TimeScale Creator datasets *(thematically ordered)* *GTS2020 age models*

59,000 datalines; in 480 columns (are curves) that are grouped into a 200 directory-subdirectory hierarchy as given below. Most text entries have pop-ups with calibrations, sources and comments. *Mouse-Over option brings up windows with details on zones/events; which include direct URL hot-links to GSSP documentation (Geologic TimeScale Foundation), Microfossil taxonomy (Planktonic Forams, Nannofossils, Radiolarians, Dinoflagellate Cysts), Large Igneous Provinces, and Impacts*

Category Group and sub-group	Subsets	*Columns*	Sources (selected major ones)
Standard International Chronostratigraphy		17 columns	
Standard Chronostratigraphy		*Eon, Era, Sub-Era, Period, Sub-Period, Epoch, Sub-Epoch, Age/Stage, Substage*	International Commission on Stratigraphy [http://www.stratigraphy.org/. Details on boundaries/GSSPs are at Geologic TImeScale Foundation [http://timescalefoundation.org/gssp].
			Sub-Epochs are a special Cenozoic set with divisions as suggested by ICS subcommissions (but official for Pleist-Holocene). Color-usage here are of their lower Stage division.
	Lt. Pleistocene-Holocene detail	*Lt.Pleist-Holocene Epochs, Sub-Epoch, Stages, GSSPs*	***Use 20cm/myr to see details.***
GSSPs *(boundary stratotypes)*		*GSSPs*	The base of each unit of the geologic time scale is defined at a specific location and point (Global Boundary Stratotype Section and Point, GSSP), where it coincides with an array of paleontological, geochemical, paleomagnetic or other markers for high-resolution global correlation. The current status of currently ratified GSSPs (with strat section, images, etc.) and possible markers for the other geologic units are summarized with updated GTS2020 tables (with images) at Geologic TimeScale Foundation [http://timescalefoundation.org/gssp/] or at the main International Commission on Stratigraphy website [http://www.stratigraphy.org] .
Alternate Precambrian Chronostratigraphy		*Alternate Era / Period / Marker events*	Van Kranendonk et al. (2012), In: The Geologic Time Scale 2012
Planetary Time Scale		*10 columns*	Harald Hiesinger and Kenneth L. Tanaka. (2020) Planetary time scale. In: Geologic Time Scale 2020 (Gradstein, Ogg, Schmitz and Ogg; compilers; Elsevier Publ.)
	Moon	*Periods / Epochs / Events*	Events are from Tanaka, K.L., Hartman, W., 2012. The Planetary Time Scale. In: The Geologic Time Scale 2012; therefore may be slightly offset from the GTS2020 ages for Epochs.
	Mars	*Periods / Epochs / Events*	
	Venus	*Periods / Events*	
	Mercury	*Periods / Events*	
Regional Stages		*59 columns*	From GTS2020 period-chapters, plus other selected regions. [See extensive pop-up windows explaining disagreements or uncertainties in calibrations.]
Jur-Cret boundary regional stages - British and Boreal	**British** regional	*Stages / Substages*	Jur-Cret boundary = From different sources; especially articles by Bill Wimbledon, by Mikail Rogov, and the Jurassic-Cretaceous boundary working group through 2020
	Boreal regional	*Stages / Substages*	
North America regional units		*Series / Stages*	CRET (and PreCamb) = GeoWhen (compiled by R. Rohde; http://timescalefoundation.org) ; Permian from Henderson (2020); Carboniferous from Heckel (2015) and Davydov (1996; GTS2004; GTS2012), Silurian from GeoWhen (compiled by R. Rohde; at http://timescalefoundation.org); Ordovician from Goldman (GTS2020); Cambrian from Peng and Babcock (GTS2020)
	Type Mississippian Lithostratigraphy (USA)	*Lithostrat w/ Salem Lms wedge / N.Amer. Mid-Continent marker in Mississippian*	Generalized from Heckel et al., 2005; with additional correlations by Paul Brenckle, written commun., October 2006)
	California		GeoWhen (compiled by R. Rohde; at *http://timescalefoundation.org)*
European regional units	**Western European and British regional units**	***W. Europe-British*** *Series*	Cret = Traditional series-level divisions; Perm-Carb = GTS2020 and German Stratigraphic Commission (2002); Ordovician = Goldman (GTS2020), Cambrian = Shanchi Peng (GTS2020)
		East Avalonian *Series (Cambrian)*	Shanchi Peng and Babcock (GTS2020)
		W. Europe *Stages / Substages*	Cret = Traditional series-level divisions; Perm-Carb = Henderson (GTS2020), Aretz (GTS2020) and German Stratigraphic Commission (2002); Ordovician = Goldman (GTS2020); Cambrian = Shanchi Peng and Babcock (GTS2020)
		British *Substages (lower Carb)*	Aretz (GTS2020); Menning et al (2006), plus advice of Peter Jones (Aust. Natl. Univ.). *[See extensive pop-up windows explaining disagreements or uncertainties in calibrations.]*
	German Basin Triassic Lithostratigraphy	*Main Germanic Facies (generalized) / Folge divisions or Members*	LithDesc (partly Feist-Burkhardt, S., et al., 2008. Triassic. In: The Geology of Central Europe. See also Triassic Fossils (with strat) at www.palaeo-online.de. Early Triassic Folge are considered to be 100kyr periodicity by Backman, Menning, Kozur, Szurlies and others
Baltoscania regional units		*Series / Subseries / Stages / Substages*	Based on Regional Stage correlation chart of Dan Goldman, Apr 2019; and he advised (July 2019) to calibrate to Ordov. Stage Slices
Paratethyan Stages	Central Paratethys	*Stages / Defining events (FADs)*	Sources = Neogene chapter of GTS2020, which updated and enhanced W. Piller (Neogene chapter of GTS2012)

Category Group and sub-group	Subsets	Columns	Sources (selected major ones)
	Eastern Paratethys	*Stages/Substages for the **Dacian** / **Euxinian** / **Caspian** sub-basins; plus Defining events (FADs)*	Source = Neogene chart in GTS2020
Iberian-Morocco regional units (Cambrian)		*Series / Stages*	ORDOV (Iberian-Bohemia): Based on Regional Stage correlation chart of Dan Goldman, Apr 2019; and he advised (July 2019) to calibrate to Ordov. Stage Slices; CAMB: Geyer, G. & Landing, E. 2004. A unified Lower - Middle Cambrian chronostratigraphy for West Gondwana. Acta Geologica Polonica, 54 (2), 179-218; plus Peng and Babcock (GTS2020)
Russian and Ural regional units	**Russia Platform** regional units (Perm-Carb; Camb)	*Series / Stages / Substages or horizons / Permian horizons (pre-2005) and Carb sub-horizons*	Main sources are Perm-Carb = Henderson (GTS2016/2020, plus Davydov, GTS2012) and Aretz (GTS2020); Ordovician = Goldman (GTS2020); Cambrian = Shanchi Peng and Loren Babcock (GTS2020) *NOTE: See the extensive RUSSIAN BIOSTRAT DATAPACK for Russian regional zones and stages.*
	Donets Basin sub-units (Carb.)	*Substages or horizons / Sub-horizons*	Parlty from Menning et al. (DCP 2006) inter-calibrations to Russian stages
	NE Siberia regional units	*Carboniferous / Cambrian stage/substage*	Carb = Davydov (GTS2012) with partial revisions by Aretz (GTS2020); Cambrian = Peng and Babcock (GTS2016; GTS2020)
	Kazakhstan		Cambrian = Shanchi Peng (chair of subcommission, to J. Ogg, Dec. 2005), revised by Peng and Babcock (GTS2020)
Tethyan regional units (Permian)		*Stages **(Pamirs)** / Stages **(Salt Range)***	Henderson and Shen (GTS2020) and Davydov (GTS2012)
East Asian regional units	**South China**	*Series / Stages*	Permian-Carb from from Henderson (GTS2012, GTS2020) and from Menning et al, 2006; except Late Carboniferous from Zhang and Zhou (2007; Carb-Perm Congress); CHINA Ordovician stage names and calibrations are from Nat. Comm. Strat. China chart (2014). A modified set is in Zhang Yuandong, Zhan Renbin et al. (2019; Science China: Earth Sci. 62: 61-88) -- plus see other chapters in that special volume "Integrative strataigraphy and timescale of China" (Shuzhong Shen et al.). Cambrian series from Shanchi Peng (2003) Chronostratigraphic subdivision of the Cambrian of China. Geologica Acta, 1: 135-144 and Peng and Babcock (GTS2020). Older Jurassic-Triassic and Devon from GeoWhen (compiled by R. Rohde; at http://timescalefoundation.org).
