

## Why StratTime (ISC)?



Whoever has never spent time trying to find the correlation between a local stage, or a nowadays disused stage and a stage of the International Chronostratigraphic Chart established by the International Commission on Stratigraphy does not need **StratTime** (Intelligent Stratigraphic Converter). This tool is actually designed to assist in the correlation of stratigraphic terms.

The new version (V. 5-5) takes into account the chronostratigraphic data published on the ICS chart v. 2022/02. Changes and additions to names, colours, notations, GSSP made since 2020 have been made in StratTime v. 5-5. In addition new functionalities have been developed. The results are not only presented in tables, but you can save them in Excel files or print them. In addition, **StatTime synthesizes**, when possible, **the results in graphical form and with standard colors**

**StratTime**, previously named “Intelligent Statigraphic Converter”, was developed for the Peri-Tethys, the MEBE and the DARIUS scientific programmes. The final objective of these programmes was to establish a synthesis of the tectonic and stratigraphic evolution of the major sedimentary basins of a vast domain extending from the Atlantic Ocean to the Pamir on both sides of the Alpine belt issued from the Tethys Ocean. Besides the new data collected during the field works, abundant datasets was found in the literature. The compilation of the published papers led to recognize **more than 1300 stratigraphic subdivision names**. As a comparison, the International Chronostratigraphic Chart version 2022-02 includes only 189 stratigraphic subdivisions. The stratigraphic subdivisions managed by **StratTime** are not restricted to the domains studied by the above-mentioned scientific programmes; the subdivisions in use in all countries of the world are encoded in **StratTime**.

As a matter of fact, many questions arise when you synthesize stratigraphic data. The more frequent one is “which ICS current stage does correspond to the subdivision cited in the paper I am reading?” The **Stage Name sheet** can help to find it out. Another one comes when you look at a map or a log with stratigraphic notations. “What time slice do these indices correspond to?” The **Stage Notation sheet** will give you the answer. If you have a numerical age result for i.e. volcanic rock the question becomes: “To which stage corresponds this age?” The **Numerical Age sheet** is your tool. Finally, if you work on kinematics or if you have magnetostratigraphic data, the **Which Chron sheet** provides you with the equivalences.

**StratTime** proposes three others useful sheets:

- **GSSP sheet** is a copy of the **International Commission on Stratigraphy (ICS)** table. The original one is on free download at the ICS website. Only the layout was modified and links between latitude & longitude location and Google Map software were added.
- **ICS charts sheet** gathers the ICS charts issued from 2000 on. These charts published by ICS, a commission of the **IUGS (International Union of Geological Sciences)**, are downloadable from ICS website. **StratTime** includes also a correlation table of the formerly published charts.



- **Color Code sheet** gives the CMYK and RVB color codes for each stage. These codes were created by the **CGMW (Commission for the Geological Maps of the World)** and **accepted as the standard by the ICS for its charts.**

**StratTime** is available on **CGMW website**.

**StratTime** was developed at **Institut des Sciences de Terre de Paris (ISTeP)**

**StratTime** is a product of the **DARIUS Programme**.



## Author

**Bruno Vrielynck is a retired CNRS searcher, geologist specialized in paleogeography.**

He was working at

Institut des Sciences de la Terre, Paris  
UMR 7193 – UPMC-CNRS  
Université Pierre et Marie Curie, Sorbonne Universités  
Paris - France



current mail : [bjm.vrielynck@orange.fr](mailto:bjm.vrielynck@orange.fr)

alternative mail : [ccgm@sfr.fr](mailto:ccgm@sfr.fr)

## Links

**International Commission on Stratigraphy (ICS)**

**International Union of Geological Sciences (IUGS)**

**Commission of the Geological Maps of the World (CGMW)**

**DARIUS Programme**

**Institut des Sciences de Terre de Paris (ISTeP)**

**These websites can also be reached by clicking their logos displayed on sheets.**

## USER'S GUIDE

### Stage Name tab

In the cell indicated by the arrow, enter or choose the name of the stage you are interest in. Some names are quite long, with difficult spelling; **StratTime will make your job easier**. Click in the yellow cell, tape the first letters, or just one if you are too tired, and select the name of the stage you search. You could also use up and down arrows once cell is highlighted.

