International Union of Geological Sciences
International Commission on Stratigraphy

International Subcommission on Stratigraphic Classification

ISSC

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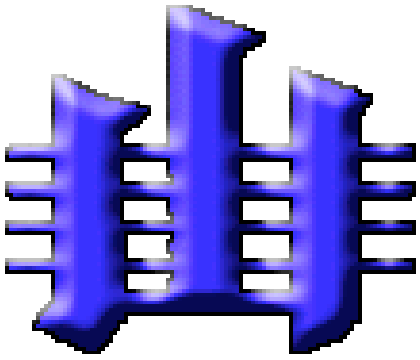

NEWSLETTER N. 16

December 2010

Edited by M.R. Petrizzo

CONTENTS

1. EDITORIAL

Welcome everyone to the ISSC newsletter for 2010. It was an eventful year thanks to the ICS workshop in Prague this past June. Prague was a fitting locale not just for its proximity to the first installed Golden Spike but also for being the home of a long and illustrious tradition of developing and applying stratigraphic concepts. It was attended by a great bunch of colleagues from around the world representing all sorts of specializations. We have to thank Petrs Kraft and Storch for being our chief hosts, and Stan Finney for leading it. My Canadian palynologist colleague, Martin Head, prepared a report on the workshop for *Geolog*, the newsletter of the Geological Association of Canada, and kindly consented to seeing it included here.

This past year also saw publication of the Magnetostratigraphy article by Cor Langereis and company. I can report that the Sequence Stratigraphy one is coming along well, although there were some changes in membership of the task group this year. Those on Lithostratigraphy, Chronostratigraphy and Biostratigraphy will I trust be completed in the coming months so that they can be sent around for comments and appear in print by the International Geological Congress in 2012.

The annual meeting of the Geological Society of America held a session entitled "Stratigraphic Standards: Where Have They Gone, What Should They Do, Where Should They Go?" which was co-sponsored by ISSC, GSA Sedimentary Geology Division, North American Commission on Stratigraphic Nomenclature, Association of Earth Science Editors, and The Paleontological Society. It was well attended and covered a wide variety of stratigraphic subject matter, sometimes quite provocatively which is good. Maria Rose and I are including the abstracts.

As ISSC chair I occasionally get requests from geologists around the world to provide opinions on matters to do with stratigraphic names and procedures. ISSC does not take individual stands on specific situations, but I do draw attention to the guidelines and examples of successful usage.

An item that will be of interest to Spanish-speaking goescientists is the recent publication of the translation of the 2005 version of the North American Stratigraphic Code, "El Código Estratigráfico Norteamericano" by the Mexican representatives on NACSN. It is available through the Instituto de Geología of Universidad Nacional Autónoma de México.

Another interesting paper, on biozones, was forwarded by Yuri Gladenkov, and it is attached for your reading pleasure. Yuri is in the Biostratigraphy working group.

This newsletter also includes the notice that Felix Gradstein was awarded the European Geosciences Union Lamarck Medal—bravo Felix! Well deserved!

As the first part of the mandate initated by Maria Cita, the publication of a series of papers on new developments in stratigraphic classification, will come to a close in 2012, members of ISSC will have to turn their minds to the next step, which is to prepare a revison of the International Stratigraphic Guide. It is time to start thinking of how and what to do about this.

Brian Pratt
ISSC chair
Saskatoon, December 2010

2. THE GSSP CONCEPT: ICS Workshop, Prague, May 31-June 3, 2010

2.1 Report of the International Commission on Stratigraphy Workshop by Martin Head

Martin J. Head (Brock University; and Chair, Canadian Stratigraphy Commission) with contributions from Charles Henderson (University of Calgary), Mike Melchin (St. Francis Xavier University), Guy Narbonne (Queen's University), Brian Pratt (University of Saskatchewan), and Barry Richards (GSC–Calgary)

Prague, capital of the Czech Republic, was an ideal location to exchange ideas and views about the concept of the Global Stratotype Section and Point (GSSP). It was at Klonk Hill near the village of Suchomasty in the Czech Republic, and not far from Prague, that the first GSSP was designated in 1972 (Martinsson, 1977). The GSSP concept underpins the modern geological time scale through a series of carefully chosen "golden spikes" that globally define the base of each major chronostratigraphic unit, and it has been the mission of the International Commission on Stratigraphy (ICS) since this time to complete the process. Presently, most periods/systems have been defined, but some (including the base of the Cretaceous) are elusive, and many lower-ranking divisions remain undefined or require revision of their GSSPs. The theme of this workshop was therefore appropriate and timely.

The workshop was hosted jointly by the Institute of Geology & Palaeontology, Charles University, and the Institute of Geology, Academy of Sciences, Czech Republic; and held in the Geoscience Building of Charles University. About 60 delegates from around the world attended, including six Canadians. Most were executive members of ICS subcommissions, with others representing national stratigraphic commissions.

The workshop began with an ice-breaker at the National Museum. The first full day consisted largely of invited presentations of existing and proposed GSSPs. The emphasis was very much on the Paleozoic, with Mike Melchin (Canada) providing an illuminating account of Silurian GSSPs, of which some were clearly holding up against the test of time while others were not. The biostratigraphic definition for the base-Silurian GSSP was clearly unworkable, and it was felt that that such GSSPs should be suspended, pending their redefinition.

The following day was spent discussing several themes relating to stratigraphic practice. These included the dual nomenclature (Lower/Early, Upper/Late etc.) that arises from the traditional distinction between time (geochronology) and time-rock (chronostratigraphy). Dual nomenclature has been challenged in recent decades (Hughes, 1989; Harland et al., 1990; Zalasiewicz et al., 2004) on grounds that "golden spikes" serve as reference points for geological time as well as for the rock record, rendering dual nomenclature superfluous. Marie-Pierre Aubry (U.S.A.) presented the case for dual nomenclature, emphasizing the philosophical differences between time and rock, and the importance of separating evidence (rock record) and inference (time). The case for single nomenclature was not specifically advocated at the workshop, although Jan Zalasiewicz (U.K.) did present a compromise position that would remove unstratified rocks of metamorphic and intrusive

Prof. Stan Finney, Chair of the ICS, addressing the workshop (Photo: MJH).

igneous origin from chronostratigraphy. Stan Finney (U.S.A. and Chair of ICS) felt that including these in chronostratigraphy in the most recent edition of the International Stratigraphic Guide (Salvador, 1994) had probably been an oversight. It was also noted that the distinction between Lower and Early, and Upper and Late, was not made in a number of languages, so was as much a linguistic problem as anything. Likewise it was observed that because some languages are written exclusively in lower case (Russian for example) or as characters with no case (Chinese for example), so discussions about when to capitalize terms such as "middle" to indicate their formal use were not universally relevant. Discussions about when to use "Mid-", "Middle" and "middle" were met more with bemusement than concern by the many non-anglophones present. Potential confusion of the word "age" as a formal geochronological term (capitalized initial) with its use in the vernacular (lower-cased) was also the topic of discussion. Suggested solutions ranged from substituting "Age" for its equivalent chronstratigraphic term "Stage" (see also Zalasiewicz et al., 2004), to coining a new term for "Age", but there seemed not to be much support for these ideas. Stan Finney remarked that context alone should be sufficient to indicate when the term was being used in a chronstratigraphic sense.

