Designation and Preservation of GSSPs: International Geostandards that define the units of the Geologic Time Scale

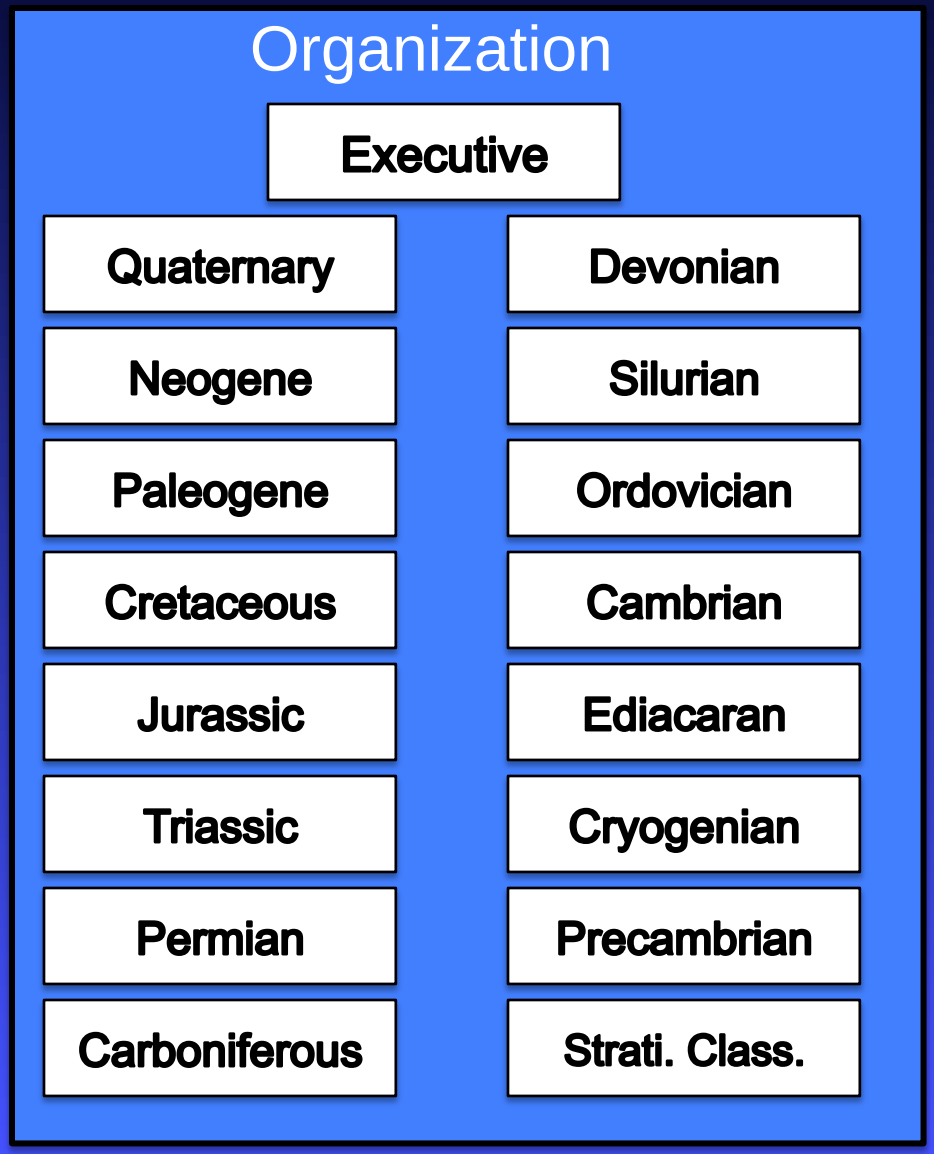
Stan Finney

Chair - International Commission on Stratigraphy

The International Commission on Stratigraphy

Establish global standards in stratigraphy, and promote and coordinate long-term international cooperation

- **Standards:**
  - ***Geologic stage boundaries & nomenclature***
  - ***Standard geologic time scale***
  - ***International Stratigraphic Guide***
- **Public information**
- **Promote education**
- **New Stratigraphic Methods**