**If the stage name is included in the 2022 ICS chart**, the named stage data are displayed on the line to the right of the name you wrote.

From left to right you read:

- the numerical age of the bottom,
- its uncertainty,
- the GSSP presence,
- the numerical age of the top,
- its uncertainty,
- the GSSP presence \*,
- the notation.
- the duration

You get also the subdivision rank (Eon, Era, Period, Epoch or Age) and indications on the authorship.

In the blank cell at the sheet bottom, you read **indications on the name origin**.

\* See the GSSP sheet for precisions on GSSP.

**If the name is not included the 2022 ICS chart, the subdivision is a local one \*\*\***, and you get less information on the right of the input name. Only the ages of the bottom and of the top, correlated to the 2022 ICS chart, are given. More information is displayed downwards.

There are several types of correlation:

**Equivalent to:** The bottom and the top of the local stage fit with the bottom and the top of a stage currently in use.

**Equivalent to the bottom:** The bottom of the local stage fit with the bottom of a stage currently in use. The top is within the same stage currently in use. You get too the percentage of duration occupied by the local subdivision.

**Equivalent to the top:** The top of the local stage fit with the top of a stage currently in use. The bottom is within the same stage currently in use. You get too the percentage of duration occupied by the local subdivision.

**Include in:** The bottom and the top of the local stage are within the stage currently in use. The percentage of duration occupied is mentioned too. The slice of time (in Ma) between the two bottoms of the subdivisions is indicated.

**Overlapping: (overlaps)** the bottom of the local stage is within a stage currently in use. The top is within the just younger stage currently in use. The percentages of durations occupied in each stage currently in use is given.

**Overlapping from... to...: (spans from ... to...)** the bottom of the local stage is within a stage currently in use. The top is within a younger stage than the one just above. This state is indicated by a line marked by "... ...". The percentages of duration occupied in the bottom stage and in the top stage are indicated.

Finally, if the subdivision is a local one, **StratTime** indicates the **region** in which it is used.

### Spelling.

In the literature it is common for the spelling of chronostratigraphic subdivisions to suffer from typos. It is not easy to identify them and, for non-specialists, to determine which is the right one. In **StratTime** if the name of the requested subdivision is incorrect, the correct spelling is displayed in red in a yellow block and preceded by "correct spelling:". There are also cases where two spellings are accepted. **StratTime** tells you this by entering the other name preceded by "other spelling:"

### In all the cases,

- at bottom of the screen, indications are given on the epoch, period and era to which the searched subdivision belongs.
- at the lower right, there is a button "**Notes on Subdivision**".
  - If the stage name is used in the 2022 ICS chart, the relative data concerning the origin of the name are given.
  - In any case, when you click on this button, you get the list of "**Related subdivisions**" which include or are included in the searched subdivision. More you get two buttons "**Table with all related units**" and "**Table with standard units**"; if you click on, **StratTime** constructs and displays tables with the listed subdivisions. With the first button, you get all related geochronologic units. With the second, appear only the Standard Global Geochronologic Units (*those quoted in the International Chronostratigraphic Chart*). The searched stage name is highlighted in yellow, the stage names used in the 2022 ICS chart are highlighted in blue, the local stage names are highlighted in pink. The columns on the right give the base and top numerical age for each related stage.

### Mini Charts:

On the "**Table with standard units**" appear two buttons named "**Simple Mini Chart**" and "**Coloured Mini Chart**". Click on it and **StratTime** constructs a chart from Eon to Age for the time slice of the unit you are looking for. If the unit sought, is not a standard it appears on the right column. On the second to last column, you read the numerical ages. The age written in a cell is that of the bottom line of the cell. The height of the rows whose numerical age cell is highlighted in blue is proportional to the duration of the subdivision. Right-click on the page to zoom out, right-click again to zoom in. On the last column you get the duration of the time slices.

Why two buttons? It's that making a simple chart is faster.