	Yangtze Platform Triassic Lithostratigraphy	*Formations / **South China** cycles*	Late Triassic = Longchang, Guizhou (mainly Enos et al., 2006 GSA SpecPaper); Middle = Yongningzhen and Guandao, Guizhou (mainly Lehrmann et al., 2015 Jour Asian Earth Sci.); Early = Chaohu, Anhui (calibration by Mingsong Li et al., 2015. EPSL)
	North China / E. Yunnan	*Epoch / Age-Stage*	From Shanchi Peng (2003) Chronostratigraphic subdivision of the Cambrian of China. Geologica Acta, 1: 135-144. with updates from Peng-Babcock'19 Cambrian chapter of GTS2020.
	Japan	*Stages*	GeoWhen (compiled by R. Rohde; at http://timescalefoundation.org). Uncertain -- not mentioned by GTS2020 authors
Australia and New Zealand	**Australia**	*Stages (Cenoz; E.Paleoz.)*	Cambrian from Shanchi Peng and Loren Babcock (GTS2012/2016/2020); others from John Laurie (GeoScience Australia, to Jim Ogg, May 2007) and GeoWhen (compiled by R. Rohde; at http://timescalefoundation.org).
	New Zealand chronostratigraphy --	*Epochs, Stages, Substages, abbreviations, boundary markers*	Modified from Raine et al. (2015) "Revised calibration of the New Zealand Geological Timescale: NZGT2015/1" (GNS Science Report 2012/39; published Feb 2015); originally from Geological Timescale (Cooper et al., 2004) with Cenozoic and Cretaceous updated to the 2004 GPTS (Hollis et al, 2010). Ordov-Camb ages made consistent with same-name Australian stages
African regional units		***South Africa** (Precambrian)*	GeoWhen (compiled by R. Rohde; at http://timescalefoundation.org).
Geomagnetic Polarity		*5 columns*	
Composite polarity scale for Phanerozoic		*Polarity chrons*	GTS2020 composites: Quat = Channell-Singer-Jicha, 2020; C-sequence: Neogene-Paleogene = synthesis of many sources by Palicke for GTS2020; Maast-Camp = Husson et al. (2011) and Thibault et al. (2012); M-Seq with M-Sequence Extension [deep-tow upward projection to surface (M27r-M37r or 3km mid-depth for M38n-M44n) = GTS2020 GeomagChapter with spline-fit by Ogg-Agterberg incorporating Andy Gale's EarlyCret assigned stage-ages; Middle-Early Jurassic outcrop compilation with cycle-scaling by Hounslow-Mischa (see GTS2020 chapter); Late Triassic Newark from Kent et al (their 2018 updates) tied to CAMP basalts at top and candidate base-Norian GSSP (Pizza Mondello) for E8, then uncertain below. Triassic-outcrop based sets after Hounslow and Muttoni (2010), Zhang et al. (2020, Carnian), Muttoni et al. (various), Li (2016 with Yan Chen revisions 2020) etc. Late Permian after Steiner (2006). Early Permian-Ordovician = modified slightly from compilations GTS2012 and the Concise GTS 2016. NOTE that Hounslow et al. (2018 for Permian; 2019 for Paleozoic; 2020 pending for Carboniferous) has proposed other versions that should be incorporated; but most are similar to what is shown here.
Geomagnetic Excursions during Quaternary Period		*Events*	Use VERTICAL SCALE of 5x or higher! Compilation by Channell-Singer-Jicha (2020) that updated Brad S. Singer (2014; A Quaternary geomagnetic instability time scale. Quaternary Geochronology, 21: 29-52)
Other Jurassic and Triassic oceanic and outcrop reference scales	Secondary scales to main composite	***Pre-M26 Deep-Tow** at depth*	Marine magnetic anomaly series from M27r to M44n are rescaled from deep-tow surveys on Japanese lineations (Sager et al.; 1998; Tominaga and Sager, 2008). These anomalies are also projected upward (bottom table) to sea surface (M27r-M37r) or mid-depth (3km; M38n-M44n)
		Crussol. Poland, England Kimm-Oxf-Callov, Spain Bath-Bajo	Polish-England Oxf-Kimm composite from Przybylski, Ogg et al. (2010. with unpublished uppermost Kimm continuation at Crussol, and Callov from Rachel Gipe (2013. Purdue Univ. thesis), and Spain Bath-Bajo from Steiner-Ogg 1987
		***Late Triassic** outcrop magnetostratigraphy*	Modified from Hounslow and Muttoni (2010), Maron et al. (2019) and Zhang, Ogg et al. (2020)
Marine Macrofossils (Mesozoic-Paleozoic)			
Ammonoids		*19 columns*	

Category Group and sub-group	Subsets	Columns	Sources (selected major ones)
Ammonoids (Mesozoic)	**Tethyan** Ammonoids	*Zones / Subzones*	Revised using Klug et al. (2015) "Ammonoid Paleobiology" book (Springer); with initial sources being CRETACEOUS = Thierry et al. (in Hardenbol et al., SEPM charts, 1998), with GTS2004 and Kilian Group (2004-2015) revisions; JURASSIC = Groupe Francais d'etude du Jurassique (1997); TRIASSIC = Mietto and Manfrin (in Hardenbol et al., SEPM charts, 1998), with considerable revisions in GTS2004 using Kozur (2003 and pers. commun., 2006. 2010), plus Marco Balini (2010) and Mike Orchard (in GTS2020 Triassic chapter)revisions; Permian = Low-Latitude suite from Kozur (2003) and Henderson (GTS2020), but see Permian suite (under Paleozoic ammonoids) by Henderson (GTS2012/2020).
	North American Western Interior	*Zones / Close-spaced zones*	W.A. Cobban (2006), with GTS2008/2012 and Andy Gale (GTS2020) revisions. Intervals with close-spaced (less than 0.3 myr) zones have a separate column to avoid over-crowding.
	Sub-Boreal (Cret-Jur) and **Arctic** (Tri) Ammonoids	*Zones / Subzones*	Revised using Klug et al. (2015) "Ammonoid Paleobiology" book (Springer); with initial sources being CRETACEOUS = Thierry et al. (in Hardenbol et al., SEPM charts, 1998), with GTS2020 (Kennedy, Gale and Mutterlose) and Kilian Group (2004-2019) revisions; JURASSIC = Groupe Francais d'etude du Jurassique (1997) with GTS2020 (Hesselbo et al.) revisions, plus Mikail Rogov (pers. commun., etc., 2010-2011); TRIASSIC = Orchard-Tozer'97 (with M. Orchard revisions, GTS2020); PERMIAN = Henderson (2020).
	Boreal (Mesoz.) Ammonoids	***Russian Platform** ammonoids (zones/subzone)*	Mainly from Konstantinov and Klet as modified by Jenks et al. chapter in Klug et al. (2015) "Ammonoid Paleobiology" book (Springer). Initial sources include GTS2004 Jurassic chapter (original was compiled by Sven Backstrom, via Felix Gradstein, ~1995), and Groupe Français d'Étude du Jurassique (1997); Triassic Ammonites Zones of Siberia (Boreal realm) are compiled by Paul van Veen (in Hardenbol et al., SEPM 1998) from Kazakov & Kurushin (1992), Dagys & Weitschat (1989), Dagys & Konstantinov (1992) and Dagys (1991).
		***High Boreal (Siberia)** ammonoids (zones/subzone)*	
Ammonoids (Paleozoic)		*SuperZones abbreviation / Zones abbreviation*	Revised using Klug et al. (2015) "Ammonoid Paleobiology" book (Springer); with initial sources being PERMIAN = Henderson (2005, GTS2020), Davydov et al.,GTS 2004, Kozur, 2003; CARBONIFEROUS = GTS2004 and GTS2012 diagrams (Davydov et al., 2004, 2012) with revisions by Aretz (GTS2020) and Boardman-Work (2013) for USA; DEVONIAN = Becker (GTS2020). NOTE: Paleozoic zonations are not as well-standardized as for the Jurassic.