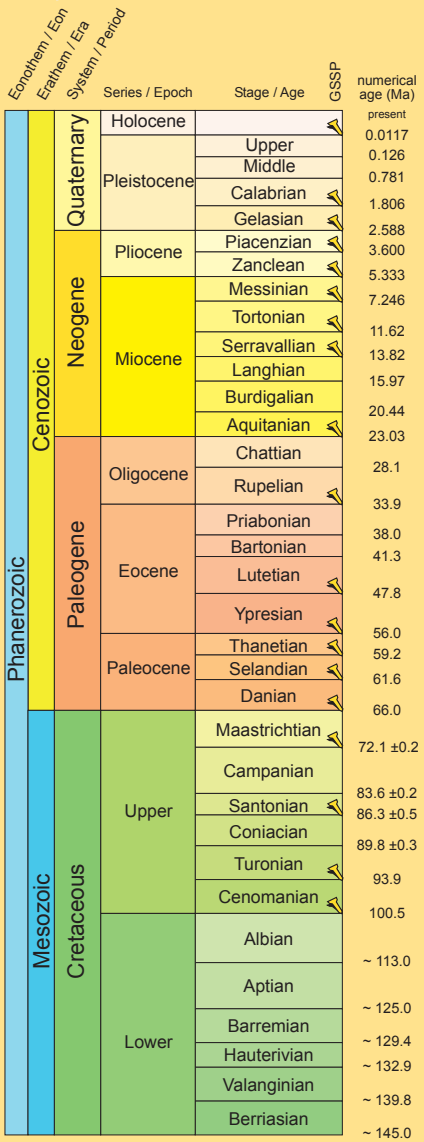
INTERNATIONAL CHRONOSTRATIGRAPHIC CHART

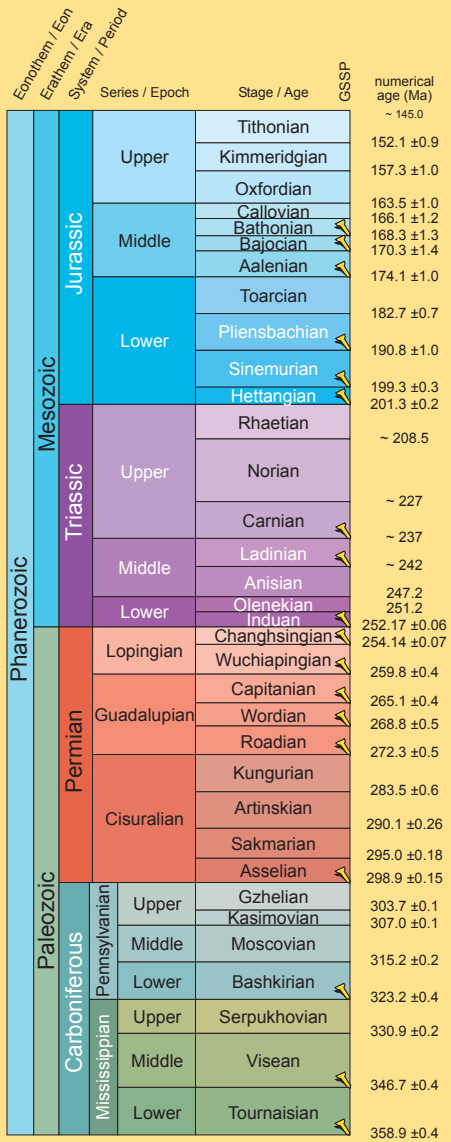
IUGS

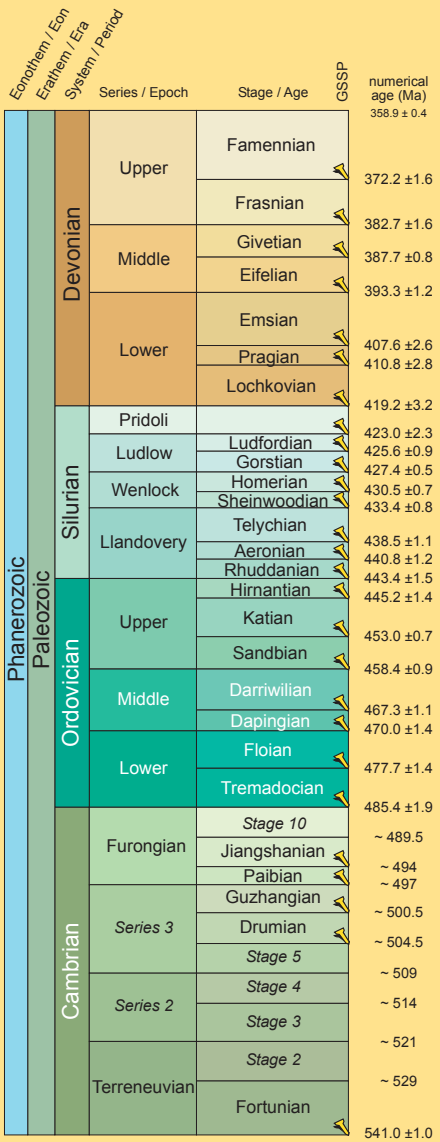
www.stratigraphy.org

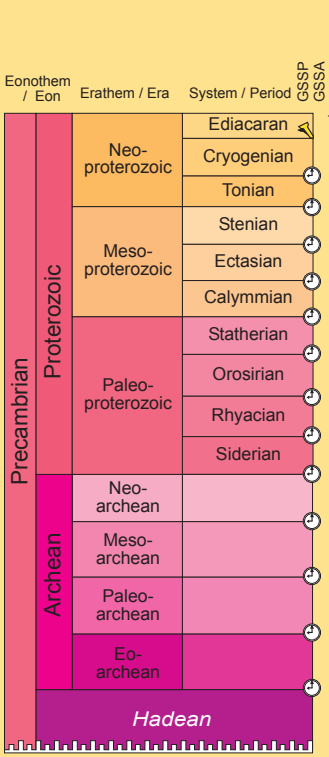
International Commission on Stratigraphy

v 2013/01









Units of all ranks are in the process of being defined by Global Boundary Stratotype Section and Points (GSSP) for their lower boundaries, including those of the Archean and Proterozoic, long defined by Global Standard Stratigraphic Ages (GSSA). Charts and detailed information on ratified GSSPs are available at the website http://www.stratigraphy.org. The URL to this chart is found below.

Numerical ages are subject to revision and do not define units in the Phanerozoic and the Ediacaran; only GSSPs do. For boundaries in the Phanerozoic without ratified GSSPs or without constrained numerical ages, an approximate numerical age (~) is provided.

Numerical ages for all systems except Permian, Triassic, Cretaceous and Precambrian are taken from 'A Geologic Time Scale 2012' by Gradstein et al. (2012); those for the Permian, Triassic and Cretaceous were provided by the relevant ICS subcommissions.

Coloring follows the Commission for the Geological Map of the World. http://www.cgm.org

Chart drafted by K.M. Cohen, S. Finney, P.L. Gibbard
(c) International Commission on Stratigraphy, January 2013

http://www.stratigraphy.org/ICSchart/ChronostratChart2013-01.pdf

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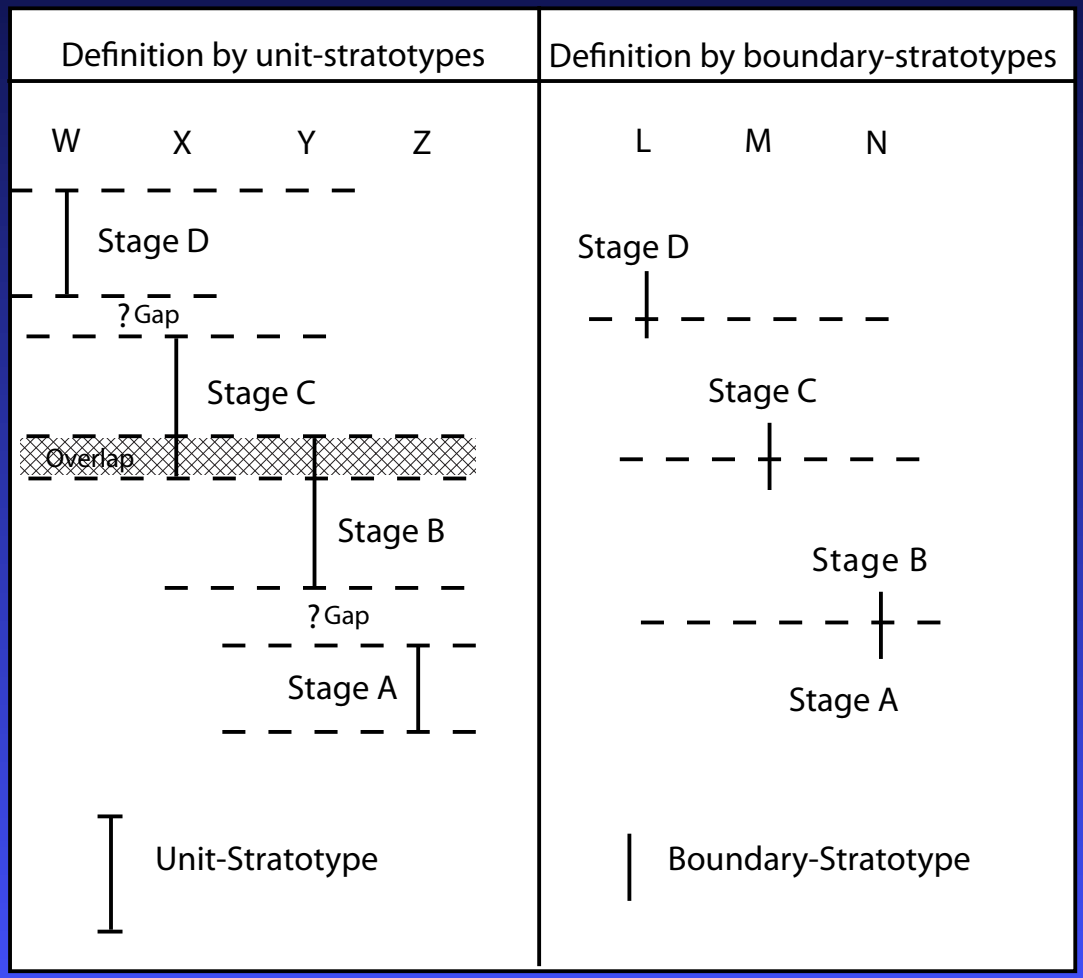
Primary advantage of boundary stratotypes over unit stratotypes: avoids gaps or overlaps between successive units.