On the "**Table with all related units**" appears one button named "**Simple Mini Chart**". Click on it and **StratTime** builds a chart with all the correlated subdivision extensions. This table may be huge (170 columns for the largest). It appears in full and could be unreadable : **Rightclick to enlarge**. On the first column, you read the numerical ages. The age entered in a cell is that of the bottom line of the cell. The height of the rows is more or less proportional to the duration of the subdivision. On the second column, you find the desired subdivision. Its extension is highlighted in yellow. The following columns

with the subdivision name in blue indicate the extension of the standard units linked to the requested subdivision. Then the columns with the subdivision name in red indicate the extension of the correlated local units.

\*\*\* See the technical help for how to save or print the resulting tables.

**NOTE that all the displayed numerical ages are related to the 2022 ICS chart. In the comment is given the numerical age related to the 2004 ICS Chart which is the reference table for computation in StratTime.**

\*\*\* The ICS has always supported the development of national and regional stratigraphic codes; these codes were helpful in the past to develop principles, and to provide testing ground for various proposals contained in the Guide.

## Stage notation tab

With this sheet, **StratTime** will help you to retrieve the used subdivision corresponding to a notation. Notations are commonly used in geological maps to indicate at first glance the formation age. They are also often used on stratigraphic logs.

Click on the grey arrow right of the yellow cell. Select the searched notation. They are arranged in alphabetic order.

On the right of the yellow cell you read:

- the name of the subdivision (Only the 2022 ICS official names are given),
- the numerical age of the bottom,
- the numerical age of the top
- the notation.

*" The letter/number symbols used for divisions down to stage/age rank and the colours of the individual units are established by the CGMW, taking as a basis its Geological Atlas of the World. This chart is updated periodically during its general assemblies occurring within the International Geological Congress and upon ratification of GSSPs by IUGS."* J. Remane et al. 2000.

**The chart** : In 2000, the first "International Stratigraphic Chart" with notations ("System Notations") was published by the ICS (J. Remane et al., 2000). In 2004, 2013 and 2016 new charts with notations were published, but no changes were made to the notations. In 2020, 2021 and 2022 modifications are made in the Pleistocene and Quaternary subdivisions. The document attached in **StratTime** indicates these changes.

## Numerical age tab

If you have **the isotopic age** for a stratum, this sheet of **StratTime** gives you the **corresponding subdivision**.

Enter the digits of the isotopic age in the yellow cell.

**StratTime** will give you all the data concerning the matching subdivision currently used.

For **age, epoch, period, and era** you have:

- the subdivision name,
- the numerical age of the bottom,
- the numerical age of the top and
- the notation.

On the left, in the orange cells, “**Intra**” is displayed if the isotopic age is in the subdivision or Limit if it is just at the boundary of two subdivisions,

Only the 2022 ICS chart used names are given.

## Which Chron? tab

This **StratTime** sheet concerns **the magnetostratigraphic polarity units** from Aalenian to Recent.

StratTime proposes four ways to help you, **depending on the data you have at hand**.

### Anomaly

**You know the notation of an anomaly** and you want to know the corresponding stage.

Click on the yellow cell, select the anomaly. **StratTime** displays:

- For the anomaly: The bottom numerical age
- The top numerical age
- The stage(s) in which the anomaly occurs

- For the stage(s): The bottom numerical age
- The top numerical age
- The notation

**Details button** on the right:

A click on this button triggers a procedure to construct and display **a table with the magnetochrons belonging to the searched anomaly**. In the right columns, you read the bottom and top numerical ages.

**\*\*\*** See the technical help for how to save or print the resulting tables.

### Magnetostratigraphy

**You know the notation of a magnetostratigraphy** and you want to know the corresponding stage(s). Click on the yellow cell, select the magnetostratigraphy. **StratTime** displays:

For the magnetostratigraphy: The bottom numerical age  
The top numerical age  
The stage(s) in which the magnetostratigraphy occurs

For the stage(s): The bottom numerical age  
The top numerical age  
The notation

**Details button** on the right:

A click on this button launches a routine that constructs and displays a **table with the magnetostratigraphies occurrences in the stage(s) in which the searched magnetostratigraphy occurs**. The searched magnetostratigraphy is highlighted in yellow. Older and younger magnetostratigraphies are highlighted in purple if they overlap the boundaries of the stage(s). In the right columns, are given the bottom and top numerical ages.