Related nomenclatural issues under discussion included the time-honoured use of the abbreviations Ma (Mega annus) to represent *events* in time, and myr (millions of years) to denote *intervals* of time. This issue has its beginnings in a letter-to-the-editor published in *GSA Today* in 2004 from the co-chairs of an IUGS Working Group on Decay Constants in Geochronology, later championed by an International Union of Pure and Applied Chemistry–IUGS Task Group on Isotope Data in the Geosciences, in which journals were urged to use Ga/Ma/ka for both events and durations of time. The full story covers 17 pages of Newsletter 15 of the ICS International Subcommission on Stratigraphic Nomenclature (http://users.unimi.it/issc/images/attach/ISSC_nl15.pdf). The IUGS did *not* approve the Task Group's recommendation, but asked the ICS to provide it with a recommendation. This explains its discussion at this workshop. Marie-Pierre Aubry (see also Aubry et al., 2009) and Brian Pratt (Canada) presented complementary facets of the issue. However, Martin Van Kranendonk (Australia) made the compelling case that context alone could determine whether "Ma" represented an event or duration, although Jim Gehling (Australia) did note that it was helpful to distinguish "myr" from "Ma" in tables and figures. A straw poll conducted during the workshop resulted in an approximate 50/50 split among attendees. A consensus emerged within a meeting of the ICS the next day that while Ga/Ma/ka are technically

correct for duration as well as events, there should be flexibility to use myr for duration in acknowledgement of long past practice.

The following day was taken up with a choice of two field excursions offered by the local organizing committee. One was to some classic Lower Paleozoic localities in the area, including the Lochovian/Pragian and Ludlow/Pridoli GSSPs, and the other to some important local Carboniferous, Cretaceous and Quaternary exposures. Both field trips

Sign near the Klonk GSSP explaining the significance of this site in defining the base of the Devonian Period/System. The GSSP is actually halfway up Klonk Hill, and is located with the help of a concrete monument that looks like a giant gunsight (Photo: MJH).

converged on the now-famous GSSP at Klonk Hill near Suchomasty. It did not seem to matter greatly that the weather had by now deteriorated to cold driving rain, although it was wisely decided to postpone the onsite toast.

Open discussions continued the following day, and Thomas Becker (Germany) presented a case for formalizing substages in the Devonian. GSSPs have not yet been used for such finely divided intervals of time, and while there was some support for using GSSPs for this purpose, it was remarked that: 1) the ICS still had many higher-priority stage boundaries to define, 2) the formal definition of substages might be handled more appropriately at the subcommission than ICS level, and 3) to figure formal boundaries at such low rank on the standard geological time scale, as promoted by the ICS, ran the risk of obscuring it with detail. The workshop ended appropriately with a rescheduled toast to the Klonk GSSP.

From a particularly Canadian perspective, I am pleased to report that the newly formed Canadian Stratigraphy Commission was represented by the following six members: Martin Head (Chair, and Neogene representative), Charles Henderson (Permian representative, and ICS Permian Subcommission Chair), Mike Melchin (Vice-Chair, Silurian representative, and ICS Silurian

Subcommission Chair), Guy Narbonne (Ediacaran representative), Brian Pratt (Cambrian representative, and ICS Stratigraphic Nomenclature Subcommission Chair), and Barry Richards (Carboniferous representative, and ICS Carboniferous Subcommission Chair).

Ad-hoc meeting of six representatives of the Canadian Stratigraphy Commission. Left to right: Brian Pratt, Mike Melchin, Martin Head, Barry Richards, Charles Henderson, and Guy Narbonne.

We met over lunch at a local restaurant and had fruitful discussions about the future of this important new national commission of the Canadian Federation of Earth Sciences (CFES)/ Fédération canadienne des sciences de la Terre (FCST), including its first task which will be to construct a CFES/FCST-authorized geological time scale poster – i.e. one featuring Canadian content as far as possible and optimized for Canadian use.

The ICS workshop at Prague did not formulate a recipe for the perfect GSSP, if such a thing exists. However, an instructive mix of the good, the bad, and the ugly, made clear what mistakes to avoid when defining a GSSP. Multiple stratigraphies are now preferably used, including multiple bio-, chemo-, sequence-, cyclo-, and magnetostratigraphy. Consequently, it is very important that boundary stratotypes extend well above and below the GSSP as well as across it. Other pointers for good practice also emerged. Auxiliary boundary stratotypes, used to extend knowledge gained from a GSSP to other geographic regions, are useful but there is presently no mechanism within ICS to approve them. This might be a matter for subcommissions alone, and it represents important future work. Regional reference stratotype sections were also discussed, particularly some currently being adopted in Russia. It is not a goal of ICS to replace regional stages, but rather to provide a framework for global comparison. Guide fossils for GSSPs should be illustrated, not merely named, and ideally curated at museums. Boundary working groups should organize field meetings because potential GSSPs need to be observed by more than just the proposers. GSSPs should not be proposed with undue haste, as this can lead to poor judgment. While it is a priority to complete the task of defining GSSPs for periods, series, and stages, there is no pressure from the IUGS or ICS to do this by a specific deadline. After the geological time scale has been defined in this way,

there will still be much work for the subcommissions, including the refinement of existing GSSPs, creation of lower rank GSSPs, and selection of auxiliary stratotypes around the world.

The primacy of biostratigraphy for defining GSSPs is increasingly being supplemented by other stratigraphic techniques. In subdividing the Cambrian, Loren Babcock (U.S.A.) noted that all 10 provisional stages can also be recognized by their geochemical signature. The GSSP concept was recently extended into the pre-Cambrian with the ratification of the Ediacaran Period (Knoll et al., 2004, 2006), and Martin van Krandendonck (Australia) presented a strong case for further subdivision of the pre-Cambrian into eons, eras and periods utilizing GSSPs that reflect global chemical and climatic events. At the other end of the time scale, the Holocene has recently been defined by GSSP in an ice core that has no biostratigraphy (Walker et al., 2008).

Good indicators of any successful meeting are the vibrant discussions that take place during coffee breaks and over lunch. The relaxed workshop schedule facilitated exchanges of views that transcended stratigraphic and national boundaries. The hard work of Stan Finney, as Chair of the ICS, the ever-helpful local organizing committee led by Petyr Storch and Petyr Kraft, and the magnificent setting of old Prague itself, combined to make this workshop an enlightening and memorable event.

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Walker, M., Johnsen, S., Rasmussen, S.O., Popp, T., Steffensen, J.-P., Gibbard, P., Hoek, W., Lowe, J., Andrews, J., Björck, S., Cwynar, L.C., Hughen, K., Kershaw, P., Kromer, B., Litt, T., Lowe, D.J., Nakagawa, T., Newnham, R., and Schwander, J., 2009. Formal definition and dating of the GSSP (Global Stratotype Section and Point) for the base of the Holocene using the Greenland NGRIP ice core, and selected auxiliary records: Journal of Quaternary Science, 24, pp. 3–17.

Zalasiewicz, J.A., Smith, A, Brenchley, P., Evans, J., Knox, R., Riley, N., Gale, A., Rushton, A., Gibbard, P., Hesselbo, S., Marshall, J., Oates, M., Rawson, P., and Trewin, N., 2004. Simplifying the stratigraphy of time. Geology, 32, 1–4.

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2.3 Report of the ICS Meeting of Officers 3rd June 2010 by Paul Bown

17 officers present:
Phil Gibbard absent - Quaternary Subcommission represented by Martin Head;
David Harper absent – Ordovician Subcommission represented by Juan Carlos Gutierrez-Marco.

Motions for informal votes, to be followed by formal email ballots.

DUAL STRATIGRAPHIC NOMENCLATURE

Vote 1. *Dual stratigraphic nomenclature*

The dual *vs.* single stratigraphic nomenclature was discussed in the main meeting on Day 2 (1st June), with the discussion following presentations by Jan Zalasiewicz (see also Zalasiewicz et al. 2004, *Geology*; 2007, *Stratigraphy*) and Marie-Pierre Aubry.