Boundary stratotypes should be chosen in sequences of essentially continuous deposition since the reference points for the boundaries should represent points in time as specific as possible.



INTERNATIONAL STRATIGRAPHIC CHART

International Commission on Stratigraphy

ICS

IUGS

Eonothem Eon	Erathem Era	System Period	Series Epoch	Stage Age	Age Ma	GSSP
Phanerozoic	Cenozoic	Quaternary	Holocene		0.0117	
			Pleistocene	Upper	0.126	
				"Ionian"	0.781	
				Calabrian	1.806	
				Gelasian	2.588	
		Neogene	Pliocene	Piacenzian	3.600	
				Zanclean	5.332	
			Miocene	Messinian	7.246	
				Tortonian	11.608	
				Serravallian	13.82	
				Langhian	15.97	
	Mesozoic	Jurassic	Upper	Tithonian	145.5 ±4.0	
				Kimmeridgian	150.8 ±4.0	
				Oxfordian	~ 155.6	
			Middle	Callovian	161.2 ±4.0	
				Bathonian	164.7 ±4.0	
				Bajocian	167.7 ±3.5	
				Aalenian	171.6 ±3.0	
			Lower	Toarcian	175.6 ±2.0	
				Pliensbachian	183.0 ±1.5	
				Sinemurian	189.6 ±1.5	
				Hettangian	196.5 ±1.0	
					199.6 ±0.6	
Phanerozoic	Paleozoic	Devonian	Upper	Famennian	359.2 ±2.5	
				Frasnian	374.5 ±2.6	
			Middle	Givetian	385.3 ±2.6	
				Eifelian	391.8 ±2.7	
			Lower	Emsian	397.5 ±2.7	
				Pragian	407.0 ±2.8	
				Lochkovian	411.2 ±2.8	
		Silurian	Pridoli		416.0 ±2.8	
			Ludlow	Ludfordian	418.7 ±2.7	
				Gorstian	421.3 ±2.6	
			Wenlock	Homerian	422.9 ±2.5	
				Sheinwoodian	426.2 ±2.4	
			Llandovery	Telychian	428.2 ±2.3	
				Aeronian	436.0 ±1.9	
				Rhuddanian	439.0 ±1.8	
		Ordovician	Upper	Hirnantian	443.7 ±1.5	
				Katian	445.6 ±1.5	
				Sandbian	455.8 ±1.6	
			Middle	Darriwilian	460.9 ±1.6	
				Dapingian	468.1 ±1.6	
			Lower	Floian	471.8 ±1.6	
				Tremadocian	478.6 ±1.7	
		Cambrian	Furongian	*Stage 10*	488.3 ±1.7	
				Stage 9	~ 492 *	
				Paibian	~ 496 *	
			Series 3	Guzhangian	~ 499	
				Drumian	~ 503	
				Stage 5	~ 506.5	
			Series 2	*Stage 4*	~ 510 *	
				Stage 3	~ 515 *	
			Terreneuvian	*Stage 2*	~ 521 *	
				Fortunian	~ 528 *	
					542.0 ±1.0	

Eonothem Eon	Erathem Era	System Period	Age Ma	GSSP GSSA
Precambrian	Proterozoic	Neo-proterozoic	Ediacaran	542
			Cryogenian	~635
			Tonian	850
		Meso-proterozoic	Stenian	1000
			Ectasian	1200
			Calymmian	1400
		Paleo-proterozoic	Statherian	1600
			Orosirian	1800
			Rhyacian	2050
			Siderian	2300
				2500
	Archean	Neoarchean		
		Mesoarchean		2800
		Paleoarchean		3200
		Eoarchean		3600
		Hadean (informal)		4000
				~4600

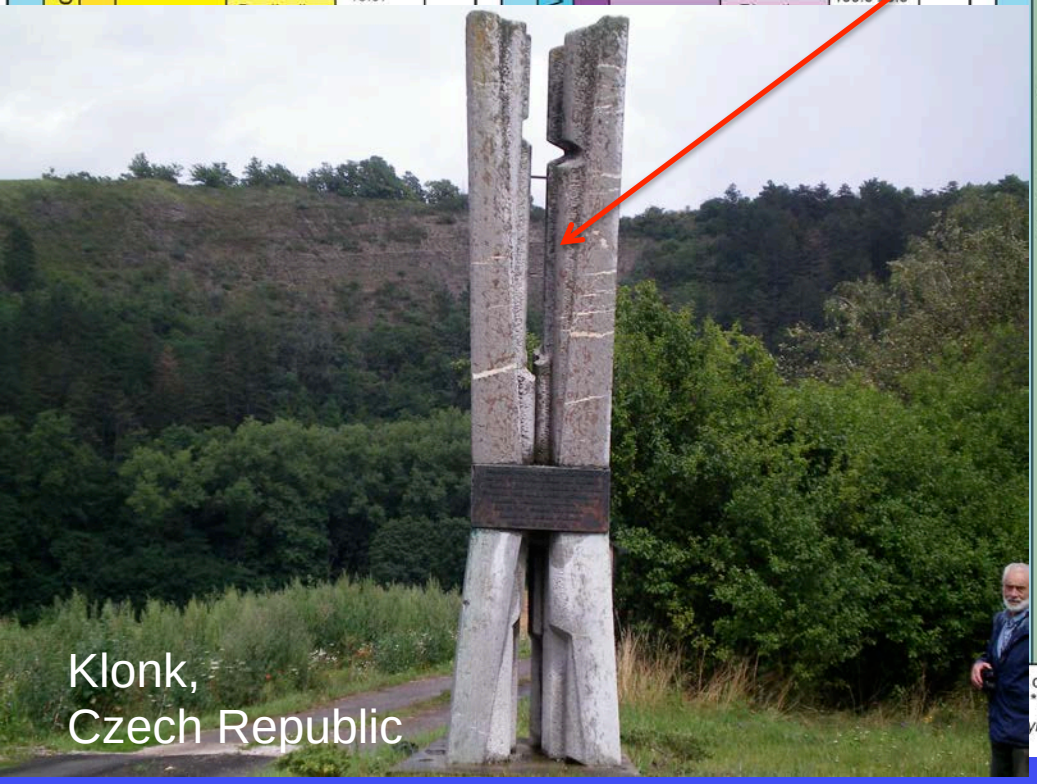


chart was drafted by Gabi Ogg. Intra Cambrian unit ages
* are informal, and awaiting ratified definitions.

yright © 2009 International Commission on Stratigraphy

Subdivisions of the global geologic record are formally defined by their lower boundary. Each unit of the Phanerozoic (~542 Ma to Present) and the base of Ediacaran are defined by a basal Global Boundary Stratotype Section and Point (GSSP), whereas Precambrian units are formally subdivided by absolute age (Global Standard Stratigraphic Age, GSSA). Details of each GSSP are posted on the ICS website (*www.stratigraphy.org*).