*\*\*\* See the technical help for how to save or print the resulting tables.*

### Subdivision

**You want to know which magnetostratigraphies occur in a subdivision.**

Click on the yellow cell, select the subdivision. Only the subdivisions of the 2022 ICS chart are available. Note that this StratTime release has no information older than Aalenian. **StratTime** displays:

For the magnetostratigraphy(s): The oldest occurrence in the subdivision  
The youngest occurrence in the subdivision

For the subdivision: The bottom numerical age  
The top numerical age  
The notation

**Details button** on the right:

A click on this button launches a routine which constructs and displays a **table with the magnetostratigraphies occurring in the searched subdivision**. Older and younger magnetostratigraphies are highlighted in purple if they overlap the boundaries of the stage(s). In the right columns are given the bottom and top numerical ages. **Note that the table will be empty for the subdivisions of the Cretaceous Quiet Zone.**

*\*\*\* See the technical help for how to save or print the resulting tables.*

### Numerical age

**You want to know which magnetostratigraphy occurs at a given numerical age.** Enter the digits of the isotopic age in the yellow cell. Note that this **StratTime** release has no information oldest than 170 Ma (Aalenian). **StratTime** displays:

For the magnetostratigraphy: The magnetostratigraphy notation  
For the stage: The bottom numerical age  
The top numerical age  
The notation



**Details button** on the right:

A click on this button launches a routine which constructs and displays a **table with the magnetochrons occurring in the stage in which the asked numerical age occurs**. The magnetochron in which the searched numerical age occurs is highlighted in yellow. Older and younger magnetochrons are highlighted in purple if they overlap the boundaries of the stage. In the right columns are given the bottom and top numerical ages.

**\*\*\*** See the technical help for how to save or print the resulting tables.

### Chart correlations

On the right bottom of the main table you have two buttons captions, **Charts 1** and **Charts 2**. A click on a button displays a large table which gives **the compilation of the 11 main charts published since 1968**.

#### Charts 1 table:

On this table each row corresponds to a magnetochron. You read for each chart the bottom and the top numerical age of a magnetochron. The left column indicates the stage in which occurs the magnetochron but depending on the 2012 Geological Time Scale (2012 GTS).

#### Charts 2 table:

On this table each row corresponds to a numerical age. For an age, ie along a row, you read the corresponding magnetochron which could differ depending on the chart you choose. The left column indicates the stage, depending on the 2012 GTS, in which the magnetochron occurs.

- TIP:** - In the two tables, the reference(s) of the chart are displayed when the cursor hovers over the chart name.
- Use the scrollbars or the mouse scroll-button to move in the tables.
  - Rightclick on the table to enlarge it; click again to reduce it.

## GSSP tab

This **StratTime** sheet is a modified copy of the **International Commission on Stratigraphy (ICS) GSSP table**.

The original can be viewed on the ICS website.



The form was modified and links between latitude, longitude localization and Google Map software were also added.

**To get the location map of the GSSP**, click on the latitude, longitude cell. Google Map will be launched with these parameters.

**To obtain a reference** displayed on the last column, click on it. Your browser will reach it.

**REMARKS:** After Google Map or browser closure, click anywhere in the right column out of the table to avoid the reopening of the Web module.

- TIP:** - Rightclick on the table to enlarge it; click again to reduce it.



## ICS Charts tab

In this sheet, **StratTime** gathers the copies of the charts, named "International Chronostratigraphic Chart", periodically updated by the ICS (International Commission on Stratigraphy) during its general assemblies. Every four year, in the framework of the ICG (International Geological Congress), the works of the ICS are ratified by the IUGS (International Union of Geological Sciences). The "International Chronostratigraphic Chart" published on this occasion is the reference (the latest are the 2016, 2012, 2008, 2004 versions). The 2020 edition was ready for the IGC NEW Delhi. The covid pandemic did not allow the usual validation. However, I consider it as such.

**On the first sheet you can read the charts issued since 2000.** At the upper right the published charts are listed by date. Click on the one you want to display. The charts ratified by IUGS are red shaded.

**TIP:** - If you are using a computer with a small screen, click on the chart to enlarge it; click again to reduce it.

- Doubleclick outside the chart to return to the first screen.

