

**The GSSP Concept – Report of the International Commission on Stratigraphy
Workshop, Prague, May 31–June 3, 2010.**

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 Klouk 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 chronostratigraphic 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 chronostratigraphic sense.

Related nomenclatural issues under discussion included the time-honoured use of the abbreviations Ma (Mega annum) 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 Subcommittee 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 Krondendonck (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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