Numerical ages of the unit boundaries in the Phanerozoic are subject to revision. Some stages within the Cambrian will be formally named upon international agreement on their GSSP limits. Most sub-Series boundaries (e.g., Middle and Upper Aptian) are not formally defined.

Colors are according to the Commission for the Geological Map of the World (*www.cgmw.org*).

The listed numerical ages are from 'A Geologic Time Scale 2004', by F.M. Gradstein, J.G. Ogg, A.G. Smith, et al. (2004; Cambridge University Press) and "The Concise Geologic Time Scale" by J.G. Ogg, G. Ogg and F.M. Gradstein (2008).

August 2009

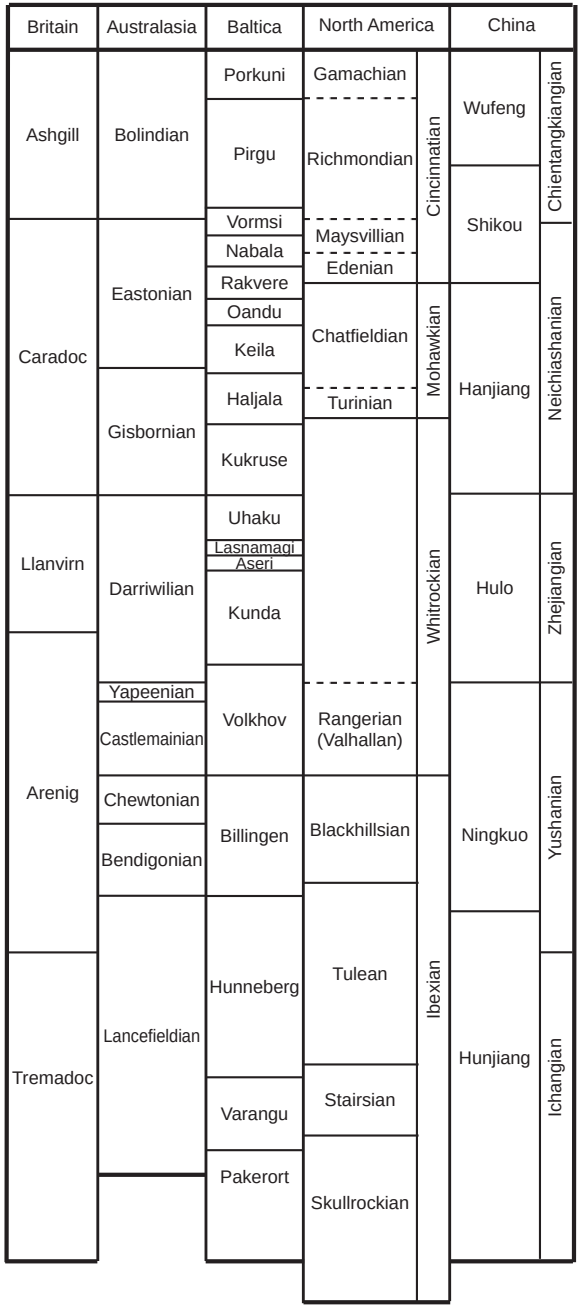
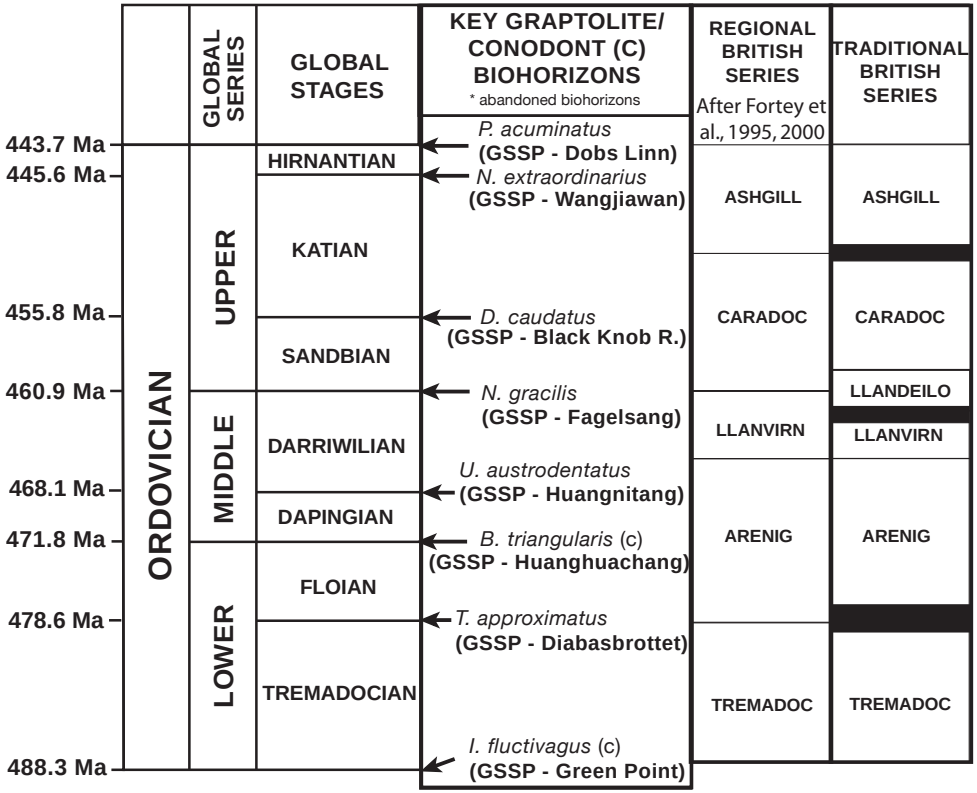


Figure 2. Regional series and stages for the Ordovician System

The Complexity of Regional Series and Stages has been greatly simplified by establishing new sets of global stage with bases precisely defined by GSSPs



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Requirements for a GSSP (Global Stratotype Section and Point):

- Must be selected in a section representing essentially continuous deposition. The worst possible choice is at an unconformity.
- Should be in a marine, fossiliferous section without major vertical lithofacies or biofacies changes.
- The fossil content should be abundant, distinctive, well preserved, and represent a fauna and/or flora as cosmopolitan and as diverse as possible.
- The section should be well exposed in an area of minimal structural deformation or surficial disturbance, metamorphism and diagenetic alternation, and with ample thickness of strata below, above and laterally from the selected boundary-stratotype.
- Should be selected in an easily accessible section that offers reasonable assurance of free study, collection, and long-range preservation. A permanent field marker is desirable.
- The selected section should be well studied and collected and the results of the investigations published, and the fossils collected from the section securely stored and easily accessible for study in a permanent facility.
- Where possible, the selection should take account of historical priority and usage and should approximate traditional boundaries.
- To insure its acceptance and use in the Earth sciences, a boundary stratotype should be selected to contain as many specific marker horizons or other attributes favorable for long-distance time correlation as possible.