	Devonian	*Zones name / subZones name*	Devonian zonations, taxa names and relative age-calibrations (relaive to conodont "master" scale) are based on Thomas Becker's detailed chart (2010/2011; which was partly incorporated in GTS2012)
	Major ammonoid markers	*events*	
	Boreal (Perm-Carb Cis-Urals)	*Zones*	Revised using Klug et al. (2015) "Ammonoid Paleobiology" book (Springer); see above for other sources
	Russian Standard Carboniferous	*ammonoid Zones*	Zones are from Russian chart (2006) which referenced: Postanovlenia MSK É, 2003
	Carboniferous USA mid-continent	*ammonoid Zones / subzone*	David Work for GTS2008; and Boardman-Work (2013) for USA Pennsylvanian
	Mid-continent USA (late-Penn)	*subzones*	
Conodonts		*24 columns*	Main suites are TRIASSIC = Tethyan zones of Kozur'03 with modifications by Mike Orchard (in GTS2020); PERMIAN-CARBONIFEROUS = GTS2012 diagrams of Henderson and of Davydov (zones used for Spline-fit of this age scale); DEVONIAN = Becker (GTS2012/GTS2020) suite used for spline-fit age model; SILURIAN = "Standard" of Mike Melchin in GTS2012/GTS2020; ORDOVICIAN = Goldman (GTS2020) with earlier sources including North Atlantic conodont zones (Figure 2.2 in Webby et al. (2004; The Great Ordovician Biodiversification Event) and Roger Cooper (chart of Nov'2010 for GTS2012). Goldman-Sadler's (GTS2020) placement relative to Australia "CONOP/spline-fit" graptolie zones are used here.); CAMBRIAN = Peng and Babcock (GTS2020 graphics). See GTS2016/GTS2020 for additonal sources.
Conodont zones (general)		*Conodont zonation (selected)*	
		Conodont subzones (Ordovician)	Goldman (GTS2020)
		Conodont major markers	TRIASSIC = mainly Orchard and Tozer (1997) and Kozur (2003); PERM-CARB = GTS2012 diagrams of Henderson and of Davydov; DEVONIAN = Thomas Becker (GTS2012)
Conodont zones (regional and alternate)	**Triassic** other zonations	***West Tethys** zones (Lt. Tri.; Rigo et al., 2018)*	West Tethys (especially Italy and adjacent regions) Modified from Rigo, M., Mazza, M., Kar‡di, V., Nicora, A., 2018. New Upper Triassic conodont biozonation of the Tethyan Realm. In: Tanner, L.H. (Ed.) The Late Triassic World: Earth in a Time of Transition, Topics in Geobiology, 46, Springer Publ., p. 189-235)
		***South China** generalized zones*	South China generalized zones: Early Tri = Chaohu modified; Mingsong Li cycle-scalings -- but it seems each S. China section uses a variant; very confusing! Middle Tri = Guandao (Lehrmann et al., 2015); Carnian = lower from Haishui Jiang. Nor-Rhaet from Tong et al. (2018)
		Arctic/Panthalassan	Orchard's "Arctic/Panthalassia" as used in GTS2020, with his Calibrations to Western Canada Basin (British Columbia, "Boreal") zones tied to ammonoid zones by Orchard (pers. commun., Oct'19), who also provided references. GTS2012/2016 used (Orchard & Tozer '97; Orchard '07 and '10; with Early and Middle Triassic as diagrammed by Orchard (Fig. 9 in Lehrman et al., 2015)
	Permian-Carboniferous other zonations	*Numbered Zones (Carb-Perm; Davydov'04)*	Zone abbreviations used by Davydov (GTS04) for his graphical correlation results (mainly Eurasia)
		Permian zones of Davydov'04; Carboniferous of Lane'08 and Russian'06	Zones are from GTS2008 update to Davydov'04 using recommendations of Rich Lane (2008) and Russian biostratigraphy chart (2006) which referenced: Postanovlenia MSK ..., 2003
		***North American Mid-Continent** zones and datums (Carb.)*	Mississippian from Lane (2005); Pennsylvanian from Barrick et al. (2013; Stratigraphy); revised by Aretz (GTS2020)
	Devonian other zonations	***MN** (Montagne Noire) set*	Compiled and correlated by Thomas Becker for GTS2020
		Former pre-GTS2020 Devon. Zonations	Based on Thomas Becker's detailed chart (2010; delivered to Gradstein and Ogg); which had older zonal nomenclatures
	Ordovician other zonations	***Baltica** Ordov. Zones / Subzones*	Based on Goldman's (GTS2020) adjacent graptolite-conodont diagrams for Baltic (source of some U-Pb dates calibrated to those conodonts); even though he warns that there are very few conodont-graptolite calibrations for any region. NOTE: This set is also used in the Main Zonation synthesis
		***North American Midcontinent** Ordov Zones / Subzones*	Based on Goldman's (GTS2020) adjacent graptolite-conodont diagrams of N.Amer. mid-continent relative to Baltic conodonts
		***China** Ordov. Zones (N. / S. China)*	Based on Goldman's (GTS2020) adjacent graptolite-conodont diagrams of China relative to Baltic conodonts
	Cambrian Australia	*Zones / Subzones*	

Category Group and sub-group	Subsets	*Columns*	Sources (selected major ones)
Graptolites		*15 columns*	
Graptolite Zones (composite)		*Graptolite Zones (general) / Markers*	This hybrid Ordovician Australian and "standard" Silurian suite was used to scale the Ordovician-Silurian by CONOP method (Cooper, Melchin, Goldman, Sadler). Devonian zonations (relaive to conodont "master" scale) are based on Thomas Becker's detailed chart (2020; delivered to Ogg and Gradstein)
Regional Graptolite zones	Australian Ordovician	*Zone/SubZones abbreviation / Name / Markers / Other datums*	Numerical ages = Tied to Spline-CONOP2020 table (Sadler-Goldman, GTS2020) with Base of Silurian assumed for top of Bo5 zone. Biostratigraphy: Goldman-Cooper (GTS2020) with sources of VandenBerg & Cooper 1992; Cooper and Lindholm 1990. Age assignments for regional zonations of N.Amer., S.China, Britain and Baltoscandia are based on Dan Goldman's zonal-comparison chart for GTS2020 relaive to Australian zones; partly based on Cooper-Sadler (GTS2012).
	North American	*Zones*	
	South China	*Zones*	
	British	*Zones / Subzones*	
	Baltoscandia	*Zones / Subzones*	
Trilobites and pre-Trilobite biostratigraphy		*11 columns*	Zonal schemes from Peng and Babcock (2016 to J.Ogg for Concise GTS; and 2019 to G.Ogg for GTS2020); Ages based on placement relative to S.China trilobite zone "primary" (2019 to G.Ogg) NOTE: Includes Small Shelly Fossils, and some Archaeocyaths
South China trilobites		*Pelagic trilobites (**Agnostids**)*	
		*Benthic trilobites (**Polymerids**)*	
		Merged SSF-trilobite zones	
Siberia trilobites		*Main Siberia set / Alternate Siberia set*	
Australia trilobites		*zones*	
Laurentia trilobites		*Main Laurentia set / Alternate Laurentia set*	
Archaeocyaths (Austr., M.Camb.)		*zones*	
Early Paleozoic Biotic Events and Divisions		*5 columns*	
		Devonian crisis episodes	Becker GTS2020
		Silurian Major Biotic Events	Bioevents -- graptolite (G) and conodont (C) from Melchin (Aug'11; updated in GTS2020) using (Jaeger, 1991; Jeppsson, 1998; Melchin et al. 1998, Jeppsson et al., 2006)
		Ordovician-Silurian Stage Slices	*Silurian-Ordovician Stage Slices (Cramer et al., Lethaia, 2011; Stig Bergstrom & Chen Xu, Lethaia, 2007)*
		Ordovician time slice	*Ordovician Time Slices (Berry et al, 2004)*
		Major Cambrian markers	Peng and Babcock (GTS2020) with ages based on placement relative to S.China trilobite zone "primary" (graphic to G.Ogg)
Other Marine and Lacustrine Macrofossils		*30 columns*	
Belemnites		*NW Europe Zones / Subzones*	Main source = R. Combemorel (in Hardenbol et al., SEPM charts, 1998)
		Balto-Scandia Zones (Lt. Cret.); Tethyan (Oxf-Haut)	
		Tethyan subZones (Lt.Jur.)	
		Russian Platform Zones (Lt. Cret.)	
Bivalves (Inoceramids, Pelecypods, etc.)	**Cretaceous Inoceramids**	***N.Amer.** inoceramid Zones / Close-spaced Zones*	N.Amer. U.Cret. = Cobban et al., 2006, USGS report, with revisions by Andy Gale (GTS2020). Europe-Russia = A.V. Dhondt (Inoceramids) and Paul van Veen (Triassic pelecypods) (in Hardenbol et al., SEPM charts, 1998); Other columns from A.V. Dhondt (Inoceramids) and Paul van Veen (Triassic pelecypods) (in Hardenbol et al., SEPM charts, 1998)
		***Western European** Inoceramids*	
		***Aquitaine** Inoceramids*	
		***Central European/ Russian** Platform Inoceramids Zones / Markers*	
	Triassic Bivalves	***West Tethys** zones*	Ranges are from Chris Roberts, pers. commun., Aug 2007; for Triassic time scale special publication of 2010; Zones are McRoberts'10; but problem fitting zone names and ranges (many inconsisent usages?)