**More:** On the left side of each chart you find a button "**Click here to Screenshot**". A click on it save a Excel file with the image of the chart. The image is also in the clipboard; you may include it in a open document by a simple "Ctrl+V". (See the technical help for futher information.).

At the end of the published chart list appears a button "**Older Charts**". Click on it to display tables with the correlations of the charts older than 2004; the recent charts are given as references. To display the table of the era, click on the captions in the upper right, "**Cenozoic**", "**Mesozoic**" and/or "**Paleozoic**". These tables are similar to the ones published in the "Geological Time Scale" volumes (2004, 2012). **StratTime** improved the correlations and added several charts.

**TIP:** - If you are using a computer with a small screen, click on the chart to enlarge it; click again to reduce it.

- Doubleclick outside the chart to return to the first screen.

**NOTE:** The terms "Early / Late" are used to refer to time events and for the formal names or epochs on time scales, whereas "Lower / Upper" are used on stratigraphic columns and for formal names of series.

## Color Code tab

Since the 2000 issue, coordinated by J. Remane, the color of individual units of the charts is established by CGMW taking as a basis its Geological Atlas of the World. In 2004, the 2000 chart colors were encoded in CMYK and RVB modes to get an easy and logical color scheme for an easy use by cartographers and geologists worldwide. Two schemes were proposed, the CGMW one, improved and completed by J.M. Pellé (BRGM), and the US Geological Survey one. In 2008 the CGMW scheme was ratified as the ICS standard. Here the 2008 version is updated taking into account a correction for Bashkirian, a stage in Carboniferous, and to allow the representation of new subdivisions created in the Quaternary in 2020, 2021 and 2022.

**NOTE:**

- The CMYK values are the primary reference system for designating the official colors.
- For color conversions using a program other than Adobe Illustrator, it is necessary to keep the reference CMYK, even if the resulting RGB values are slightly different.

- The K value is 0 in all the code. Users may adjust this value to obtain a modified hue. However, this modification could alter the readability of the overprint features.

- TIP: - If you are using a computer with a small screen, click on the chart to enlarge it; click again to reduce it.
- When you are on the bottom of the chart, doubleclick out of the chart to go back to the top.





## Technical Help

**StratTime** is designed to make your job easier and adapt to your computer. Here are some tips that will help you to save time and protect your eyesight.




### Specific logos

Several logos were designed for **StratTime**.

Four logos are links. A click on them leads to the help windows or to references,

- Help logo:  to get specific information on how to read the displayed sheet or the displayed chart.
- Technical help logo:  it appears in the help screens and leads to this window
- StratTime logo:  leads to the general explanation about **StratTime**.
- Reference logo:  leads to the references included in **StratTime**

Three logos are indicative,

- Click on chart to enlarge:  a click on the displayed chart enlarge or reduce it.
- Doubleclick to go back:  see below the doubleclick explanation.
- Rightclick on chart to enlarge:  a click with the right button enlarge or reduce the table.  
The clicked cell appears in the middle of the screen.

### Cursors

Four cursor shapes are used in **StratTime**: cross, arrow, simple, hand.



**Cross** appears in inactive parts of screens. There you can doubleclick.



**Arrow** indicates - a box with a choice (**the box is yellow**). Click on the grey arrow and make your choice in the displayed list  
or - a box to launch table constructions (**the box is white or blue**). Click on the box to process.

*It appears too on the indicative logos and on the help text but without any action.*



**Simple cursor** appears in a box where you have to enter a numerical age. Highlight the displayed digit and enter the new one.



**Hand** appears on links or charts which can be enlarged.

- The links to websites are commented with the name of the site; a click on the logo launches your internet browser.
- The intra StratTime links go to the searched chart or to the help windows.
- When you have a chart on which the hand shaped cursor appears, you can click on it to enlarge or to reduce it.

### **Doubleclick**

Double click is frequently used in **StratTime**.

- If the **yellow colored tabs are visible** at the bottom of screen, the double click is inactive except for the GSSP, ISC Charts and Color Code sheets. When these sheets are displayed, a doubleclick **when the cursor is cross shaped** leads to the top of the sheet.
- If the **yellow colored tabs are not displayed** at the bottom of screen, a doubleclick **when the cursor is cross shaped** leads back to the calling sheet. In this case the logo "Doubleclick to go back" appears on the sheet.