Jan Zalasiewicz presented a for case *Geochronology* being defined as dealing with time relationships in all rocks and *Chronostratigraphy* defined as dealing with time relationships in stratified rocks. Both time scales could be retained, exactly as before, while the geochronological scale alone might suffice (for some workers). Marie-Pierre Aubry presented the case for retention of the dual system of nomenclature that explicitly differentiates between time and chronstratigraphic units.

MOTION 1. To maintain the dual system of stratigraphic nomenclature.

YES 15, NO 2, ABSTAIN 0

MOTION 2. Chronostratigraphic nomenclature should not be applied to non-stratified rocks.
YES 12, NO 3, ABSTAIN 1

AGE AND STAGE

Vote 2. *Usage of Age and Stage*

Stage is a chronostratigraphic unit and Age the corresponding geochronologic unit. Stage should be used only as a chronostratigraphic unit.
There was discussion concerning the potential confusion caused by the general use of age *vs.* the specific use of Age.

MOTION 3. Stage should be used exclusively as a chronostratigraphic unit.

YES 16, NO 1, ABSTAIN 0

Ma *vs.* Ma and myr

Vote 3. *Ma vs. Ma and myr*

The use of *Ma* as the single unit of deep-time (as recommended by the IUGS–IUPAC Task Group on Isotope Data in the Geosciences) as opposed to the historic usage of *Ma* as a point in time (i.e. a date) together with *myr* as a unit of time denoting duration, was discussed in the main meeting on Day 2 (1st June), with discussion following on from presentations by Brian Pratt (see also Pratt, *ISSC Newsletter*) and Marie Pierre Aubry (see also Aubry et al., 2009, *Stratigraphy*). There followed considerable discussion of the validity of retaining two different units for time *vs.* the need

to retain clarity in the written word and on diagrams. A straw poll of the audience was approximately 50:50.

MOTION 4. We agree with the IUGS–IUPAC Task Group's recommendation to apply *Ma*, generally, as the single unit of deep time, but recommend that authors be able to use *myr* in particular cases where clarity can be improved.

YES 7, NO 8, ABSTAIN 2
As no majority was achieved, a second motion was proposed:

MOTION 5. We neither accept nor reject the IUGS–IUPAC Task Group's recommendation to apply *Ma*, generally, as the unit of deep time. We accept the argument for *Ma* as a single unit for time but would recommend flexibility, allowing for the retention of *Ma* as specific notation for points in time (i.e. dates) and *myr* as a unit of time denoting duration. We agree with the spirit of this statement.

YES 17, NO 0, ABSTAIN 0

ICS VOTING PROTOCOLS

Vote 4. *ICS voting protocols*
As most voting is now achieved through email ballot we recommend that the statutes be revised to specifically mention email ballots. Furthermore, we recommend that the 60 days currently required for voting, be changed to 30 days, i.e. all votes should be cast within 30 days.

MOTION 6. ICS voting should be carried out, normally, through email ballots.

YES 17, NO 0, ABSTAIN 0

MOTION 7. ICS voting should be completed within a 30-day period.

YES 17, NO 0, ABSTAIN 0

Others matters

GSSPs

Completion of the GSSP project is currently the principle aim of ICS. However, there is no need to rush to judgement. GSSP proposals should clearly demonstrate reliability of correlation to other sections, and should be circulated and discussed prior to balloting. Subcommissions that still have many GSSP to define are encouraged to focus resources on particular GSSPs in turn.

Stratigraphic Information Task Group

Although presently a task group, we envisage the imminent appointment of a voting membership and a move towards establishment of full subcommission status. ICS Subcomission Chairs will be *ex officio* members of the task group.

Jim Ogg requests that ICS Subcomission Chairs check the GSSP information on the SITG website (http://stratigraphy.science.purdue.edu/) and also the stratigraphic information available within Time Scale Creator.

3. State of the art of the ISSC PROJECT "New developments in Stratigraphic classification"

Papers published:
Cita M. B. , 2007. New developments in stratigraphic classification. A project of the International Subcommission on Stratigraphic Classification ISSC. Newsletters on Stratigraphy 42(2), p. 69-74.

Strasser A., Hilgen F. and Heckel P., 2007. Cyclostratigraphy - concepts, definitions, and applications. Newsletters on Stratigraphy 42(2), p. 75-114.

Weissert H., Joachimski M., Sarthein M., 2008. Chemostratigraphy. Newsletters on Stratigraphy 42(3), p. 145-179.

Langereis C. G., Krijgsman W., Muttoni G., and Menning M., 2010. Magnetostratigraphy – concepts, definitions, and applications. Newsletter on Stratigraphy 43(3), p. 207-233. (paper attached)

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CYCLOSTRATIGRAPHY
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Outline distributed in ISSC Newsletter 7 (June 2005).
Comments received and forwarded to the leader. Available in the ISSC archive kept by the secretary Maria Rose Petrizzo.
Full text distributed in January 2006, comments received.
Paper published: Strasser A., Hilgen F. and Heckel P., 2007. Cyclostratigraphy - concepts, definitions, and applications. Newsletters on Stratigraphy 42(2), p. 75-114.

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Outline distributed in ISSC Newsletter 9 (June 2006).
Comments received and distributed in ISSC Newsletter 10 (November 2006)
Full text distributed in appendix to ISSC Newsletter 11 (June 2007), comments received
Paper published: Weissert H., Joachimski M., Sarthein M., 2008. Chemostratigraphy. Newsletters on Stratigraphy 42(3), p. 145-179.

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Comments received and forwarded to the leader. Available in the ISSC archive kept by the secretary Maria Rose Petrizzo.
Full text distributed in February 2007, comments received and followed by a heated on-line debate (see http://strata.geol.sc.edu/SeqStratForm.html). Rejected in its first version.
Second revised version rejected by an ad-hoc international review committee of five experts chaired by Chris Kendall. Gianolla has not contributed to this version.
Task Group disbanded.

A **new group** has been appointed by the ISSC Officers at Oslo:
Leader: Octavian Catuneanu, Canada, octavian@ualberta.ca
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Outline has not been distributed by the current group but one was distributed by previous group.
Comments from the first outline were forwarded to the leader, and made available in the ISSC archive.
Full text will be distributed in early 2011, and comments will be incorporated.

Working Groups:
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Outline distributed in ISSC Newsletter 12 (December 2007).
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Full text distributed in February 2009, comments received.
Paper published: Langereis C. G., Krijgsman W., Muttoni G., and Menning M., 2010. Magnetostratigraphy – concepts, definitions, and applications. Newsletter on Stratigraphy 43(3), p. 207-233.

4. Stratigraphic Standards at 2010 GSA Denver Annual Meeting: Program and abstracts

2010 GSA Denver Annual Meeting (31 October –3 November 2010)

Session No. 96 **Monday, 1 November 2010**

8:00 AM-12:00 PM, Colorado Convention Center: Room 607

T143. Stratigraphic Standards: Where Have They Gone, What Should They Do, Where Should They Go? *(GSA Sedimentary Geology Division; North American Commission on Stratigraphic Nomenclature (NACSN); International Subcommission on Stratigraphic Classification (ISSC); Association of Earth Science Editors (AESE); Paleontological Society)*