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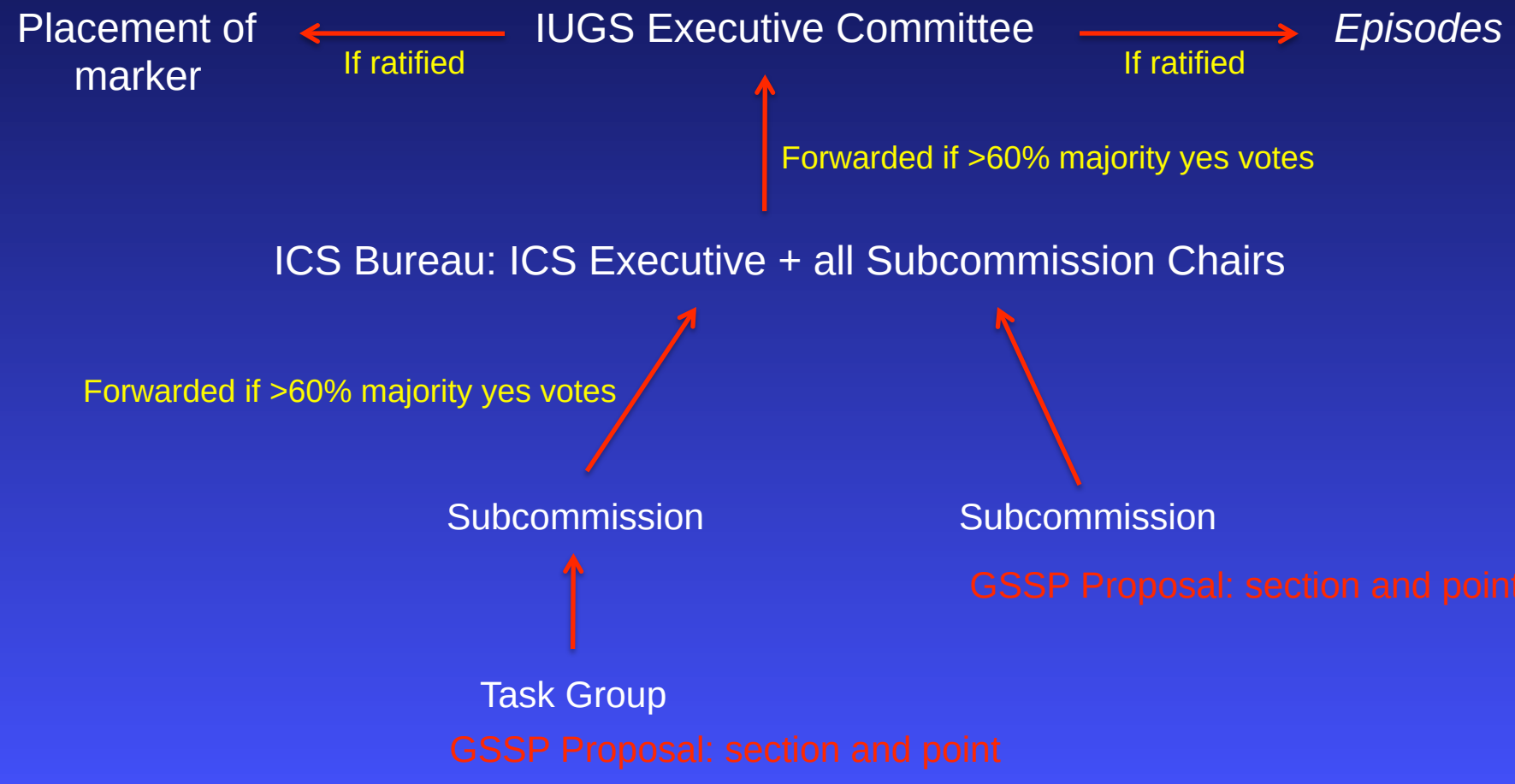
The Legitimacy of GSSPs and the units they define as Global Standards