### **Screen**

When **StratTime** is launched the first time in your computer, the window does not fit your screen. With a click in the second tab, the window fully fits your display device. You have to do the same process **to resize the StratTime window**.

### **Save and Print button**

When **StratTime** builds a table or a mini-chart you may save it and/or print it. Just click the command button.

If you requested the backup, the file in xlsx format is located in the "\StrWork" sub-directory created in the one where **StratTime** is installed. If it is a correlation table, its name is Corel\_Tabl\_8-5-2022\_075931. It will be Mini-Chart\_8-5-2022\_075934 for a Mini-Chart and Magdetails\_8-5-2022\_075939 for magnetostratigraphic details. The digits correspond to the current date and time. You may delete the directory "\StrWork", it will be recreated if necessary.

If you clicked on Print the usual dialog with your printer begins. Do as usual.

On the sheet with the "ICS Charts" a button allows you to put the image of the chart in the clipboard and save it in an Excel file. If you have a document open, you can insert the chart image by a simple "Ctrl+V". The .xlsx file is saved in the "StrWork" subdirectory. Its name will be comparable to **Chart-2022\_11-6-2022\_190647** where "Chart-20xx" is the year of the chart. The following digits correspond to the current date and time.

## REFERENCES

Here are the main references used in **StratTime**, you will find more in the references written in bold.

- Berggren W.A., 1972, A Cenozoic time-scale: some implications for regional geology and paleobiogeography. *Lethaia* 5: 195–215.
- Berggren W.A., Kent D.V., Flynn J.J. & van Couvering J.A., 1985, Cenozoic geochronology. *Geological Society of America Bulletin* 96(11): 1407–18.
- Berggren W.A., Kent D.V., Swisher C.C. & Aubry M.-P., 1995, A revised Cenozoic geochronology and chronostratigraphy. In W.A. Berggren, D.V. Kent, M.P. Aubry & J. Hardenbol (eds.), Geochronology, Time Scales and Global Stratigraphic Correlations: An Unified Temporal Framework for a Historical Geology, *Society of Economic Paleontologists and Mineralogists Special Publication*, Vol. 54. Tulsa, SEPM. pp. 129–212.
- Cande S.C. & Kent D. V., 1992a, A new geomagnetic polarity time scale for the Late Cretaceous and Cenozoic. *Journal of Geophysical Research* 97: 13 917–51.
- Cande S.C. & Kent D. V., 1992b, Ultrahigh resolution of marine magnetic anomaly profiles: a record of continuous paleointensity variations? *Journal of Geophysical Research* 97: 15 075–83.
- Cande S.C. & Kent D.V., 1995, Revised calibration of the geomagnetic polarity timescale for the Late Cretaceous and Cenozoic. *Journal of Geophysical Research* 100: 6093–5.
- Comité Français de Stratigraphie (J. Rey, ed.), 1997. Stratigraphie Terminologie Francaise. *Bull. Centres Rech. Explor.-Prod. Elf Aquitaine*, Memoir 19: 164 pp.
- Gee J.S. & Kent D.V., 2007, *Source of Oceanic Magnetic Anomalies and the Geomagnetic Polarity Timescale*. Treatise on Geophysics, vol. 5, pp. 455-507, Elsevier
- Gradstein F.M., Agterberg F., Ogg J.G., Hardenbol J., Van Veen P., Thierry J. & Huang Z., 1994, A Mesozoic time scale. *J. Geophys. Res.* 99 (1994) 24051-24074.
- Gradstein F.M., Agterberg F.P., Ogg J.G., Hardenbol J., van Veen P., Thierry J. & Huang Z., 1995, A Triassic, Jurassic and Cretaceous time scale. In W. A. Berggren, D. V. Kent, M.-P. Aubry & J. Hardenbol, eds., Geochronology, Time Scales and Global Stratigraphic Correlations: A Unified Temporal Framework for a Historical Geology. *Society of Economic Paleontologists and Mineralogists Special Publication*, Vol. 54: Tulsa, SEPM, pp. 95–128.
- Gradstein F.M. & Ogg J.G., 1996, A Phanerozoic time scale. *Episodes* 19: 3–5, with insert.
- Gradstein F.M., Ogg J.G. & Smith A.G. and coll., 2004, *A Geologic Time Scale 2004*. Cambridge University Press.**
- Gradstein F.M., Ogg J.G. & Schmitz M. (eds.), 2012, *The Geologic Time Scale 2012*. Elsevier, 1176 p.**
- Gradstein F.M., Ogg J.G. & Schmitz M. (eds.), 2020, *Geologic Time Scale 2020*. Elsevier, 1390 p.**
- Haq B.U., Hardenbol J. & Vail P.R., 1987, Chronology of fluctuating sea levels since the Triassic. *Science* 235: 1156–67.
- Hardenbol J. & Berggren W.A., 1978, A new Paleogene numerical time scale. In G. V. Cohee, M. F. Glaessner & H. D. Hedberg, eds., *Contributions to the Geologic Time Scale. Studies in Geology*, Vol. 6. Tulsa, American Association of Petroleum Geologists, pp. 213–34.