Arthur Donovan, Brian R. Pratt and L.E. Edwards, Presiding

Paper #	Start Time	
96-1	8:00 AM	CONSISTENCY IN THE USE OF STRATIGRAPHIC NOMENCLATURE: WHAT'S AN EDITOR TO DO?: **EASTON, Monica Gaiswinkler**, Ontario Geological Survey, 933 Ramsey Lake Road, Level A3, Sudbury, ON P3E 6B5 Canada, monica.easton@ontario.ca
96-2	8:15 AM	THE INTERNATIONAL COMMISSION on STRATIGRAPHY AND GSSPs: **FINNEY, S.C.**, Geology, California State Univ, Long Beach, CA 90840, scfinney@csulb.edu
96-3	8:30 AM	GSSP CHALLENGES AND SOLUTIONS: MARRIAGE OF BIOLOGICALLY TO GEOCHEMICALLY DETERMINED DEFINITIONS?: **DAVYDOV, Vladimir**, Department of Geosciences, Boise State University, 1910 University Drive, Boise, ID 83725, vdavydov@boisestate.edu and SCHMITZ, Mark, Department of Geosciences, Boise State University, 1910 University Drive, Boise, ID 83725
96-4	8:45 AM	BOUNDARY STRATOTYPES, EVOLUTIONARY THEORY AND PALEOECOLOGY: **PFEFFERKORN, Hermann W.**, Department of Earth and Environmental Science, University of Pennsylvania, Philadelphia, PA 19104-6316, hpfeffer@sas.upenn.edu
96-5	9:00 AM	THE EXTINCTION OF PALEONTOLOGY AND THE FUTURE OF STRATIGRAPHY: A DISTINCTLY PRE-CENOZOIC PERSPECTIVE: **CRAMER, Bradley D.**, Kansas Geological Survey/Department of Geology, University of Kansas, 1930 Constant Avenue, Lawrence, KS 66047, cramerbd@gmail.com and MUNNECKE, Axel, GeoZentrum Nordbayern, Fachgruppe Paläoumwelt, Universität Erlangen, Loewenichstrasse 28, Erlangen, D-91054, Germany
96-6	9:15 AM	FORMATIONS — IN CONCEPT AND IN THE FIELD: **WEBB, Fred Jr**, Department of Geology, Appalachian State University, Boone, NC 28608, fwebbjr@charter.net and RAYMOND, Loren A., Emeritus, Geology, Appalachian State University, Boone, NC 28608
96-7	9:30 AM	LITHOSTRATIGRAPHY AND CHRONOSTRATIGRAPHY: A MASSIVE ACCUMULATION OF LARGELY SUBAERIAL CARBONIFEROUS SILICICLASTICS IN BOLIVIA THAT CHALLENGE STANDARD STRATIGRAPHIC CORRELATION: **ANDERSON, Heidi**, Department of Geological Sciences, University of Idaho, PO Box 443022, Moscow, ID 83844, handerson@vandals.uidaho.edu and ISAACSON, Peter E., Department of Geological Sciences, University of Idaho, Moscow, ID 83844-3022
96-8	9:45 AM	STANDARDIZING TEXTURE, CLASTIC ROCK CLASSIFICATION AND GRAPHIC LOGS FOR INTERPRETING PROCESS-GENERATED STRATIGRAPHIC SEQUENCES: **FARRELL, Kathleen M.**, North Carolina Geological Survey, Raleigh Field Office and Core Repository, 1620 MSC, Raleigh, NC 27699-1620, Kathleen.Farrell@ncdenr.gov
96-9	10:00 AM	THE FUTURE OF LITHODEMIC UNITS AND THEIR ROLE IN PRECAMBRIAN STRATIGRAPHY: **EASTON, R.M.**, Ontario Geological Survey, Precambrian Geoscience Section, B7064, 933 Ramsey Lake Road, Sudbury, ON P3E 6B5 Canada,

mike.easton@ontario.ca

96-10	10:15 AM	FROM COMBINED GLACIAL ALLO- AND LITHOSTRATIGRAPHY TO GLACIAL SEQUENCE STRATIGRAPHY: **RÄSÄNEN, Matti Erik** and HUITTI, Janne Vihtori, Department of Geology, University of Turku, Vesilinnantie 5, Turku, 20014, Finland, mrasanen@utu.fi
96-11	10:30 AM	STRATIGRAPHIC STANDARDS AND SEQUENCE STRATIGRAPHY: THE QUEST FOR FORMALIZATION CONTINUES: **ABREU, Vitor**[1], NEAL, Jack[1], BLUM, Mike[1], BOHACS, Kevin M.[2], DEMKO, Tim[2], GARFIELD, Tim[1], KENDALL, Christopher[3], GESLIN, Jeff[1], JONES, Clive[1], and KALBAS, James L.[4], (1) ExxonMobil, Houston, TX 77210, vitor_abreu@yahoo.com, (2) ExxonMobil Upstream Rsch Co, 3120 Buffalo Speedway, Houston, TX 77096, (3) Geological Sciences, University of South Carolina, Columbia, SC 29208, (4) ExxonMobil Development Company, Houston, TX 77381
96-12	10:45 AM	STILL STRIVING TO ATTAIN FORMALIZED "SEQUENCE STRATIGRAPHIC" NIRVANA: **DONOVAN, Arthur**, BP, 1 Windermere Lane, Houton, TX 77063, donovan@bp.com
96-13	11:00 AM	"MA" MEANS "MILLIONS OF YEARS BEFORE PRESENT": **EDWARDS, Lucy E.**, U.S. Geological Survey, MS926A National Center, Reston, VA 20192, leedward@usgs.gov
96-14	11:15 AM	DATUM AND DURATION: A CLARIFICATION: **AUBRY, Marie-Pierre**, Department of Geological Sciences, Rutgers University, Wright Labs, 610 Taylor Rd, Piscataway, NJ 08854-8066, aubry@rci.rutgers.edu, VAN COUVERING, John A., Micropaleontology Project Inc, Kissena Boulevard, Flushing, NY 11367, CHRISTIE-BLICK, Nicholas, Department of Earth and Environmental Sciences and Lamont-Doherty Earth Observatory of Columbia University, Palisades, NY 10964, FERRUSQUÍA, Ismael-Villafranca, Instituto de Geología, Universidad Nacional Autónoma de México, Ciudad Universitaria, 04510, Mexico, LANDING, Ed, New York State Musuem, Madison Avenue, Albany, NY 12230, OWEN, Donald E., Department of Earth and Space Sciences, Lamar University, PO Box 10031, Beaumont, TX 77710, and PRATT, Brian R., Department of Geological Sciences, University of Saskatchewan, Saskatoon, SK S7N 5E2, Canada
96-15	11:30 AM	GONE OR JUST FORGOTTEN? — A RECOMMENDATION TO RECOGNIZE THE TERTIARY AS A FORMAL PERIOD/SYSTEM OF THE CENOZOIC: **ORNDORFF, Randall C.**[1], EDWARDS, Lucy[2], RUPPERT, Leslie F.[3], CRAIGG, Steven D.[4], FULLERTON, David S.[5], STAMM, Nancy R.[6], and SOLLER, David R.[6], (1) U.S. Geol. Survey, MS 908, Reston, VA 20192, rorndorf@usgs.gov, (2) United States Geological Survey, National Center, 12201 Sunrise Valley Drive, Reston, VA 20192, (3) Eastern Energy Resources Science Center, U. S. Geological Survey, MS 956, National Center, 12201 Sunrise Valley Drive, Reston, VA 20192, (4) U.S. Geological Survey, Atlanta, GA 30360, (5) U.S. Geological Survey, Denver, CO 80225, (6) U.S. Geological Survey, 926-A National Center, Reston, VA 20192
96-16	11:45 AM	THE PLEISTOCENE AND THE QUATERNARY: A STUDY IN OPTIONS: **VAN COUVERING, John**, Micropaleontology Project Inc, Kissena Boulevard, Flushing, NY 11367, vanc@micropress.org, AUBRY, Marie-Pierre, Department of Geological Sciences, Rutgers University, Wright Labs, 610 Taylor Rd, Piscataway, NJ 08854-8066, DOWSETT, Harry J., US Geological Survey, 926A National Center, Reston, VA 20192, and DELSON, Eric, Department of Anthropology, Lehman College and The Graduate Center, City University of New York, New York, NY 10016

ABSTRACTS:

CONSISTENCY IN THE USE OF STRATIGRAPHIC NOMENCLATURE: WHAT'S AN EDITOR TO DO?