Ogg et al., 2008

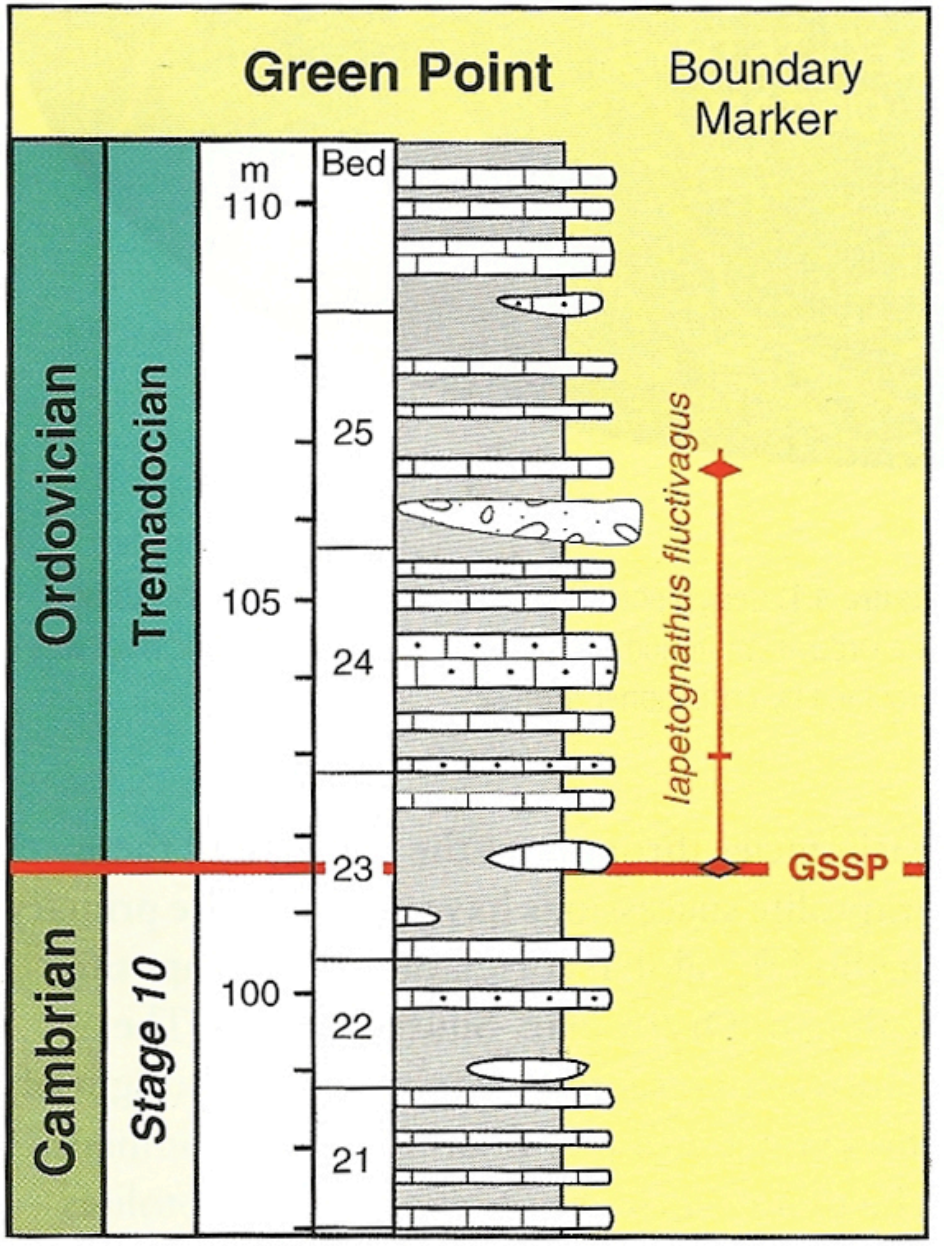
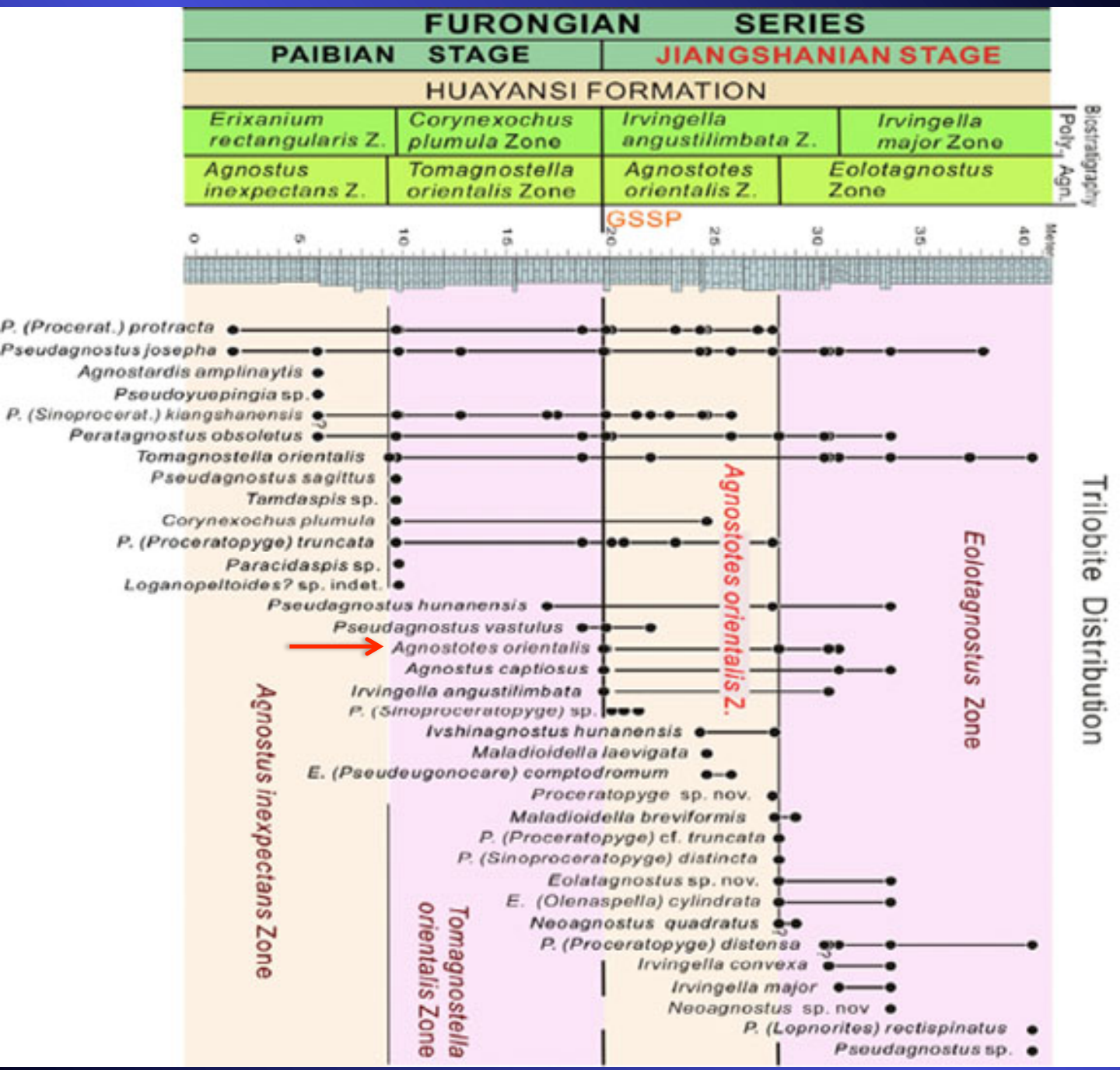


Figure 5.3. Stratigraphy of the base Ordovician GSSP in the Green Point section, Newfoundland, Canada, with the primary boundary markers.


FURONGIAN SERIES
PAIBIAN STAGE
JIANGSHANIAN STAGE
HUAYANSI FORMATION
Erixanium rectangularis Z.
Corynexochus plumula Zone
Irvingella angustilimbata Z.
Irvingella major Zone
Agnostus inexpectans Z.
Tomagnostella orientalis Zone
Agnostotes orientalis Z.
Eolotagnostus Zone
Biostratigraphy
Poly. Agn.
GSSP
0
5
10
15
20
25
30
35
40
Meter
P. (Procerat.) protracta
Pseudagnostus josepha
Agnostardis amplinaytis
Pseudoyuepingia sp.
P. (Sinoprocerat.) kiangshanensis
Peratagnostus obsoletus
Tomagnostella orientalis
Pseudagnostus sagittus
Tamdaspis sp.
Corynexochus plumula
P. (Proceratopyge) truncata
Paracidaspis sp.
Loganopeltoides? sp. indet.
Pseudagnostus hunanensis
Pseudagnostus vastulus
Agnostotes orientalis
Agnostus captiosus
Irvingella angustilimbata
P. (Sinoproceratopyge) sp.
Ivshinagnostus hunanensis
Maladioidella laevigata
E. (Pseudeugonocare) comptodromum
Proceratopyge sp. nov.
Maladioidella breviformis
P. (Proceratopyge) cf. truncata
P. (Sinoproceratopyge) distincta
Eolatagnostus sp. nov.
E. (Olenaspella) cylindrata
Neoagnostus quadratus
P. (Proceratopyge) distensa
Irvingella convexa
Irvingella major
Neoagnostus sp. nov
P. (Lopnorites) rectispinatus
Pseudagnostus sp.
Agnostus inexpectans Zone
Tomagnostella orientalis Zone
Agnostotes orientalis Z.
Eolotagnostus Zone
Trilobite Distribution