		***North America** zones*	
		***Boreal** zones*	
		***Ranges** - Genera / Species*	Ranges are from Chris Roberts, pers. commun., Aug 2007; for Triassic time scale special publication of 2010
	Siberian Pelecypod	*Zones / Subzone*	Paul van Veen (Triassic pelecypods) (in Hardenbol et al., SEPM charts, 1998)

Category Group and sub-group	Subsets	Columns	Sources (selected major ones)
Conchostracans		*Conchostracan Zones / Zonal markers*	Kozur and Weems (2010) and Kozur (pers. commun. to J.Ogg, 2011); as modified by Weems and Lucas (2015) and Geyer and Kelber (2018)
Brachiopods		***Tethyan** Zones / Subzone*	B. Laurin (in Hardenbol et al., SEPM charts, 1998)
		***Boreal** Zones / Subzone*	
Rudists		***Western Europe** datums*	J.-P. Masse and J. Philip (in Hardenbol et al., SEPM charts, 1998)
		***Periadriatic** datums*	
Ostracodes and Dacryonarids		***Boreal** Ostracode datums*	J.-P., Colin et al. (in Hardenbol et al., SEPM charts, 1998)
		***Tethyan** Ostracode datums*	
		***French** Ostracode Zones / Subzones / Datum*	J.-P., Colin et al. (in Hardenbol et al., SEPM charts, 1998)
		Devonian Ostracode Zones / SubZones / Datum	Devonian Pelagic ostracode zones are from Groos-Uffenorde et al (2000; Cour. Forsch.-Inst.Senckenberg 220:99-111; http://www.jstor.org/view/00223360/ap040327/04a00090/0). Relative calibration to conodont zones was revised by Thomas Becker (2019; diagram to J.Ogg for GTS2020)
		***Dacryoconarid** Zones (Devonian)*	Devonian Dacryonarid scale from Becker (GTS2020). Dacryoconarids are tentaculites -- an extinct genus of molluscs. The taxonomic classification is uncertain, but some group them with pteropods.
Microfossils			
Planktonic and Benthic Foraminifers		*35 columns*	
Planktonic Forams			All datums have popups with URL links to Mikrotax. Cenozoic = from Wade et al., 2011 (with revisions in Concise GTS2016/GTS2020). CRETACEOUS = May 2011 meeting of Late Cretaceous microfossil working group (UCL) modifying ODP Leg 171 and other scales, plus later revisions by Brian Huber and others (GTS2016/GTS2020). JURASSIC = Gradstein et al. (2017; J.Swiss Palaeo); update of B. Stam, 1986, G. Bignot and M. Janin, 1984
		Sub-Tropical Zones / Subzone	Cenozoic Sub-Tropical Zones from Wade et al., 2011 (with revisions in Concise GTS2016/GTS2020); Cretaceous from GTS2020 composite (different contributors)
		N,P Zones (Cenozoic)	Zonation of Blow, 1979; Berggren & Miller, 1988; Berggren et al'1995
		Formal Foram Zones name / SubZones name (Cenozoic)	
		Foram Zones Marker	
		Other Foram FAD/LAD	
		Additional Neogene and lesser Paleogene Foram FAD/LAD	Mainly these are events not in Wade et al'11; but were tabulated in Lourens et al'04 (esp. Medit.) or Berggren et al'95. Plus, a few of the events in Wade et al'11 that seemed relatively minor.
Benthic Foraminifers		*27 columns*	
Larger Benthic Forams		*Tethyan Shallow Benthic Zones (SBZ, etc.) / Markers*	Various authors in Hardenbol et al (SEPM charts, 1998): [SBZ set of Oligocene-Miocene = B. Cahuzac and A. Poignant. plus detailed Paleocene-Eocene = J. Serra-Kiel and L. Hottinger -- Larger foram vs Planktonic zone diagram sent by R.Speijer, Feb'11 for GTS2012. Cenozoic zone details from Working Group on Larger Foraminifera (SBZ zones): http://cenozoicforaminifera.com/. Upper Cretaceous = M. Bilotte. Lower Cretaceous = Annie Arnaud Vanneau. Jurassic & Triassic = B. Peybernes.]
		Other Larger Benthic Foram datums (Ceno-Cret)	
		Jurassic Larger Benthic Foram datums (Bassoullet'97)	Jean-Paul Bassoullet -- chapter on "Les Grands Foraminiferes"; in Groupe Français d'Étude du Jurassique (1997)
	Benthic Foram Letter stages (East Indies)	*Letter-stage / Benthic Foram Stage Datum (Philippines) / Other datums*	Matsumaru, Kuniteru, 2011. A new definition of the Letter Stages in the Philippine Archipelago. Stratigraphy, 8 (no. 4): 237–252.
Fusulinids and Benthic Forams (Carb-Perm)		*Benthic Foram Zones Abbreviation / Name*	Scheme of Davydov (GTS04)
		***Standard Permian-Carboniferous** fusulinid zone*	PERM = Shen and Henderson (Perm. Subcomm. Chart, 2013; assuming names of events are also names of zones), revised by Henderson and Shen (GTS2020); CARB = Zones are from Aretz (GTS2020) and some from Russian chart (2006) which referenced: Postanovlenia MSK …, 2003
		Benthic Foram Zones abbreviation of Davydov for Mississippian	
		Major Benthic-Foram Markers	Perm = Henderson and Shen (GTS2012, GTS2020); Carb = Aretz (GTS2020) and Davydov, 2004
	Regional Benthic-Foram scales (Carb-Perm)	*Boreal (Urals) Benthic Foram Zone*	Davydov (1996, Carb-Perm chapters in GTS2004, unpublished zonation table to GTS2004, and unpublished Permian correlation chart), with Mississippian revised by Aretz (GTS2020)
		Tethyan Benthic Foram Zone	
		N.Amer. Mid-Continent Zones / Assemblage / Marker	MISS = Paul Brenckle (pers. commun., October 2006; and in Lane and Brenckle, 2005), PENN = unpublished ExxonMobil'01, PERMIAN = Davydov (1996; 2001)
		Other N.Amer. Mid-Continent	Ross and Ross (1988, 1995b)

Category Group and sub-group	Subsets	Columns	Sources (selected major ones)
		North American Cordilleran Zones / Assemblages / marker	Paul Brenckle (pers. commun., October 2006; and in Lane and Brenckle, 2005)
Smaller Benthic Forams	Boreal Cret Smaller Foram	*Markers / Datums*	F. Magniez-Jannin (in Hardenbol et al., SEPM charts, 1998)
	Tethyan Jurassic (Ruget&Nicollin'97)	*Zones / Subzones / Markers*	Christiane Ruget and Jean-Pierre Nicollin -- chapter on "Les Petits Foraminiferes Bentiques Degages"; in Groupe Français d'Étude du Jurassique (1997)
	Tethyan Jurassic (SEPM'98)	*Zones / Markers / Other Datums*	F. Magniez-Jannin and C. Ruget (in Hardenbol et al., SEPM charts, 1998)
North Sea Microfossil Zones		*4 columns*	Gradstein et al. 2011 (partly based on Gradstein, Kaminski and Agterberg; 1999) -- see NORLEX datapack for extensive update, images, etc.
		Zones / Event	
		Deep-water agglutinated foraminifers	
Calpionellids		*4 columns*	J. Remane (in Hardenbol et al., SEPM charts, 1998), with GTS2004 revisions.
		Zones / SubZones / Abbrev. / Datums	
Calcareous Nannofossils		*19 columns*	All calcareous nannofossil datums have popups with URL links to Nannotax for individual images, etc.
Tropical and Mid-latitude Calcareous Nannofossils	CN, CC, NJT, NT	*Zones / SubZones / Zones name*	CENOZOIC (low and middle latitudes) = Backman-Agnini et al. (2012; 2014) with direct cycle-ages from Raffi et al. (Neogene GTS2020). Paleogene events reviewed and enhanced by Paul Bown, June 2011. Late CRETACEOUS = mainly Late Cret. working group (London, June2011), which modified Burnett (1999) and Erba et al (1995) as tabulated by ODP Leg 171B Init. Repts. (Table 2, p. 17-18). Middle and Early CRETACEOUS = compiled by Jim Bergen (while at BP-Amoco), based on publications by Tim Bralower et al (1995), J. Bergen (1994) and Eric de Kaenel. Tethyan Early-Middle Jur zones from Mattioli and Erba (1999); Late Jur zones from Casellato, 2011.