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To ensure consistency in journals, books and publication series, editors use a variety of resources, such as dictionaries, style guides, journal Internet sites, lexicons and the "North American Stratigraphic Code", to research, check and confirm facts, references and stratigraphic nomenclature. Most often, the changes suggested by editors are straightforward objective corrections intended to improve the text for the benefit of both authors and readers. However, subjective decisions must also be made, frequently in the area of stratigraphic nomenclature, which pose more difficult scenarios for both the author in having to change their preferred (although incorrect) name and for editors in having to

enforce the correct terminology. So, when an author remains adamant, what recourse does the editor have? Who can police stratigraphic nomenclature? and What is the most effective method for enforcement? A variety of responses will be presented.

THE INTERNATIONAL COMMISSION on STRATIGRAPHY AND GSSPs

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The mission of the International Commission on Stratigraphy is to establish an International Chronostratigraphic Chart with a single set of global units at the ranks of Stage, Series, and System with the lower boundary of each defined by a Global Standard Boundary-Stratotype Section and Point or GSSP, which are the basis for the geochronologic units of the Geologic Time Scale with the ranks of Age, Epoch and Period. GSSPs mark points in time that define the beginnings of the time units. GSSPs have been selected for 61 of the 101 stages of the Phanerozoic and for the Ediacaran System of the Proterozoic.

Selection of a GSSP is a long-term endeavor. Historical revisions to a chronostratigraphic unit, differing concepts of it among specialists, and different units from different regions must be evaluated, and determination made for the single unit to be used as a global standard. Stratigraphic signals at the preferred stratigraphic level must be evaluated to determine those that offer the greatest potential for reliable correlation of the lower boundary of the unit into as many facies and as worldwide as possible. Successions worldwide must be studied to determine which best meet the criteria for a global stratotype section. These activities are carried out by ICS subcommissions. For a stratigraphic horizon in a single stratigraphic section to be further considered as a GSSP, a formal proposal must be submitted to a vote. Approval requires a supermajority (>60%) of "yes" votes within the appropriate Subcommission. If approved by a Subcommission, the proposal is forwarded to the voting membership of ICS - the executive officers of ICS and chairs of all ICS Subcommissions, where the proposal must again receive a supermajority of "yes" votes. If approved by ICS, a recommendation is forwarded to the IUGS Executive Committee, where a majority vote ratifies the ICS recommendation. Subsequently, the GSSP is marked by a plaque and an article on the GSSP is published in Episodes. Given the length of this process and the many levels of approval, as well as the discussion and deliberation that occurs at each level, the GSSPs and the units they define truly warrant validity, legitimacy, and authority as global standards.

GSSP CHALLENGES AND SOLUTIONS: MARRIAGE OF BIOLOGICALLY TO GEOCHEMICALLY DETERMINED DEFINITIONS?

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The core of the GSSP concept proposed over 40 years ago was the biochronological evolutionary approach that in regards to the GSSP principles provided the precise definition of the boundary, its reliable correlation, and stability of the Global Time Scale (GTS). The procedure of GSSP establishment is two-fold: the boundary is defined in the rock record, and the position of the boundary is determined by a biological evolutionary event within a chronocline that serves as a primary correlation tool. Thus the objective fixing of the "golden spike" in the rock record is kept semi-independent of the subjectiveness of taxonomic interpretation.

During last decade this concept has been strongly challenged. Several GSSPs that were proposed 20-30 years ago, when revisited in later studies have been found lacking. An examples: (1) Siphonodella sulcata - the index conodont species to define the D/C boundary was recently found below the established boundary; (2) no index fossils have been found at the current GSSP for the base of the Wenlokian Series of the Silurian; (3) new sets of series and stage names are proposed for the Ordovician and Cambrian because of the difficulty in global correlation. Thus, the major principle - the stability - of the GTS is devalued. A lesson is that even a highly refined taxonomic zonation (cf. conodonts) cannot provide the reliable/stable bases for modern chronostratigraphy because of the at times subjective and interpretive nature of taxonomy. Thus, new and more objective approaches are essential. The definition of a GSSP at a correlative marker horizon, such as an ash bed with zircons or other dateable mineral in a biostratigraphically constrained section that appears as close as possible to the traditional boundary can better serve the needs of the GTS. Recent advances in dating techniques (IDTIMS U-Pb and 40Ar/39Ar) provide unprecedented temporal resolution that rivals traditional biostratigraphy. The nature of the ash bed (instantaneous appearance in an undisturbed sequence) fulfills many of the principles of GSSP establishment. Once established in the ash bed, and volcanic minerals are radiometrically dated, the GSSP can be correlated through marine/continental/volcanic facies and provinces. All other traditional tools (bio, chemo-, cyclostratigraphic) thus complement the radiometric one.

BOUNDARY STRATOTYPES, EVOLUTIONARY THEORY AND PALEOECOLOGY

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Boundaries between chronostratigraphic units are defined physically in a carefully selected Global Boundary Stratotype Section and Point (GSSP). Currently, the first appearance datum (FAD) that coincides with the boundary in this particular section of a single new species in an evolutionary sequence is then selected. In reality, this single FAD becomes the de facto tool for any further correlations. Evolution is taken into account and current practice seems to be the best and most precise method available.

However, speciation is known to occur mostly in small isolated populations that are rarely if ever preserved. Only the spread of the new species after barriers are removed is visible to us as a FAD. While these migrations are mostly rapid and instantaneous by stratigraphic standards they can still be time transgressive wherever other barriers exist. Thus, we do not see the origin of a new species but rather its introduction into a widespread environment. If one uses taxa that form new species through phyletic gradualism one encounters two other problems. If a species is changing slowly, any boundary is gradational and a question of definition. If a new species originates it will rarely if ever happen sympatrically, i.e. in the same environment where the original species survives, but rather allopatrically, i.e. in an area where all individuals of the species change. Again what we will see in the GSSP is a migration event. Therefore, single FADs carry with them uncertainty and one should look for a more robust method to achieve the best results.

It is suggested to record bio-events, i.e. FADs and LADs (last appearance datum) for as many groups as are present and do so for a significant stratigraphic distance below and above the GSSP. In this way the GSSP is defined as a point in a sequence. In reality some or many of these bio-events will not be present in a section elsewhere. However, those that are present are still forming a comparable sequence and allow correlation. This method will require the cooperation of specialists for all the groups present and increase the complexity of the work and the definition of GSSPs. The significant stratigraphic distance that has to be investigated below and above the GSSP will be different for different environments and the number of bio-events necessary differ for different taxonomic groups.

THE EXTINCTION OF PALEONTOLOGY AND THE FUTURE OF STRATIGRAPHY: A DISTINCTLY PRE-CENOZOIC PERSPECTIVE

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Stable isotope chemostratigraphy of carbon and strontium provide a unique chronostratigraphic tool that has begun to transform the science and art of global chronostratigraphic correlation of pre-Cenozoic strata. Particularly through the integration of high-resolution chemostratigraphy with equally high-resolution biostratigraphy, lithostratigraphy, and sequence stratigraphy, global chronostratigraphic resolution of Paleozoic and Mesozoic strata approaching that of the Neogene can now be achieved. Unfortunately, while pre-Cenozoic geology stands at the brink of the largest stratigraphic revolution since the introduction of seismic stratigraphy nearly four decades ago, the entire enterprise may not be practicable another ten years from now.

