. London, 253 pp.

IGC (INTERNATIONAL GEOLOGICAL CONGRESS), 1970. *Report of the Twenty-Third Session. Czechoslovakia 1968. General Proceedings*. Prague, Academia, 227 pp.

IGC (INTERNATIONAL GEOLOGICAL CONGRESS. R. K. Sundaram, general ed.), *1972. Report of the Twenty-Second Session. India1964. Part XVII. General Proceedings*. New Delhi, (1) 247 pp, (2) 143 pp.

LLOPIS LLADÓ, N. (ed) ,1958 Fascicule 10a. Espagne. In PRUVOST, P. (ed) *Lexique Stratigraphique International.Volume I. Europe*. Paris, Centre National de la Recherche Scientifique, 1-96.

MIALL, A. D., 1992. Exxon global cycle chart: An event for every occasion?. *Geology*, 20, 787-790.

MITCHUM, R. M. JR., VAIL, P. R., AND THOMPSON, S., 1977. Seismic Stratigraphy and Global Changes of Sea level. Part 2: The depositional sequence as a basic unit for stratigraphic analysis. In PAYTON, C. E. (ed) *Seismic Stratigraphy - applications to hydrocarbon exploration. American Association of Petroleum Geologists*. Memoir 26, 53-62.

MARECHAL, R., 1993. A new lithostratigraphic scale for the Palaeogene of Belgium. *Bulletin de la Société belge de Géologie*, 102 (1-2), 215-229.

MCLAREN, D. J., 1972. Report from the Committee on the Silurian-Devonian boundary and stratigraphy. *Geological Newsletter*, 1972 (4), 268-288.

NACSN (NORTH AMERICAN COMISSION ON STRATIGRAPHIC NOMENCLATURE)., 1983. North American Stratigraphic Code. *The American Association of Petroleum Geologists Bulletin*, 67 (5), 841-875.

PAYTON, C. E. (ed) Seismic Stratigraphy - applications to hydrocarbon exploration. *American Association of Petroleum Geologists. Memoir* 26, 516 pp.

PIAZ, G. DAL AND TREVISAN, L.(ed), 1956 Fascicule 11. Italia (In PRUVOST, P. (ed) *Lexique Stratigraphique International.Volume I. Europe*. Paris, Centre National de la Recherche Scientifique, 1-186.

POMEROL, C. 1973. *Stratigraphie et Paléogéographie. Ère Cénozoïque (Tertiaire et Quaternaire)*. Paris, Doin éditeurs, 269 pp.

REGUANT, S. 1989. Nomenclaturas estratigráficas nacionales e internacionales: descripción y evaluación. *Revista de la Sociedad Geológica de España*, 2 (3-4), 177-188.

REMANE, J. AND GOHRBANDT, K. H., 1994. International Commission on Stratigraphy (ICS). *Episodes*, 17 (3), 75-76.

RIBA, O., AND REGUANT , S., 1986. Una Taula dels temps geològics. *Arxius de la Secció de Ciències*, 81, 1-127.

SALVADOR, A. (ed.), 1994. *International Stratigraphic Guide*. Second edition. Boulder, The International Union of Geological Sciences and The Geological Society of America, Inc., 214 pp.

SORNAY, J., 1968. Aptien. (In *Lexique Stratigraphique International. Volume VIII. Termes stratigraphiques majeurs*. Paris, Centre National de la Recherche Scientifique, 109 pp.

VERA, J. A., 1994. *Estratigrafía. Principios y Métodos*. Editorial Rueda, Madrid, 806 pp.