	NN,NP	*Zones / Subzone*	
	CN,CP,NC	*Zones / Subzone*	
	UC (Lt. Cret.)	*Zones / Subzone*	
	Tethyan Nanno Zone Marker		
	UC Tethyan Subzone Marker (if not NC-CC)		
	Other Tethyan Nanno FAD/LAD		
	Additional Plio-Pleist datums		High-resolution *(need expanded vertical scale)*; mainly Lourens et al. (GTS2004/GTS2012 tables)
Boreal Nannofossils	Boreal UC,BC,NJ,NT Nanno	*Zones / Subzone*	Upated from Paul Bown's book (1998). NEOGENE = updated in Raffi et al. (GTS2020); PALEOGENE = Composite of ODP studies -- reviewed and enhanced by Paul Bown, June 2011. Late CRETACEOUS = mainly Burnett (1998); Early CRETACEOUS = mainly Bown et al. (1998); JURASSIC = Bown and Cooper (1998); TRIASSIC = Bown (1998).
	Boreal NK Zones / KN Zones		
	Boreal Nanno Zone Marker		
	Boreal Nanno subzonal and other markers		
Dinoflagellate cysts, Acritarchs and Chitinozoans		*22 columns*	
Dinoflagellate cysts			All datums have popups with URL links to Dinoflaj3.
	N.Atl./Boreal	*Zones / SubZones / selected Markers*	CENOZOIC = King, C., 2016 -- In Geol.Soc.London Spec.Report 27 (2 chapters, and back-of-book Appendix); CRETACEOUS = mainly J.-C. Foucher and E. Monteil (in Hardenbol et al., SEPM charts, 1998). JURASSIC = Poulsen and Riding (2003). TRIASSIC = P.A. Hochuli (in Hardenbol et al., SEPM charts). SEPM Boreal Dinoflagellate Cysts compiled in SEPM chart by J.-C. Foucher and E. Monteil (1998 publ. Date)
		Costa & Manum'88 (Powell'04) Zones / subzone	D biozones of Costa and Manum (1988). Migrated and enhanced by Powell in GTS2004; Calibrations are based upon placement of FAD/LADs by Powell in GTS2004 figures.
		Other Boreal, NW Europe datums	
	***North Sea** (NORGES project*	*Zones / Events*	From the NORGES project sent in Nov. 2005. See the separate NORGES DATAPACK
	*Cenozoic of **NW Europe***	*Events (SEPM'98)*	Williams et al. (Cenozoic charts in Hardenbol et al., SEPM 60, 1998)
	Tethyan	*Cenozoic datums (high-res.)*	"W" = Low-lat, w. N.Atl., "I" = Italy; Williams et al. (Cenozoic chart in Hardenbol et al., SEPM charts, 1998); Neogene: Mediterranean and North Atlantic; Paleogene: Mediterranean
		E.Cret.-Jur. Zones	E. Monteil (in Hardenbol et al., SEPM charts, 1998)
		Tethyan Mesozoic zonal and other major markers	*(Triassic is mainly S.Hemis.)*; E. Monteil (in Hardenbol et al., SEPM charts, 1998)
		Other E.Cret. Tethyan markers	E. Monteil (in Hardenbol et al., SEPM charts, 1998)
Chitinozoa			DEVONIAN = from Becker (GTS2020 figures); SILURIAN = Standard Chitinozoan Zone (from subcommission); ORDOV = Goldman's (GTS2020) adjacent chitiniozoan-conodont diagrams for Baltic chitinozoans relative to Baltic conodonts
	Ordov-Silur-Devon	*Zones*	
	Other Devonian zones	*Zones / Datums*	Calibrations based on T. Becker table (Mar'19 for GTS2020)

Category Group and sub-group	Subsets	Columns	Sources (selected major ones)
	Other Ordovician Regional zones	*North American Chitinozoa Zone*	Figure 2.2 in Webby et al. (2004; The Great Ordovician Biodiversification Event); North America was in main zonal scale.
		North Gondwana Chitinozoan Zone	Based on Goldman's (GTS2020) adjacent chitiniozoan-conodont diagrams for Baltic chitinozoans relative to North Gondwana chitinozoans
Acritarchs	Acritarchs (Devonian)	*Events*	Becker (GTS2020 charts to J.Ogg)
Siliceous Microfossils		*21 columns*	
Diatoms			Based mainly on recommendations and datum reviews by John Barron and his colleagues in 2019-2020. Cenozoic radiolarian datums have popups with URL links to Mikrotax for taxonomy and images.
	Cenozoic **low-latitude** Diatoms	*Zones / Subzones / zonal Marker / other Events*	Low-Latitude zones and polarity calibrations from J. Barron (2015; 2006 - Site 1219) and Scherer, R.P., Gladenkov, A.Y., Barron, J.A. (2007) Methods and applications of Cenozoic marine diatom biostratigraphy, Paleont. Soc. Short-course; Main age calibration and other events/zones for Plio-Mio are revised using Raffi et al. GTS2020 (Table 29.6); although their Early Miocene calibrations are ca. 1 to 2 myr older than Barron (2006; Site 1219, used here). Additional Neogene events from earlier Barron-Baldauf papers used in GTS2012 version. Eocene zones/datums from Barron (2015; Palaeo-3); with some revisions after Witkowski et al (2020)
	North **Pacific mid-latitude** Diatoms (with global Paleoc-Eoc & Arctic Late Cret)	*Zones / SubZones / Abbrev. / zonal Marker / other Events*	Scherer-Gladenkov-Barron (2007) update of Neogene of Maruyama and Shiono (ODP Leg 186 Sci. Results; which was largely based on Maruyama (2000; ODP Leg 167, Sci. Results; which also suggested "NPD" abbreviations for zones modified from Yanagisawa and Akiba, 1998). Paleogene zones and boundary markers include Lt.Eoc. of Barron (2015). Zonal names abbreviated for convenience. Late Cret = Arctic zones/markers (Tapia & Harwood, 2002)
	South Ocean Diatoms	*Zones / Subzones / zonal Marker / other Events*	Scherer et al. (2007) for zones/datums. Other non-marker events from Baldauf, Barron, ODP 119/ Harwood Leg120 converting their ages from Berggren et al'95 scale - BUT VERY UNCERTAIN ON THIS LIST. Late Eocene from Barron (2015; Palaeo-3)
Radiolarians			CENOZOIC = Mainly Chris Hollis (GTS2020). MESOZOIC = partly from P. de Wever (in Hardenbol et al., SEPM charts, 1998), but Triassic includes some of Kozur (2003). Cenozoic radiolarian datums have popups with URL links to Mikrotax for taxonomy and images.
***Cenozoic-Jurassic** Radiolarians*	Radiolarians **(Low Latitude)**	*Zones / Marker / other major Datums*	
		Other Neogene Radiolarian datums (not used on PEAT table)	
	Southern mid-latitude zRP and Antarctic zRP zones	*Zones / SubZones (southern mid- and high latitude)*	Mainly from Chris Hollis (GTS2020; and pers. commun. to J.Ogg in 2019). Cenozoic radiolarian datums have popups with URL links to Mikrotax for taxonomy and images.
***Triassic-Permian** Radiolarians*	**Tethyan** Radiolarian	*Zones / Subzones*	Triassic-Permian Radiolarian zones are from Kozur'03 tables. Correlations are shown here relative to ammonite zones or his conodont zones in the same tables. Kozur (Jan 2006) provided additional details, especially onTriassic zonal boundary datums.