To answer 21st-century questions regarding the rates and nature of changes in the ocean-atmosphere-biosphere system, one must begin with chronostratigraphic control of sufficient detail to address the question being asked. Recently, we have begun to demonstrate that global chronostratigraphic correlation on the order of tens of k.y. can be achieved as far back as the Silurian, and it appears there is no a priori reason such resolution cannot be achieved at least as far back as the Cambrian. Worryingly however, much of the expertise in paleontology and stratigraphy required to achieve such results exists in the minds of researchers either quickly approaching or well past retirement age. The lack of production of new paleontologists and stratigraphers in the past three decades has begun to take its toll as hundreds of years of hard-won stratigraphic and paleontological expertise are facing the real threat of being lost forever.

Paleontology and stratigraphy, in their broadest sense, are the disciplines that decipher the order of events in the stratigraphic record, and without the order, how can anyone pretend to understand the cause-and-effect relationships within the ocean-atmosphere-biosphere system? The paleontological and stratigraphic databases are dynamic sets of data that require constant updating and recalibration and unless the few remaining masters of such artforms can rise with a single voice and begin to reverse this trend, the library of earth history that is the stratigraphic record will be left without librarians.

FORMATIONS — IN CONCEPT AND IN THE FIELD

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"A formation is body of rock identified by lithic characteristics and stratigraphic position... and is mappable at the Earth's surface" (North American Stratigraphic Code, revised 2005). Many mappers apply the name "formation" to map units in ways that do not strictly conform to the Code because of practical difficulties in applying the rubric to the rocks being mapped. This is true for "formations" that are defined on the basis of detailed descriptions of well-exposed roadcut or cliff exposures. Tracing such units across a terrain where outcrops are sparse is commonly not feasible. Thus, units so defined may be unmappable; yet mappability is tacitly expected by many non-mappers. Mappers also may encounter situations in which formations named nearly a century ago, are present, but are not mappable locally as separate units. The practical solution to such problems is to combine two or more defined formations into a map unit assigned a designation such as "Ersatz Formation and False Formation, undivided". Such a solution is useful in mapping rocks, but is one not strictly in agreement with the Code. Additional difficulties arise where rocks of two formations interfinger or are gradational within a significant stratigraphic thickness, so that placement of the contact between them is subjective. This is especially true in instances where formation names are extended for long distances from their described type sections and lateral facies changes exist. Contact placement is further complicated where diagenetic changes at the boundary impose different textures or compositions on depositionally and lithologically similar rocks. In such cases, we may chose secondary criteria for defining contacts. Thus, although defining map units that exhibit one or more of the complications noted here, as "formations," is not always in strict accord with the Stratigraphic Code. The solutions to the mappability problems are practical for those of us who map rocks. New terminology is unnecessary. We point out these examples to remind non-mappers that while historical precedence, lithologic detail, and stratigraphic units defined in road cuts and other well exposed sections provide guides for mappers, mappers must define units and apply the formation designation in ways that yield code required mappability in such terrains.

LITHOSTRATIGRAPHY AND CHRONOSTRATIGRAPHY: A MASSIVE ACCUMULATION OF LARGELY SUBAERIAL CARBONIFEROUS SILICICLASTICS IN BOLIVIA THAT CHALLENGE STANDARD STRATIGRAPHIC CORRELATION

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Stratigraphic nomenclature can be difficult to assign and apply in thick nonmarine successions where lateral variability in lithology and thickness of units is significant. The Carboniferous Machareti Group, a glacially influenced siliciclastic unit consisting largely of interbedded diamictites and sandstones, is deposited within the Tarija-Chaco Basin in southern Bolivia, northern Argentina, and western Paraguay. Within this depositional area, the Machareti Group has been divided into 2, 4, and 5 formations with each country dividing the group based upon the dominant lithologies in their region, neglecting to account for lithostratigraphic changes across political boundaries. Sandstone interbeds within the Machareti Group increase to the north where it becomes impossible to establish the location of formation contacts using the same methodology used in southern sections (first occurrence of sandstone). Significant lateral variability in thickness of the Machareti Group due to deposition within paleovalleys and syndepositional tectonics further complicates the establishment of lithostratigraphic units, especially in the lower formations which may be only locally derived. Additionally, the establishment of a chronostratigraphic framework for these units has been challenging due to a lack of geographically wide ranging macrofossils within limited marine units, poorly productive palynological samples, and contrasting ages of micro- and macro-fossil data. For these reasons, numerous age schemes have been suggested for the Machareti Group and individual formations with ages ranging from the Famennian (late Devonian) to the Moscovian (mid Pennsylvannian). Given the differing ages and lithologies of the formations across the depositional area and the difficulty in applying formation names, a revision of the current stratigraphic nomenclature is necessary.

STANDARDIZING TEXTURE, CLASTIC ROCK CLASSIFICATION AND GRAPHIC LOGS FOR INTERPRETING PROCESS-GENERATED STRATIGRAPHIC SEQUENCES

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Process sedimentology links a hierarchy of event strata (bed by bed) with dynamic geomorphic processes. Proposed here is an integrated approach to classifying clastic sediment and rock, constructing graphic logs, and assigning facies codes, for interpreting process-generated stratigraphic sequences. This method requires a universally applicable,

texturally-based classification of clastic sediment that is independent from composition and cementation, and closely allied to process sedimentology. Revisions to Folk's (1980) texturally-based classification are proposed to accommodate this. His triangular diagram showing proportions of gravel, sand and mud is modified to include a complete range of textural classes. An assumption is made that this classification universally applies to all clastic sediment and is independent from composition.
The proposed modifications provide bases for standardizing logging practices, graphic log templates, lithofacies codes, and their derivatives – hydrofacies or permeability codes and aquifer or reservoir characteristics. A direct result is that the principles of process sedimentology can be consistantly applied to compositionally variable rock sequences, especially mixed siliciclastic and bioclastic assemblages of strata. The graphic logs produced are powerful tools that are ready for comparison with downhole logs and interpretation in a sequence stratigraphic context. The linking of genetically related lithofacies to dynamic geomorphic processes, helps define beds, bedsets, parasequences, parasequence sets, and higher orders of facies sequences, such as systems tracts in the stratigraphic hierarchy. Examples of shelf successions, Cretaceous to Holocene in age, are provided.
The proposed method is comprehensive, but flexible, and is usable in conjunction with other classification systems. It applies to a broad range of facies, depositional settings, clast compositions, and degrees of consolidation and cementation. If primary clastic fabrics are obscured or diagenetically altered, or if unit is chemically precipitated, replaced, or recrystallized, the method is limited without additional analyses.

THE FUTURE OF LITHODEMIC UNITS AND THEIR ROLE IN PRECAMBRIAN STRATIGRAPHY

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The 1983 North American Stratigraphic Code introduced the concept of lithodemic units — lithostratigraphic units applicable to igneous and metamorphic rocks where the law of superposition does not apply. The concept should be well-suited to mapping Precambrian terrains, but apart from a few examples from North America, Britain and Fennoscandia, the geoscience community has been slow to adopt formal lithodemic units. Nonetheless in 2008 the British Geological Survey (BGS) introduced a lithodemic framework for igneous rocks in the United Kingdom, and are working on a similar proposal for metamorphic rocks. The BGS proposal suggests broadening the hierarchy of lithodemic units from the 3 defined in the Code (e.g., lithodeme, suite, supersuite) to 6 (e.g., dike, dike-swarm, cluster, subsuite, suite, supersuite). Like the Code, the BGS proposal applies "complex" to 2 classes of rocks (e.g., sedimentary + intrusive) rather than a heterogeneous mixture of one rock class (e.g., solely intrusive). Furthermore, in North America, several informal lithodemic-based chronostratigraphic units have gained local acceptance (e.g., gneiss associations, tectonic assemblages). Also, there are several proposals to use regional short-duration geologic events, such as emplacement of mafic dike swarms, as global chronostratigraphic correlation tools. One reason for the slow adoption of lithodemic units in Precambrian mapping may be that the reliance on high-precision geochronology has meant that researchers think in chronostratigraphic, rather than lithostratigraphic units, especially when it comes to correlation of rock units.
What does the future hold for lithodemic units? First, an evaluation is needed with respect to an expanded hierarchy of units as well as considering the definition of the term complex given its entrenched use in describing certain igneous rocks (e.g., alkalic complexes). Second, education of the geoscience community in adapting lithodemic units to their chronostratigraphic equivalents may be needed, given the importance of isotopic dating in Precambrian mapping and stratigraphy. As a first step, recommendations with respect to defining mafic dike swarms as lithodemic and chronostratigraphic entities should be priority given their potential importance in global stratigraphic correlation.

