

# Cambrian chronostratigraphy: Current state and future plans

Loren E. Babcock<sup>a,\*</sup>, Shanchi Peng<sup>b</sup>

<sup>a</sup> School of Earth Sciences, 125 South Oval Mall, The Ohio State University, Columbus, Ohio 43210, USA

<sup>b</sup> Nanjing Institute of Geology and Palaeontology, Chinese Academy of Sciences, 39 East Beijing Road, Nanjing 210008, China

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## Abstract

Important steps have been made by the International Subcommittee on Cambrian Stratigraphy (ISCS) toward global chronostratigraphic subdivision of the Cambrian. The consensus of opinion is that the system should be subdivided into four series representing subequal spans of time. The lower two series will correspond approximately to the traditional Lower Cambrian, the third series will correspond approximately to the traditional Middle Cambrian, and the fourth series corresponds approximately to the traditional Upper Cambrian. The fourth series, called the Furongian Series, was ratified by the International Commission on Stratigraphy (ICS) and the International Union of Geological Sciences (IUGS) in 2003.

Selection of horizons representing evolutionary events that can be correlated on a global scale, and which can be used as stage or series boundaries, is much more difficult for the lower two series intervals of the Cambrian than it is for the upper two series intervals of the Cambrian. The most practical concept for subdividing the system into stages involves the establishment of two stages each for the first and second series and the establishment of three stages each for the third and fourth series. The lowermost stage of the Furongian, called the Paibian Stage, has been ratified by the ICS and the IUGS.

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## 1. Introduction

In recent years, the International Subcommittee on Cambrian Stratigraphy (ISCS) of the International Commission on Stratigraphy (ICS) has made important philosophical and practical steps toward developing a chronostratigraphic subdivision of the Cambrian System. Historically, the Cambrian System was subdivided into three series, but lack of international consensus on series boundaries has hindered precise correlation globally. Further complicating the development of a

uniform chronostratigraphic nomenclature has been the addition to the lower part of the Cambrian of a thick succession of rather poorly fossiliferous strata following ratification of the Global Standard Stratotype-section and Point (GSSP) for the base of the system at the then-recognized first appearance datum (FAD) of the trace fossil *Trichophycus pedum* (originally *Phycodes pedum*) in the Fortune Head section, Newfoundland, Canada (Brasier et al., 1994; Landing, 1994). If subdivision of the Cambrian into a tripartite system with boundaries for the lower, middle, and upper series in positions approximating those used in past decades were to be continued, the series would represent dramatically unequal intervals of time. The lower series would represent approximately 29 million years (myr), the

\* Corresponding author. Tel.: +1 614 292 0358.

E-mail addresses: [babcock.5@osu.edu](mailto:babcock.5@osu.edu) (L.E. Babcock), [speng@nigpas.ac.cn](mailto:speng@nigpas.ac.cn) (S. Peng).

middle series would represent approximately 12 myr, and the upper series would represent approximately 13 myr (Gradstein et al., 2004). Furthermore, the evolutionary events (identified by biostratigraphic markers) used to identify the boundary positions would be unlikely to have true global significance and correlation potential. For these reasons, the ICS has voted to abandon use of the traditional series/epoch terms Lower/Early, Middle/Middle, and Upper/Late for the Cambrian, and to substitute new series/epoch terms that have application on a global scale.

The purpose of this paper is to provide a progress report on the current and developing nomenclature for Cambrian chronostratigraphy in order that scientists will have a uniform set of stratigraphic tie points to refer to when discussing evolutionary or other events of local, regional, or global scale. The ICS has endeavored for many years to develop an internationally acceptable working model for subdivision of the Cambrian into series/epochs and stages/ages. Discussions held during the ICS Workshop in Suanbo Spa, South Korea (September 2004), which were reported at the Sino-German Symposium on Environmental and Biological

Processes of the Cambrian Explosion in Nanjing, China (September 2004), resulted in the development of a consensus of opinion that the most practical and internationally acceptable solution is to subdivide the Cambrian System into four new series (Babcock et al., 2005). The series would represent subequal time intervals. Relatively few candidate fossils exist for international correlation in the first two series, but a larger number of candidate fossils exist in the last two series (Geyer and Shergold, 2000). For this reason, the lower two series are expected to be divided into two stages each, and the upper two series are expected to be divided into three stages each (Babcock et al., 2005). In 2003, the International Commission on Stratigraphy (ICS) and the International Union of Geological Sciences (IUGS) ratified a proposal forwarded by the ICS for the uppermost series of the Cambrian (Furongian Series) and the lowermost stage of the Furongian (Paibian Stage; Peng and Babcock, 2003; Peng et al., 2004). Some of the horizons and their corresponding evolutionary events proposed for delimiting internal subdivisions of the Cambrian (Fig. 1) still require detailed evaluation to determine whether

SYSTEMS	SERIES	STAGES	BOUNDARY HORIZONS (GSSPs) OR PROVISIONAL STRATIGRAPHIC TIE POINTS
Ordovician	Lower	Tremadocian	
Cambrian	Furongian Series	Cambrian Stage 10 (Undefined)	FAD of <i>Iapetognathus fluctivagus</i> (GSSP)
		Cambrian Stage 9 (Undefined)	FAD of <i>Lotagnostus americanus</i>
		Paibian Stage	FAD of <i>Agnostotes orientalis</i>
	Cambrian Series 3 (Undefined)	Cambrian Stage 7 (Undefined)	FAD of <i>Glyptagnostus reticulatus</i> (GSSP)
		Cambrian Stage 6 (Undefined)	FAD of <i>Lejopyge laevigata</i>
		Cambrian Stage 5 (Undefined)	FAD of <i>Ptychagnostus atavus</i>
	Cambrian Series 2 (Undefined)	Cambrian Stage 4 (Undefined)	?FAD of <i>Oryctocephalus indicus</i>
		Cambrian Stage 3 (Undefined)	?FAD of <i>Olenellus</i> or <i>Redlichia</i>
	Cambrian Series 1 (Undefined)	Cambrian Stage 2 (Undefined)	FAD of trilobites
		Cambrian Stage 1 (Undefined)	?FAD of SSF or archaeocyathid species
Ediacaran			FAD of <i>Trichophycus pedum</i> (GSSP)

Fig. 1. Chart showing planned chronostratigraphic subdivision of the Cambrian System. Stages, series, and GSSP levels that have been ratified by the ICS and IUGS (as of December 2004) are indicated. Other proposed subdivisions are identified as undefined units (with numbers). Potential GSSP levels, which are currently indicated by provisional international tie points, are also indicated. Acronyms: GSSP: Global Standard Stratotype-section and Point; FAD: first appearance datum; SSF: small shelly fossil.

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