Green Point,
Newfoundland
Canada

Dedication of GSSP for
Cambrian-Ordovician
Boundary

GSSP for base of Middle Ordovician Series and Dapingian Stage

ZUMAIA
SECTION
2010/MAIATZA/06

STANLEY FINNEY
Jna.
ICS erakundeko presidente nagusia
MARKEL OLANO
Jna.
Gipuzkoako diputatu nagusia
IÑAKI AGIRREZABALAGA
Jna.
Zumaiako alkatea
XABIER ORUE-ETXEBARRIA
Jna.
Paleontologiako katedraduna EHU-UPV

ZUMAIA: LURRAREN HISTORIA LABARRETAN IDATZIA
P/E
S/T
D/S
K/T
DENBORA GEOLOGIKOA
ZUMAIKO LABARRAK IBAKURTZEN
P/E
S/T
D/S
K/T

GIPUZKOA

GSSP

ZUMAIA SECTION
Global Boundary Stratotype Section and Point
43.3006ª N Latitude / 2.2594ª W Longitude
Thanetiar Estaien oinerako Estratotipo Globala
Estratotipo Global para la base del Piso Thanetiense
Global Stratotype for the base of the Thanetian Stage
Placed 30.5 m above the base of Itzurun Formation and defined by the Magnetic base of Chron C26n.
Estimated age: 58.7 ± 0.2 Ma
This Section and Point defines the base of the Thanetian Stage of the Paleocene Series and Paleogene System and serves as the standard GSSP for the world.
06 / 55 / 2010
Gipuzkoako Foru Aldundia
IUGS
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ICS
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Viernes, 7/5/2010

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Dos líneas del tiempo en el acantilado de Zumaia

La meca de los geólogos se convierte en una referencia internacional excepcional con la fijación de sendos clavos dorados

MALEN RUIZ DE ELVIRA - Madrid - 06/05/2010

Voto: Resultado ★★★★½ 190 votos

Cuatro eventos geológicos presentes en el acantilado de Zumaia, según un esquema de la Diputación General de Guipúzcoa. Los dos marcados con clavos dorados son los de referencia mundial - DIPUTACION GENERAL DE GUIPÚZCOA

Los acantilados de la playa de Itzurun, en Zumaia, cuyos estratos inclinados representan 50 millones de años de historia de la Tierra, e incluyen la huella del meteorito que supuestamente hizo desaparecer a los dinosaurios, se convierten hoy oficialmente en la referencia mundial de dos líneas del tiempo, un caso excepcional. El presidente de la Comisión Internacional de Estratigrafía, Stanley Finney, y el Diputado General de Guipúzcoa, Markel Olano, colocarán los dos *clavos dorados* que reconocen el gran valor científico del *flysch* de Zumaia.

Los clavos dorados del ferrocarril

Afloramiento geológico en la playa de Itzurun (Zumaia, Guipúzcoa). · JAVIER HERNÁNDEZ

La noticia en otros webs
- webs en español
- en otros idiomas

Así se oficializan los estratotipos internacionales de sendas líneas de tiempo dentro del Paleoceno, lo que es excepcional que ocurra dentro de una misma sección geológica, explica el geólogo Juan Carlos Gutiérrez Marco. Se trata de los límites Daniense/Selandiense (hace 61,1 millones de años, que coincide con un brusco descenso global del nivel del mar) y Selandiense/Thanetiense (hace 58,7 millones de años, que coincide con una inversión repentina del campo magnético terrestre). Zumaia compitió científicamente durante años con otros candidatos extranjeros a estratotipos de límite, pero finalmente venció como el mejor lugar en el planeta para definir estos límites geológicos.

La sección de Zumaia es un referente geológico internacional desde hace ya más de 50 años. Geólogos de todo el mundo han realizado sus investigaciones en la zona aportando así un conocimiento científico excelente sobre la sección. Comprende el periodo Paleoceno en su totalidad y muestra 4 límites temporales relacionados con 4 eventos bruscos en la historia de la Tierra: el K/T (gran extinción de los dinosaurios); el D/S (gran caída del nivel del mar), el S/T (los polos magnéticos se invirtieron) y el P/E (uno de los mayores calentamientos de la historia). "Es espectacular, tenemos información sobre los sedimentos marinos acumulados durante 50 millones de años, una magnífica imagen de lo que ha sido la historia de la Tierra, con mucha precisión. Es uno de los mejores afloramientos del mundo", dice Finney.