	N.Amer. (Triassic)	*Zones / Subzones*	Carter (1993), Kozur (2003)
	Major radiolarian events (Triassic)		
	Cis-Ural Radiolarians	*Zone (Permian)*	Kozur (2003)
Charophytes and Calcareous Algae		*4 columns*	Charophytes from J. Riveline (in Hardenbol et al., SEPM charts, 1998), and Early Cretaceous Green Algae from J.-P. Masse (in Hardenbol et al., SEPM charts, 1998)
	Charophyte	*Zones / Markers*	
	W Europe Calc. Algae	*horizons*	
	W Periadriatic Calc. Algae	*horizons*	
Plants (spores, pollen, flora)		*8 columns*	
Triassic spores and pollen	Pollen / Spores **(Germanic/Alpine)**	*Events*	Kürschner, W.M., and Herngreen, G.F.W., 2010. Triassic palynology of central and northwestern Europe: a review of palynofloral diversity patterns and biostratigraphic subdivisions. In: Lucas, S.G. (editor), The Triassic Timescale. The Geological Society, London, Special Publication, 334: 263-283; and P.A. Hochuli (in Hardenbol et al., SEPM charts, 1998)
	Pollen / Spores **(Arctic)**	*Events*	From SEPM chart (1998; converted to GTS2012)
Silur-Devon-Carb spores, pollen, flora	**Flora Macro**	*Zone (Dev-Carb)*	Plant macrofossils. Carboniferous = GTS2004 diagrams (Davydov et al., 2004). Devon = Becker (GTS2020); See http://www.devoniantimes.org/who/pages/archaeopteris.html and other pages at Devonian Times
	Western Europe Miospores	*Zones name / Abbreviation*	Devonian zonations relative age-calibrations (relaive to conodont "master" scale) are based on Thomas Becker's detailed chart (2020; delivered to Ogg and Gradstein); Abbreviations from Davydov et al. (GTS2004)
	Eastern Europe Miospores	*Abbreviation / EE zone*	Devonian zonations relative age-calibrations (relaive to conodont "master" scale) are based on Thomas Becker's detailed chart (2020; delivered to Ogg and Gradstein)
	Australian Spores (Devon)	*Zones / Subzones*	Australian: relationships to conodonts scheme taken from Young (in Young & Laurie, 1996) Price et al. 1985; Young in Young & Laurie 1996. Southeast Standard: Partridge 2006 & Backhouse, assorted). NOTE: Needs revision. Use detailed versions in Australian Datapack (TSCreator website)
		Zones (Southeast Std.)	Southeast Standard: Partridge 2006 & Backhouse, assorted
Vertebrates (Land and Marine)		*21 columns*	GTS2020/2016 diagrams
Fish and Reptiles (Silurian-Cretaceous)			

Category Group and sub-group	Subsets	*Columns*	Sources (selected major ones)
Amphibians-Reptiles (Carboniferous-Cretaceous)			Lucas, S.G., Sullivan, R.M., and Spielmann, J.A., 2012. Cretaceous vergtebrate biochronology, North American Western Interior. J. Strat., 36: 436-461.; Lucas, S.G., 2009. Global Jurassic tetrapod biochronology. Volumina Jurassic 6: 99-108"; Lucas, S.G., 2010d. The Triassic timescale based on nonmarine tetrapod biostratigraphy and biochronology. In: Lucas, S.G. (editor), The Triassic Timescale. The Geological Society, London, Special Publication, 334: 17-39. AND Perm-Carb from Lucas publications. SEE ALSO: http://www.devoniantimes.org/who/pages/densignathus.html and other pages on Tetrapods at Devonian Times
	Land Vertebrates	*Zones (faunachrons)*	
	Vertebrate Datum	*event*	Devonian zonations, taxa names (relative to conodont "master" scale) are based on Thomas Becker's detailed chart (2020; delivered to Ogg and Gradstein for his GTS2020 chapter).
Devonian-Silurian Fish	Sharks	*Zones (Devon)*	
	Armored Fish (Placoderm)	*Zones (Devon)*	
	Acanthodian-Thelodont	*Zones (Devon-Silur)*	
	Australian Early Fish	***Phoebondont** Assemblages*	
		***Turinid** Assemblages*	
Mammals			J. Hooker (GTS2020, GTS2012; and pers. commun. to J.Ogg, 2019) and Woodburne (2004)
North American Mammals	NALMA (Zones) / Subzones	*Zones / Subzones / Bioevents / other Bioevents*	
Europe Mammals	ELMA / MN-MP / Other	*Zones*	European Land Mammal Ages (ELMA). "an interesting quote from my communication with by Jerry Hooker last year: Oh dear. It's all rather a mess. MP levels aren't meant to span time, they are intended to be points in time and are defined on the whole fauna of the reference locality and ordered on evolutionary grade. So they are not really biostratigraphy, which is why I dislike them a great deal. " (Robert Speijer to J.Ogg, 3Sept2019)
		Bioevents / other Events	
Asian and China Mammals	ALMA / China LMA	*Zones*	
		*S.Asia **Neogene** bioevent*	
South America Mammals	SALMA	*Zones*	Neogene zonal ages are from J.A. Van Dam in Neogene chapter of GTS2012. Paleocene are from Hooker (GTS2012 chart); and Eocene-Paleocene from Woodburne et al. (Jour S.AmerEarthSci2014) with additional revisions by R. Speijer (GTS2020)
Australia		*Zones*	Neogene zonal ages are from J.A. Van Dam in Neogene chapter of GTS2012. All ages given as rounded Ma (implies no ties to polarity, etc.)
Hominid Evolution		*5 columns*	Main sources (from 2016 datapack) = Primate Fossil Record (Cambridge Univ Press; 2002); Tattersall & Schwartz (Evolution of Genus Homo; Ann. Rev. Earth & Planet. Sci., 2009); Australian Museum website; NOVA Human evolution website; Smithsonian website . NOTE: **Humanoid datapack** at TSC download page has images and active links.
Tool intervals (3 Ma, generalized)	Paleo-Neolithic / Tool cultures / Europe tool cultures	*Zones*	
	Main Homo and Australopithecus species	*Ranges*	
	Primate Evolution Major Events		
Radioisotopic Dates (Paleozoic)		*1 column*	Paleozoic dates used for GTS2020 age model spline-fits are positioned at the center of their biostratigraphic assignments. Popups have only a brief summary. Details are in GTS2020 Appendix (Mark Schmitz et al.) and relevant period chapters of the Paleozoic. Abbreviations for age control: C = conodont zone, F = benthic foraminifer zone, G = graptolite zone, Sub = within substage.
Sequences, Sea-Level and Stable Isotopes			
Sequences, Onlap and Sea-Level Curves		*38 columns total*	
Phanerozoic Sequences and Major Trends		*10 columns*	Paleozoic = Haq and Schutter (2008, Science) with Seq-stage-nomenclature ExxonMobil group (Chengjie Liu et al., Jan'08. who also modified some of the previous SEPM nomenclature for Ceno-Mesozoic; and I applied Bilal Haq's later (2018) Period-Stage-Number philosophy). Triassic = Haq (2018, GSA Today); Jurassic = Haq (2017, GSA Today); Cretaceous = revised from Haq (2014); Cenozoic = Hardenbol et al. (SEPM charts, 1998) with revisions by Chenglie Liu (2008). *[See GTS2020 chapter by Mike Simmons on Eustacy for a comprehensive review and critique.]*
		Sequences (Global, Tethyan)	
		Paleozoic Seq of Haq-Schutter'08 "Age-name"	Haq, B.U., and Schutter, S.R., 2008. A chronology of Paleozoic sea-level changes. Science (3 Oct 2008), 322: 64-68.
		Phanerozoic T-R Cycles	

Category Group and sub-group	Subsets	Columns	Sources (selected major ones)
		Mega T-R Trends	
Period-level Sequences	**Boreal Jurassic** *(SEPM98)*	*Sequences / T-R Cycles*	Hardenbol et al. (1998; SEPM); because they were uncertain on calibration to Tethyan sequences in parts of Jurassic.
	Paleozoic Sloss Sequences	*Mega- / Super-sequences*	Haq, B.U., and Schutter, S.R., 2008. A chronology of Paleozoic sea-level changes. Science (3 Oct 2008), 322: 64-68.
Perm-Carb-Dev *Sequences*	Major Perm-Carb-Dev sea-level trends	*Major **North American** Pennsylvanian glacials*	Heckel, 2013; and Ross-Ross'95
		Perm-Carb Main T-R episodes	
		Permian-Carb Major T-R Trends	
	E.Carboniferous Eurasian	*3rd-order sequences*	Mississippian (Early Carboniferous) 3rd-order from Aretz chart of 25Mar'19 for GTS2020
	Medium and High-resolution cycles	***Donets Basin*** *400-kyr cycle (Penn-earliest Perm)*	Schmitz-Davydov'12 drew saw-tooth sequences, with SB schematically as 1/16th (1/4th of 100kyr cycle) below MFS.