- Harland W.B., Cox A.V., Llewellyn P.G. *et al.*, 1982, *A Geologic Time Scale*. Cambridge University Press.
- Harland W.B., Armstrong R.L., Cox A.V. *et al.*, 1990, *A Geologic Time Scale 1989*. Cambridge: Cambridge University Press.
- Heirtzler J. R., Dickson G. O., Herron E. M., Pitman W. C. & Le Pichon X., 1968, Marine magnetic anomalies, geomagnetic field reversals, and motions of the ocean floor and continents. *Journal of Geophysical Research* 73: 2119–39.
- Holmes A., 1913, *The Age of the Earth*. London: Harper.
- Holmes A., 1937, *The Age of the Earth*. London: Nelson.
- Holmes A., 1947, The construction of a geological time-scale. *Transactions Geological Society of Glasgow* 21: 117–52.
- Holmes A., 1960, A revised geological time-scale. *Transactions of the Edinburgh Geological Society* 17: 183–216.
- Huestis S.P. and Acton G.D., 1997, On the construction of geomagnetic timescales from non-prejudicial treatment of magnetic anomaly data from multiple ridges. *Geophys. J. Int.*, 129, 176–182
- Kent D.V. and Gradstein F.M., 1983, A Jurassic and Cretaceous geochronology. *Bulletin of the Geological Society of America* 96: 1419–27.
- Kent D.V. and Gradstein F.M., 1986, A Jurassic to Recent Geochronology. The Western North Atlantic Region: The Geology of North America. Vol. M, Boulder, *Geological Society of America*, pp. 45–50.
- Kulp J.L., 1961, Geologic time-scale. *Science* 133: 1105–14.
- La Brecque J.L., Kent D.V. & Cande S.C., 1977, Revised magnetic polarity time scale for Late Cretaceous and Cenozoic time. *Geology* 5: 330–5.
- Lowrie W. & Alvarez W., 1977, Late Cretaceous geomagnetic polarity sequence: detailed rock and palaeomagnetic studies of the Scaglia Rossa limestone at Gubbio, Italy. *Geophysical Journal of the Royal Astronomical Society* 51: 561–81.
- Odin G.S., 1982, *Numerical Dating in Stratigraphy*. Vols. 1 and 2. Chichester: Wiley-Interscience.
- Odin G.S., 1994, Geologic time scale (1994). *Comptes rendus de l'Académie des Science de Paris, série II* 318: 59–71.
- Ogg J.G., Ogg G. and Gradstein F.M., 2008. *The Concise Geologic Time scale*. Cambridge University Press, 150 pp.
- Ogg J.G., Ogg G. and Gradstein F.M., 2016. *A Concise Geologic Time scale*. Cambridge Elsevier Sciences Ltd, 240 p.
- Remane J., 2000, International stratigraphic chart, with explanatory note. Sponsored by ICS, IUGS and UNESCO. 31st International Geological Congress, Rio de Janeiro 2000, p. 16.
- Young G.C. & Laurie J.R., 1996, *An Australian Phanerozoic Timescale*. Melbourne: Oxford University Press, 279 pp. + charts.