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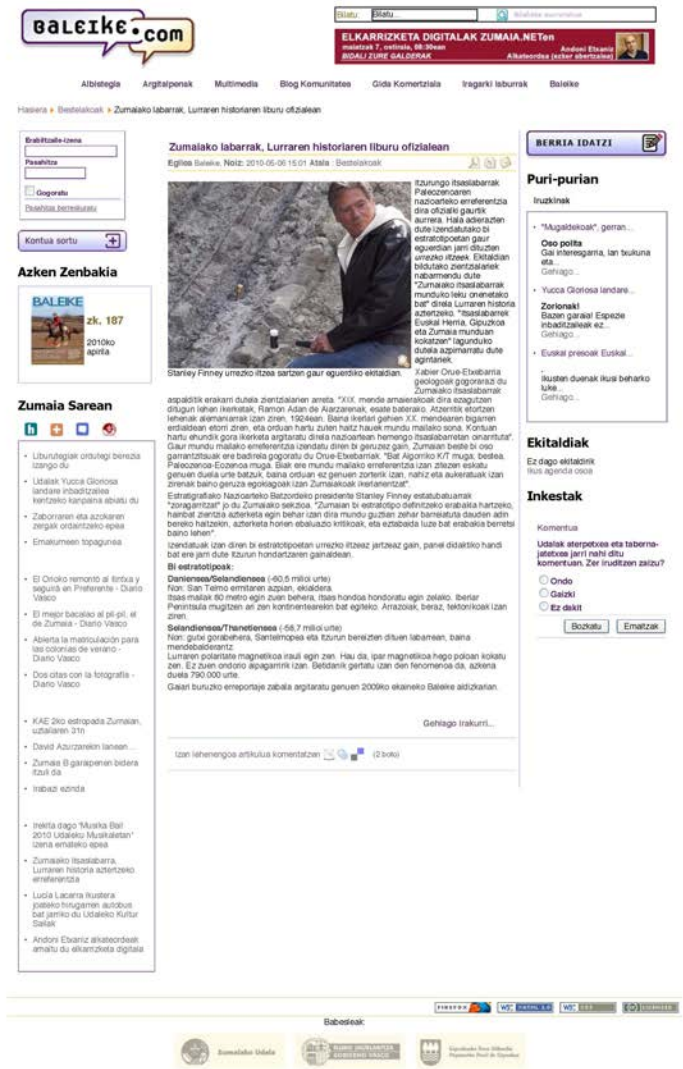
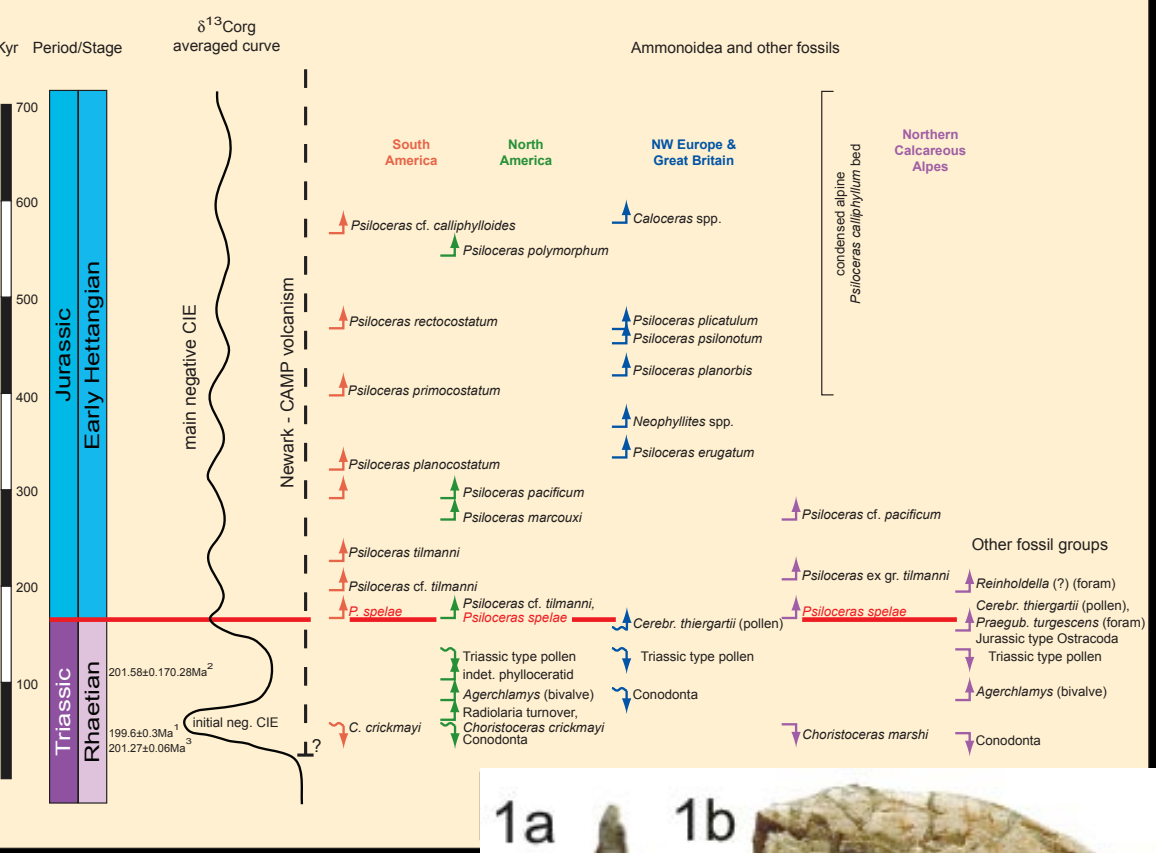
Lo más visto | ...valorado | ...enviado

1. Dos heridos por arma de fuego en la Puerta del Sol
2. Madrid fundó una orden femenina ilegal con 900 jóvenes esclavas
3. Las máquinas se apoderan de Wall Street y provocan el pánico en el mercado
4. Cameron comunica sus planes de Gobierno
5. Los conservadores británicos ganan las elecciones sin mayoría absoluta
6. El telescopio 'Herschel' detecta una estrella 'imposible'
7. ¿Ahora sí que se casarán?
8. Francia localiza las cajas negras del Airbus que se estrelló en el Atlántico
9. La 'locura' de Totti
10. La Expo de Shanghai se desinfla

Contrata ya la Cuenta Euribor Self Bank. | Listado completo

Los clavos dorados del ferrocarril




Kyr
Period/Stage
δ13Corg averaged curve
Ammonoidea and other fossils
700
600
500
400
300
200
100
Jurassic
Early Hettangian
Triassic
Rhaetian
main negative CIE
Newark - CAMP volcanism
initial neg. CIE
201.58±0.170.28Ma2
199.6±0.3Ma1
201.27±0.06Ma3
South America
North America
NW Europe & Great Britain
Northern Calcareous Alpes
condensed alpine Psiloceras calliphyllum bed
Psiloceras cf. calliphylloides
Psiloceras polymorphum
Caloceras spp.
Psiloceras rectocostatum
Psiloceras plicatulum
Psiloceras psilonotum
Psiloceras primocostatum
Psiloceras planorbis
Neophyllites spp.
Psiloceras erugatum
Psiloceras planocostatum
Psiloceras pacificum
Psiloceras marcouxi
Psiloceras cf. pacificum
Psiloceras tilmanni
Psiloceras ex gr. tilmanni
Psiloceras cf. tilmanni
P. spelae
Psiloceras cf. tilmanni,
Psiloceras spelae
Cerebr. thiergartii (pollen)
Psiloceras spelae
Other fossil groups
Reinholdella (?) (foram)
Cerebr. thiergartii (pollen),
Praegub. turgescens (foram)
Jurassic type Ostracoda
Triassic type pollen
Triassic type pollen indet. phylloceratid
Agerchlamys (bivalve)
Radiolaria turnover,
Choristoceras crickmayi
Conodonta
Triassic type pollen
Conodonta
Agerchlamys (bivalve)
C. crickmayi
Choristoceras marshi
Conodonta
?

1a
1b
1 cm
2

国家级地质遗迹保护

CHINA

GSSPs are located in:

China – 10, United Kingdom – 9, Italy – 9, United States – 7, France – 5, Spain – 5, Czech Republic – 3, Canada – 2, Sweden – 2, Morocco – 2, Austria – 1, Germany – 1, Portugal – 1, Malta – 1, Tunisia – 1, Egypt – 1, Kazakhstan – 1, Uzbekistan – 1, Australia – 1, Greenland Ice Core - 1

GSSPs are located in United States:

Turonian Stage, Cretaceous System, near Pueblo, Colorado, Denver and Rio Grande Railroad cut

Capitanian Stage, Guadalupian Series, Permian System, Guadalupe Mountains, Texas, NPS

Wordian Stage, Guadalupian Series, Permian System, Guadalupe Mountains, Texas, NPS

Roadian Stage, Guadalupian Series, Permian System, Guadalupe Mountains, Texas, NPS

Bashkirian Stage, Pennsylvanian Subsystem, Carboniferous System, Arrow Canyon, Nevada, BLM

Katian Stage, Ordovician System, Black Knob Ridge, Atoka, Oklahoma, Private Land

Drumian Stage, Cambrian System, Drum Mountains, Millard County, Utah, BLM