		Mid-Continent *400kyr or medium Devon-Carb-Perm Sequences*	Permian = Ross-Ross'95 plus Henderson (GTS2020, and pers.commun. to J.Ogg); lowermost Permian = Wardlaw (unpubl.); Upper Carb = Heckel, 2013; Heckel et al., 2007; Lower-Middle Carb = Ross-Ross'87/88; Devonian = Johnson et al. (1985)
		High-Resolution *Carb-Perm Sequences*	Heckel, 2013; and Ross-Ross'95
	Devonian *(Johnson'85)*	*T-R episode / cycles / trend / schematic curve*	Calibrations according to Becker (GTS2020 charts to J.Ogg)
Silurian-Ordovician *Sea Level*		***Silurian*** *Oceanic episodes (Jeppsson'06)*	Jeppsson (1998) as shown in Johnson (2006)
		Ordovician-Silurian Sea Level and Intervals (Nielson '04; Johnson '06)	Silurian = Johnson (2006); Ordovician = Nielsen (2004)
		Late Ordovician *Sequences (Central USA; Holland '08)*	Steven Holland (3 Mar'08; stratum@uga.edu ; to J.Ogg). See www.uga.edu/strata/ordoss and www.uga.edu/strata/cincy/strata/strata.html for details and references
	Ordovician Sealevel (Baltoscandia) *(Nielsen'04)*	*Events / Curve*	Silurian = inter-regional (Johnson, 2006); Ordovician = Baltoscandia (Nielsen, 2004)
		Silurian *schematic Sealevel (Loydell '98)*	Loydell (1998) as drawn and calibrated to graptolite zones by Mike Melchin (Aug'11 for GTS2012 charts)
Coastal Onlap (schematic)		*Coastal Onlap segmented (synthetic)*	Coastal onlap for CENOZOIC = offsets from long-term curve are directly from Hardenbol et al. (SEPM charts, 1998). MESOZOIC-PALEOZOIC = Schematic with SB Falls set from Bilal Haq's diagrams as Minor SB = 20m, Medium = 45m, Major = 80m relative to long-term envelope, based on advise from B. Haq to J.Ogg. [Cret = Haq'2014; Jur = Haq'2017; Tri = Haq'2018; Paleozoic = Haq and Schutter, 2008]
		Coastal Onlap (synthetic)	
Sea-level (m relative to present)	**Phanerozoic** synthesis *(Hardenbol-Haq)*	***Short-Term*** *Phanerozoic*	CENOZOIC = offsets from long-term curve are directly from Hardenbol et al. (SEPM charts, 1998). MESOZOIC-PALEOZOIC = Schematic with SB Falls set from Bilal Haq's diagrams as Minor SB = 20m, Medium = 45m, Major = 80m relative to long-term envelope, based on advise from B. Haq to J.Ogg. [Cret = Haq'2014; Jur = Haq'2017; Tri = Haq'2018; Paleozoic = Haq and Schutter, 2008]
		Mean *Sea Level (intermediate term; synthetic)*	Computed as mid-point of Coastal-onlaps. See above for method.
		Long-Term *Phanerozoic*	CENOZOIC = offsets from long-term curve are directly from Hardenbol et al. (SEPM charts, 1998). MESOZOIC-PALEOZOIC = Schematic with SB Falls set from Bilal Haq's diagrams as Minor SB = 20m, Medium = 45m, Major = 80m relative to long-term envelope, based on advise from B. Haq to J.Ogg. [Cret = Haq'2014; Jur = Haq'2017; Tri = Haq'2018; Paleozoic = Haq and Schutter, 2008]
	Cenozoic sealevel *(Miller et al., 2020)*	***Cenozoic*** *smoothed*	Miller, K.G., Browning, J.V., Schmelz, W.J., Kopp, R.E., Mountain, G.S., and Wright, J.D. 2020. Cenozoic sea-level and cryospheric evolution from deep-sea _18O and continental margin records. Science Advances. 6 (20), article #eaaz1346: 15 pp. https://advances.sciencemag.org/content/6/20/eaaz1346.full. Based on conversion of oxygen-isotope data. ["Smoothed sea-level estimates are from _18O and Mg/Ca (obtained by interpolating to 20-ka intervals and using a 49-point Gaussian onvolution filter, removing periods shorter than 490 ka)}. Timescale is GTS2012 (not migrated to GTS2020; because Miller et al., 2020, did not indicate whether biozones (or type) or chrons were used) => some excursions may be shifted by up to 1 myr?
		High-Res Plio-Pleist *Sea Level*	Miller, K.G., Browning, J.V., Schmelz, W.J., Kopp, R.E., Mountain, G.S., and Wright, J.D. 2020. Cenozoic sea-level and cryospheric evolution from deep-sea _18O and continental margin records. Science Advances. 6 (20), article #eaaz1346: 15 pp. https://advances.sciencemag.org/content/6/20/eaaz1346.full. Based on conversion of oxygen-isotope data
Stable Isotopes (O-18, C-13, Sr)		*28 columns (including overlays)*	
Oxygen-18 and Temperature			
	Plio-Pleist Marine Oxygen-18 composite	*Plio-Pleist Oxygen-18 composite (Benthic Foraminifera)*	Lisiecki, L. E., and M. E. Raymo (2005), A Pliocene-Pleistocene stack of 57 globally distributed benthic d18O records, Paleoceanography, 20, PA1003, doi:10.1029/2004PA001071. [scale = +2.5 to +5.2 per-mil PDB]. (Needs 20 cm/myr !! to see details).
		Marine Isotope Stages *-- Warm MIS / Cold MIS*	***(Needs 20 cm/myr !! to see details).*** Numbering, including Pliocene extension, from Crowhurst (2002) -- see above curve for relatively placement to their O-18 curve. Warm/interlacial MIS (odd numbers), and Cold/glacial MIS (even numbers) listed in seoparate columns to avoid over-crowding.
	Cenozoic-Campanian Marine Oxygen-18 Composite		Derived from Cramer (2009) and migrated to GTS2020 assuming his data was calibrated to Cande-Kent'95 polarity chrons. But only every 10th item from 9-point averaging of Benthic foraminifer compilation (29000 data points in original) is shown here, except for some short-term excursions; NOTE: Cramer had two sets -- original and "adjusted" (which removed many of the original)

Category Group and sub-group	Subsets	*Columns*	Sources (selected major ones)
	Miocene-Paleocene Oxy-18 **events**		Miocene-Oligocene event suite from Boulila-Galbrun-Millet et al. (2011) based on definitions by Miller et al. (1991, 1998) and additional calibrations by Pekar et al (2002); Eocene-Paleocene events after Zachos et al. (2008), Westerhold et al. (2008, 2014, 2015) and Dinares-Turell et al. (2014), with additional revisions by Robert Speyer (GTS2020)
Paleozoic-Mesozoic Oxygen-18 and tropical/subtropical marine temperature (Grossman & Joachimski, GTS2020)	Calcite-derived	*Oxy-18 calcite (per-mil VPDB)*	Grossman & Joachimski (Oxygen Isotope stratigraphy chapter of GTS2020): Paleozoic to early Cretaceous red curve = Brachiopods and bivalves, Jurassic-early Cretaceous blue curve = Belemnites, Cretaceous curves = Planktonic foraminifera (black = non-glassy; green = glassy)
		Isotopic temperature (calcite; ¡C)	
	Apatite-derived	*Oxy-18 apatite (per-mil VSMOW)*	Grossman & Joachimski (Oxygen Isotope stratigraphy chapter of GTS2020): Paleozoic to Triassic black curve = Conodont apatite; Jurassic-Cenozoic green curve = Fish apatite
		Isotopic temperature (apatite; ¡C)	
Tropical (red) and Global Average (black) Temperature			Scotese, C., Song, Mills (2021, Phanerozoic Paleotemperatures: The Earth's changing climate during the Last 540 million years; in press, Earth Science Reviews). Red = Tropical; Black = overlay of Global average
Cryogenian-Ediacaran Glaciations			Sturtian, Marangoan "Snowball Earth" episodes; plus mid-Ediacaran Gaskier's glaciation -- Rooney, A.D., Strauss,, J.V., Brandon, A.D., and Macdonald, F.A., 2015. A Cryogenian chronology: Two long-lasting synchronous Neoproterozoic glaciations. Geology, 43: 459-462.
Carbon-13 curves and events	*per-mil PDF*		*[scale = +5 to -0.3 per-mil PDB]*
	Phanerozoic-Proterozoic Carbon-13 Composite	*detailed curve*	MESOZOIC-PALEOZOIC-Proterozoic = Compacted suite from Cramer & Jarvis (GTS2020 chapter on carbon isotope stratigraphy), which was mainly a splice of intervals from numerous publications [WARNING: that method created some "not real" JUMPS at junctions between studies from different regions!]. Their original had ca. 10,000 points/period; and this dataset is about every 10th point from sliding mean, but more detail at excursions. CENOZOIC (0-70 Ma) = Derived from Cramer (2009) and migrated to GTS2020 assuming his data was calibrated to Cande-Kent'95 polarity chrons. But only every 10th item from 9-point averaging of Benthic foraminifer compilation (29000 data points in original) is shown here, except for some short-term excursions; NOTE: Cramer had two sets -- original and "adjusted" (which removed many of the original);
	Carbon-13 excursions (GTS2020)	*events*	
	Anoxic Episodes (Jur-Cret; Silur-Devon)	*events*	CRETACEOUS OAE's = modified from Gale (GTS2020) and Cramer & Jarvis (GTS2020); JURASSIC (145-200 Ma) = Jenkyns et al. (2002) enhanced by Glowniak and Wierzbowski (2007) for mid-Oxf, Kemp et al. (2005) for early Toarcian, and Palfy et al (2001) for Tri-Jur boundary
Other 13C episodes - Cambrian, Silurian-Devonian; Aptian	**Aptian** Stage 13C intervals	*Apt zones (Herrle) / C-segments (Italy)*	Aptian segments from Herrle et al'04 ("Ap-Al") and Bottini-Erba-et al'15 ("C-intervals; approx.)