FROM COMBINED GLACIAL ALLO- AND LITHOSTRATIGRAPHY TO GLACIAL SEQUENCE STRATIGRAPHY

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Formal stratigraphic classification is a fundamental scientific tool for developing a regional knowledge of the geologic evolution of any period in the Earth's history. For the subfield of Quaternary geology, the selection of stratigraphic classification criteria is as important a paradigmal decision as was the adoption of sequence stratigraphy for petroleum geology in the 1980s.
The few currently existing national Quaternary stratigraphic frameworks are based on lithostratigraphy. As the true nature of the Quaternary depositional units especially in glaciated shield areas is often that they are arranged in unconformity-bounded, lithologically varying packages, allostratigraphy may be regarded as the most promising descriptive approach for stratigraphic classification. A classification based on the combined use of allostratigraphic and

lithostratigraphic data should fit better for such areas, with alloformations as the fundamental units and lithostratigraphic units filling out the framework where appropriate. Lithostratigraphy is undoubtedly applicable, but it should be applied in a stricter manner than it has been used.
The combined use of allo- and lithostratigraphy provides a hierarchical classification system for glacigenic deposits and creates a basis for sequence stratigraphic interpretations. It supports detailed chronostratigraphic and diachronic work in order to improve our understanding of the complicated Quaternary couplings of astronomic forcing, climatic change and continental glacial dynamics that have determined the distribution and nature of glacial depositional and erosional products. The classification would provide a hierarchical framework for glacigenic deposits, which could potentially support stratigraphic information systems, databases and digital spatial models more effectively than the traditional lithostratigraphic frameworks.
In the presentation practical recent field examples on the application of the combined use of allo- and lithostratigraphy are discussed.

STRATIGRAPHIC STANDARDS AND SEQUENCE STRATIGRAPHY: THE QUEST FOR FORMALIZATION CONTINUES

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Attempts to formalize sequence stratigraphy over the last 2 decades have been challenging and divisive because of model-driven versus observation-based interpretations, cumbersome nomenclature, and imprecise and inconsistently-used definitions. The association between base-level changes, formation of surfaces, and stratal stacking that define systems tracts is at the heart of the confusion. In some cases, terms like "highstand" and “lowstand” have been used to identify systems tracts because of specific stratal stacking, whereas in other cases, stratal stacking has been inferred to reflect relationships to sea level because of the terms themselves. Considering that sea level changes cannot be directly observed from the geologic record, this terminology implies the need of a "model" to interpret geologic data. Moreover, these terms conflict with others that are related to shoreline translation, or processes that can be directly observed from the geologic record, such as "transgression", "regression", "progradation", and “retrogradation".
We propose a "back-to-basics" approach, emphasizing five key observations that can be made from any geologic data: lithofacies, lithofacies association, vertical stacking, stratal geometries and stratal terminations. These observations should be placed in the context of the lateral movement of the shoreline (transgression and regression) and shoreline trajectory (shelfal accommodation creation and destruction). Model-driven terms like highstand, lowstand, maximum flooding surface, and falling stage should be abandoned and replaced by observation-based terms like aggradation-progradation, progradation-aggradation, surface of maximum transgression and degradation, respectively. Finally, after more than 20 years of applications, much basic research remains to be done on the relationship between stratal stacking, and various controls, and on the formation and significance of key surfaces that demarcate changes in stacking patterns.

STILL STRIVING TO ATTAIN FORMALIZED "SEQUENCE STRATIGRAPHIC" NIRVANA

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Like the legendary Tower of Babel, the land of unconformity/discontinuity-bounded stratigraphic units has devolved into a world of incomprehensible tongues, where few sects can still truly understand the other. Truth be told, little consensus now exists as to what are sequence boundaries, disconformities, or even discontinuities. Furthermore, years of sectarian warfare have made it difficult for many proponents to see the limitations of their own methodologies, appreciate the utility of other methodologies, or truly comprehend the real reasons to formalize sequence stratigraphy.
In reality, no single sequence methodology is the ultimate panacea or should hold sole title to the “sequence” mantle. Depositional setting and fit for purpose actually dictates the best “sequence” methodology for a given time or place. So what can be done to escape the discontinuity-bounded Tower of Babel and attain formalized Sequence Stratigraphic Nirvana? Find consensus, look for a paradigm shift, and move forward. While there may be little agreement as to which type of surface is the best sequence boundary, or if a given surface is an unconformity, there is general consensus that the different surfaces utilized in the various “sequence” methodologies are all mappable. In fact, one could argue that the true essence of sequence stratigraphy is not simply identifying unconformities or discontinuities, but mapping a variety of stratal surfaces. Thus a paradigm shift from unconformity/discontinuity-bounded stratigraphic units to surface-bounded stratigraphic units may provide the flexible framework for the various sequence methodologies to coexist, prosper, and each attain formalized Nirvana.

"MA" MEANS "MILLIONS OF YEARS BEFORE PRESENT"

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Several decades ago, stratigraphers recognized the need for a shorthand way of expressing time before the present. In 1978, for example, a single publication used the following for "million years" in relation to the geologic time scale: Ma, MA, m.a., Ma with a minus sign, m.y., MY, M.Y., My, my, My ago, M.Y. old, m.y.B.P., 106 y. In contrast, only y and yr were used for "year" when part of an expression for decay constant or half-life.

From among several choices in the literature by the early 1980s, the North American Code of Stratigraphic Nomenclature [1983, Article 13, remark (c)] selected the recommended abbreviations: ka, Ma, and Ga. The Code states that these abbreviations mean, respectively, 103, 106, and 109 years before the present, where the unit of time is the modern year and the present refers to AD 1950. This shorthand has become widely used in the geological literature and was incorporated into the 1994 (second edition) International Stratigraphic Guide. The widespread use is largely due to the need to distinguish clearly the concepts of a specific point in time (e.g., 10 Ma, a time in the Miocene 10 million years before present) from a duration of time (10 million years, anytime). The shorthand is unambiguous because there is no confusion as to the direction of measurement (an event at 100 Ma occurred before an event at 10 Ma) and no confusion as to the reference date (AD 1950).

Recent debate on precise means of expressing time concepts may be a consequence of the distinction, or lack thereof, between units of measure and the coordinate system to which the measurement is related. The goal of unambiguous communication cannot be achieved when one group of scientists uses the specific terms ka, Ma, and Ga to mean simply 103 years, 106 years, and 109 years; and another group of scientists uses the identical terms to mean 103 years before AD 1950, 106 years before AD 1950, and 109 years before AD 1950.

The use of the single letter "a" as a symbol or shorthand notation for "annus" where "annus" means a specified number of seconds is undesirable for a variety of historical, procedural, and practical reasons. The abbreviation for petayears would be Pa (international symbol for the unit of pressure Pascal). In English, "1 to 2 a ago" is awkward; in French it's even more awkward (il y a 1 à 2 a).