	Devonian detailed 13C named events	*detailed curve*	Devonian = Becker (GTS2020); Silurian = Melchin (GTS2020)
	Cambrian isotopic intervals		by Loren Babcock (originally derived from Zhu et al. (2006), then enhanced and rescaled by Peng-Babcock for GTS2020. Most names seem to relate to China, therefore tied to their China zones where possible.
***Strontium** 87/86*	*[scale = 0.7068 to 0.7093]*	*detailed curve*	John McArthur (2020, Lowess version 6, supporting compilation for GTS2020) [NOTE: He rescaled graphics from his GTS2012 (which had no table) ?] GTS2016 had included Becker (2012); and part of SILURIAN from Cramer (2011; as indicated by Melchin in GTS2012"
Global Reconstructions (images		*1 column*	
	Versions by Ron Blakey	*images*	Late Precambrian to Recent globes by Ron Blakey [*https://deeptimemaps.com/global-series-thumbnails/*] , based on Chris Scotese's reconstructions [at *http://www.scotese.com*]
Quaternary (high-resolution)		*19 columns*	From Phil Gibbard and Martin Head's chart "Global chronostratigraphical correlation table for the last 2.7 million years; ICS Quat. Subcomm. for GTS2020 chapter)
Quaternary Regional Stages			
	Italian marine	*Stages / Substages*	
	North America	*Stages / Substages*	
	NW Europe	*Stages / Substages*	
	British	*Stages / Substages*	
	Russian Plain	*Stages / Horizons / Sub-horizons*	
	Ukrainian Loess Plain	*Stages*	
	New Zealand	*Stages*	

Category Group and sub-group	Subsets	Columns	Sources (selected major ones)
Chinese Loess	Divisions	*detailed L - S intervals*	Based on ties of Gibbard-Head (GTS2020) to Marine Isotope Stages (MIS) glacial (Loess) and interglacial (Soil) on chart; and ages are often fixed to those MIS ones. NOTE: Soil formation (high MagSusc) overprints upper portion of previous Loess (glacial); therefore base of "S" might be in what was originally the Loess deposited in last cold stage of the previous glacial. The actual "S" formation "onset" is therefore younger than the age of the altered Loess.
	Magnetic Susc.		An Zhisheng et al. (1990) [measured from their diagram; Magnetic susceptibility (SI units) = 0 to 230]. Gibbard-Head GTS2020 chart has a much more detailed version to 2.7 Ma. Before 1 Ma, the Zhisheng An (1990) version is too vague; so not reproduced here.
Antarctic Ice Cores	delta-Deuterium	*detailed curve*	Jouzel, J., et al. 2004. EPICA Dome C Ice Cores Deuterium Data. IGBP PAGES/World Data Center for Paleoclimatology Data Contribution Series # 2004-038. NOAA/NGDC Paleoclimatology Program, Boulder CO, USA. Accessed from NCDC Paleoclimatology Program. [scale = -450 to -360 per-mil]
	CO_2	*detailed curve*	CO_2 curve accessed from NCDC Paleoclimatology Program, and spliced together -- Gas Ages 0-11 ka = Taylor Dome (Indermuhle et al., 1999a; depth 356 to 86 m); 11-27 ka = Taylor Dome (Smith et al., 1999; depth 388.195 to 120.25 m); 27-60 kyr = Taylor Dome (Indermuhle et al., 1999b; depth 470.915 to 380.820 m). 64-417 kyr = Vostok (Barnola et al., 2003; depth 3304.4 to 986.2 m); 417-649 kyr = Dome C (Siegenthaler, 2005; depth 3059.61 to 2771.68 m) *[scale = 180 to 1300 ppmv]*
Milankovitch curves			Analyseries 2.0 output using: Laskar, J., Robutel, R., Joutel, F. Gastineau, M., Correia, A.C.M., Levrard, B. (2004). A long-term numerical solution for the insolation quanties of the Earth. Astronomy & Physics. 428, 261 - 285]
	Insolation 65N	*detailed curve*	[W/m2] function of time and true longitude (season). From time = 0 to 2500 kyr BP. With starting season = 0 deg. from vernal point. With ending season = 180 degrees. With latitude = 65 degrees (north>0, south<0). using the Laskar 2004 solution. And with solar constant = 1365 W/m2. *[scale = 335 to 410 Watts/m2]*
	Eccentricity	*detailed curve*	
	Obliquity	*detailed curve*	
	Precession	*detailed curve*	
Impacts, Volcanism, Tectonics		*Total of 49 columns*	
Carbonate Trends		*5 columns*	Data from Kiessling et al., 1997 -- as summarized by Markello, J.R.; Koepnick, R.B.; Waite, L.E.; and Collins, J.F., 2006, The Carbonate Analogs Through Time (CATT) Hypothesis and the Global Atlas of Carbonate Fields- A Systematic and Predictive look at Phanerozoic Carbonate Systems, in Lukasik, J. and Simo, T. eds., Controls on Carbonate Platform and Reef Development, SEPM Special Publication
	Carb Platform Reefs		
	Carb Platform Organisms		
	Carb Platform - Platform Types		
	Carb Platform - Carbonate builders		
	Major Reef builders		Based on Hallam and Wignall (1997) and James (1983) -- as summarized by Lowell Waite (author) and Roger Gilcrease (compiler), 2002. Phanerozoic Cycles and Events (NV PXD Global Stratigraphic Chart 02.DSF), March 27, 2002 (printed by Pioneer Natural Resources; permission provided by L. Waite).
Hydrocarbon System overviews		*6 columns*	Mainly from Lowell Waite (author) and Roger Gilcrease (compiler), 2002. Phanerozoic Cycles and Events (NV PXD Global Stratigraphic Chart 02.DSF), March 27, 2002 (printed by Pioneer Natural Resources; permission provided by L. Waite); with additional items from Markello et al. (2006)
	Icehouse / Greenhouse		after Fisher, 1981 (from Waite, 2002)
	Anoxic Intervals		Markello, J.R.; Koepnick, R.B.; Waite, L.E.; and Collins, J.F., 2006, The Carbonate Analogs Through Time (CATT) Hypothesis and the Global Atlas of Carbonate Fields- A Systematic and Predictive look at Phanerozoic Carbonate Systems, in Lukasik, J. and Simo, T. eds., Controls on Carbonate Platform and Reef Development, SEPM Special Publication
	Major Source Rocks		Markllo et al. (2006)
	Global Source Rocks		With % of world's total generated: Ulmashek and Klemme, 1990 -- as summarized by Lowell Waite (author) and Roger Gilcrease (compiler), 2002.
	Reservoir Intervals		With % of world's trapped reserves: Ulmashek and Klemme, 1990 -- Lowell Waite (author) and Roger Gilcrease (compiler), 2002.
	Major Evaporite Seals		Major evaporite packages (seal facies) from Sun, 1994 -- as summarized by Lowell Waite (author) and Roger Gilcrease (compiler), 2002.
Impacts		*14 main columns:*	*Mainly from Earth Impact Database, 2008 (2018 revised website). [Impacts].. Meteor Impacts [dashed => estimated; arrow UP => younger than this level; DOWN => older]. Popups have URL links for details on every event, Includes a column for impact-icon.*
	Global effects (>50 km crater)		
	Regional Impacts (<50 km crater)	*Europe, Russia-Asian, Australian, African, North American, South American*	Pairs of columns (5-50 km, and <5 km) for each region
	Recent impacts		
Large Igneous Provinces (LIPs)		*9 columns*	Mainly from Large Igneous Provinces Commission website -- Large Igneous Provinces (LIPs) Through Time.. For details click [LIPs]. All events have popups with URL links to their maps and summaries; plus "LIP of the Month" as appropriate.
	Super LIPs; Major LIPs		
	Regional LIPs of smaller extent	*Asia, Europe to Urals, Africa, N.America, S.America, India and Indian Ocean, Australia-Antarctica*	Columns for each region
Passive Margins		*13 columns*	

Category			
Group and sub-group	**Subsets**	***Columns***	**Sources (selected major ones)**
	Modern margins	*General / Arctic / Atlantic / Pacific / Indian / Southern*	Bradley, D.C., 2008. Passive margins through earth history. Earth-Science Reviews, 91: 1Ð26. doi:10.1016/j.earscirev.2008.08.001. (Especially the on-line supplement tables.)
	Past margin history (by region)	*North American / European / Middle east and South Asia / Russian-Chinese / South American / African / Australian-Indonesian*	
Precambrian Crust Formation		*2 columns*	
	Crust Formation curve / events		Modified from Van Kranendonk, GTS2012