DATUM AND DURATION: A CLARIFICATION

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Contention has recently arisen within the earth-historical community with regard to the proper notation for expressing values in geological time. The most widely used is a parallel system in which age before present is indicated by the symbols Ma (Mega-annus), Ga (Giga-annus) and ka (kilo-annus), compared to simple quantities abbreviated as Myr (millions of years), Gyr (billions of years) and kyr (thousands of years), among several schemes. An effort has been made by some geochronologists to restrict this to a single set for both age and quantity, with the result that some professional societies and journals have imposed Ma, Ga, and ka in all cases. This may meet the needs of geochronologists, for whom all time measurements are ages before present, but it is not relevant to the earth sciences as a whole. The dual system reflects the fact that time, in geology as in history, is measured both in the age of a given point in time, and in the duration of an interval between two points, neither of which need be the present. The points themselves -- called dates in historical calendars and datums in geological time scales -- have no duration, aside from the underlying assumption that the stated value is the quantity of years before the present. Each point is unique among an infinity of values in an ordinal progression; in contrast, there can be an infinity of durations with the same value, defined by different points. As for the validity of the Ma/Myr notation system, it must be pointed out that in the International System of Units (SI) there is no approved symbol for year. As a result of orbital variations, the quantity "year" can only be precisely related to the second (the SI base unit for time) if a single reference year is specified. Thus, with no logical or conventional objection, the various abbreviations and symbols for year values that earth scientists have developed out of practical necessity can now be standardized with the Ma convention for datums and the Myr convention for duration, to express the nuances of geological time.

GONE OR JUST FORGOTTEN? — A RECOMMENDATION TO RECOGNIZE THE TERTIARY AS A FORMAL PERIOD/SYSTEM OF THE CENOZOIC

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The term “Tertiary” was prominent on geologic time scales until it suddenly disappeared at the time of the 1989 International Geological Congress (IGC) in Washington, D.C. Later, the time scale produced for the 2004 IGC in Florence, Italy, was significantly different than previous international time scales and quite controversial: it listed the Paleogene and Neogene as the only two periods of the Cenozoic Era – the Quaternary was removed or considered informal. Subsequently, the Quaternary was restored as the youngest period of the Cenozoic and, in June 2009, the Executive Committee of the International Union of Geological Sciences formally ratified a proposal lowering the base of the Quaternary to correspond to the base of the Gelasian Stage. Although the U.S. Geological Survey (USGS) did not support the new definition of the base of the Quaternary, it adopted this change for the purpose of international consistency. Because “Tertiary” is still used by many scientists to represent the interval between the top of the Cretaceous (65.5 Ma) and the base of the Quaternary (2.588 Ma) and remains a viable term for communication in the geological sciences, we feel it is now time to reassess how the Tertiary should be defined. The terms Tertiary and Quaternary have been used on USGS geologic maps for more than a century and are still used by geologic mappers. The USGS Geologic Names Committee recommends retention of the Tertiary as a formal period/system with the Paleogene and Neogene as subperiods/subsystems. This recommendation is consistent with a 2008 proposal by Head, Gibbard, and Salvador to have the Tertiary recognized as a period/system with the Paleogene and Neogene as subperiods/subsystems. We ask for support from other geologic organizations in North America to work together to retain the Tertiary for future geoscientists.

THE PLEISTOCENE AND THE QUATERNARY: A STUDY IN OPTIONS

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In June 2009 the International Union of Geological Sciences ratified a proposal from the Innternational Union for Quaternary Research, or INQUA, following its approved by a majority of the International Commission on Stratigraphy, to give the Quaternary formal status as a System/Period. In this proposal, the base of the Quaternary was established a priori in the Gelasian GSSP at 2.58 Ma, in accord with the most recent view of INQUA as to when “glacial climates” began. In order to conform to this new Quanternary, however, the INQUA proposal also redefined the Lyellian Pleistocene by moving its lower boundary from the base of the Calabrian Stage (dated to 1.81 Ma), where it had been located since 1948, to that of the Gelasian Stage -- thereby increasing the duration of the Pleistocene by 44% .What the IUGS apparently failed to consider in approving this “adjustment” was its impact on the many disciplines that employ the Plio-Pleistocene chronostratigraphic boundary, rather than the concept of Quaternary climate, as a fundamental metric in their research. Opposition to the drastic change was immediate and widspread in the affected disciplines, with many researchers refusing to employ the new definition With this controversy before us, we here examine the availability and legitimacy of options in using the Geological Time Scale. A crucial fact is that the authority of the IUGS to define the properties of the GTS is based on a relatively recent consensus among earth scientists, rather than any official directive, to use the version of the time scale published under IUGS auspices.. It follows that adherence to IUGS decisions in this regard is still a matter of consent by the users. This is demonstrated in a canvass of journals that publish research in the disciplines most affected by the recent decision, in which we found that none require their manuscripts to follow any particular version of the GTS. In addition, several journals are making a point to inform authors who may be confused by the current dispute, that they have the option to agree or disagree with the revised Plio-Pleistocene boundary, whatever their views on the Quaternary.

5. EGU LAMARK MEDAL 2010 TO FELIX GRADSTEIN

Our warm congratulations to Felix.

European Geosciences Union

EGU Home | Awards & Medals | Awards & Medals

- Home
- Statements
- General Contact
- Publications
- Meetings
- Inside EGU
- Membership
- Awards & Medals
  - > Awards & Medals
  - General Information
  - Proposal and Selection of Candidates
  - Proposal Submission
- Media & Outreach
- Collaborations
- Sponsored Events

Awards & Medals

Jean Baptiste Lamarck Medal 2010

Felix Gradstein

The Jean Baptiste Lamarck medal is awarded to Felix Gradstein for his outstanding research in stratigraphy, micropalaeontology and geochronology.

Resumé:

Felix M. Gradstein has a long (over 35 years) and distinguished career in the fields of stratigraphy, micropalaeontology and geochronology. He is renowned for coordinating the development of the international geological time scale: over the last 25 years Gradstein et al.'s Time Scales, most recently the 2004 "Geologic Time Scale" (GTS2004), have become a ubiquitous 'gold standard' for all Earth Scientists.

Gradstein has authored over 140 scientific publications in the fields of geological time scales, quantitative stratigraphic methods, stratigraphy and sedimentology of petroleum basins, plate tectonics, palaeoceanography, and deep-water micropalaeontology. He has a career that spans the divides between industry, government and academia, with periods working for Esso and Saga Petroleum, the Geological Survey of Canada, and Dalhousie University. He is currently Professor in the Natural History Museum, University of Oslo. Gradstein has also been very active in professional activities, serving as Chair of IGCP Project 181 and the ICS-IUGS Committee on Quantitative Stratigraphy (1985–1993), as well as being Chair of the International Commission on Stratigraphy (ICS) from 2000 to 2008.

Gradstein is working diligently on a new version of the Geologic Time Scale that should come out within the next two years. Partly as a result of GTS2004, and its special effort to quantify its uncertainty, the ICS, CHRONOS, EARTH TIME, and GTS NEXT (projects) have yielded major new insights in isotope geochronological dating, and a flurry of important new chronostratigraphy and age dates. This is all finding its way into a new Geologic Time Scale, with new data involving the planetary and Cryogenian–Ediacaran scales, inorganic and organic isotope chronology, paleophyticum times, sequence stratigraphy and many others areas.

6. ANNOUNCEMENTS

"El Código Estratigráfico Norteamericano": Spanish translation of the North American Stratigraphic Code

Cover of the Spanish translation of of the 2005 version of the North American Stratigraphic Code, "El Código Estratigráfico Norteamericano" by the Mexican representatives on NACSN. It is available through the Instituto de Geología of Universidad Nacional Autónoma de México.

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Contents


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Pleasure
Choice
Sympathy
Fun
Happiness
Innovation
Partnership
Star
Music
Entertainment
Kindness
Luck
Love
Understanding
Family
Smile
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Peace
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Merry Christmas and Happy New Year!